DEVELOPMENT STUDY -

VA HOSPITAL BUILDING SYSTEM

RESEARCH STUDY REPORT

RESEARCH STAFF
OFFICE OF CONSTRUCTION
VETERANS ADMINISTRATION
WASHINGTON, D.C. 20420

Development Study -

VA Hospital Building System

Application of the Principles of Systems Integration
to the Design of VA Hospital Facilities

Research Study Report
Project Number 99-R047

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Foreword

This report consists of three parts, the major functional content of the material in each part being so independent of one another that each part is referred to as "Volume".

Volume One, the Design Manual, is the primary product of the project. It is intended to be a basic document for the VA and for A/E contractors working on system hospitals. It is structured so that the Office of Construction may adopt it in whole or in part as a Construction Standard, and subject it to regular review and revision. It describes the Building System Prototype Design and suggests a general procedure by which the Design may be utilized on a building project.

Volume Two, the Data Base, contains information on user needs, functional requirements, costs of existing hospitals, labor unions, and laws and regulations. It is intended to serve in conjunction with the Design Manual during application of the system to a specific building project.

Volume Three, the Project Report, is the consultants account to the Veterans Administration of the systems integration program. It provides a summary, conclusions, recommendations, and various appendices such as the design rationale, example designs, special procedures and the cost and time analysis.

An overview of the project may be obtained by reading Section 100, Basic Concepts, in the Design Manual, and Section 600, Narrative, in the Project Report.

It will be noticed by the reader of the full report that a number of ideas are repeated in several places. This is intended to allow a certain amount of independence among the volumes, and to assure that significant points will not be missed by those reading only limited portions of the text.

Acknowledgements

We are indebted to the many persons in the Veterans Administration who gave so generously of their time. We would like to thank those officers in the Department of Medicine and Surgery and the Office of Construction, and the staff of the hospitals visited, for their most helpful advice and encouragement.

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DESIGN MANUAL

VOLUME 1

Volume One, the Design Manual, is the primary product of the project. It is intended to be a basic document for the VA and for A/E contractors working on system hospitals. It is structured so that the Office of Construction may adopt it in whole or in part as a Construction Standard, and subject it to regular review and revision. It describes the Building System Prototype Design and suggests a general procedure by which the Design may be utilized on a building project.

100 BASIC CONCEPTS

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110 The Prototype Design

111 SCOPE

111.1 ORGANIZATION

The building system developed for Veterans Administration hospitals is presented in the form of a Prototype Design supplemented by a Data Base. The Prototype Design is divided into two basic categories of components: planning modules and building subsystems.

- **BUILDING SYSTEM**
  - **PROTOTYPE DESIGN**
    - **PLANNING MODULES**
    - **BUILDING SUBSYSTEMS**
  - **DATA BASE**

The Design Manual consists of a description of the planning modules and building subsystems, followed by a discussion of design procedure. The Data Base is in a separate volume.

111.2 BACKGROUND AND INTENT

111.2.1 A Working Hypothesis

The building system described in this manual was developed in response to a set of problems the Veterans Administration has been experiencing in the design and construction of hospitals.

Briefly, these problems are: rising costs, lengthy periods between programming and occupancy, accelerating obsolescence and inadequate building performance. The general approach has been the application of the so-called “principles of systems integration”. (For a discussion of these principles, see Section 610).

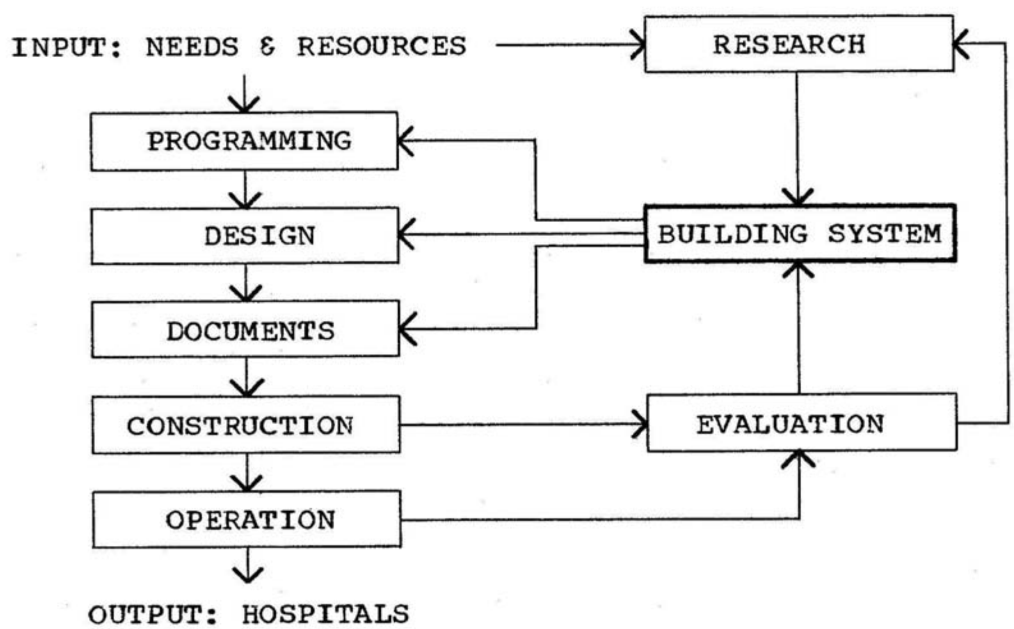
The particular method employed was the direct design of a building system by consultants to the Research Staff of the Office of Construction, on the basis of building products already on the market. There has been no attempt to develop new products or a proprietary “kit of parts”. The innovations suggested by the Prototype Design are in the nature of more or less unconventional ways to use or combine conventional materials and components.

Insofar as these new ways are untested by actual field application, the Prototype Design may be thought of as a "working hypothesis". Simply stated, the hypothesis is, "If a hospital is designed, constructed, maintained and altered in accordance with the rules and recommendations set forth in the Design Manual, then the problems stated above will all be alleviated to some significant degree."

111.2.2 Long Range Development

On the basis of the evaluation of hospitals utilizing the system, the hypothesis can be tested and modified. The Prototype Design is subject to continual review and revision as experience accumulates. Also, as the original innovations are either rejected or integrated into standard procedures, new innovations can be introduced into the Prototype Design for successive projects.

The building system should thus be viewed as a component within a larger system, namely the VA's total managerial system for the programming, design, construction, operation and evaluation of hospitals.



The building system is not intended to substitute for any existing component of the larger system; it is an additional component whose function is to supplement and contribute to the effectiveness of the others.

It performs this function primarily by providing a carefully coordinated set of guidelines for making certain decisions during the building design process, and also by providing a common frame of reference for all components of the larger system.

111.2.3 Variability

Some of the guidelines are so fundamental to the Prototype Design that they establish what must be considered fixed characteristics of the system. If any of these characteristics is significantly modified in the design, construction or alteration of a building, then that building cannot properly be said to be an application of the particular system described in the Manual. These fixed characteristics are discussed under the heading of "Basic Design" at the beginning of each section on the planning modules and the building subsystems. All other characteristics may be considered variable and have the force of recommendations.

If the working hypothesis is to have a fair test, a certain degree of caution must be exercised when introducing variations. One of the underlying causes of the problems to which the system addresses itself is the lack of adequate coordination at certain key points in the conventional design and construction process. The intended beneficial effect of the Prototype Design in many instances depends more on the high level of internal coordination between its characteristics than on the particulars of the characteristics themselves. Thus, when a "variable" characteristic is altered, there is a danger of inadvertently reintroducing a major causal factor of the very problem the system is trying to solve. To assure that the intended level of coordination can be maintained when deviating from any of the guidelines, a careful check must be made on the implications of the change for all other characteristics of the specific design under development.

112 PLANNING MODULES

112.1 DEFINITION AND FUNCTION

The planning modules are units of building volume, one story high and varying in floor area according to a specific dimensional discipline. They represent large scale assemblies of building subsystems with assured internal capacity for various functional arrangements. Their function is to expedite the preliminary planning of a hospital by providing a simplifying conceptual step between the extreme complexity of a typical hospital program (master plan) and the generation of alternative design configurations for the building. They also provide a basis for initial structural and mechanical design decisions before the detailed program or architectural design has been worked out.

112.2 TYPES

There are four types of planning modules: structural bays, space modules, service modules and fire sections.

PLANNING MODULES
- **STRUCTURAL BAYS**
- **SPACE MODULES**
- **SERVICE MODULES**
- **FIRE SECTIONS**

In each case a range of sizes and shapes may be generated for response to variations in program, site and budget.

The larger types of module are built up out of the smaller (See Figure 110-1). The structural bay is thus the basic unit of which all other modules are composed. However, it is the service module which provides the essential "building block" for preliminary design (See Figure 110-2).

112.3 THE SERVICE MODULE

A service module is distinguished by the fact that it is served by a single independent horizontal distribution network; it is a unit of service as well as a unit of functional space. It is organized into three basic components: the functional zone below the ceiling, the service zone above the ceiling, and a special structural bay called the service bay located at the boundary.

Figure 110-1. THE PLANNING MODULES

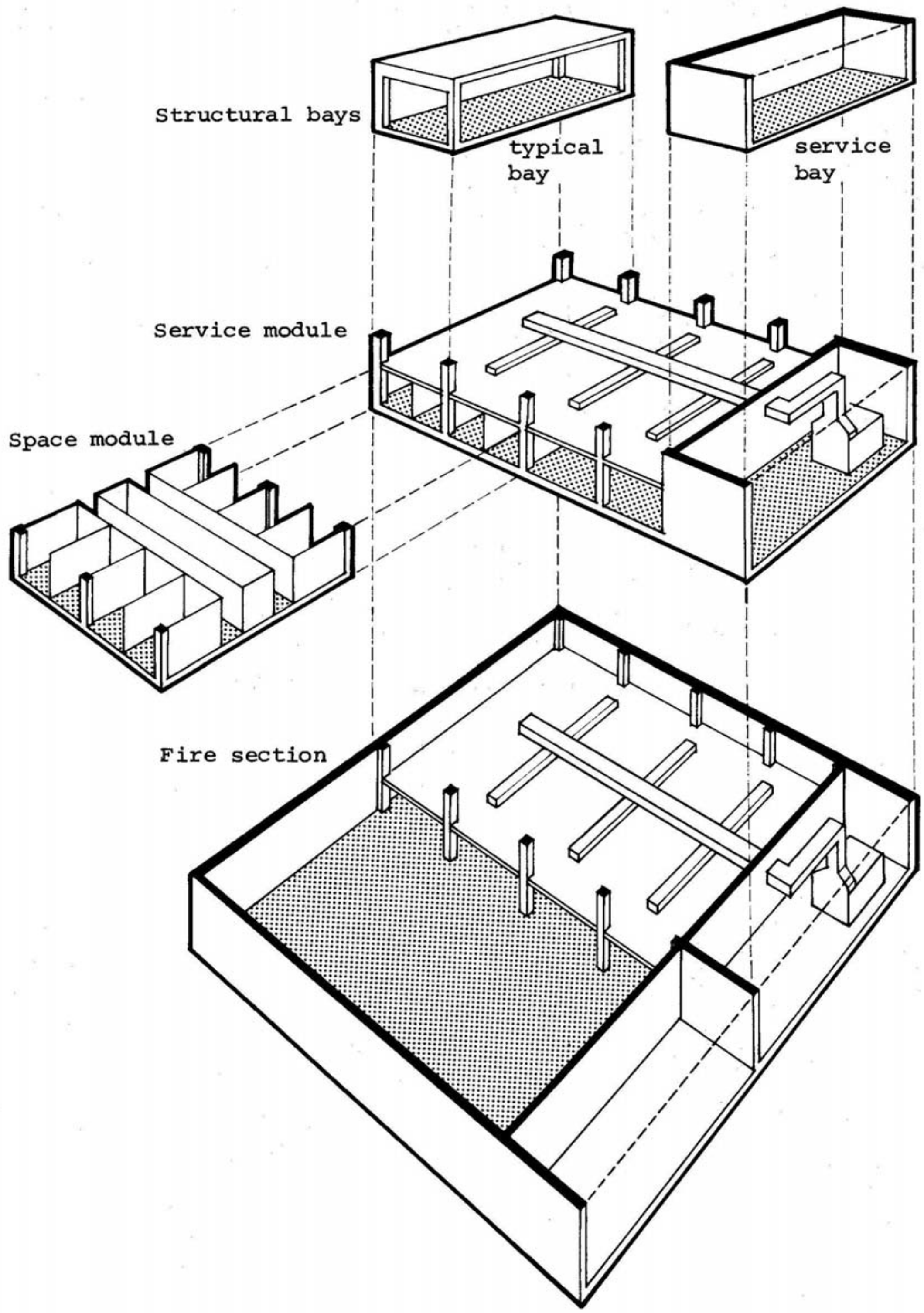
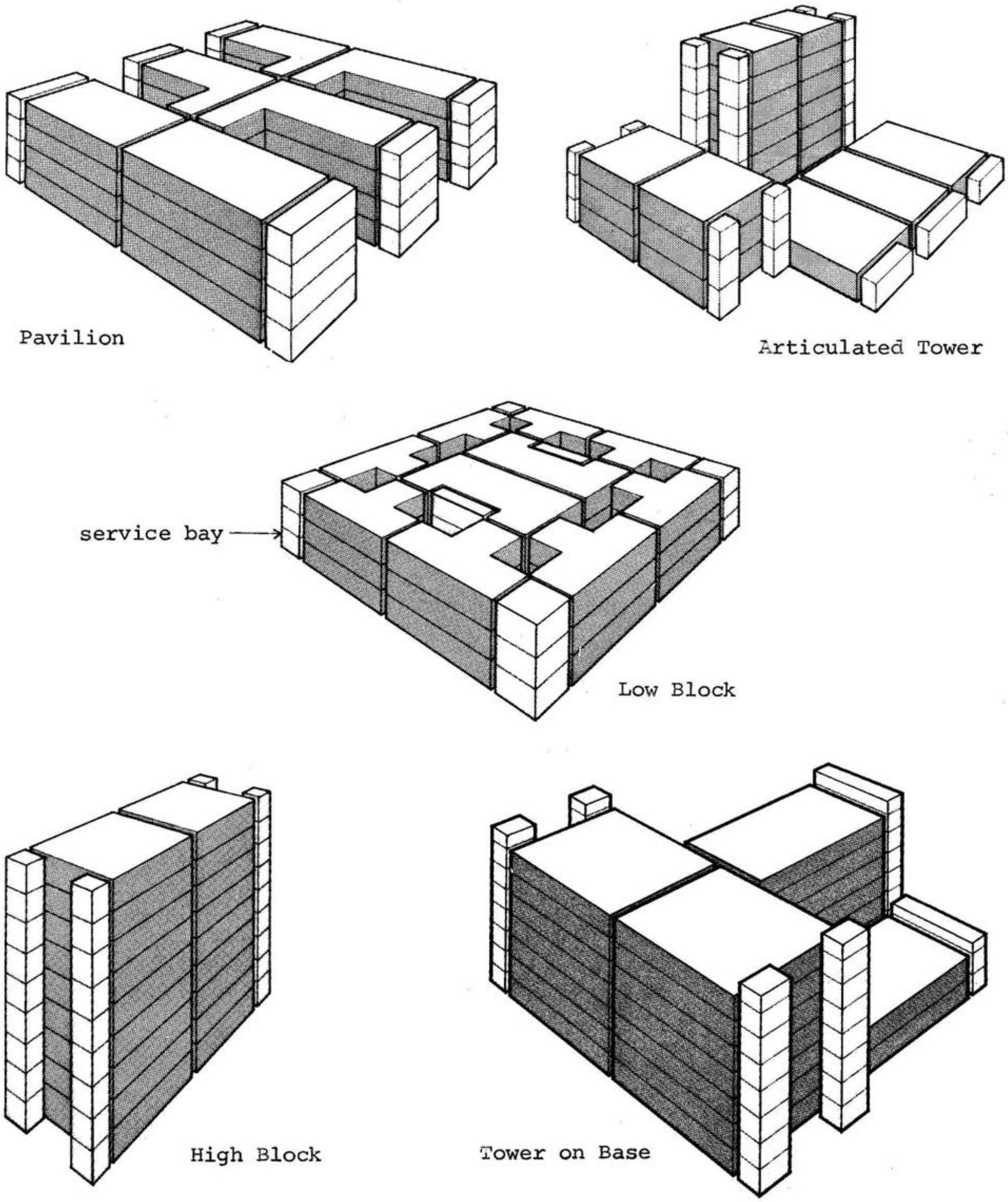


Figure 110-2. THE SERVICE MODULE AS A BUILDING BLOCK FOR ALTERNATIVE BUILDING CONFIGURATIONS



The service bay encloses mechanical and electrical rooms, service shafts, emergency stairs, etc. The arrangement of service modules on successive floors is such that their service bays are stacked. The resulting “towers” provide for main vertical service distribution, as well as for lateral bracing of the structure.

112.4 SPACE MODULES AND FIRE SECTIONS

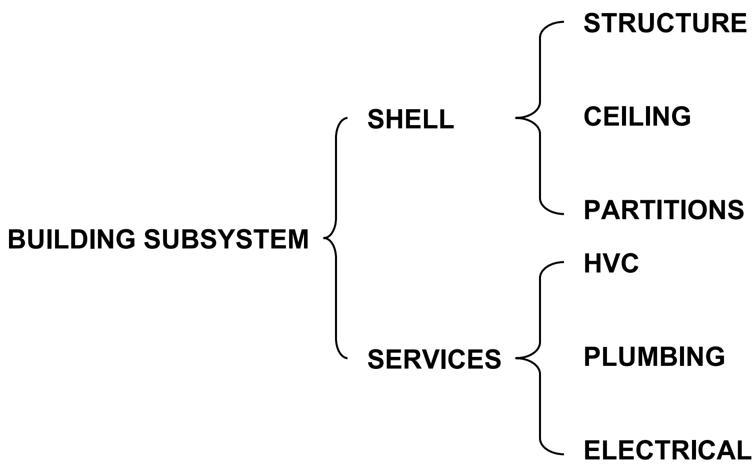
Space modules are subunits of service modules occurring in bed-care areas. They have been designed to take into account the special requirements of these areas, such as exterior exposure at the building perimeter (aspect).

Fire sections are building subdivisions providing internal horizontal exits. Service module boundaries will coincide with the boundaries of fire sections, which are arranged according to applicable codes and regulations.

113 BUILDING SUBSYSTEMS

113.1 INTEGRATED AND NON-INTEGRATED SUBSYSTEMS

Six building subsystems are specifically within the scope of the Prototype Design. They are referred to as the integrated subsystems. Structure, ceiling and partitions are "shell" subsystems, and heating-ventilating-cooling, plumbing and electrical distribution are "service" subsystems (See Figure 110-3).



All other subsystems, such as transportation, communication, exterior wall and foundations, have been excluded and are referred to as the non-integrated subsystems.

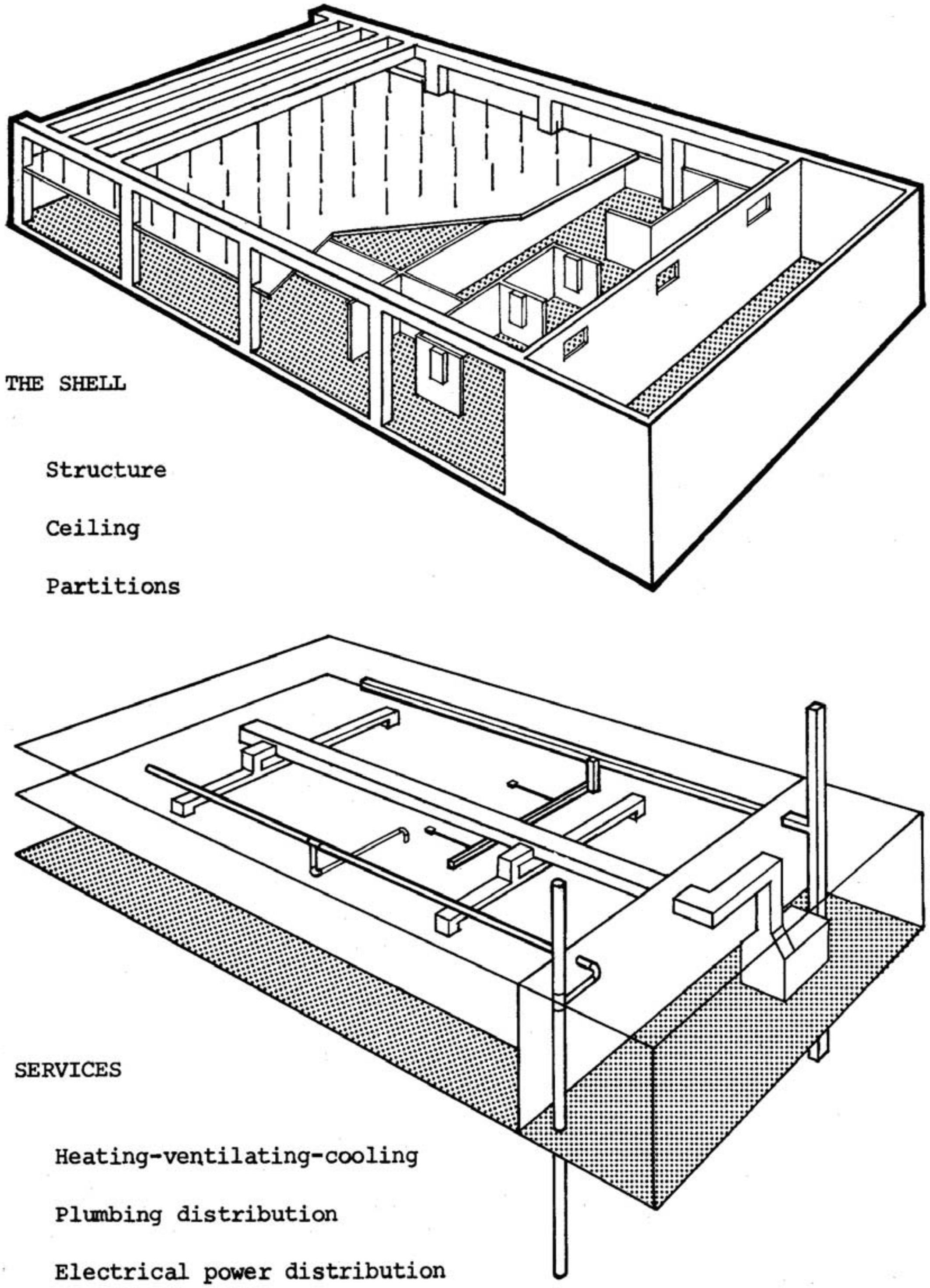
113.2 THE SHELL

The Prototype Design calls for a post and beam, shear wall braced structural system. Shear walls are to be located mainly at the perimeter of the frame, concentrated in the service bays.

The ceiling subsystem is conceived of as a ceiling-platform assembly which, along with a supporting framework, is designed to allow movement of workmen and materials over its entire surface. The platform is hung from the beams above, at a uniform height throughout each fire section. Access to the resulting "interstitial" space is primarily horizontal, via the service bays.

Two-hour partitions required for shaft enclosures and fire section boundaries run from slab to slab. All other partitions are one-hour rated or non-rated and stop at the ceiling-platform.

Figure 110-3. THE BUILDING SUBSYSTEMS



113.3 SERVICES

Distribution from the building's central stations to vertical risers should be located in a highly accessible service space, such as a service basement, or a service zone between floors. For purposes of the Prototype Design, it is assumed that the use of a service basement will be the typical case. The pre-organization of this space was not considered appropriate due to the extreme variability of site conditions, hospital size and program, and design configuration. Once the design configuration for a particular hospital has been determined, the service basement can be organized by establishing reserved zones in a manner suggested by the Prototype Design for the service modules.

The principle criterion for the location of service shafts and risers is the minimum obstruction to functional space planning that can be achieved with a reasonably efficient distribution network. Vertical distribution is largely limited to the building perimeter and concentrated in the service bays.

Horizontal distribution within the service module is restricted to the service zone above the ceiling. This zone is organized into a series of subzones, each exclusively reserved for a specific class of service distribution components. With the exception of gravity drains, all services downfeed through the ceiling. Wherever feasible, surface mounted service lines and terminals are clustered and concealed in furred out partition components or in proprietary enclosures.

113.4 PERMANENT AND ADAPTABLE COMPONENTS

Certain components of the building subsystems are either assumed to rarely require renovation during the life of the building or are sized in original design to minimize the probability of such a requirement; these components are designated "permanent". They include most structure and ceiling components, two-hour partitions, and certain main distribution lines of the service subsystems. All other components are designated "adaptable" in the sense that they are subject to alteration on a random basis during the life of the building. They are specifically designed to facilitate extension, relocation and replacement. Accessibility to all components for purposes of efficient maintenance is stressed in overall system design, regardless of classification as permanent or adaptable.

113.5 DESIGN SPECIFICITY

113.5.1 The Basic Design

It is the intent of the Prototype Design to have nationwide applicability. Also, it is presently limited to the use of whatever building products are available for each job, since special products have not been developed for the system. No single highly specific building system could be expected to be consistently cost-effective in all possible situations, so the design decisions concerning "fixed characteristics" are only of the type which can reasonably be made in advance of specific construction projects.

113.5.2 Generic Design Options

Within the constraints established by the basic design decisions for each subsystem, a limited number of alternative types of solution has been identified. For example, in response to the performance requirements, the only presently adequate basic class of mechanical system is all-air, within which generic options have been limited to the single-duct and the dual-duct types. The choice between these options, and the detailed design of either, must be performed by the VA and the A/E on a local basis.

113.5.3 Detailed Designs

The detailed design of the various subsystems, including selection of component products, is most effectively executed by the A/E who can respond to the special conditions of a particular site and program. The Prototype Design has gone as far as practical toward making time-consuming decisions and simplifying assumptions in advance without unnecessarily constraining design freedom.

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120 Application

121 PROCEDURE

The approach to procedure is the same as that taken to the Prototype Design itself in that a highly specific predetermined “system” procedure is considered neither feasible nor desirable. Specific procedures must be tailored to each project as appropriate to program, site, budget, available technology, etc. The Design Manual simply sets forth general guidelines applicable to any project utilizing the building system.

In principle, the system can be used in programming and budgeting. For example, the size of a proposed hospital could be specified as so many service modules of given capabilities, which would allow a variable bed count in the completed facility, and a budget figure could be assigned to each module. However, the Design Manual deals directly only with design and construction. The section on procedure starts with the assumption that a hospital program (master plan) has been generated and a preliminary budget established in the normal manner.

The advantage provided by the planning modules is that preliminary planning can start somewhat earlier than usual. Alternative schematic designs can be generated on the basis of a preliminary program which provides only gross area requirements for nursing units, administrative departments, etc. The modules establish basic structural and service distribution patterns “automatically” with the development of each schematic design. The adaptability of the modules also allows response to program and budget changes to occur more efficiently throughout the entire design and construction process.

In the case of the building subsystems, the tasks of engineering design, architectural detailing, specification writing, etc., can be executed within the framework of existing policies and established responsibilities. The function of the Manual is to provide some basic decisions in advance which can substantially simplify certain time-consuming tasks, plus a coordinated set of criteria to assist in making other decisions. Care must be taken in cost estimating and preparation of contract documents to ensure that the unique characteristics of the Prototype Design are taken into account and clearly communicated. For instance, the integrated subsystems are not presented in the Design Manual according to conventional specification divisions or construction sub-contracts; thus VA Master Construction Specifications used for a system building must be carefully edited to ensure complete applicability to the detailed design, and in some cases, new specification sections may have to be developed.

122 THE DATA BASE

To provide a Data Base for the Prototype Design, information on user needs, functional space requirements, costs, labor union restrictions, codes, and various applicable regulations was collected and analyzed. This information can be of considerable value in the selection of generic design options, the development of specific system designs, and in the planning and design of the hospital itself. Therefore it is presented as a supplement to the Design Manual, and to the program (master plan) for each hospital.

The Data Base is subject to growth and change in much the same manner as the Prototype Design. Its scope is presently limited to the material that was particularly relevant to the Systems Integration program. A major addition will be the evaluations of hospital projects utilizing the system.

The Design Manual and Data Base are thus integral parts of the “A/E package” provided to the designer in each building project to assist him in making the most effective use of previous experience within the VA, as well as his own resources.

200 THE PLANNING MODULES

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210 The Structural Bay

211 BASIC DESIGN

The structural bay is the basic unit of which all other modules are composed (See Figure 210-1). A special variation of the structural bay called the service bay encloses mechanical and electrical rooms, service shafts, emergency stairs, etc. (See Section 220: The Service Module).

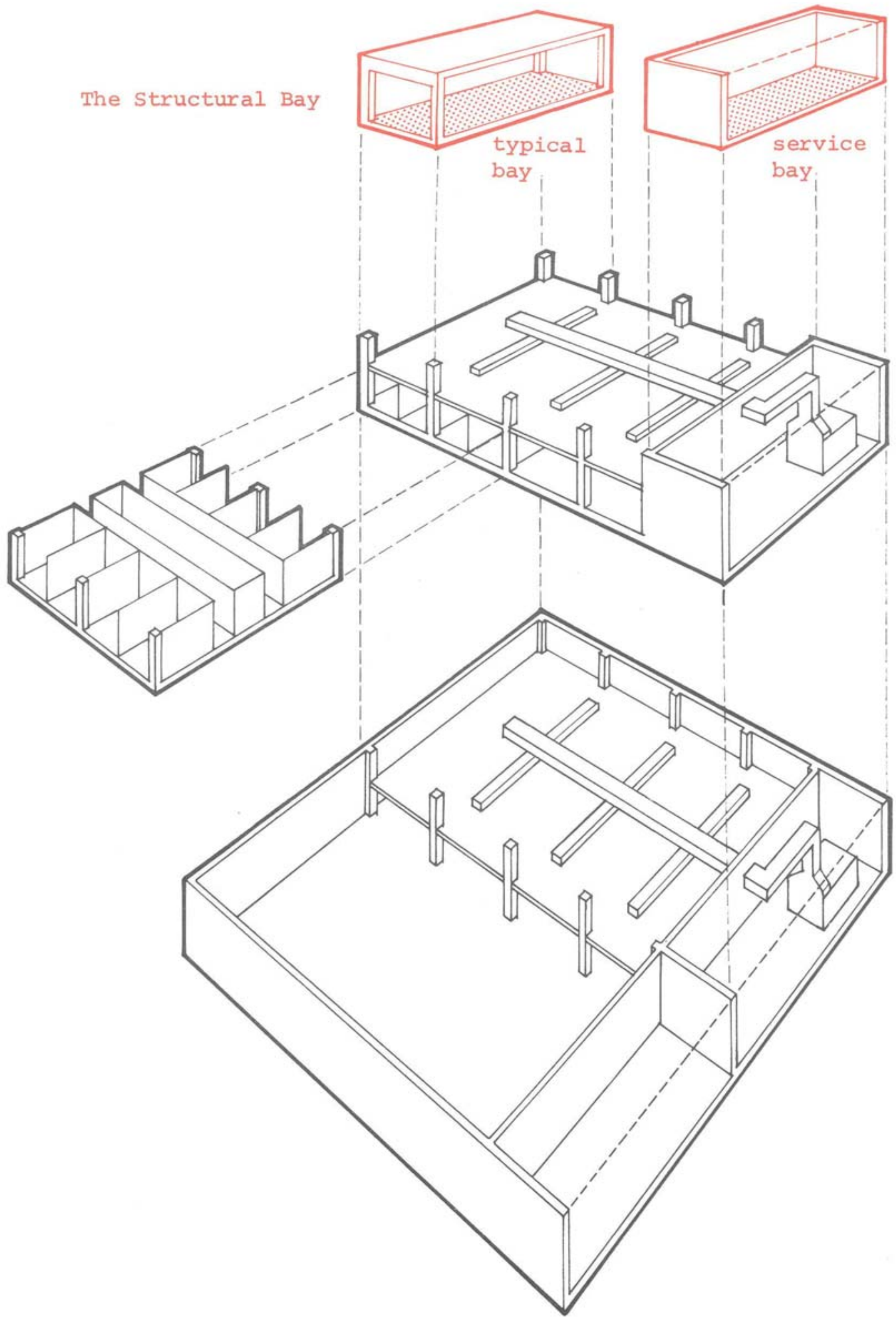
The range of structural bay sizes established for the Prototype Design is based on a constant bay width of 22'6" and a variable bay depth ranging from 40'6" to 58'6" in 4'6" increments plus, where required, an 18'0" cantilever. (See Section 131.5.1.)

These dimensions are derived from the organizational requirements of the nursing unit as the most repetitive and most stable functional unit in the hospital (See Section 230: The Space Module) and subsequently confirmed as suitable for the functional space requirements of the non-bed care portions of the hospital. The bay width is consistent with general VA practice. The bay depths are somewhat greater than those commonly found in VA hospitals, but less than the spans seen in some current projects.

Two features of the narrow structural bay compared to large two-way spans are: it permits a finer adjustment of overall plan shape, and it is a valuable small-scale increment of expansion.

The dimensions of the structural bay are thus derived from the need to achieve certain functional arrangements of space. If in time these arrangements lose validity, new structural bays can be established.

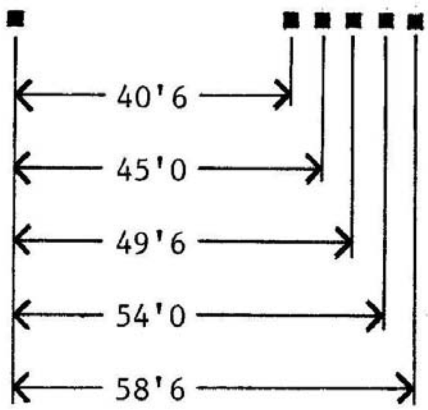
Figure 210-1. THE STRUCTURAL BAY



212 CAPABILITIES

212.1 BANDS OF FREE SPACE

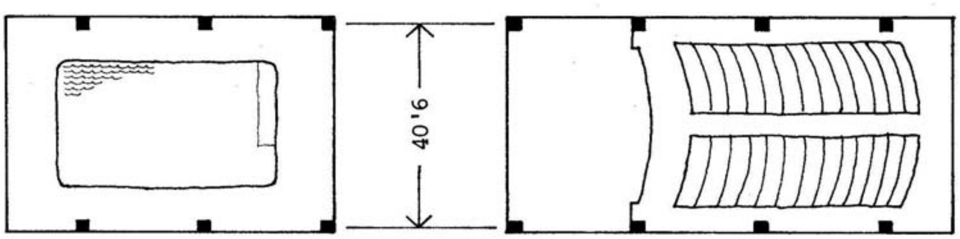
The rectilinear bay system provides bands of free space equal to the bay depth. The minimum dimension of this band is 40'6" and the maximum dimension is 58'6".



212.2 SPECIAL AREAS

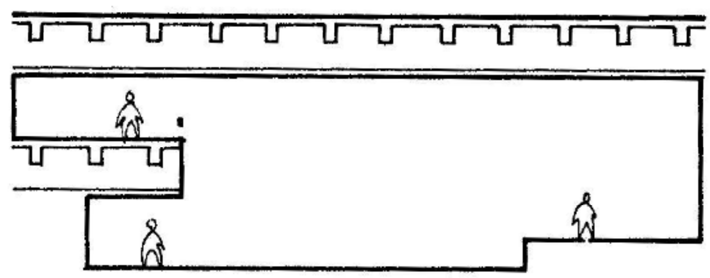
212.2.1 Large Column-Free Rooms

Where the occasional large column-free room occurs in the hospital, such as the auditorium, gymnasium, etc., there are no critical organizational relationships that would inhibit its location within one of these bands of free space. The minimum of 40'6" can readily accommodate any auditorium with a seating capacity of up to 200 seats, and a band of 58'6" can accommodate an auditorium with a seating capacity of up to 400 seats.

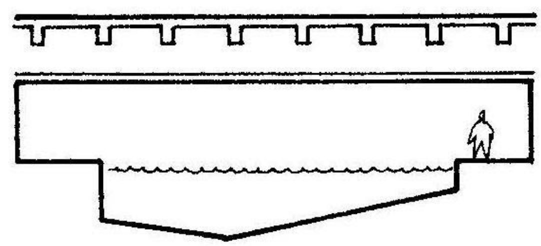


However, the auditorium, gymnasium and swimming pool have other requirements such as height, penetration of slab, etc., that imply some modification to the basic structural system.

In the case of the auditorium and gymnasium, two levels might be used to satisfy the necessary height requirements.



The swimming pool could be located in the basement or on the ground floor because of its weight and to minimize disruption of the service zone.



212.2.2 Suites of Large Rooms

In the repetitive situation where a number of large rooms occur in a precise organizational pattern, such as Surgery and Radiology, it may become necessary to intersect a line of columns. In these cases, the 22'6" bay spacing becomes critical. As stated previously, this bay width is consistent with general VA practice and the simulation studies in Section 710, Design Rationale, Planning Modules, demonstrate how the organization of these critical areas can be readily achieved within the constraints of the structural system.

220 The Service Module

221 BASIC DESIGN

The service module is a unit of space, one floor in height, served by its own service distribution system including the air-handling unit.

In plan, the service module consists of a number of typical structural bays plus a service bay. In section, the service module consists of the service bay, a functional zone and a service zone.

Air-handling units and/or supply and exhaust ducts, electrical equipment, and all vertical piping and risers are located in the service bay. Distribution from the bay to the functional zone is via the service zone above the ceiling. (See Figure 220-1). Therefore, the functional zone is free from the constraint of vertical service penetrations.

Dimensional characteristics of service modules are determined by the space modules, by the service content and service organization necessary to support the activities housed, and by the overall structural characteristics required for resistance of lateral forces.

The optimum size for an independent service module is about 10,000 square feet, which represents a good compromise between largeness for economy and smallness for adaptability. The actual area of the service module, exclusive of the service bay, will vary according to the size of the structural bay and the plan configuration, and may range from 5,000 to 20,000 square feet, which is currently the maximum size for a fire section.

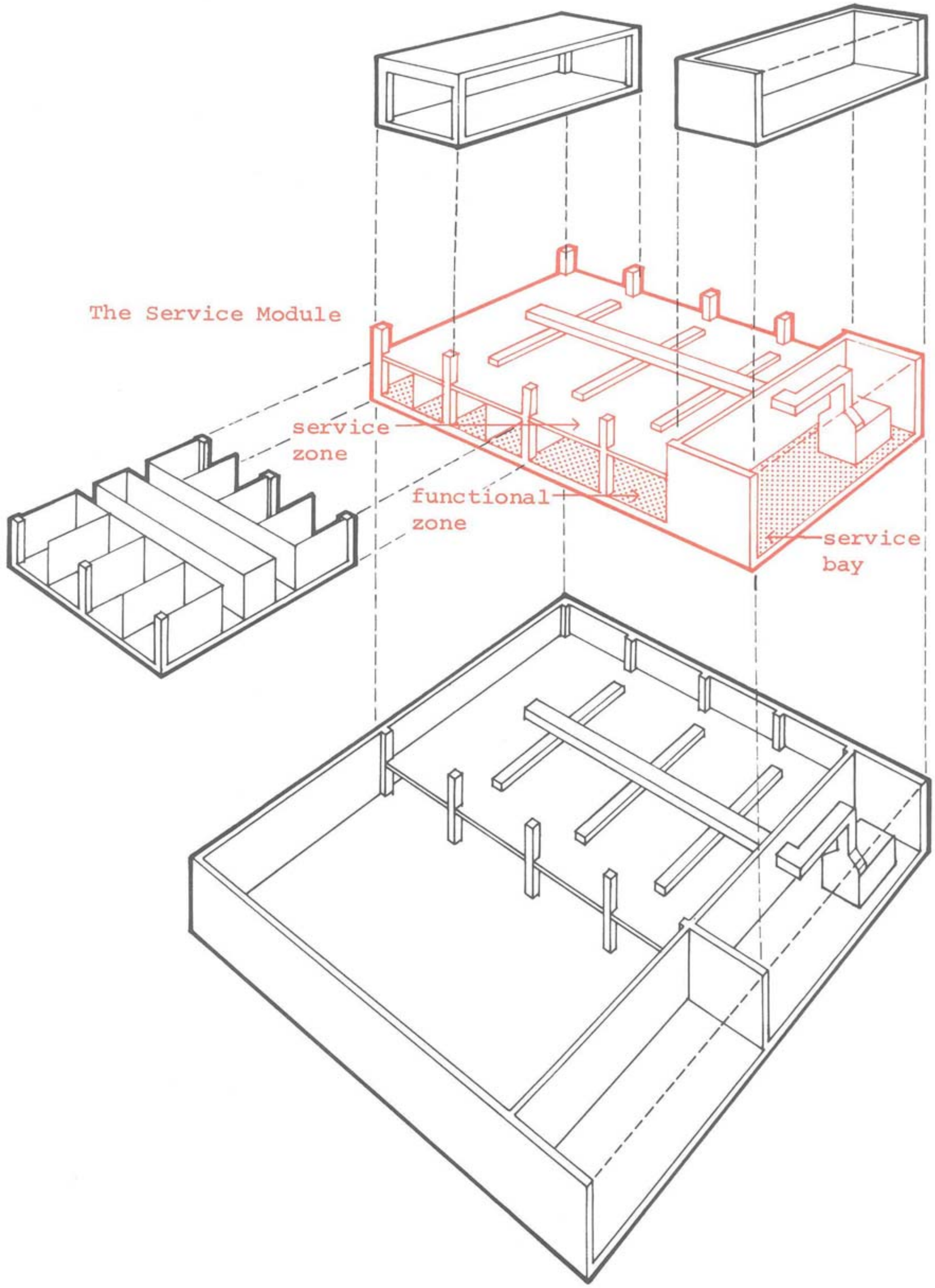
221.1 BENEFITS

The service module is the most significant of all the planning components in that it combines and coordinates all the interrelated characteristics of building organization, namely, function, structure, service distribution and fire safety.

221.1.1 Design

The integration of these characteristics within a single unit of space provides the opportunity to conceptualize a building as an assembly of “building blocks”.

Figure 220-1. THE SERVICE MODULE



The “building block” concept offers considerable advantage in design, construction, and operation and maintenance.

Once derived, the service module provides a means of manipulating overall plan configuration with the assurance that the subsystem capability remains.

Furthermore, the use of service modules with known assembly characteristics and precoordinated building subsystems can shorten the design process and allow construction to start prior to completion of detailed planning, should this be desired.

221.1.2 Adaptability and Variability

The mechanical independence of the service module permits one unit to undergo alterations while adjacent units can continue to operate unaffected. Some functional areas that do not operate on a 24-hour basis can be shut down when not in use, and some units can use 100% outside air while others use 25%.

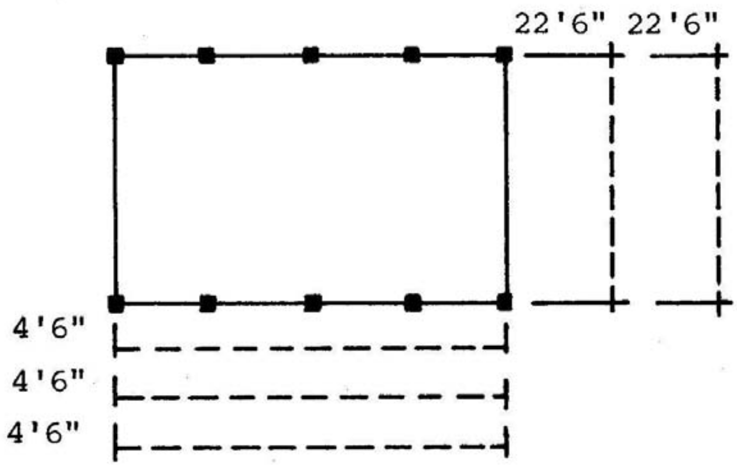
221.2 DERIVATION

The service module is directly derived from the requirements for efficient organization of the structural and services subsystems. These establish a scale of space and performance sufficiently generalized to be compatible with a wide range of departmental sizes and environments. In the patient bedroom areas, the service module is more precisely tuned to the functional requirements of the nursing unit by means of the space module. (See Section 230: The Space Module).

222 SIZE AND SHAPE

222.1 RANGE OF SIZES

The overall dimensions of service modules, exclusive of service bays, vary in length in increments of 22’6”, and in width in increments of 4’6”.



The full range of simple rectangular areas available as service modules, exclusive of service bays, is fixed by structural, services distribution and fire safety considerations. (See Figure 220-2.)

222.1.1 Thermal Expansion Joints

Shear wall locations are limited to the perimeter of service modules, except that they may occur within the service bays. In fact, the wall between a service bay and the rest of the module in which it occurs will normally be a shear wall. Since independent structural units, as defined by thermal expansion joints, cannot exceed 300 feet in any dimension, and each such unit must have a reasonably balanced array of shear walls, most design configurations will involve shear walls spaced closer than 300 feet. Thus, the maximum dimension of a service module could not be larger than this figure.

222.1.2 Diaphragm Proportion

In the patient bedroom areas, where service modules are made up largely of space modules, each service module would have at least two opposite boundaries at exterior walls. Floor slabs, acting as diaphragms spanning between two shear walls, should not exceed a proportion of three to one in length to width.

Figure 220-2. NOMINAL SERVICE MODULE DIMENSIONS

BAYS	1	2	3	4	5	6	7	8	9	10	11	12	13	14
LENGTH	22.5	45	67.5	90	112.5	135	157.5	180	202.5	225	247.5	270	292.5	315
WIDTH														
40.5	911	1822	2734	3645	4556	5468	6379	7290	8201	9112	10024	10935	11846	12758
45	1012	2025	3038	4050	5062	6075	7088	8100	9112	10125	11138	12150	13162	14175
49.5	1114	2228	3341*	4455	5569	6682	7796	8910	10024	11138	12251	13365	14479	15592
54	1215	2430	3645*	4860	6075	7290	8505	9720	10935	12150	13365	14580	15795	17010
58.5	1316	2632	3949*	5265	6581	7898	9214	10530	11846	13162	14479	15795	17111	18428
63	1418	2835	4252	5670	7088	8505	9922	11340	12758	14175	15592	17010	18428	19845
67.5	1519	3038	4556*	6075	7594	9112	10631	12150	13669	15188	16706	18225	19744	21262
72	1620	3240	4860*	6480	8100	9720	11340	12960	14580	16200	17820	19440	21060	
76.5	1721	3442	5164*	6885	8606	10328	12049	13770	15491	17212	18934	20655		
81	1822	3645	5468*	7290	9112	10935	12758	14580	16402	18225	20048			
85.5	1924	3848	5771	7695	9619	11542	13466	15390	17314	19238	21161			
90	2025	4050	6075*	8100	10125	12150	14175	16200	18225	20250				
94.5	2126	4252	6379	8505	10631	12758	14884	17010	19136	21262				
99	2228	4455	6682	8910*	11138	13365	15592	17820	20048					
103.5	2329	4658	6986	9315	11644	13972	16301	18630	20959					
108	2430	4860	7290	9720*	12150	14580	17010	19440	21870					
112.5	2531	5062	7594	10125	12656	15188	17719	20250						
117	2632	5265	7898	10530*	13162	15795	18428	21060						
121.5	2734	5468	8201	10935	13669	16402	19136	21870						
126	2835	5670	8505	11340	14175	17010	19845	22680						
130.5	2936	5872	8809	11745	14681	17617	20554							
135	3038	6075	9112	12150	15188	18225	21262							
139.5	3139	6278	9416	12555	15694	18832	21971							
144	3240	6480	9720	12960	16200	19440	22680							
148.5	3341	6682	10024	13365	16706	20048								
153	3442	6885	10328	13770	17212	20655								

±10,000 sq.ft.   ±15,000 sq.ft.   ±20,000 sq.ft.

1:1 proportion (square)

3:1 proportion

longest module recommended

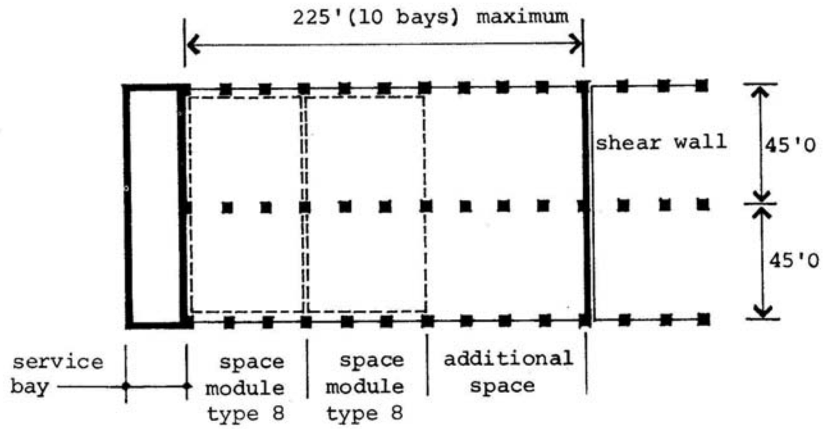
widest module recommended

1 bay = 22.5 feet

beam span module = 4.5 feet

* space modules

For example: space module type 8 (See Section 233: Catalog of Space Module Capabilities) has an overall width of 90 feet. With a three to one ratio, the maximum length of diaphragm is limited to ten structural bays (225 feet). Thus, no nursing floor service module based on this particular space module type can be longer than 225 feet.



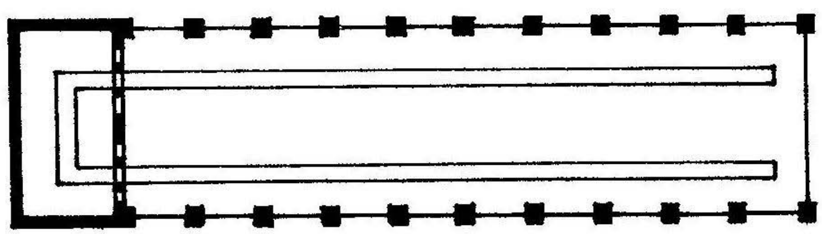
222.1.3 Fire Sections

Service modules are optimum at about 10,000 square feet as far as the HVC subsystem is concerned, and fire sections as close to the 20,000 square foot code limit as possible are best for purposes of minimizing obstructions by two hour fire partitions. A relatively efficient combination is two service modules per fire section. However, in situations involving service modules which must be larger than 10,000 square feet, which will be the case when certain space modules are combined, the fire sections will have to be the same size as the service module. In this event, there is a conflict between minimizing the service module and maximizing the fire section, in which a reasonable compromise may be in the neighborhood of 15,000 square feet.

222.2 RANGE OF SHAPES

222.2.1 Narrow Service Modules

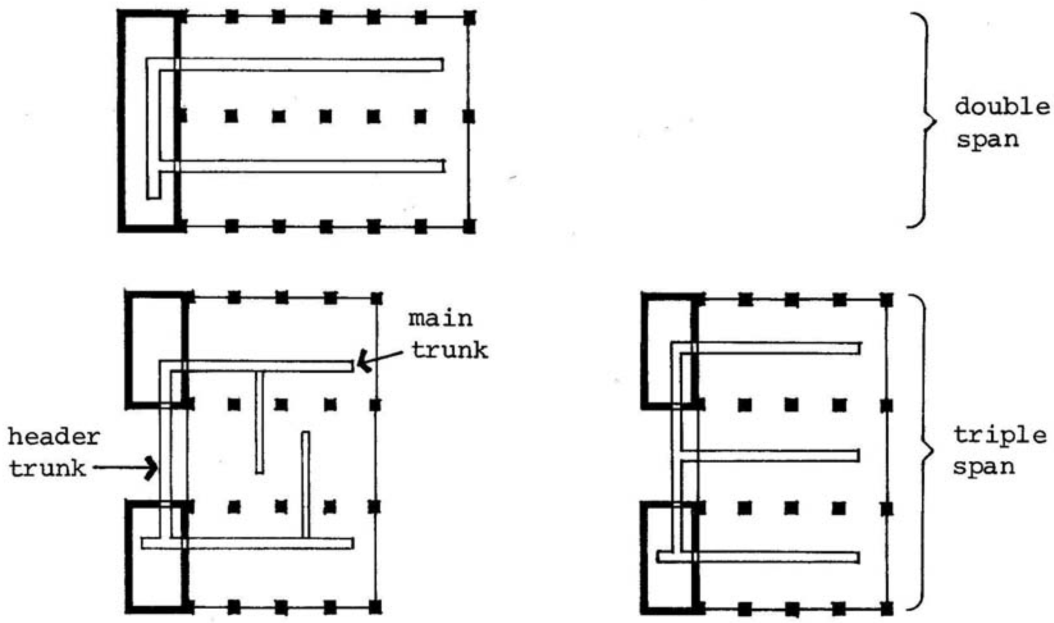
Service modules narrower than about 50 feet are difficult to organize into longitudinal service distribution zones with good accessibility. They also produce a serious problem of coordination where the main distribution lines penetrate the shear wall between the service bay and the rest of the module. These difficulties are significant in a 10,000 square foot module, which if 50 feet wide would be 200 feet long; they would be very serious in a 15,000 square foot module, which at the same width would be 300 feet long. It is therefore not advisable to constitute long service modules of single span bays with less than the 49'6" span provided by the system.



222.2.2 Wide Service Modules

The greatest width of service module that can be generated by a double span within the system is 117 feet.

Wider modules would require more than one interior girder. Since modules of the 10,000 square foot optimum size would require two supply trunk ducts, even with a single duct reheat system, it is a simple matter to serve a doubt span module. A triple span, however, would require either long branches, or an additional trunk duct.

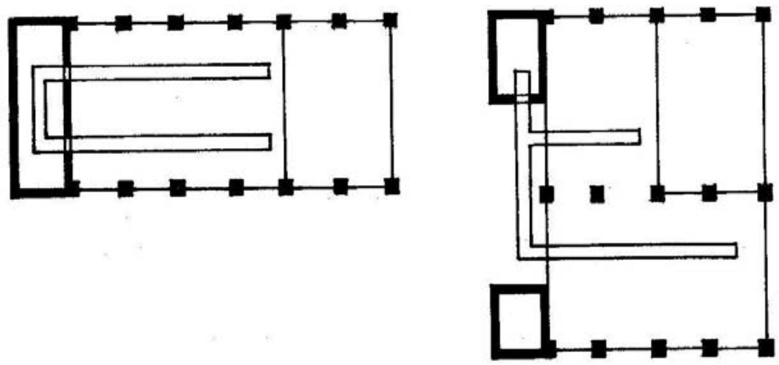


Moreover, 117-foot wide service modules in the 10,000 to 15,000 square foot range would be approximately square, whereas wider modules would be shorter, thus requiring a large amount of header ductwork between main trunks in proportion to the trunks themselves.

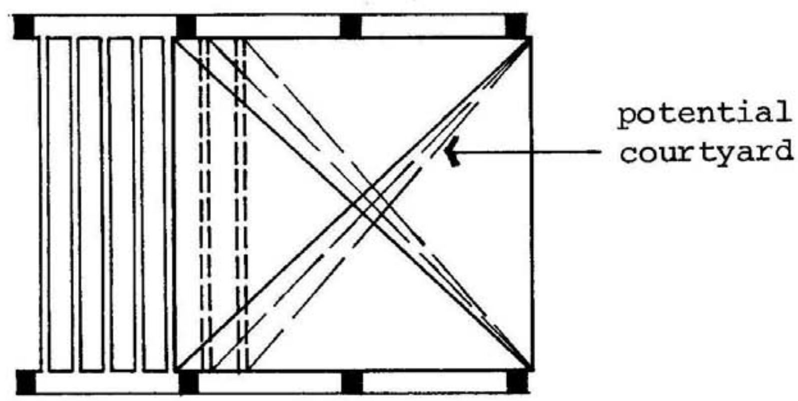
222.2.3 Special Service Modules

The simple rectangle, discussed previously, is the most effective shape of service module in terms of structure and service distribution.

In the majority of hospital configurations, this shape can be readily maintained but in many larger hospitals courtyards may be required. Courtyards can be readily formed by omitting structural bays from that end of the service module opposite to the service bay.

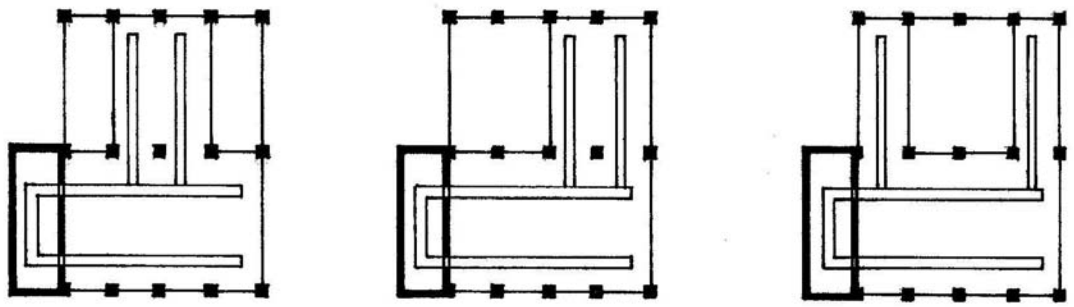


Where courtyards are formed within a single span, the length of the courtyard can vary in increments of the particular beam spacing.



In some configurations, service modules other than rectangles may be appropriate. (See Section 251: Design Configurations.) Service modules can be 'L', 'T', or 'U' shapes provided that the constraints imposed by the structural bay and service distribution are respected.

These service modules may be regarded as single span service modules with a limited number of additional bays attached laterally. Main distribution of the mechanical, electrical and plumbing subsystems is confined to the single span service module and the additional bays are served by branch distribution.



This branch distribution imposes a limit on the density of services that can be provided in these additional bays and the dropped girder restricts access. Therefore, the functions accommodated in these bays should have a low order of service demand.

223 SERVICE BAYS

In its simplest form, each service module will contain a service bay which houses all the basic equipment for the three service subsystems and all vertical service distribution to and from the module. The vertical distribution includes all supply services from the central plant and all risers and shafts to roof-level equipment or outlets.

The concentration of all vertical services within the service bay area will leave the functional zone free for planning and replanning without the traditional impediment of service stacks. Locating all service equipment here too also frees the functional zone, and simplifies the organization of the service zone where access and space for equipment would be more complex and cause problems of industrial safety.

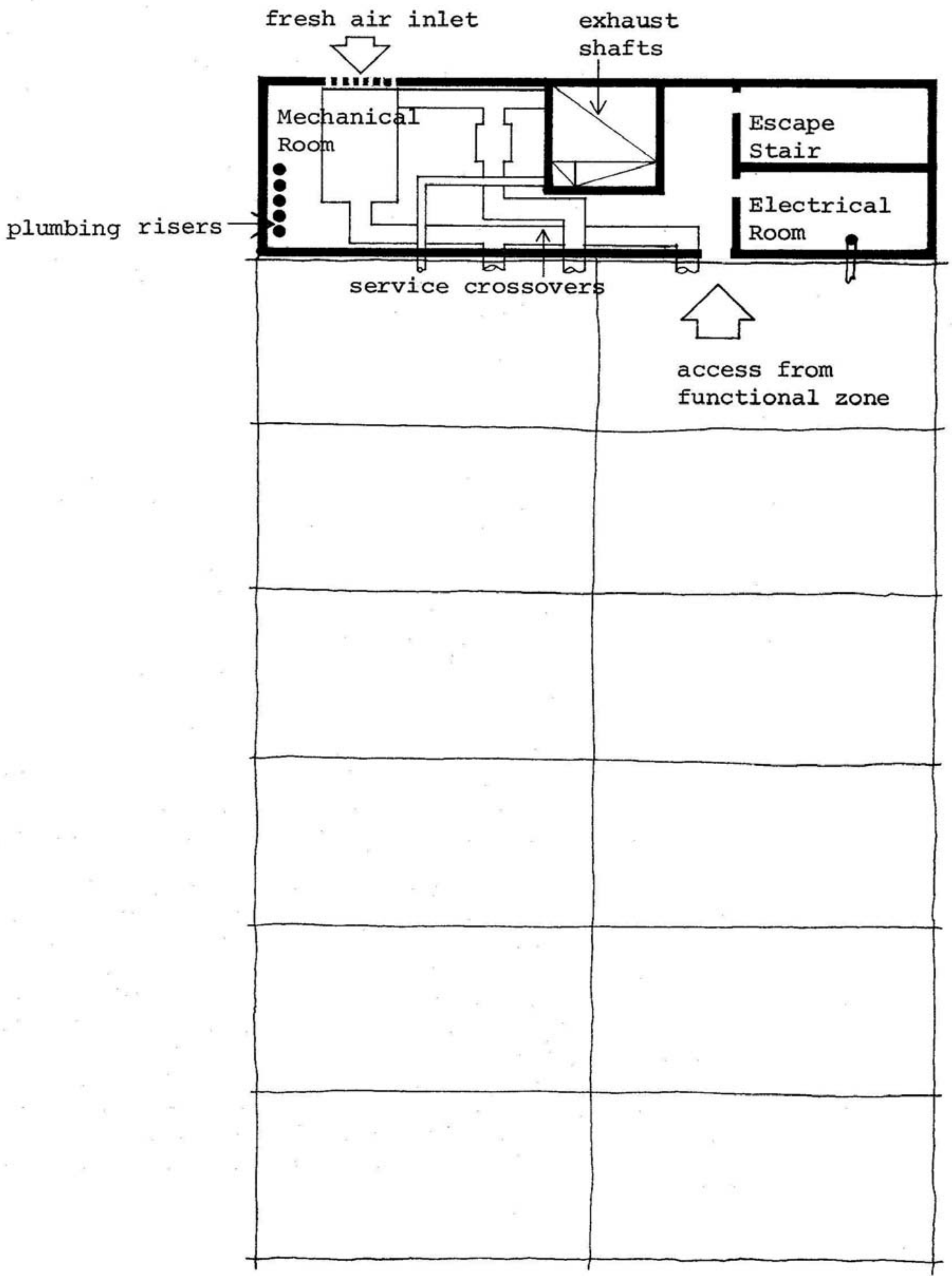
223.1 TYPICAL ARRANGEMENT

The components of the service bay are the mechanical room, exhaust shafts, electrical room, plumbing and normally an escape stair. All these areas will be entered at the functional zone level. Any required crossover of services from equipment or risers to align with service zone main distribution, such as HVC header ducts or electrical and plumbing runs, must take place within the service bay to avoid overcrowding of the near end of the service zone (See Figure 220-3.)

The service bay will always be located on a side of the service zone parallel to the beams, so that the main service distribution into the service zone is made perpendicular to, and directly under the beams.

The mechanical room will contain typically the air-handling unit for the service module with a direct inlet through an external wall for outside air supply, and the general return/exhaust fan. The exhaust shafts will include general exhaust, and toilet and special exhaust, leading to roof mounted fans. The plumbing risers will include the pressure systems, drainage and piping for heating and cooling water to the HVC system. The electrical room includes all the electrical and communications equipment such as transformers, related switchgear and branch circuit panels, etc., for the service module.

Figure 220-3. TYPICAL SERVICE BAY



The service bay will provide some of the shear walls for the overall seismic resistance of the structural frame. It will also normally be bounded by two-hour fire partitions (or shear walls) as it always occurs at the boundary of a fire section and also contains special hazard areas.

223.2 VARIATIONS

The organization of service bays described above will be typical for service modules generated from two-aspect space modules and for most other conditions. But there are two important variations:

223.2.1 Split Service Bays

Service modules based on four-aspect space modules will necessitate the use of a split service bay giving an external aspect to the bedrooms between the equipment rooms. Figure 220-4 shows a typical arrangement for this variation. Modules of this type are all comparatively wide; the illustration is based on two bays of 49'6". The service crossovers in this case will take place in an accessible exterior housing placed between the equipment rooms at the service zone level.

223.2.2 Internal Service Bays

The second major variation occurs in large hospital configurations where some service bays must be placed in an internal position between service modules. (See Figure 220-5.) Three special conditions arise in this situation. The first is the omission of the escape stair, as the service bay becomes part of a horizontal exit between the service modules lying to either side. The second condition is the requirement for a maximum width of access between the two functional zones to facilitate circulation. The third condition is the problem of providing outside air to the air-handling units. As discussed under Section 340, the preferred solution is to place these units at roof level and duct down supply air to the service module. This means that the area originally containing the mechanical room becomes a set of supply duct shafts to the various floor levels. In a moderate-rise building these will take up less floor area than a mechanical room and therefore leave more space for the circulation access described above. Where a group of internal service bays are lined up through a building configuration, this is referred to as a service strip. (See Section 411.6.3.)

Figure 220-4. SPLIT SERVICE BAY

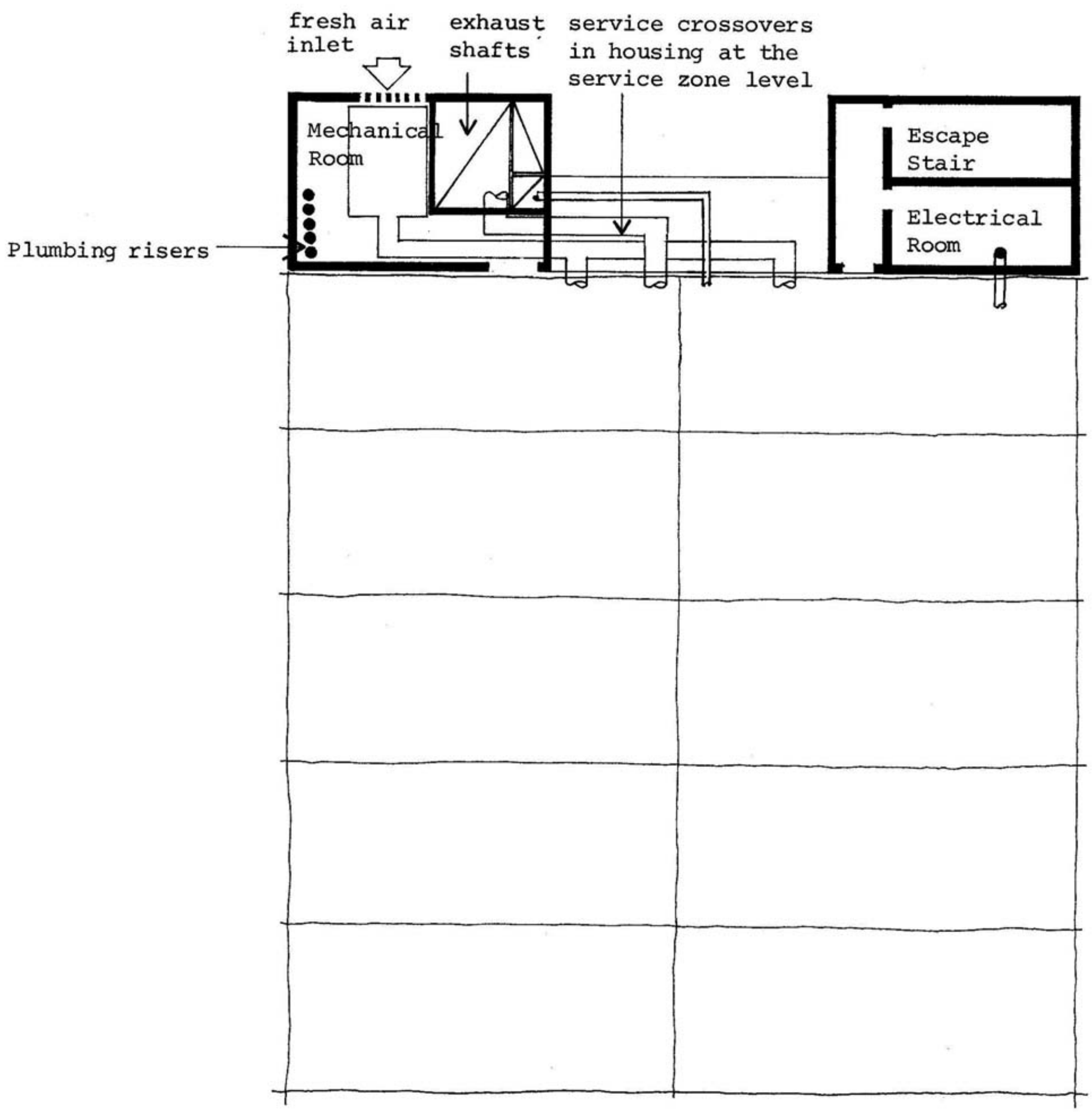
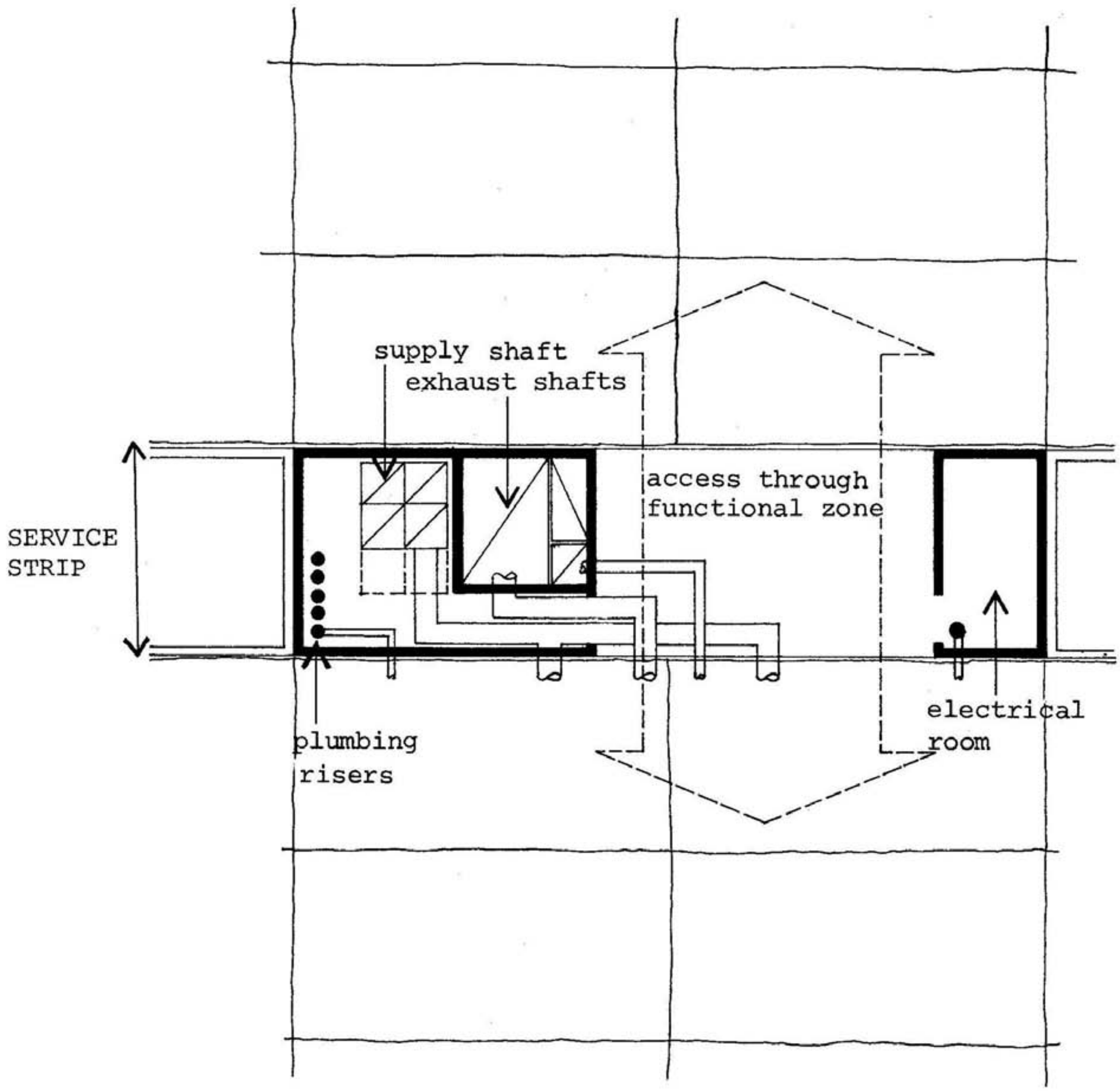


Figure 220-5. INTERNAL SERVICE BAY



223.3 LOCATION

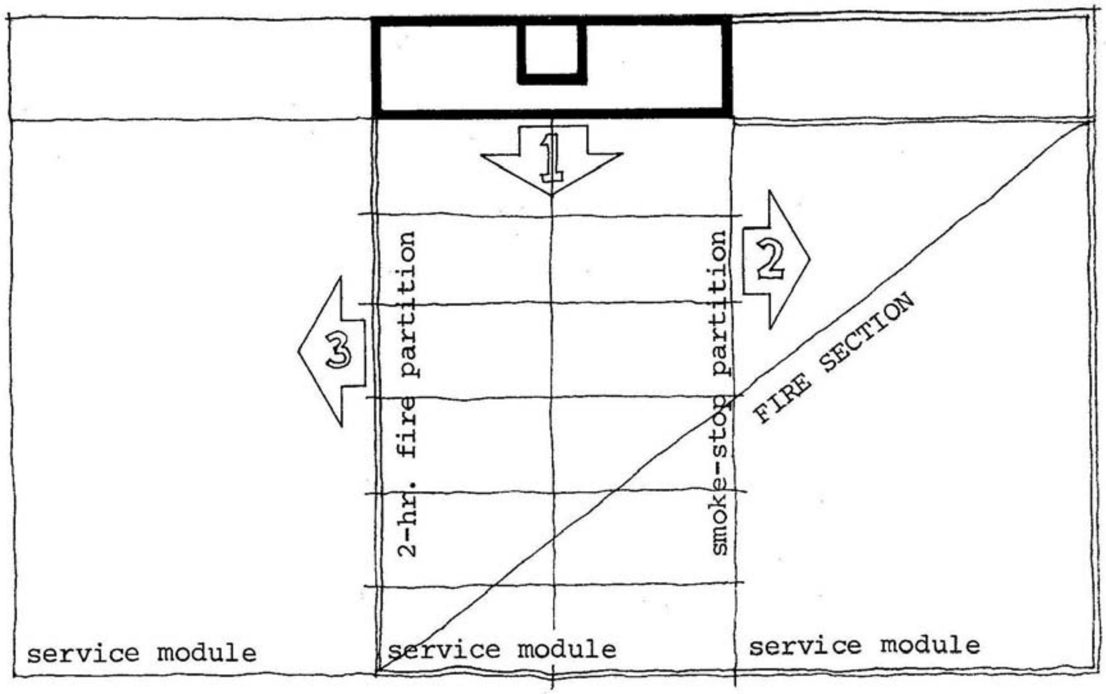
The location and design of the service bay is important for fire safety and acoustics. All the elements require two hour fire enclosure and the mechanical room requires acoustic isolation. This isolation can be maintained by absorbent room linings, isolation mounting for equipment and, most important, the sealing of all openings through the shear walls into the functional and service zones. The mechanical room must be designed to allow installation and removal of the air-handling unit through the opening in the exterior wall provided for the outside air inlet. All other equipment change can be handled by service elevators outside the service bay. Appropriate access routes through the functional zone to such elevators will be required for equipment handling.

223.4 PRIORITY OF SERVICE

The services distribution and the equipment rooms in any service bay will be designed to handle the service requirements of its own service module. It is, in fact, the service control point for the module.

But to allow for some diversification, it might be appropriate to share service between modules, either in the case of excessively high local service loads, or to share an unusual service. This coupling is simple to achieve where two service modules are in the same fire section, as there is only a smoke stop or plenum barrier between the service zones. Servicing to modules outside the fire section through the two-hour fire partition is also feasible, except that sealing the duct and pipe openings and fire dampering the ducts makes this option more complicated. See diagram below.

Despite the relative ease of this sharing of services, it is highly preferable to avoid the use of these options to simplify the control zones of each service, preserve the simplicity of maintenance, and avoid the complications of fire safety devices.



PRIORITY OF SERVICE

224 SERVICE ZONE

The service zone carriers the horizontal service distribution of the service module. All services are downfed to the functional zone with the exception of the gravity drains from the service module above.

All service runs will be organized on the basis of reserved subzones and channels to simplify design and installation, and to preserve rights-of-way for future service runs. The subzones and channels are organized as follows:

1. Subzones: define the direction of travel of the services. They are horizontal layers of the service zone. The main service distribution lines are all parallel, each connecting to branches at right angles to the mains, and the branches connecting, where required, to laterals at right angles to the branches. The mains and laterals will run parallel to the girders, the branches parallel to the beams.

2. Channels: define a reserved location in a subzone for a particular service. They generally apply only to the main distribution; for example, HVC supply ducts, etc.

With this organization it is obvious that no shortcut or point-to-point routing of services can be permitted without jeopardizing the predictability of initial or future installations.

The working height of the service zone is likely to be about seven feet based on service subzone requirements. This figure is about the maximum acceptable to some authorities before the service zone is considered a separate story, with some consequent regulation disadvantages.

224.1 SUBZONES

The following descriptions note the typical contents and criteria for each subzone. See Figure 220-6.

S1 Floor Slab.

This subzone equals the depth of floor finish, topping slab and structural slab.

S2 Branch Distribution: parallel to beams.

This subzone will contain the structural beams, pressure piping, and the gravity drainage and vents for the service module above. The calculated depths required for these components will govern the design depth of the subzone.

S3 Main Distribution: parallel to girders.

This is the major subzone and is reserved for main distribution of services through the length of the service zone. It is divided by service into channels. The depth will be governed by the requirements for HVC supply and return/exhaust ducts. (See Section 344.2.)

S4 Branch Distribution: parallel to beams.

This subzone contains the HVC and electrical branches and vents, with the HVC branches governing the design depth.

S5 Lateral Distribution: parallel to girders.

This subzone will take the final service run to its location over the service drop into the functional zone. It will contain HVC flexible duct and terminals, electrical conduit and junction boxes, and final plumbing runs. Any projections from the ceiling construction, such as I-beam strongbacks, will run parallel to the services at this level. The HVC flexible duct and terminals will determine the design depth for this subzone.

S6 Platform/Ceiling

This subzone equals the overall depth of the walk-on platform, ceiling structure and finish.

224.2 CHANNELS

Channels are plan subdivisions of a subzone and define the rights-of-way of particular services. At the S3 level, they provide reserved space for the main distribution of services, both those originally required for the service module and any predicted future need. Figure 220-8 shows a representative set of channels in a service zone of two spans of 40’6”. Included are subzones designated for personnel access.

Figure 220-6. SUBZONES: SECTION THROUGH BEAMS

All dimensions are nominal.

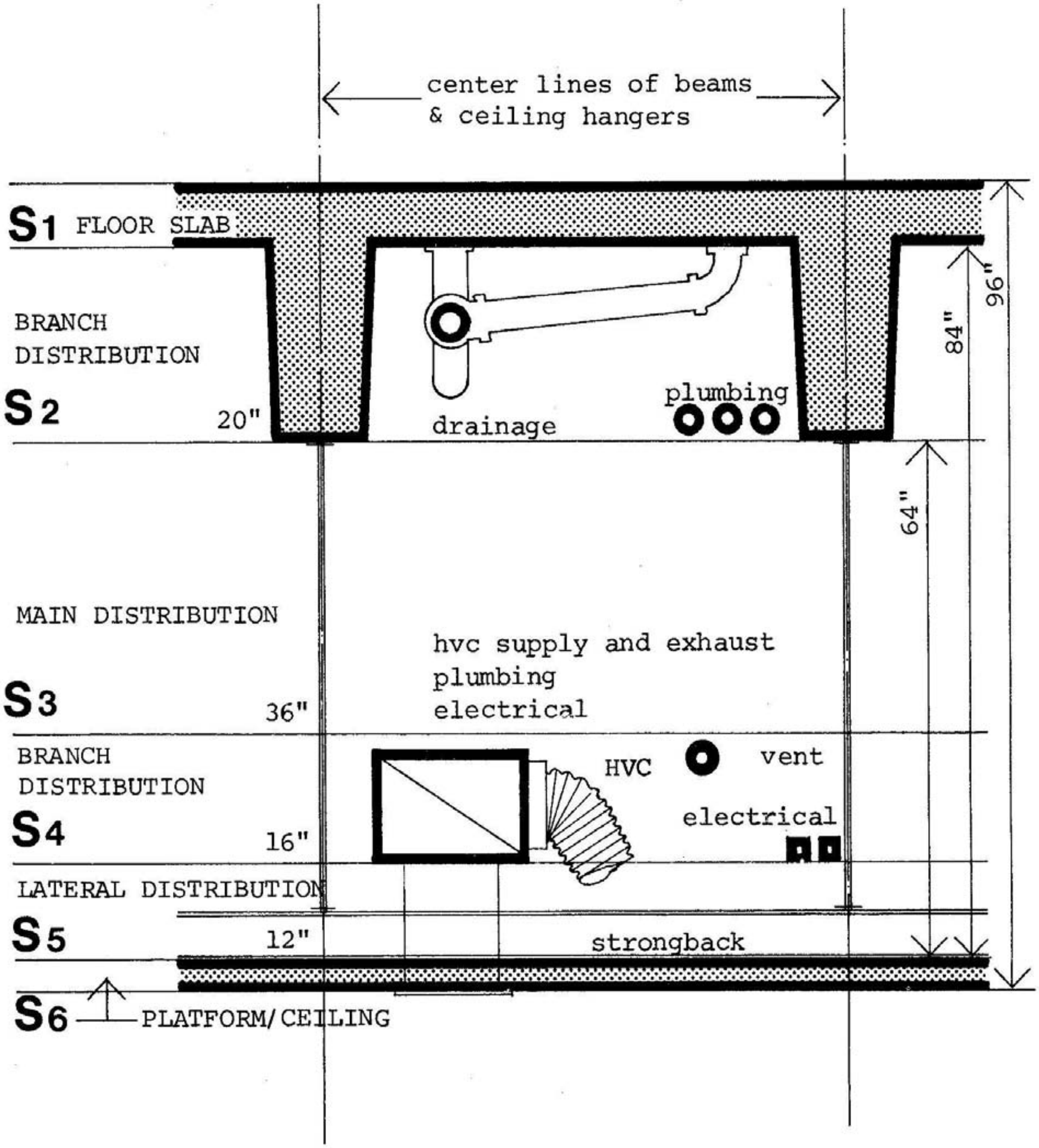


Figure 220-7. CHANNELS: SECTION PARALLEL TO BEAMS

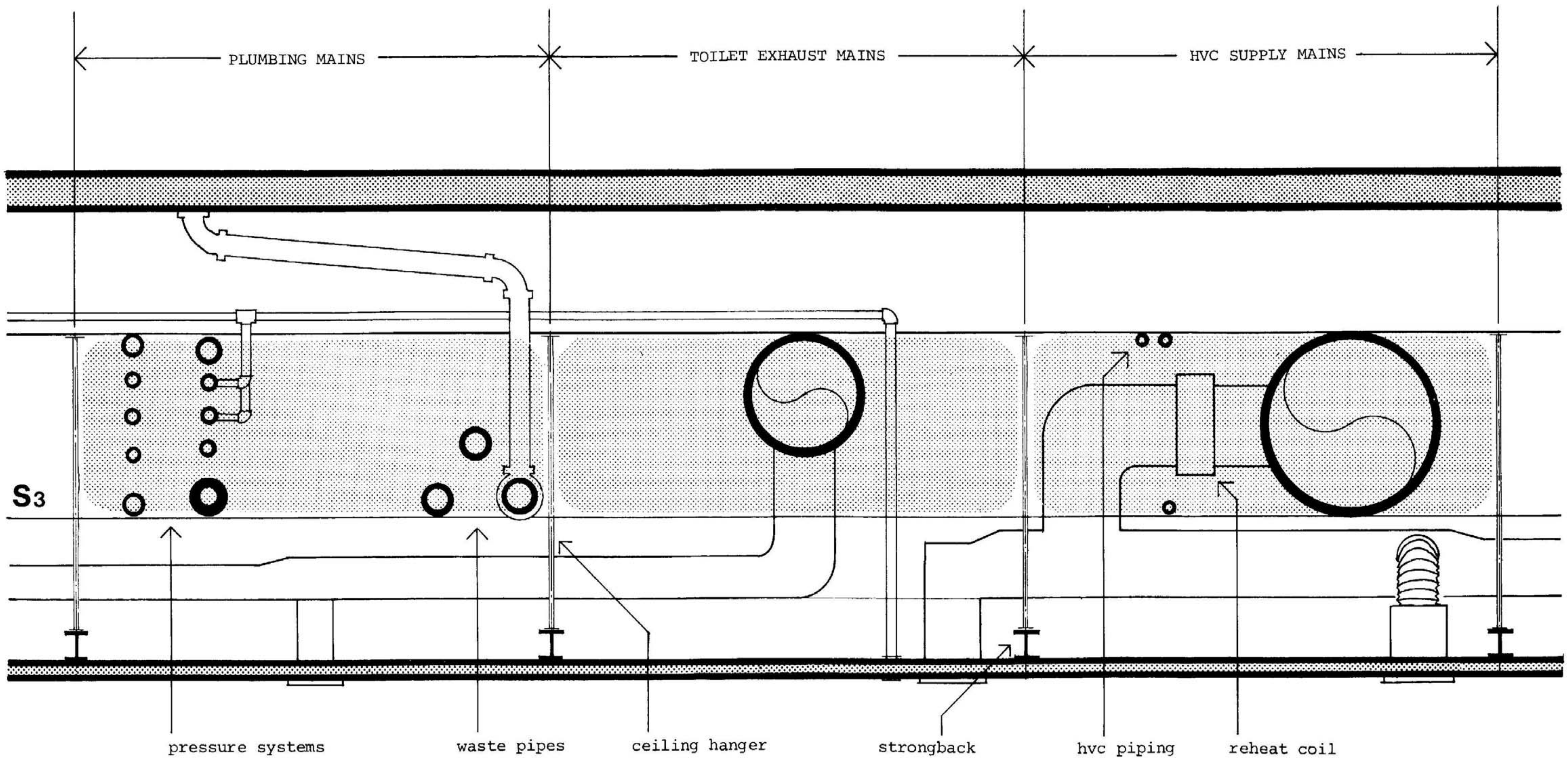


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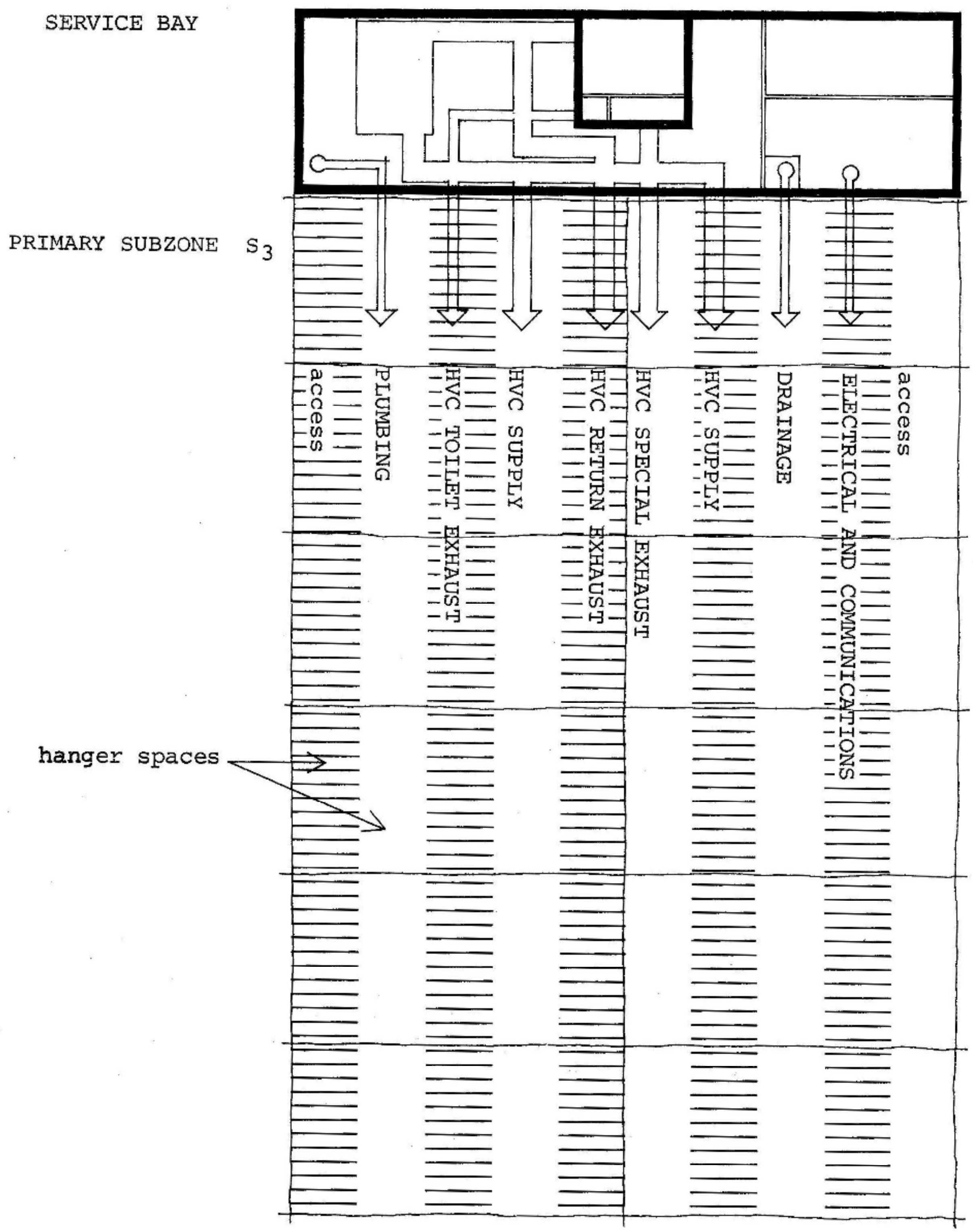
Figure 220-8. CHANNELS: PLAN



These should be located towards the ends of the cross section to avoid the obstruction of branch ducts and branch services.

The sequence of channels will be controlled by three factors:

1. The position of the source of supply in the service bay. The location of mechanical room, electrical room and plumbing shaft will follow a similar pattern in all service modules.

2. The constraints on openings through the shear wall. These can be estimated on the basis of maximum service requirements for the module, and the shear wall constraints as discussed under the structural subsystem, Section 310.

3. The horizontal space required to connect from each main to the service branches.

The horizontal dimension of the channels will be governed by the width of the service module, the number of channels required and the distance between ceiling hangers. These hangers will serve as the physical reference points for the channels. They can be expected to support approximately 45 - 50 square feet of ceiling each, and therefore, in the case of beam spacing at 5’7-1/2” centers, would be about 8’ to 9’ on center along the beams. The mains require about this range, for instance, for a single-duct HVC supply main with its associated terminal-reheat coils and ducting. (See Figure 220-7.)

It would be a useful extension of channeling to also divide subzones S2 and S4 into service rights-of-way. The greater diversity of runs in these subzones would make specific rules more difficult, but a careful organization of the branch runs would help preserve predictable areas for future penetration of the floor slab and ceiling respectively. Rules defining a maximum of one HVC branch duct per hanger spacing and carefully considered stacking of plumbing and electrical branches would also give predictable access for maintenance. Figure 220-6 suggests such a branch channeling within subzones S2 and S4.

224.3 ACCESS AND MAINTENANCE

As discussed above, channels reserved for personnel access will be positioned near the edges of the service zone. They will be reached from the service bay by doors through the shear wall. Similar doored openings will allow passage where required to adjacent service zones through the surrounding two-hour fire partitions and shear walls. Secondary access through the ceiling could be provided where convenient.

The service zone must be designed to conform to code provisions for industrial safety. This requirement is simplified by the fact that all major equipment is restricted to the service bay. The service zone must be suitably lit, ventilated and signposted.

It is assumed that maintenance routines will be primarily concerned with a weekly HVC check, and for other services at longer intervals. But if materials-handling systems are routed through the service zone, e.g., pneumatic tubes, tote box carriers, etc., more frequent access to these systems may be necessary.

224.4 CONSTRUCTION DESIGN

As discussed above, the ceiling hanger spacing will define channels. The direction of beams and strongbacks, and the depths of beams will visually locate subzones. This would provide physical references in the service zone both for the initial positioning of services and for later revisions to the layout.

The installation of main distribution and branch ducts will need careful coordination with the ceiling subsystem erection. But as soon as practical, the ceiling should be installed to provide a working platform for the completion of the service distribution.

Where two service zones exist within one fire section, a smoke stop partition should be erected between them. This partition would also provide a plenum barrier where both service zones are used as exhaust/return plenums in the HVC subsystem.

224.5 ACOUSTICS

Every precaution should be taken in design and construction to restrict sound transference into the functional zone.

All openings through the shear wall must be closed around the service mains to provide fire security, but the seal should also provide acoustic separation. All openings through the ceiling subsystem for services should be sealed as well. Mufflers may be required where return air boots are used with an exhaust/return plenum HVC system.

Noise generating plumbing should be suspended on isolating devices and precautions should be taken in services layout to prevent noise transmission between service runs causing secondary sound paths to the functional zone.

225 FUNCTIONAL ZONE

The functional zone is that portion of the service module which houses the hospital activities, and which can be internally organized in various ways to accommodate the different functions.

225.1 HEIGHT

The height of the functional zone is constant on any one floor and is typically 9’0” in the nursing areas and 10’0” in the support areas of the hospital (See Section 722.3).

225.2 PERMANENT COMPONENTS

Generally, the only permanent vertical components which occur within the functional zone are the structural columns. Shafts, shear components, and two hour fire partitions are located at the perimeter so as not to interfere with planning freedom (or with horizontal service distribution in the service zone above).

225.3 PARTITIONS

Partitions within the functional zone are typically relocatable and do not penetrate the ceiling-platform. (See Section 326.)

There is no explicit planning grid for partitions. However, a dimensional discipline is implied by the spacing of the structural beams in the floor and the spacing of the structural members in the ceiling-platform. These limit the location of service drops and floor drains and, therefore, the location of partitions which are associated with them. (See Section 333.4.)

225.4 SERVICES

Except for drains, all services to the functional zone are down-fed through the ceiling from the service zone above. As a general rule, it is recommended that service distribution components should be surface mounted and not housed within partitions. (See Section 723.1 for rationale.)

225.4.1 The degree to which surface mounting of services is able to be carried out depends on several factors, such as, cost, asepsis, rate of change, etc., and will vary from one functional area to another and from one project to another.

230 The Space Module

231 BASIC DESIGN

The space module represents in plan the physical requirements for bed-care functions of the hospital. Space modules are generated from an analysis of current VA nursing unit requirements. Eleven different space modules represent the current range of different VA nursing care programs and different planning solutions to those programs. Each space module represents a different range of performance in terms of area, organization, aspect (perimeter exposure) and functional content.

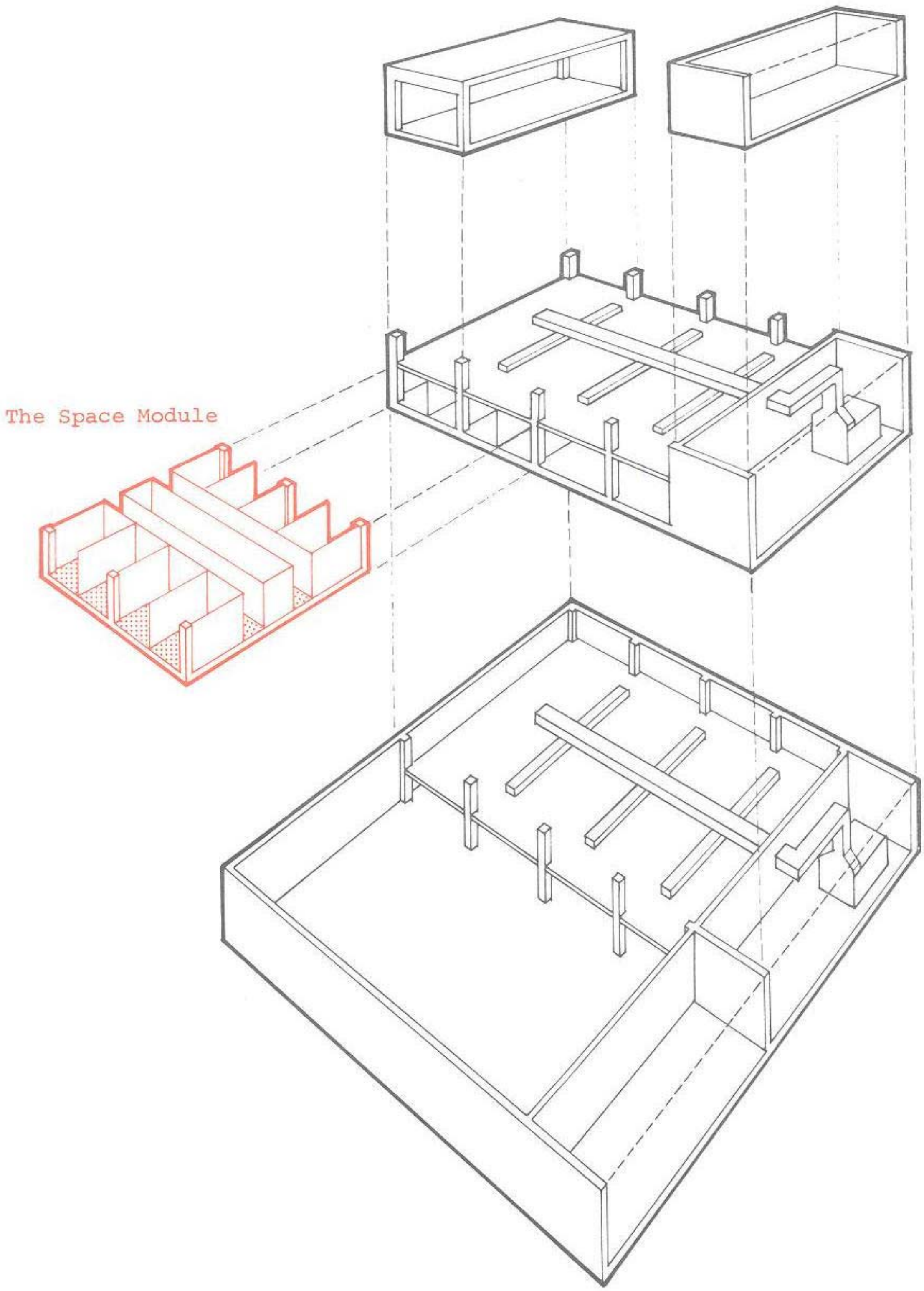
The space modules are intended to respond in a predictable and repetitive way to VA Master Plan requirements and, accordingly, to form the basis from which functional planning can proceed.

The space module may be the same size or smaller than a service module (exclusive of the service bay), but in no case can be larger than a service module.

The space module functions on the basis that its shell and services will be provided within the service module envelope with assurance of complete compatibility. (Figure 230-1)

Once derived, the space modules were tested with other nursing unit plans and modified where necessary to accommodate various ranges of patient and associated bed-care functions. Thus, the space modules represent a summary of current VA needs, and can be used in preliminary planning to determine the relevant size and shape of the service modules in the bed-care portion of the hospital. Through the bed-care service module, the space module, in many building configurations, also has an indirect effect on the size and shape of the service modules in the rest of the hospital. Traditionally in hospital design, the nursing unit is one of the first functional areas to be resolved and the dimensional disciplines developed there to a large extent establish the framework for the design of the remaining hospital functions. Thus, the concept of the space module is a significant innovation in that it permits the planner to quickly come to terms with the one area of the hospital that has the most direct bearing on the overall organization of the hospital.

Figure 230-1. THE SPACE MODULE



The Space Module summary sheet (Figure 230-8) describes the module types. The catalog of space module capabilities (Section 233) elaborates on the summary sheet and indicates other possible organizational, access and assembly capabilities for each of the 11 module types.

The space module concept should be viewed as a highly dynamic constituent of the Prototype Design. The catalog of space modules represents the present VA philosophy of bed care organization which is constantly subject to reevaluation and change brought about by advancing medical knowledge and technology.

232 SPACE MODULE CHARACTERISTICS

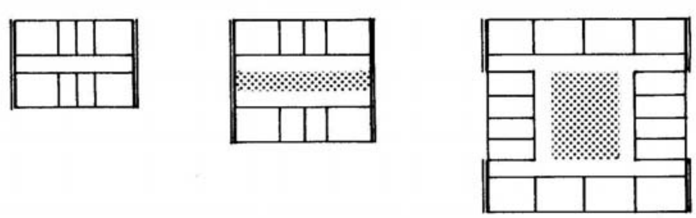
232.1 DERIVATION

The general nursing unit, which contains the majority of beds in the typical VA hospital, was used as the generating organization for the modules.

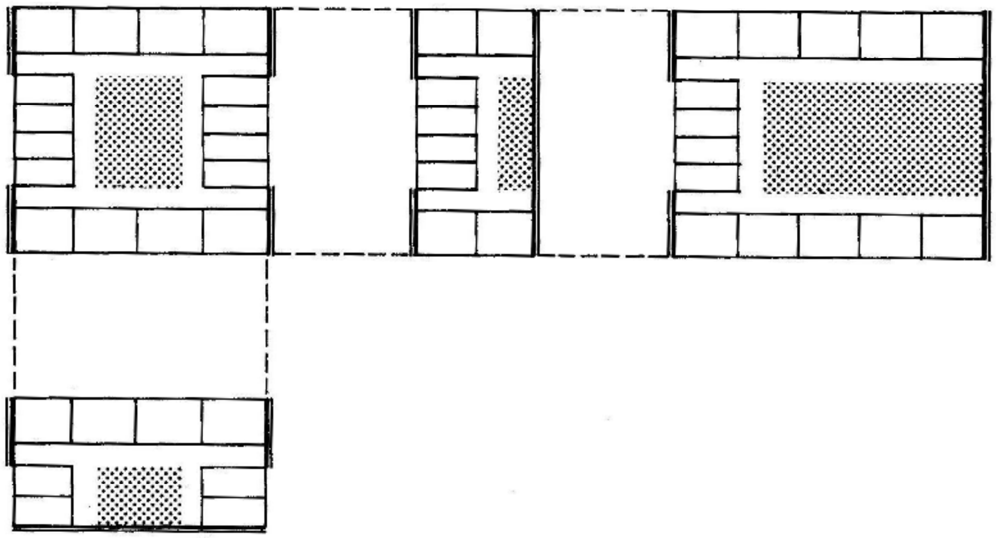
The Veterans Administration is currently using a 40-bed general nursing unit pattern with predominantly four-bed rooms. During the investigation of user needs, it was determined that a subdivision providing two 20-bed units would be desirable for periods of intensive nursing activity, i.e., the daytime shift. Furthermore, it was determined that existing levels of nurse staffing could accommodate such a pattern. It was consequently decided to base the space module on a 20-bed general nursing unit with the provision that the module must always be capable of combination with other modules to form 40-bed or larger units.

232.2 ASPECT

232.2.1 Aspect refers to the number of perimeter faces available for exposure to natural light and, therefore, the amount of perimeter potentially available for connection either to other space modules and/or a service bay and/or additional space (see catalog of space module capabilities. Section 233.) Two- and four-aspect space modules are included in the system. It will be noted that the four-aspect modules cannot be easily combined with other modules to form a functional entity; therefore, a 40-bed functional unit was used for this module type.



232.2.2 The four-aspect modules can be readily modified to produce three-aspect modules, if required: either a twenty-bed nursing unit by using one-half of the four-aspect modules, or a forty-bed nursing unit by increasing the length of the four-aspect module by one structural bay width.

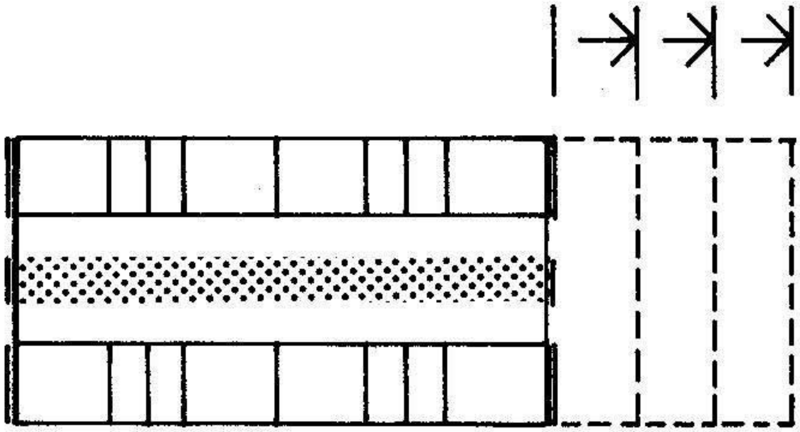


232.3 AREA OF SPACE MODULES

The gross area of a nursing unit varies width the number of beds, the sanitary facilities provided in each room and the desired amount of direct patient care support (core). The modules provide a range in approximate area from 3,350 to 6,075 square feet for 20-bed modules and form 8,900 to 10,500 square feet for 40-bed modules. This area will provide sufficient space for a reasonable amount of direct care support adjacent to patient beds and a complete range of bedroom sanitary facilities.

232.4 ADDITIONAL SPACE

The space module area can be supplemented with additional space as a means of accommodating functions not necessary for direct patient care support such as education, certain offices, shared diagnostic, treatment or staff facilities, vertical circulation systems, etc. This additional space on the nursing floor can be constructed with the building system but does not possess the organizational characteristics of the space modules. The amount of additional space varies with the hospital program. It is provided by extending the structural frame in increments of one bay.



232.5 INTERIOR ORGANIZATION

Two basic nursing unit organizations are provided:

1. Core or “race track”. The core plan provides a central area (core) for direct patient care support facilities. The core is surrounded by corridors which lie between it and the patient bedrooms. The bedrooms are on the perimeter of the building.

   Core plans may be two- or four-aspect. The two-aspect core modules may be joined end to end with each other to form end-entry 40-bed units. They may also be end-attached to a shared section of additional space, forming end-entry 20-bed units. The attachment capability of the four-aspect core modules is limited to their corners. (See Catalog of Space Module Capabilities, Section 233.)

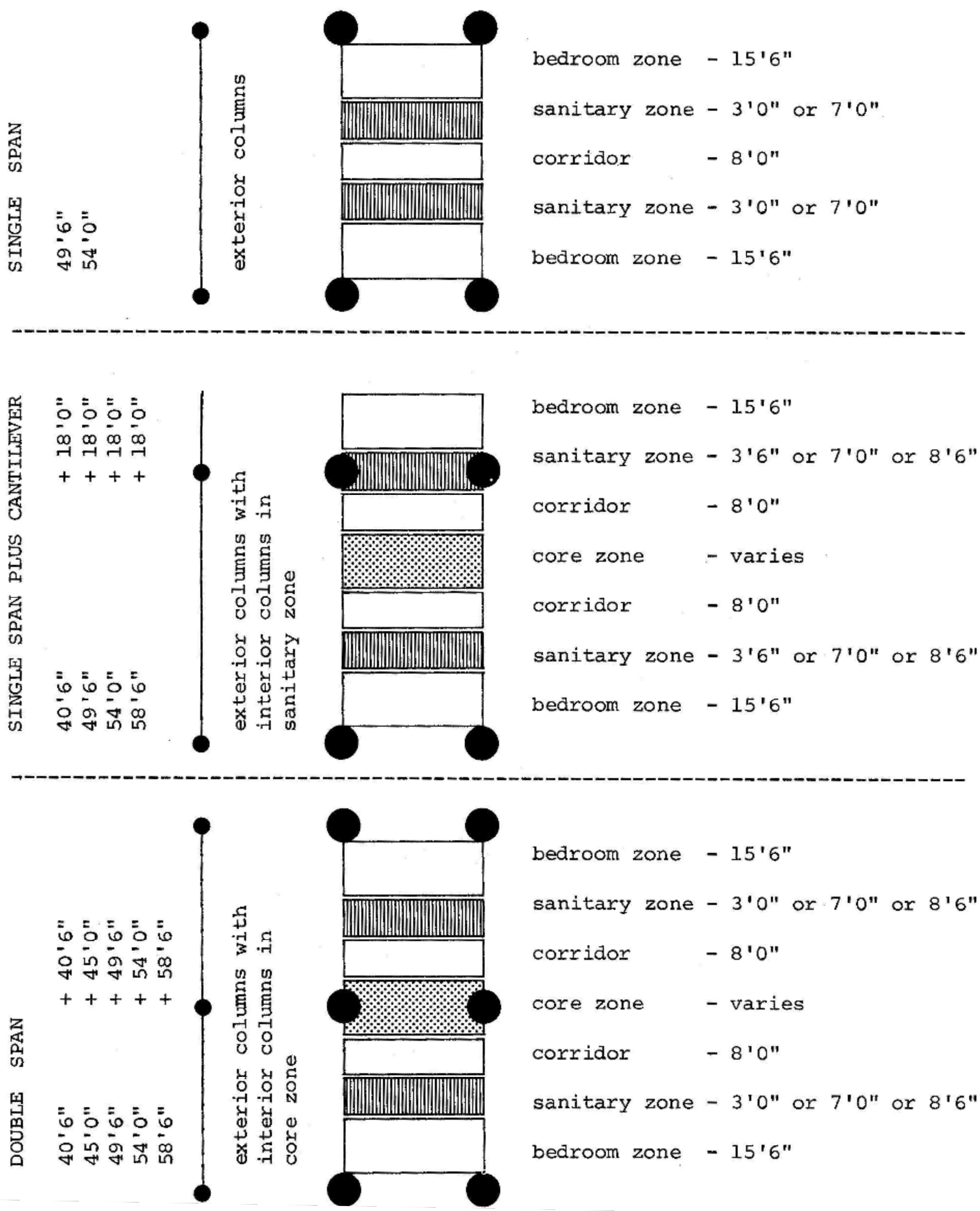
2. Double-loaded corridor. The double-loaded corridor module depends on additional space for direct patient care support facilities and therefore is most effective when two modules share a common central access. (See Catalog of Space Module Capabilities, Section 233.)

232.6 PLAN ZONES

The cross-section of a general nursing unit consists of a series of related zones: bedroom, sanitary, circulation and core zones.

The particular combination of one-, two- and four-bed rooms in conjunction with the extent of corridors, sanitary and core facilities, required by the Veterans Administration, will determine the appropriate structural span (See Figure 230-2), hence the module type.

Figure 230-2. PLAN ZONES



The initial selection of a module type will fix the unit width and consequently the potential capability of each zone. For example, in a double-loaded corridor unit with a width appropriate for handwashing facilities in each room, it is virtually impossible to add toilet facilities at a later date without a reduction in the number of beds. It may be appropriate, therefore, to select a module wider than initially needed to provide future adaptability.

232.6.1 Bedroom Zone

The Veterans Administration currently desires optional arrangements of one-, two-, and four-bed rooms. Furthermore, a degree of interchangeability from one type to another is advantageous. To obtain this measure of flexibility, the respective width and depths of the one-, two-, and four-bedrooms must be compatible. The widths are interchangeable by virtue of the 22'-6" structural bay width. (See Section 232.7 and Figure 230-4). Bedroom depths vary as in Figure 230-3. Therefore, to ensure optimum interchangeability, the bedroom zone depth is fixed at 15'-6", the critical minimum dimension for two- and four-bedrooms.

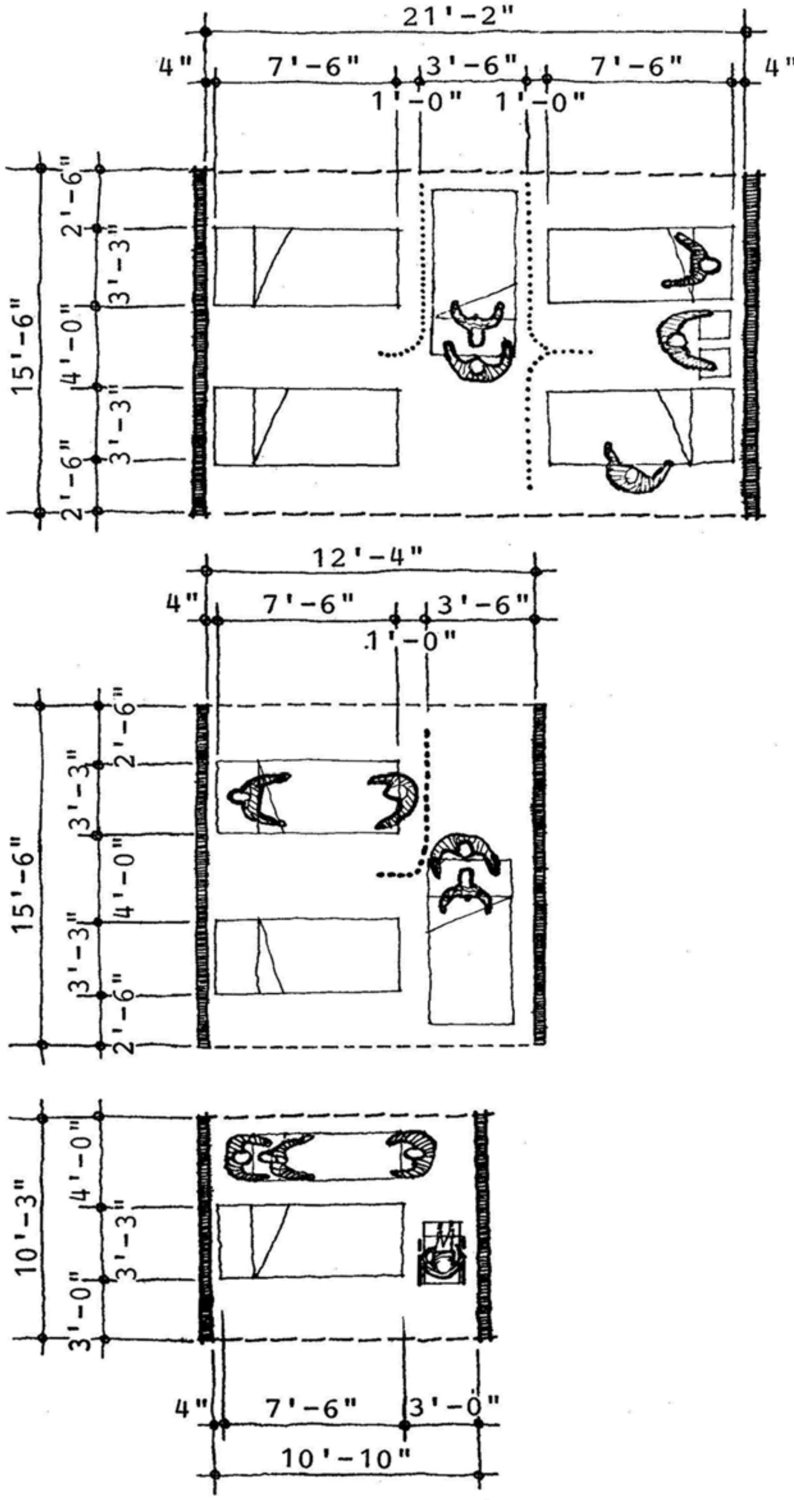
232.6.2 Sanitary Zone

This zone contains sanitary facilities for the patient bedroom. Careful studies provided the following options:

option one	3'0"	–	lavatory for handwashing only
	3'6"	–	lavatory for handwashing only in conjunction with an interior column
option two	7'0"	–	lavatory and toilet or lavatory toilet and shower plus a 4'0" wide bedroom access from corridor.
option three	8'6"	–	lavatory, toilet, shower and nurse-server plus a 4'0" wide bedroom access from corridor.

The sanitary zone is primarily a means to determine the appropriate width of space module and need not necessarily occur between bedroom and corridor.

Figure 230-3. PATIENT ROOM CRITICAL DIMENSIONS



Some plans may locate the sanitary facilities at the exterior wall.

A sample catalog has been prepared to show a variety of plan arrangements of fixtures possible in each of the above options for the one, two and four bedrooms. These plan arrangements also show the accommodation of an interior column when a module type with a single span plus cantilever condition is adopted (See figures 230-2, 5, 6 and 7).

232.6.3 Corridor

Corridor widths are 8'-0" clear.

232.6.4 Core

The core size may be varied: (a) by selecting a particular depth of sanitary zone, (b) by selecting modules of different widths. The designer will, in most cases, also have flexibility in allocating certain functions to the core or additional space. These two options should allow sufficient adaptability in accommodating program variations from facility to facility or from unit to unit.

232.7 STRUCTURAL BAY WIDTH

The width of the structural bay, always 22'-6", is based upon a dimensional discipline for bedroom widths of 4'-6" (see Figure 230-4.) This dimensional discipline has been derived from a study of the comparative critical widths for one-, two-, and four-bed rooms. (See Figure 230-3.)

232.7.1 Four-bed Rooms

Four-bed rooms are 22'-6" wide, center to center, which equals 5 x 4'-6" or one structural bay.

237.7.3 One-bed Rooms

One-bed rooms are 11'-3" wide, center to center, which equals 2.5 x 4'-6" or one-half of one structural bay.

237.7.3 Two-bed Rooms

Two-bed rooms are 13'-6" wide, center to center, which equals 3 x 4'-6" or three-fifths of one structural bay. Three bays are required to create a block of five rooms.

Figure 230-4. BEDROOM WIDTH VARIATIONS

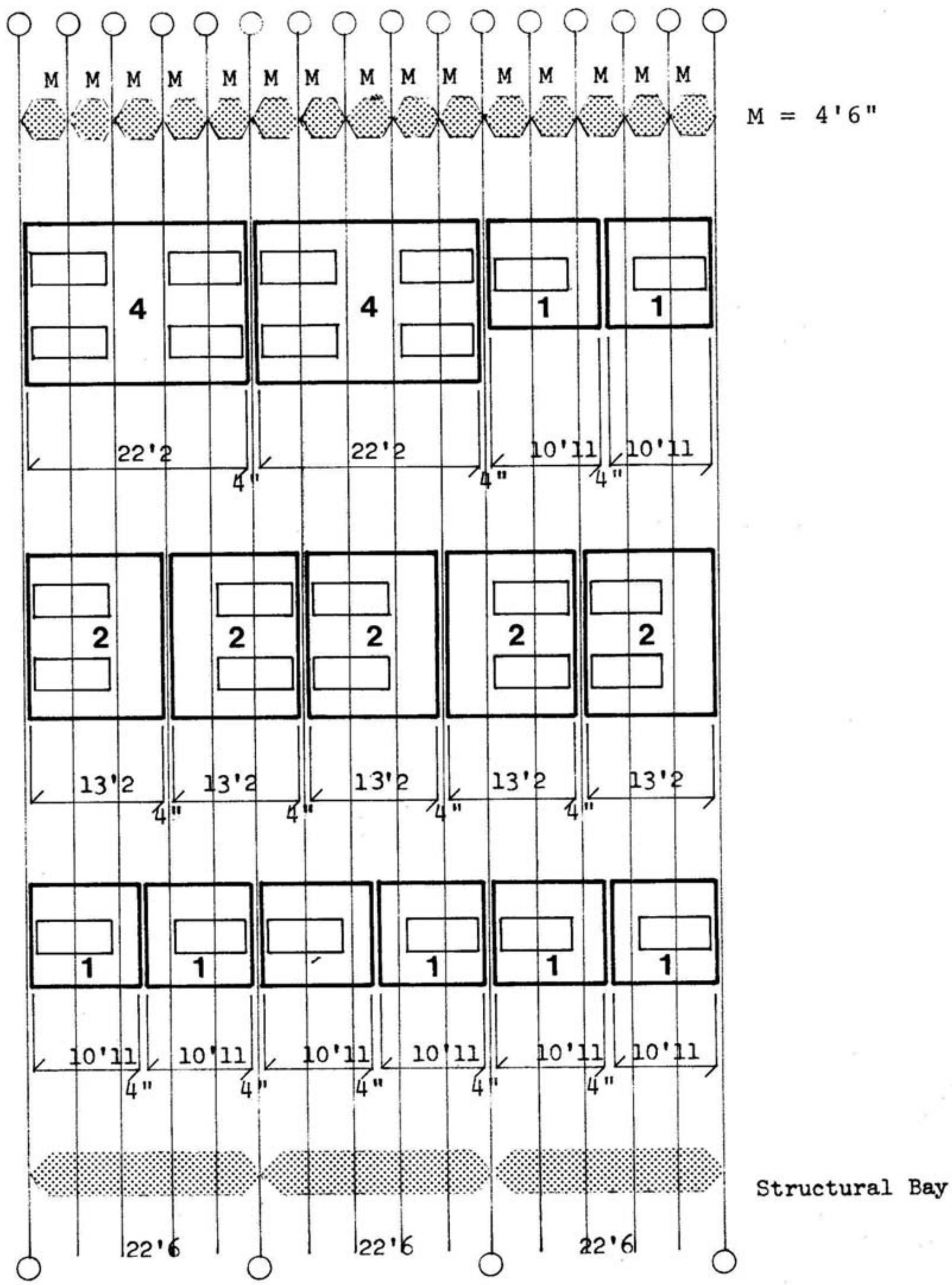


Figure 230-5. SANITARY ZONE OPTIONS: SAMPLE STUDIES

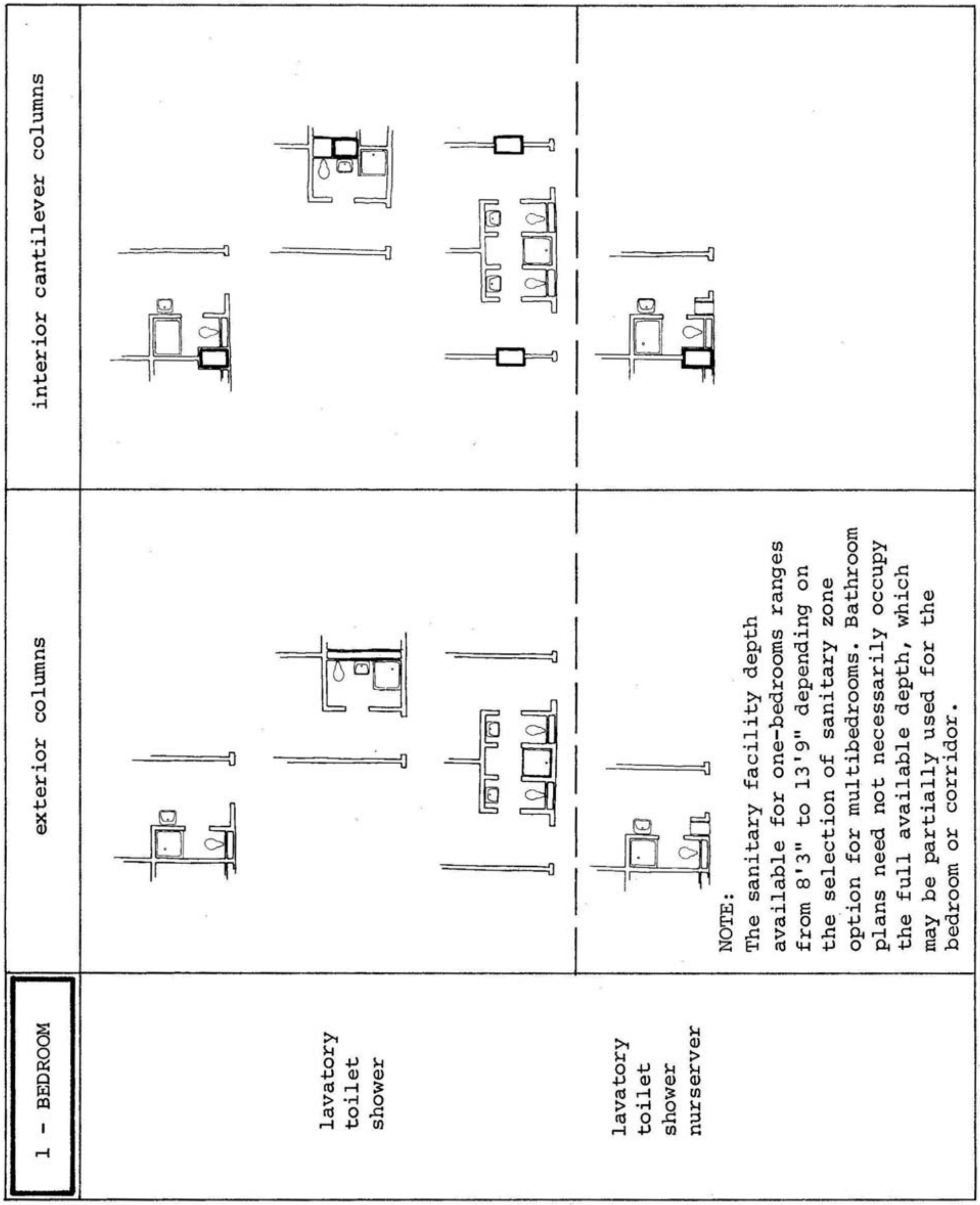


Figure 230-6. SANITARY ZONE OPTIONS: SAMPLE STUDIES

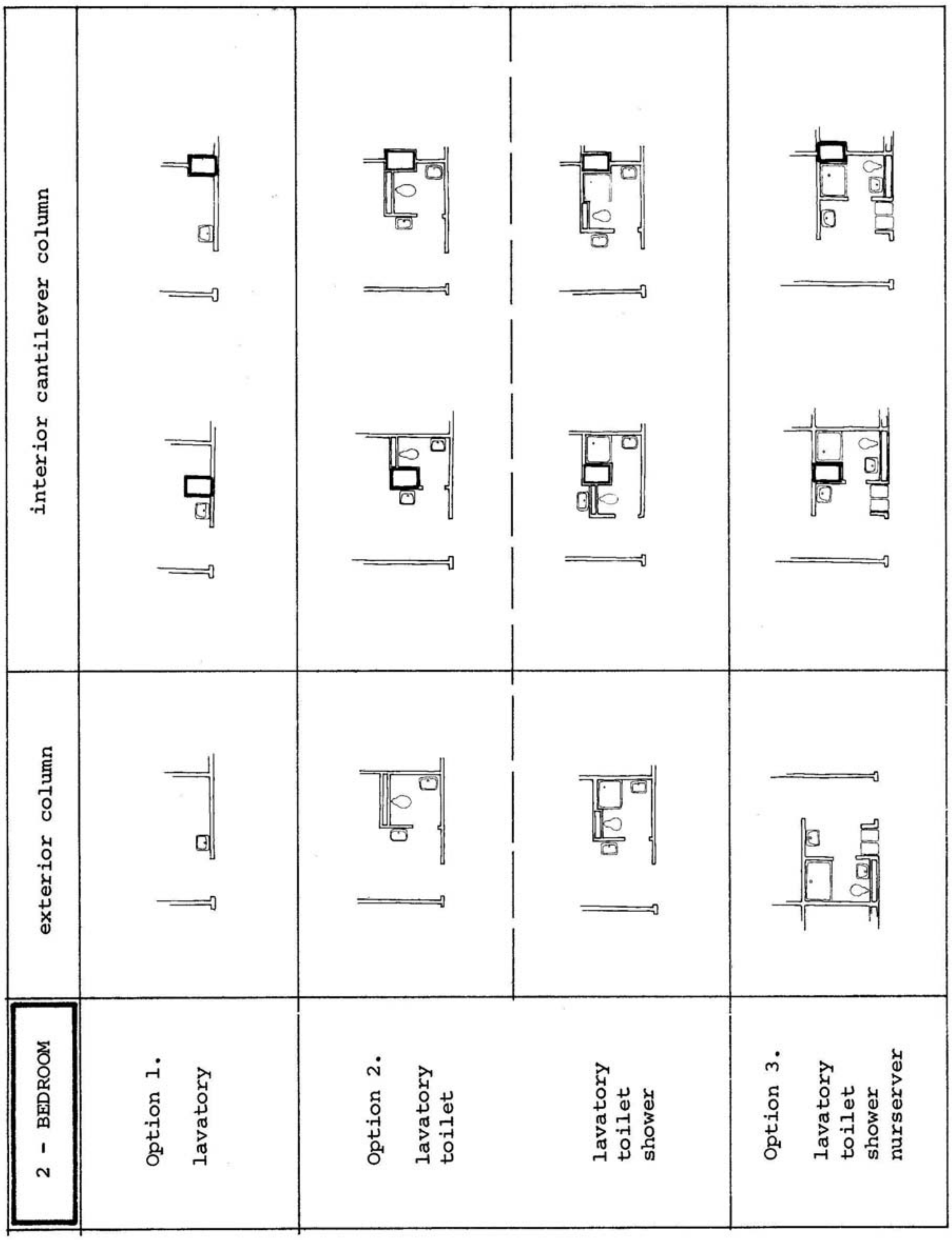
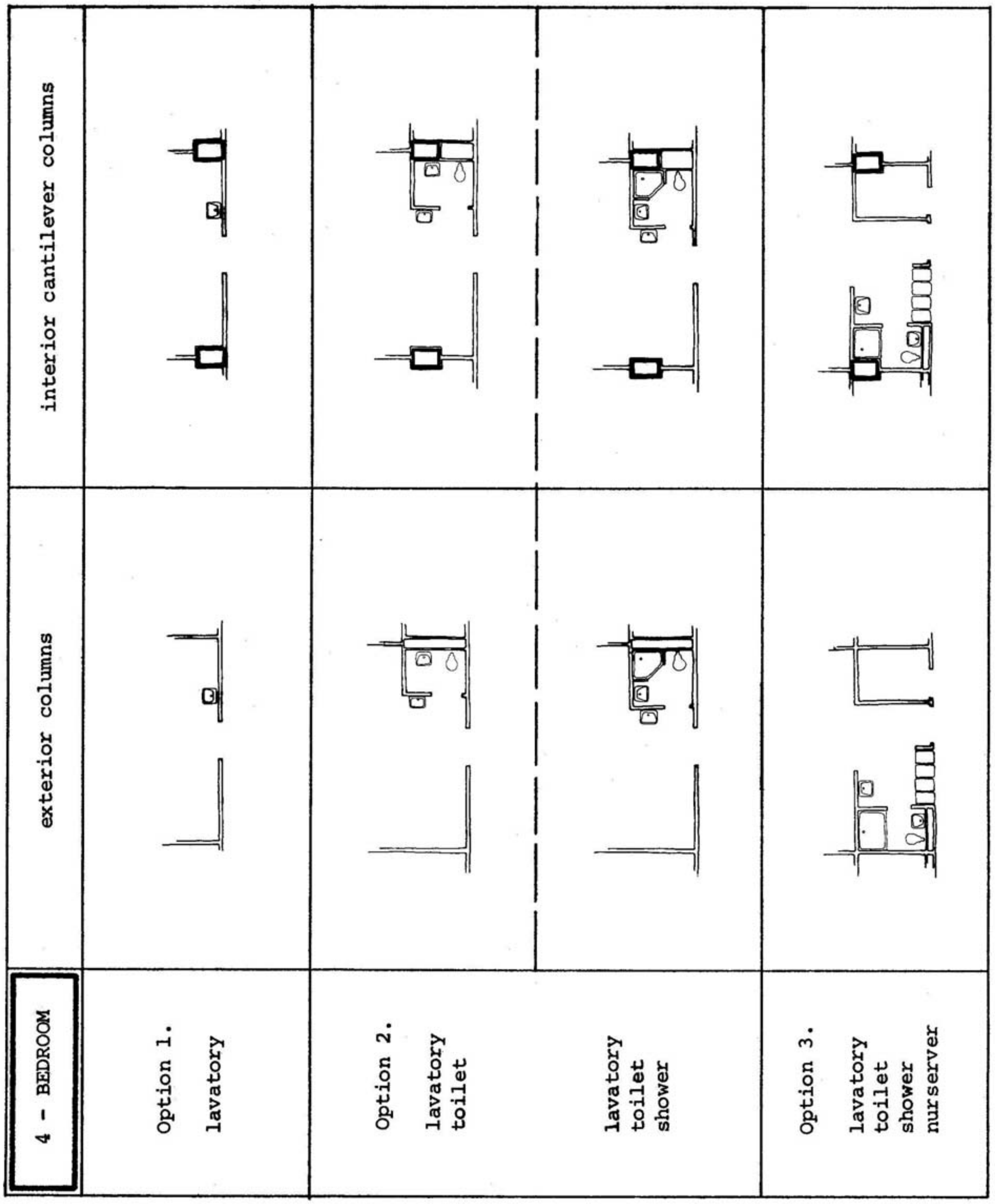


Figure 230-7. SANITARY ZONE OPTIONS: SAMPLE STUDIES



232.8 PLANNING AROUND COLUMNS

Figure 230-4 indicates that columns always occur on the between-room wall of one- and four-bed rooms. In two-bed rooms, columns will occur in one of three positions. In modules using cantilever beams the column will fall in the sanitary zone. Figure 230-5, 6 and 7 indicate a range of plans for the respective sanitary zones, with particular emphasis on the most difficult conditions, that is, where a column falls within the sanitary zone.

232.9 MINIMUM COLUMN-FREE AREA

In addition to providing a range of gross area options, and in the interest of economy, the space modules have been designed to insure a column-free area of sufficient size to permit intensive care units or other functions requiring large unobstructed space. The minimum dimensions of this column-free area are approximately 40 feet by 66 feet. (See Section 712.2.)

233 CATALOG OF SPACE MODULE CAPABILITIES

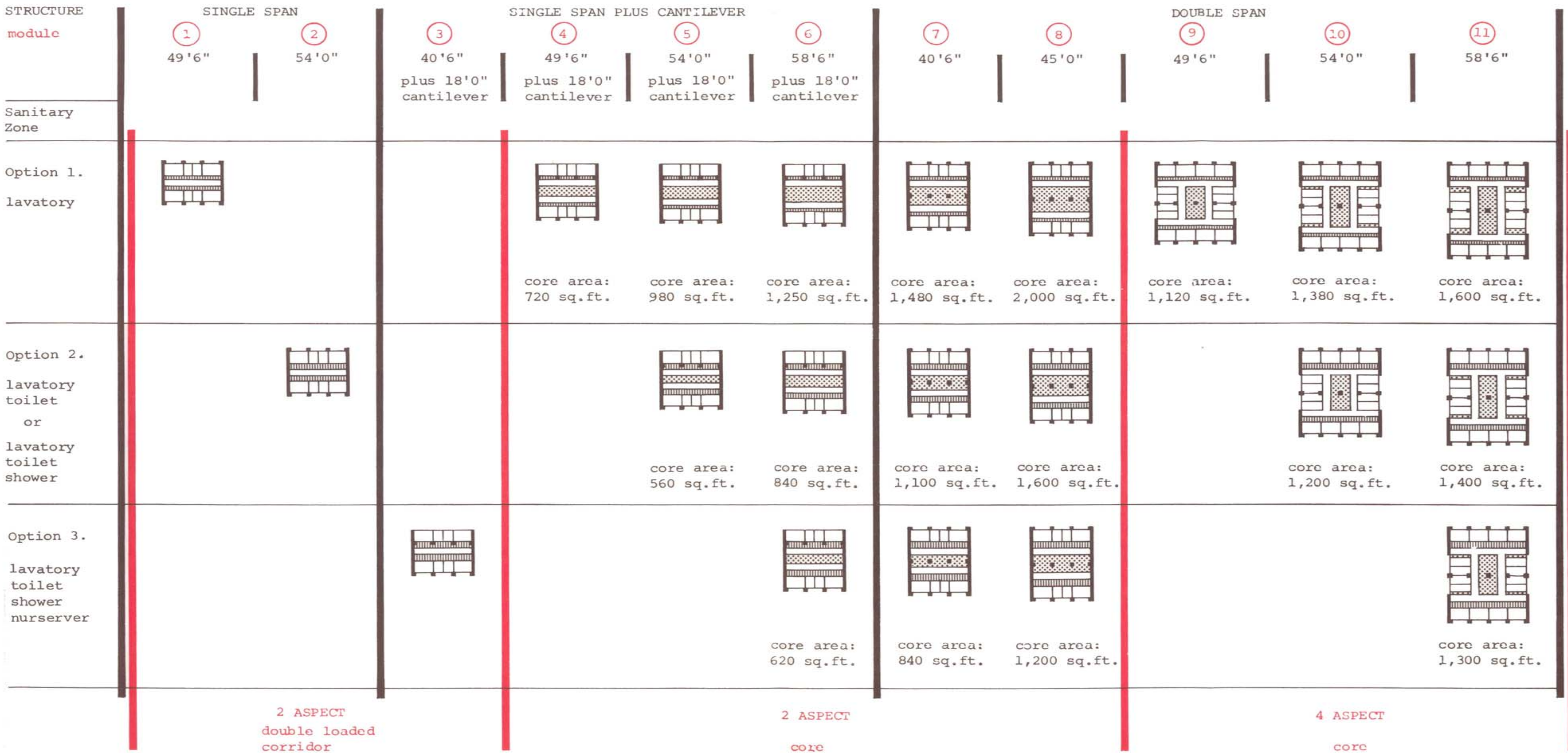
The catalog of space module capabilities indicates certain suggested organizations, access and assembly capabilities and a partial range of functional content for each of the eleven module types. Functional content and patterns of organization are by no means limited to these examples, however.

It is anticipated that the functional capability of the eleven space modules will grow as they are tested and refined within the VA. The more the capabilities of the space modules are known, the more rapid and accurate the design process leading to the commencement of construction can become.

It should be noted that in the catalog of space module capabilities all dimensions and areas are taken to: 1) the outside edge of the cantilever, or 2) the center line of interior and exterior columns.

In addition to the space module catalog, it may be helpful to refer to the example schematic design solution shown in Section 730.

Figure 230-8. **SPACE MODULE SUMMARY SHEET**



Shaded areas indicate Sanitary Zones and Support Zones (core area). Heavy line indicates the potential interface with either a Space Module and/or a service bay and/or additional space (Catalog of Space Module Capabilities).

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Figure 230-9. SPACE MODULE TYPE 1

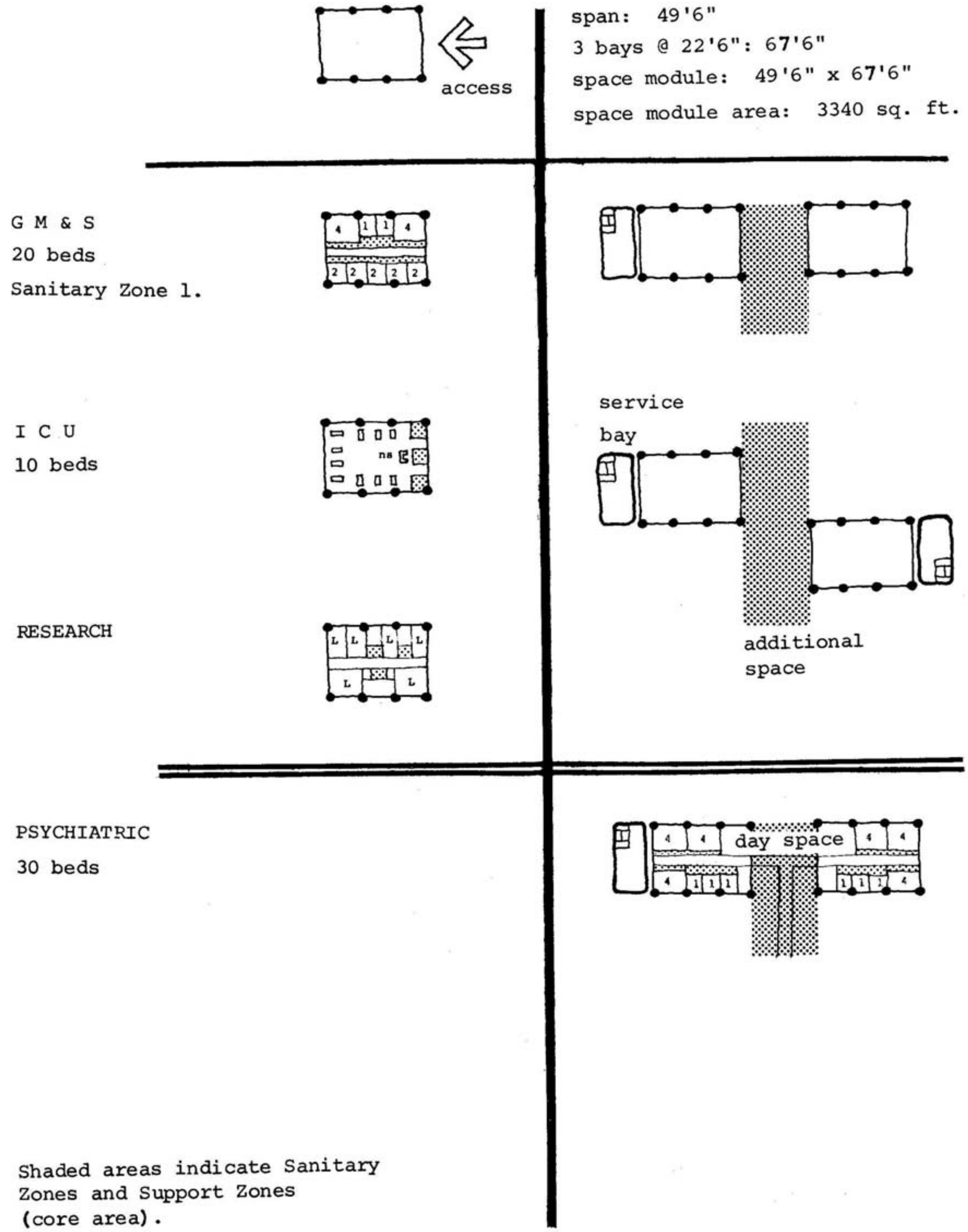


Figure 230-10. SPACE MODULE TYPE 2

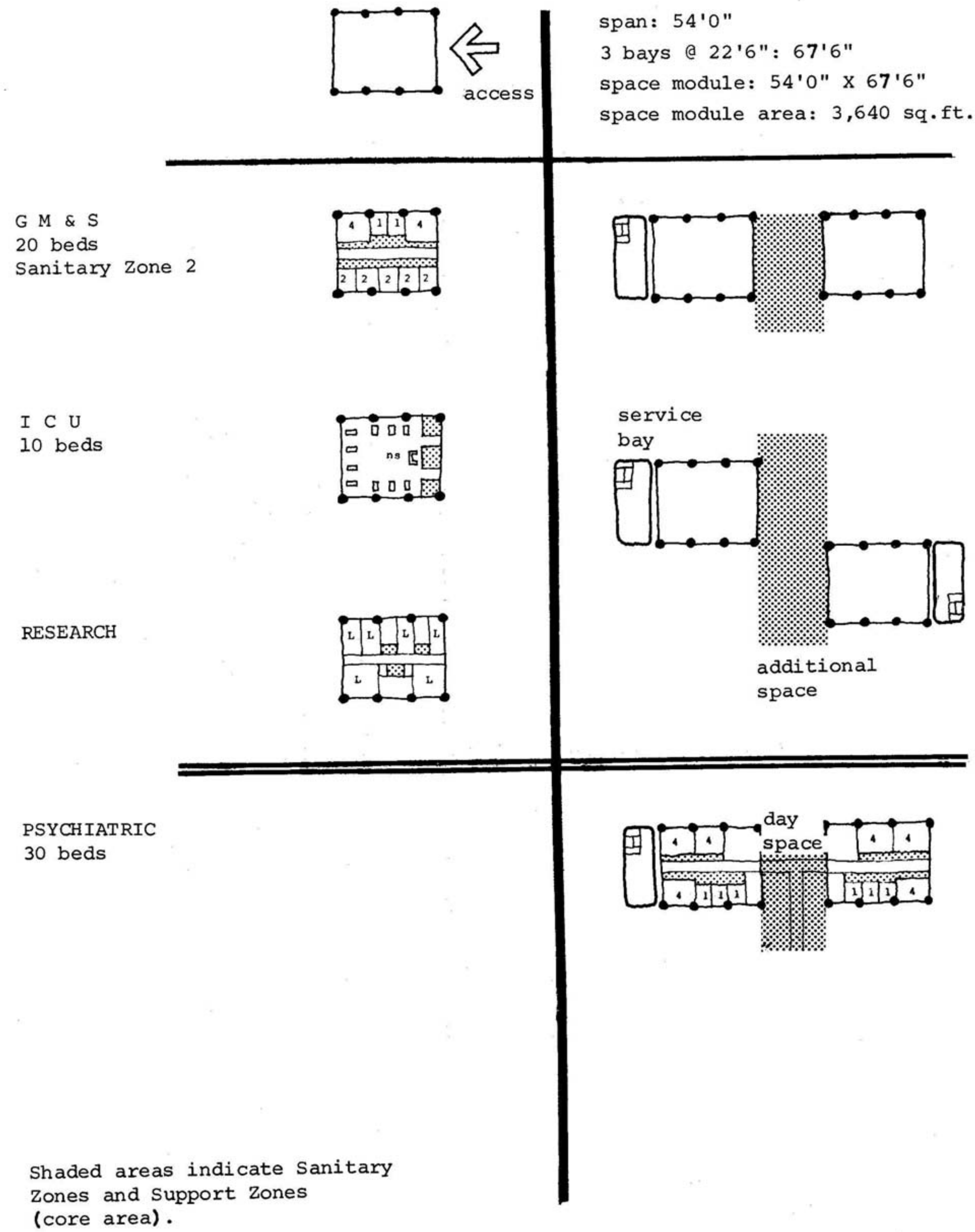


Figure 230-11. SPACE MODULE TYPE 3

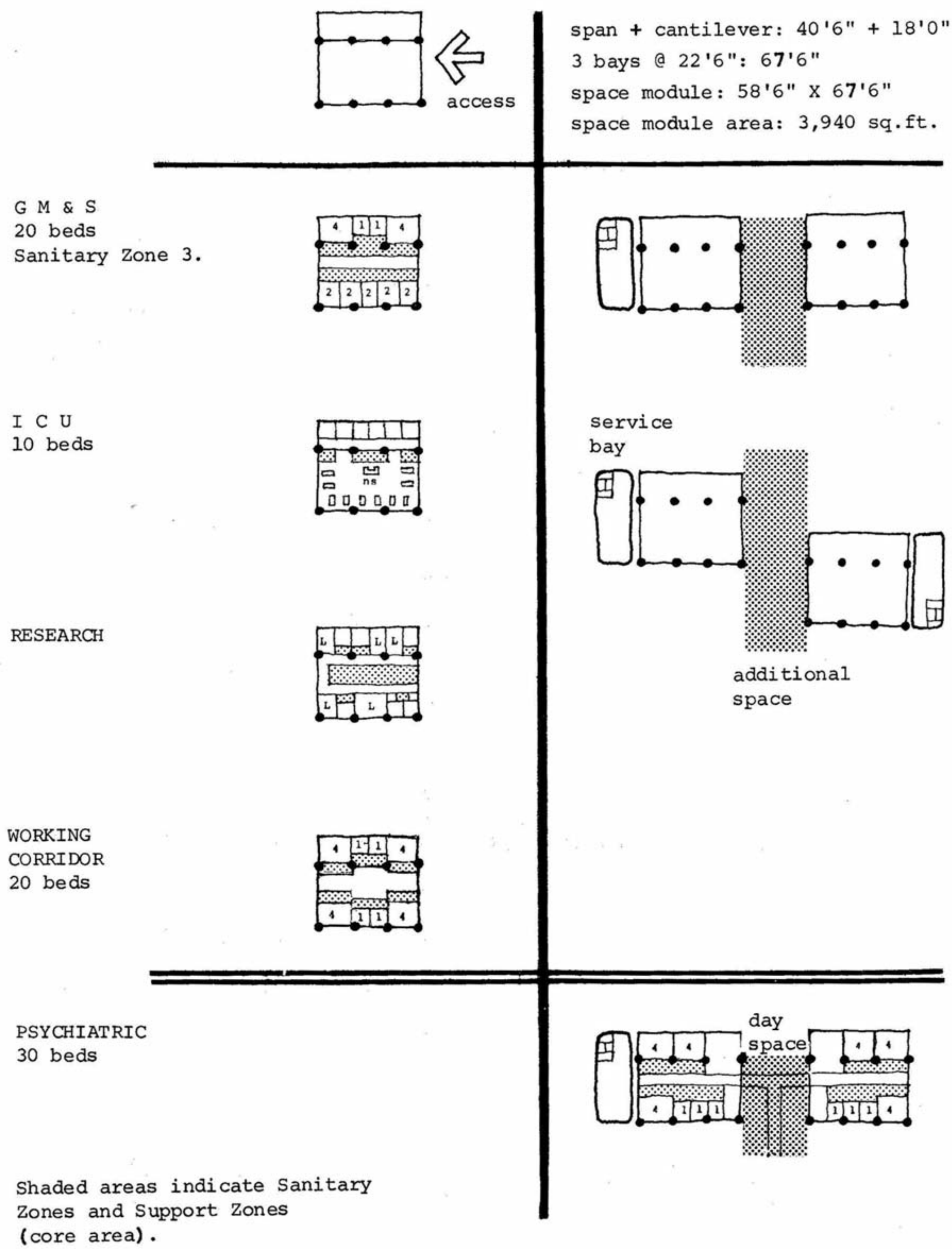


Figure 230-12. SPACE MODULE TYPE 4

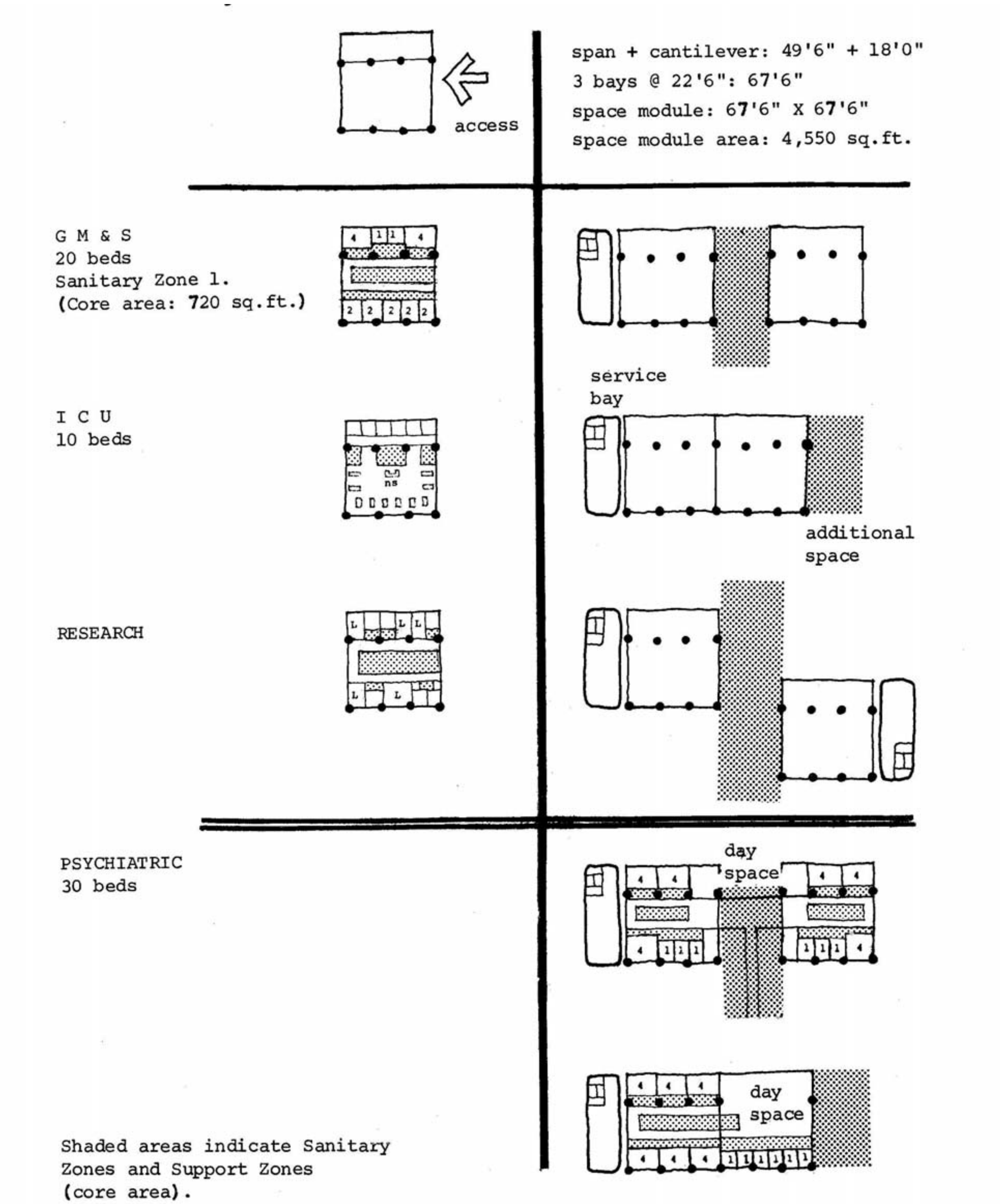


Figure 230-13. SPACE MODULE TYPE 5

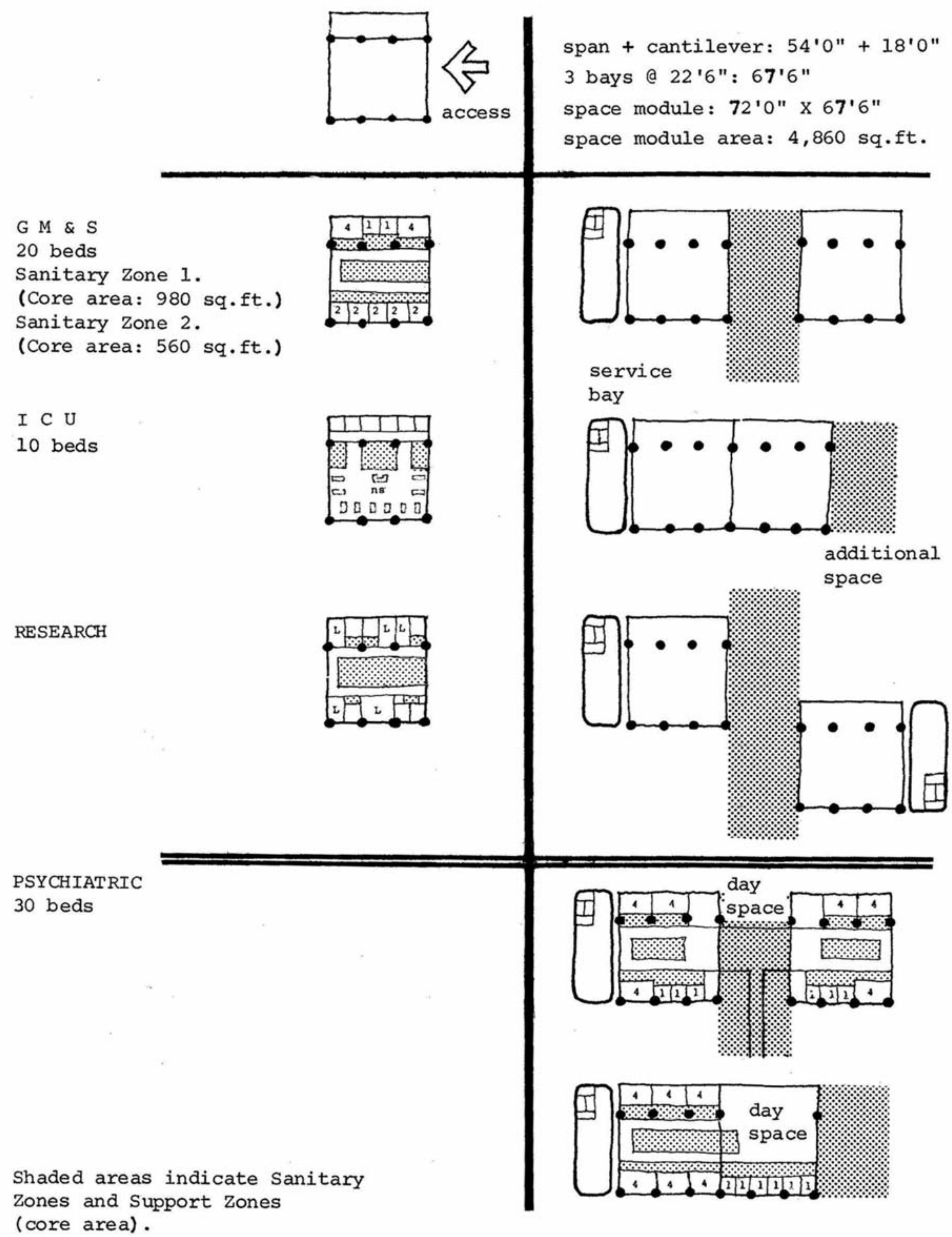


Figure 230-14. SPACE MODULE TYPE 6

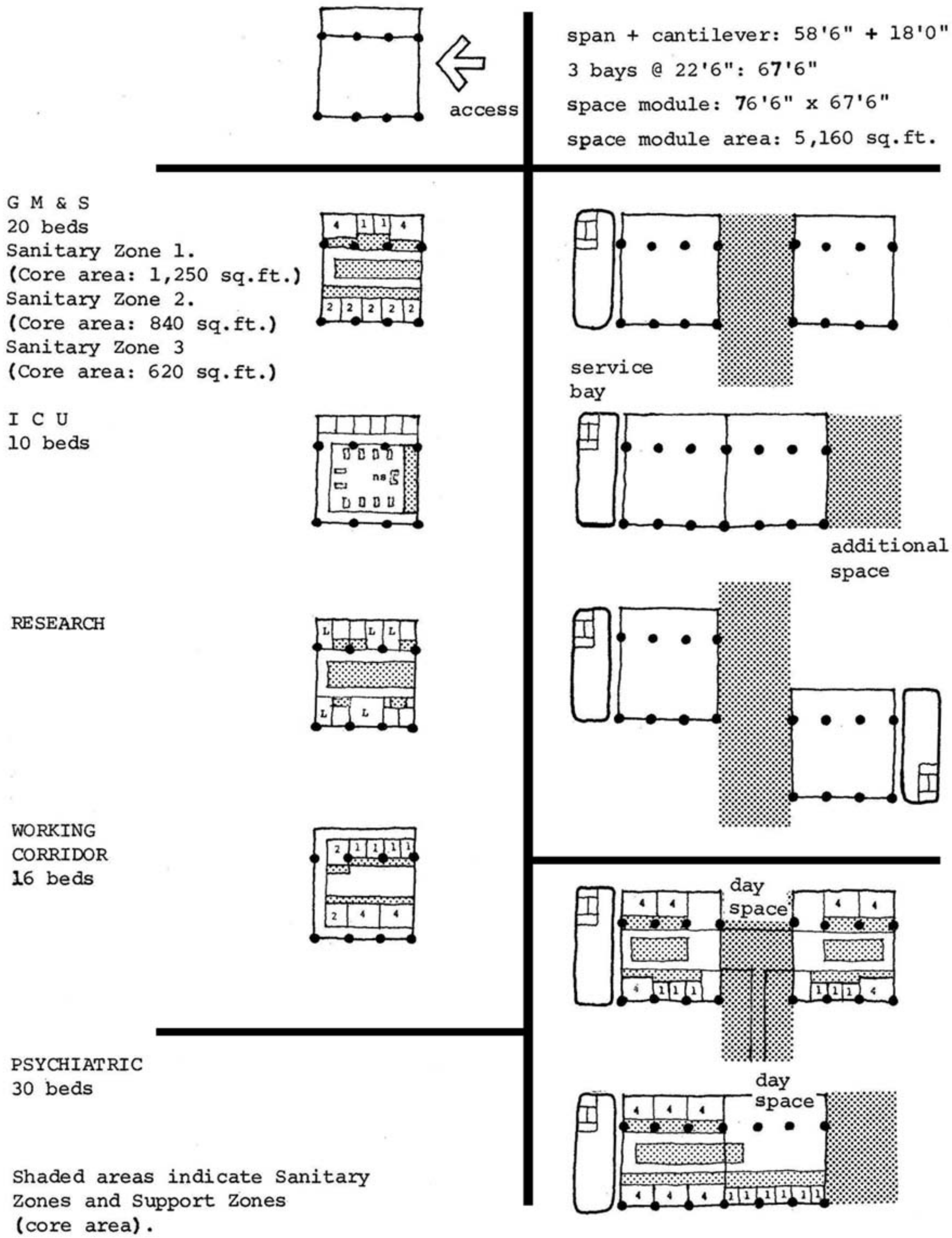


Figure 230-15. SPACE MODULE TYPE 7

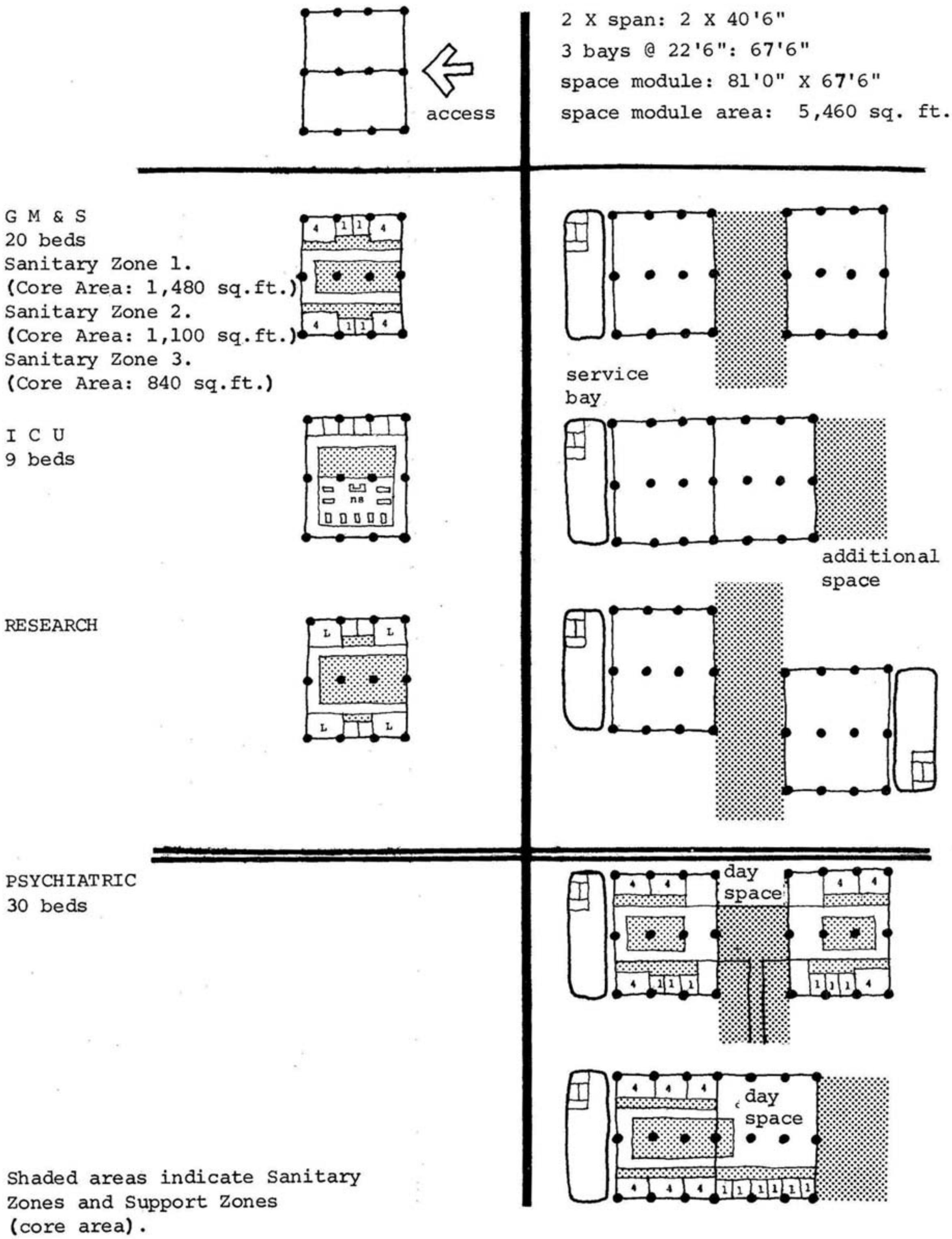


Figure 230-16. SPACE MODULE TYPE 8

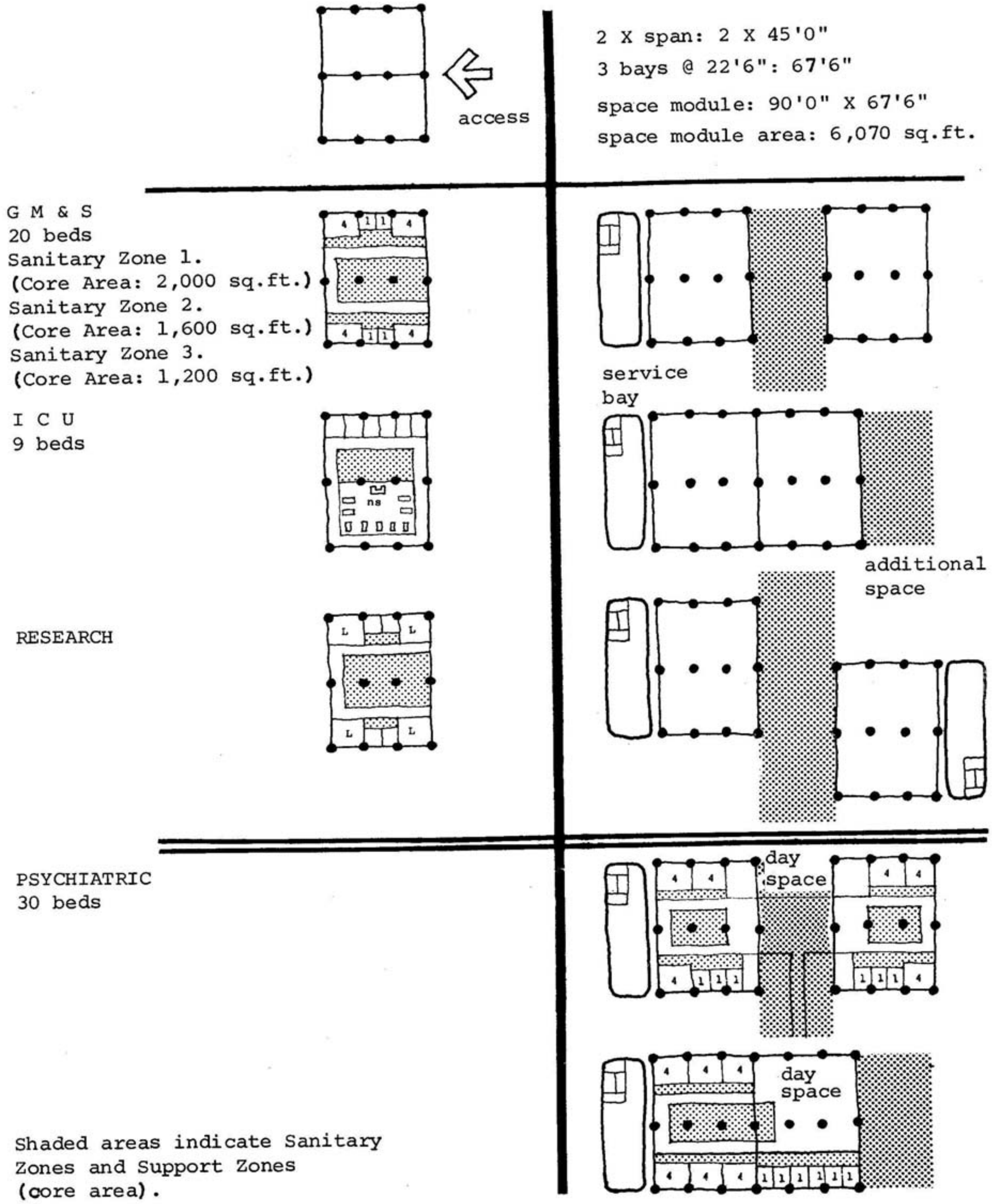


Figure 230-17. SPACE MODULE TYPE 9

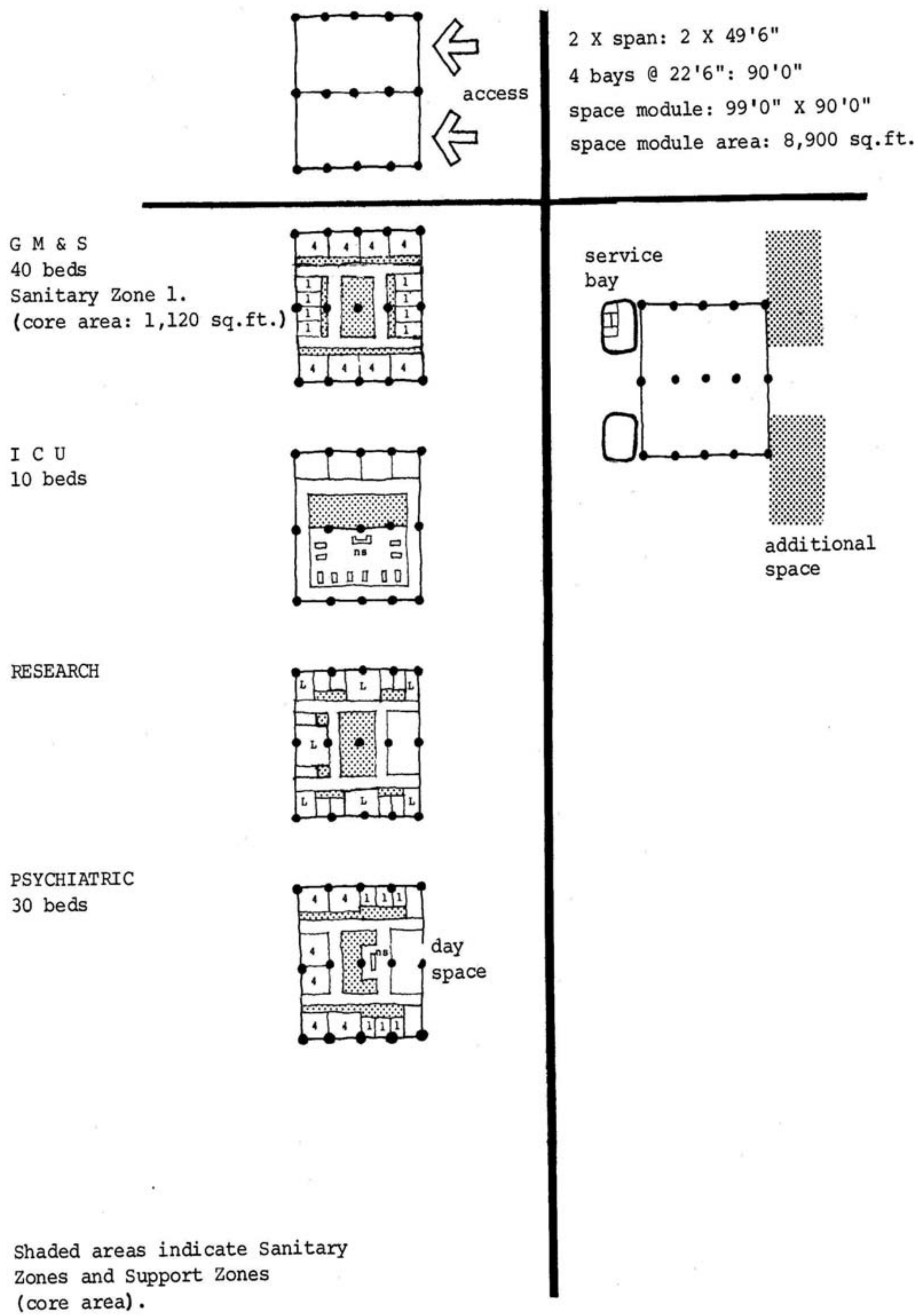
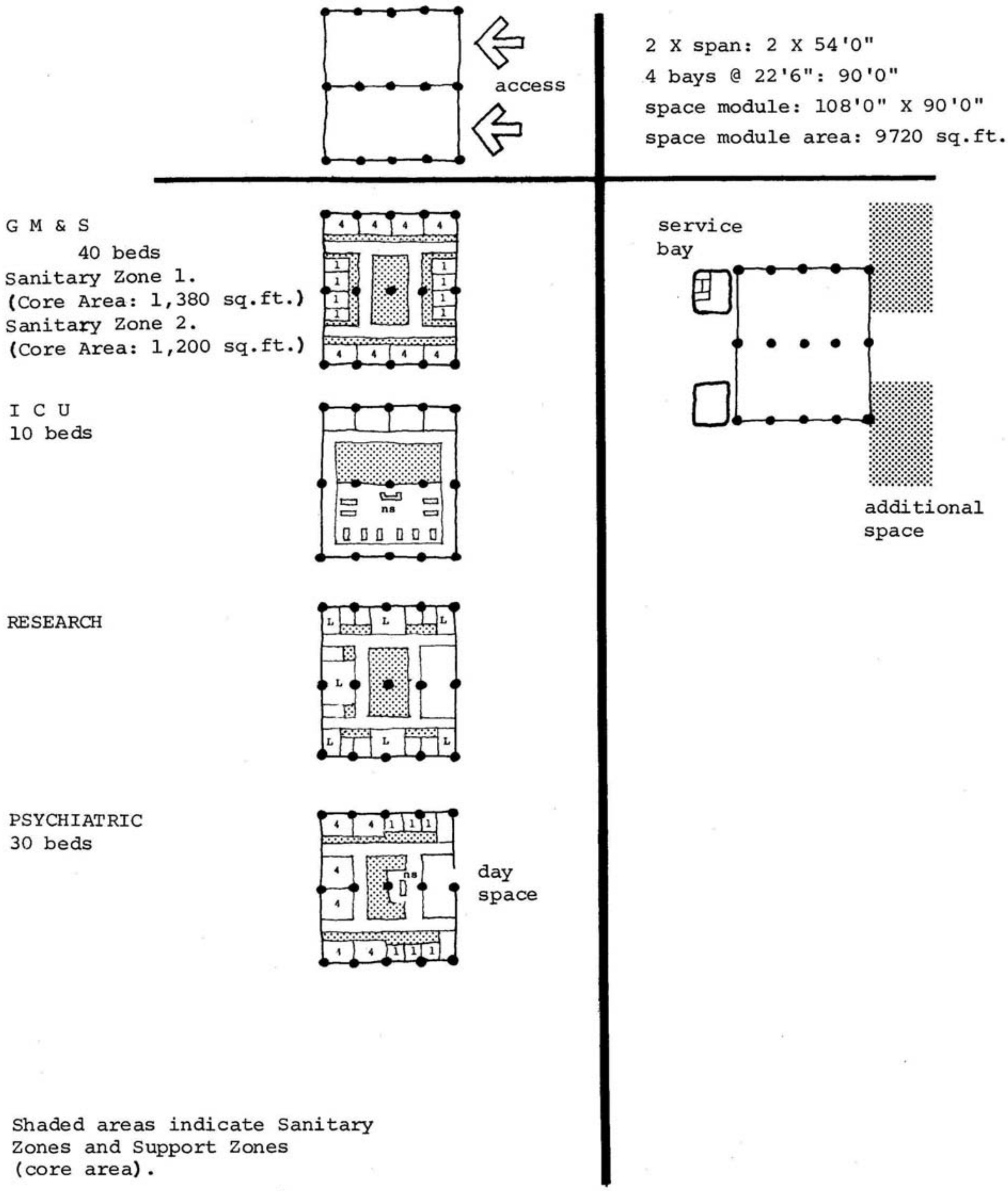
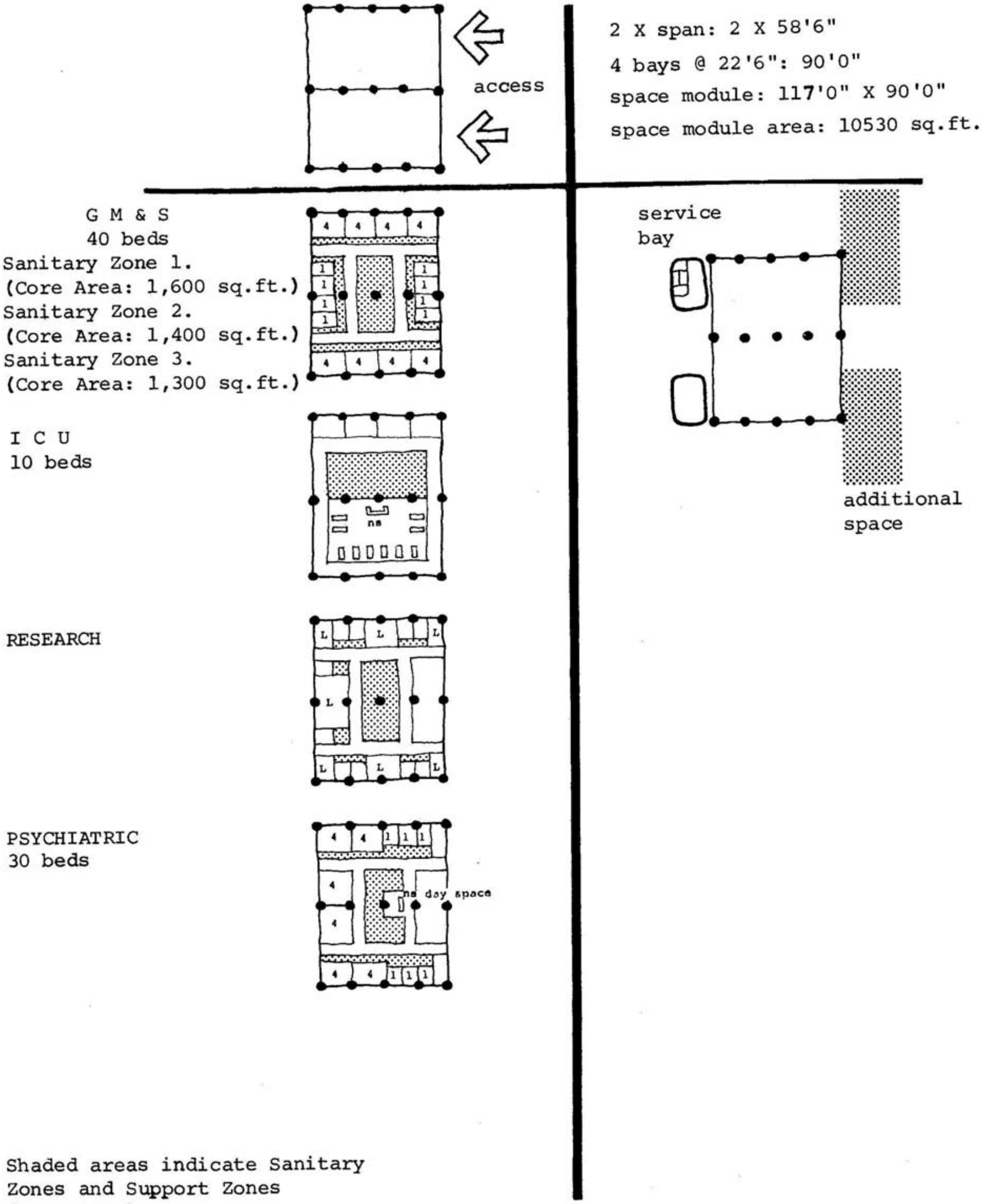


Figure 230-18. SPACE MODULE TYPE 10



Shaded areas indicate Sanitary Zones and Support Zones (core area).

Figure 230-19. SPACE MODULE TYPE 11



Shaded areas indicate Sanitary
Zones and Support Zones
(core area).

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240 The Fire Section

241 BASIC DESIGN

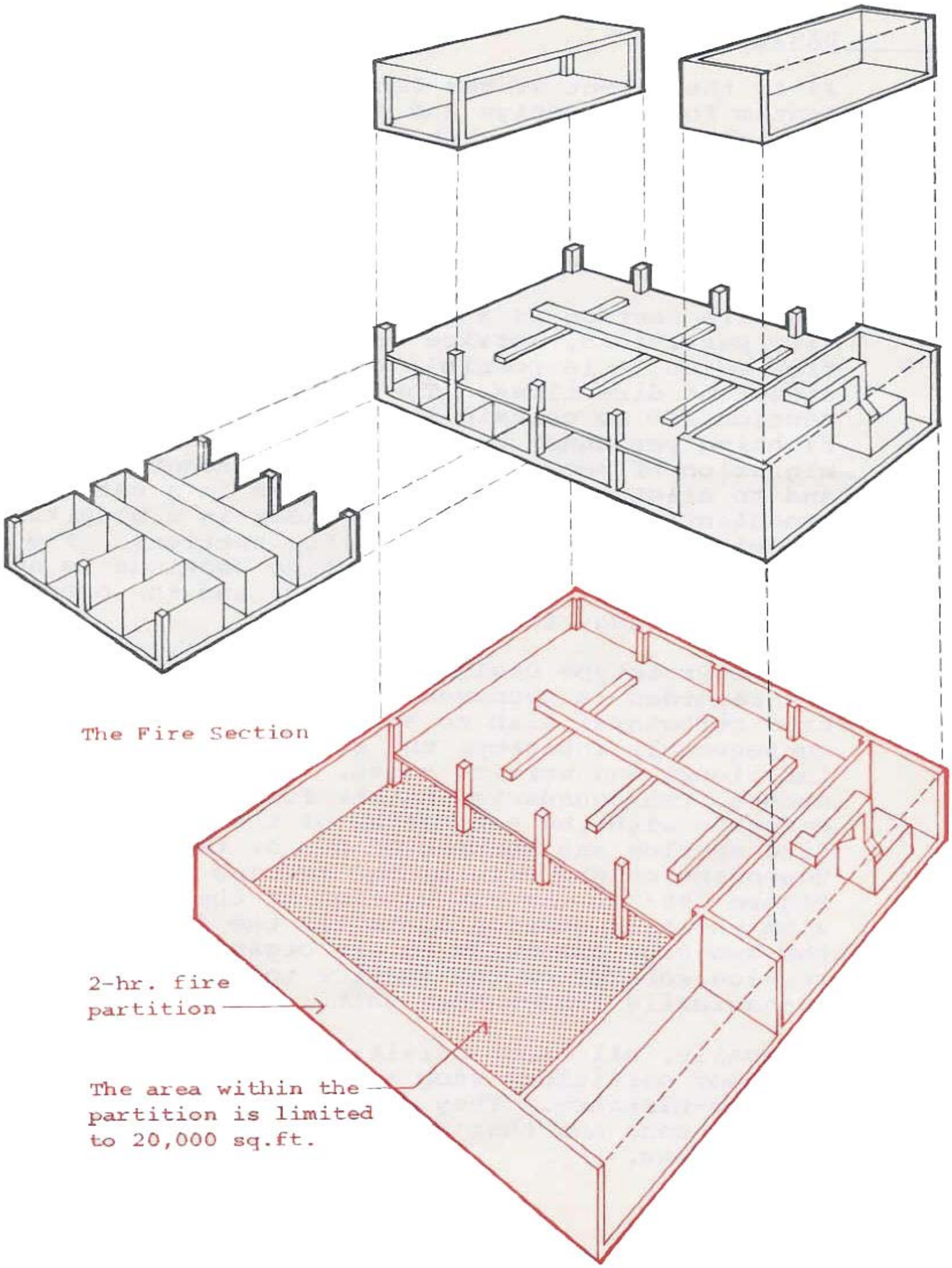
It is the intent of the Prototype Design to provide a system for the design and construction of buildings in complete compliance with current fire safety codes and regulations. The role of the fire section as a planning module is to ensure that the requirements for fire safety are fully met in a manner that is compatible with the other objectives of the Prototype Design, in particular, functional and mechanical adaptability.

The fire section is a unit of area bounded by two-hour fire partitions, service bay walls and exterior walls, from which it is possible to exit in at least two different directions. The main purposes of the fire section are to contain a fire long enough to enable fire fighting personnel to deal with it, to prevent the migration of smoke and fumes to adjacent occupied areas and to allow the exit of occupants in a safe and expedient manner. Thus, any floor in a hospital can be conceived as an assembly of fire sections. The size, and therefore the number, of fire sections is determined by current codes and regulations, and the overall fire-safety strategy for the building.

In the Prototype Design, the two-hour fire partitions are regarded as permanent components as they must span from structural slab to structural slab, and consequently interrupt the continuity of both the functional and service zones. To the greatest practical extent, the boundaries of the fire section should coincide with the boundaries of the of the service module. A fire section may consist of one or two service modules depending on the size of the service module. (See Figure 240-1.) The correlation of the service module with the fire section minimizes the disruptive effect of the two-hour partition on the organization of the service zone since the service module is conceived as a mechanically independent unit.

Typically, all other partitions including smoke stop and corridor partitions stop at the one-hour fire-resistive ceiling-platform. They do not interfere with the service zone and thus can be easily relocated during alterations.

Figure 240-1. THE FIRE SECTION



242 FIRE SECTION CHARACTERISTICS

242.1 SIZE

242.1.1 Use of a fire section approaching the maximum code size of 20,000 square feet will minimize the necessity of expensive fire-rated elements. The optimum service module size (exclusive of the service bay) is about 10,000 square feet. When the sum of the area of two adjacent service modules is less than 20,000, two modules per fire section should be used. When the sum of adjacent service modules exceeds 20,000 square feet, each module will coincide with a fire section.

242.1.2 It must be noted that fire safety codes and regulations which govern fire section size and existing requirements are subject to constant review and change. For example, much attention is currently focused on the use of automatic sprinklers throughout the hospital. If this concept is implemented, it is reasonable to anticipate that certain relaxations with regard to the size of the fire section and criteria for exit distances may follow.

242.2 SHAPE

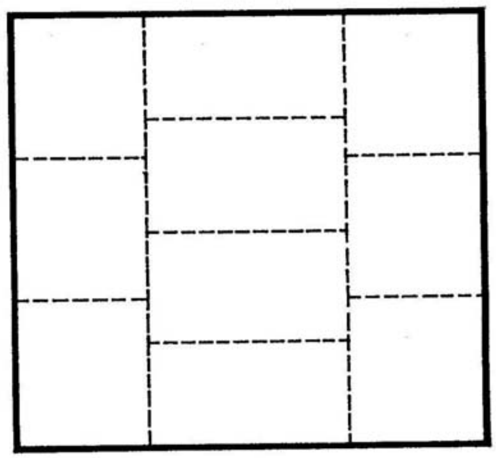
Service modules are most efficient when their boundaries are regular and form a simple shape. The fire section boundaries, which are coincidental with those of the service module, should also be simple in shape.

242.3 RELATION TO FUNCTIONAL ZONE

242.3.1 In a traditional planning sequence, fire separations are determined after all rooms have been configured. Separation walls follow an irregular path along the boundaries of rooms. In applying the system, fire section boundaries are to be determined prior to detailed planning, and establish a regular framework of permanent components within which departmental areas must be planned (See Figure 240-2). The fire sections must be carefully configured and coordinated with internal corridor arrangements to ensure that required exit distances can be maintained.

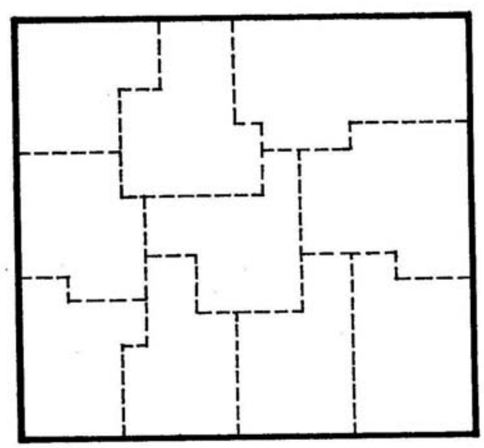
242.3.2 A rectilinear system of fire separations imposes minor constraints on planning while offering significant advantages in the organization of service zones. Fire separation walls in the functional zone can be penetrated by fire-rated doors at any point either in initial construction or in subsequent alterations.

Figure 240-2. FIRE SECTION PLANNING: SYSTEM vs. CONVENTIONAL



System Design:

Fire Sections establish regular planning framework derived from Service Modules, within which departmental requirements and relationships must be resolved.



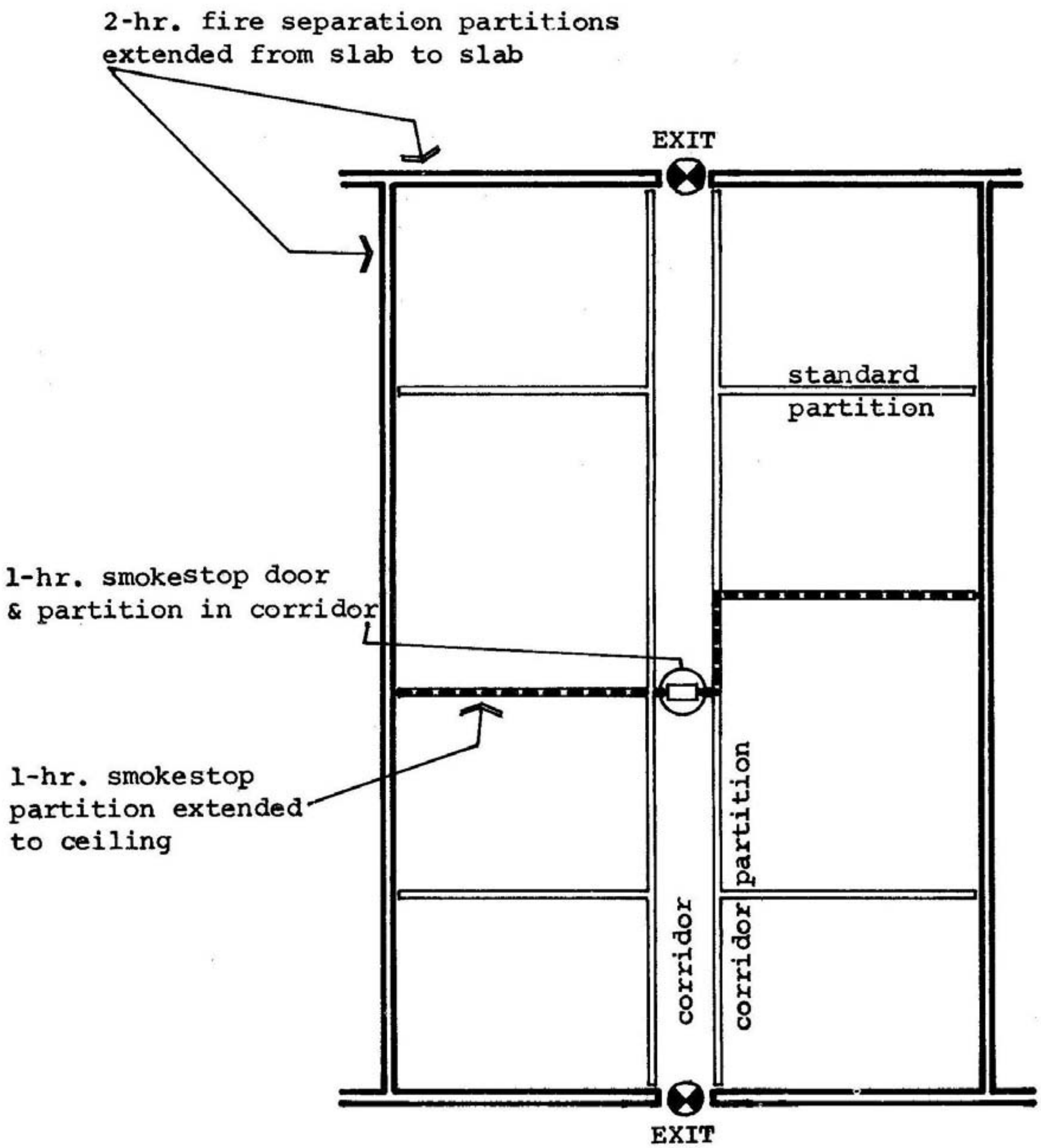
Conventional Design:

Irregular pattern of fire sections defined by 2-hour fire partitions which follow least disruptive route through planned departmental layouts.

The planning constraint is rather one of a need to conform to preset wall configurations. This may require a minor increase in the size of a room or a department. It also requires coordination between fire separation walls and large open areas such as a therapy pool, an auditorium, kitchen-dining area, etc. or open departments such as medical records or certain types of laboratories. These constraints to planning are to a large extent predictable and can be accommodated. As such, they are judged less critical when compared to the alternatives of irregular service zones or relocation of slab to slab fire separations in subsequent alterations.

242.3.3 As stated previously, unlike two-hour fire partitions, smoke stop partitions and corridor partitions span from the structural slab to the one-hour fire-resistive ceiling-platform. They are considered adaptable components and can be located along the boundaries of individual rooms. (See Figure 240-3.) There is one exception. If cost and engineering analysis indicated definite advantages, the service zone could be used as a return air plenum. In such a case, all smoke stop partitions would have to span from structural slab to structural slab with appropriate protection to all penetrations. Consequently, the location of these partitions could become critical in terms of maintaining the continuity of the service zone. Where possible, they should be located at the boundary between service modules.

Figure 240-3. PARTITION REQUIREMENTS



250 Planning Module Applications

251 DESIGN CONFIGURATIONS

A sample range of design configurations have been developed to illustrate the potentials and constraints of the planning module approach. Specifically, a configuration classification system is proposed and the assembly characteristics of each planning module are indicated relative to that system. However, there is no intent to define a preferred set of configurations.

251.1 ASSEMBLY CLASSIFICATION

251.1.1 A Classification Framework

Configurations were analyzed and classified by three characteristics:

1. hospital floor size – in this case, the number of beds/floor was used as a measure of size

2. generic hospital types

3. design complexity – defined in terms of simple and compound assemblies – categories which organize configurations by assembly characteristics of the planning modules.

251.1.2 Hospital Floor Size

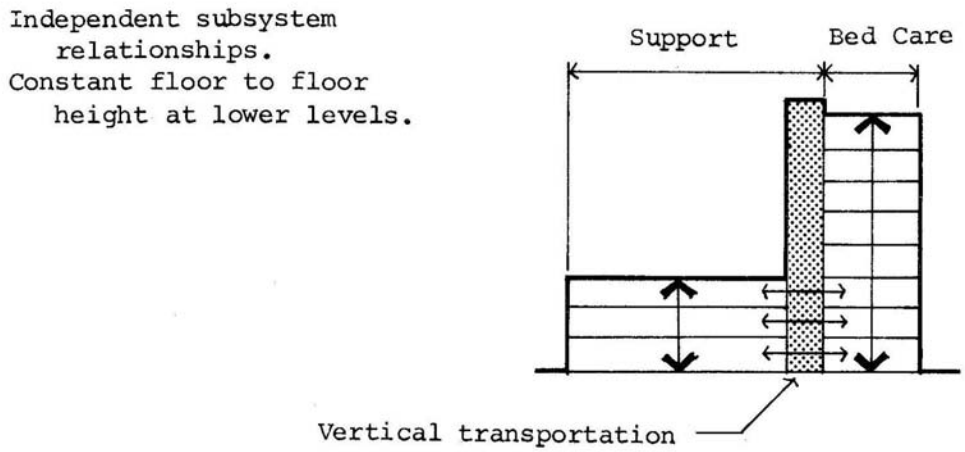
The number of beds is a basic measure of the comparative size of configurations. For example, one can examine all basic configurations containing 160 beds per floor and identify a representative sample of various service module assemblies.

251.1.3 Generic Hospital Types

Hospital types vary in their relationships between the bed care and support areas, and these relationships must be reconciled within the limits of the system.

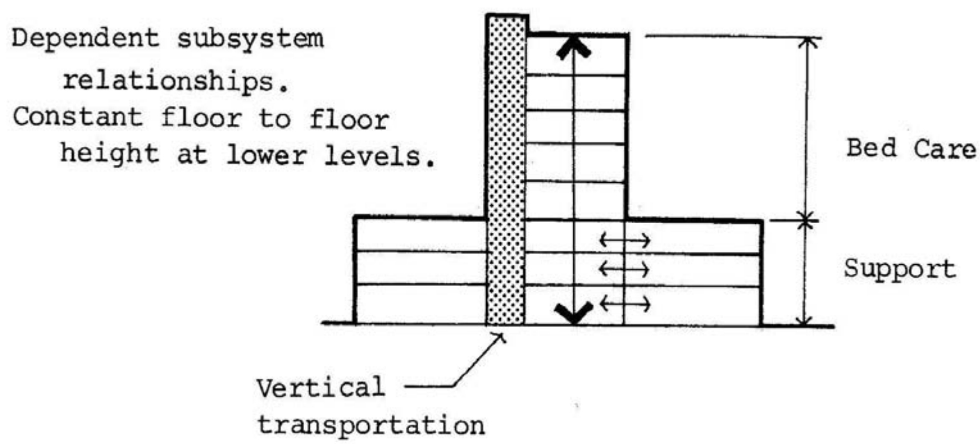
1. Tower separate from a base

   Nursing functions are generally separate from the support functions. There is a relative independence of choice of planning modules and assembly patterns between the tower and the support area, although the floor-to-floor heights in the lower bed care floors must be equal to those in the support area to provide horizontal continuity.



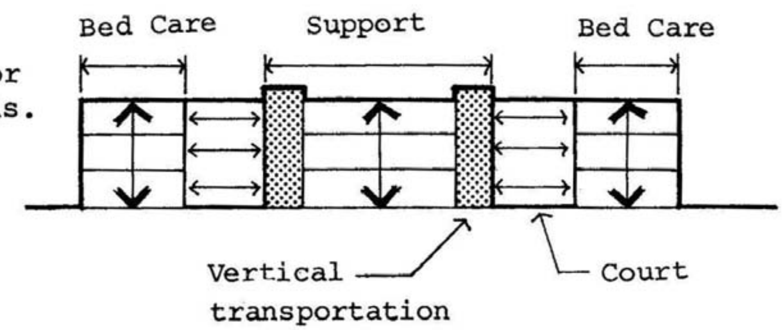
2. Tower on a base

   The tower on a base needs a maximum of coordination between bed care and support areas since the organization of the tower service module pattern fundamentally affects the organization of the service modules in the base.



3. Horizontal Hospital

   The horizontal hospital demands a close coordination of floor-to-floor heights. Because of this contiguity, the higher ceiling required in many support functions may have to be carried over into the bed care area.



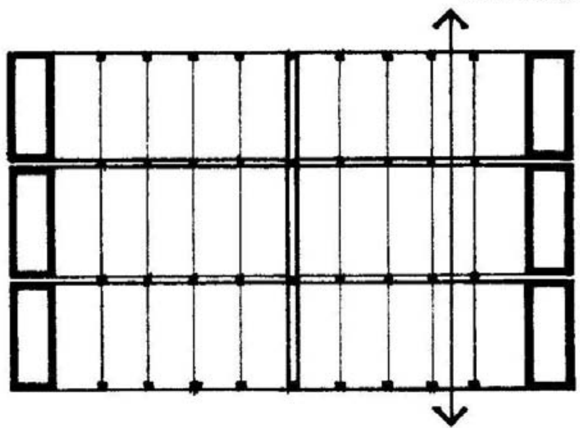
251.1.4 Design Complexity

From an analysis of the assembly characteristics of the relevant building subsystems and planning modules, a consistent pattern emerged which has been used as a means of classifying subsystems and understanding their implications on design configurations.

Plan configurations fall into two broad categories called simple and compound assemblies of service modules. (See Figure 250-1.)

1. Simple Assemblies

   Simple assemblies result when the respective disciplines of a unidirectional structural bay and an exterior service bay location are maintained throughout any given configuration.



2. Compound Assemblies

   A compound structural assembly is one which contains structural bays that adjoin one another at right angles. A compound mechanical assembly is one in which an interior service bay is used.

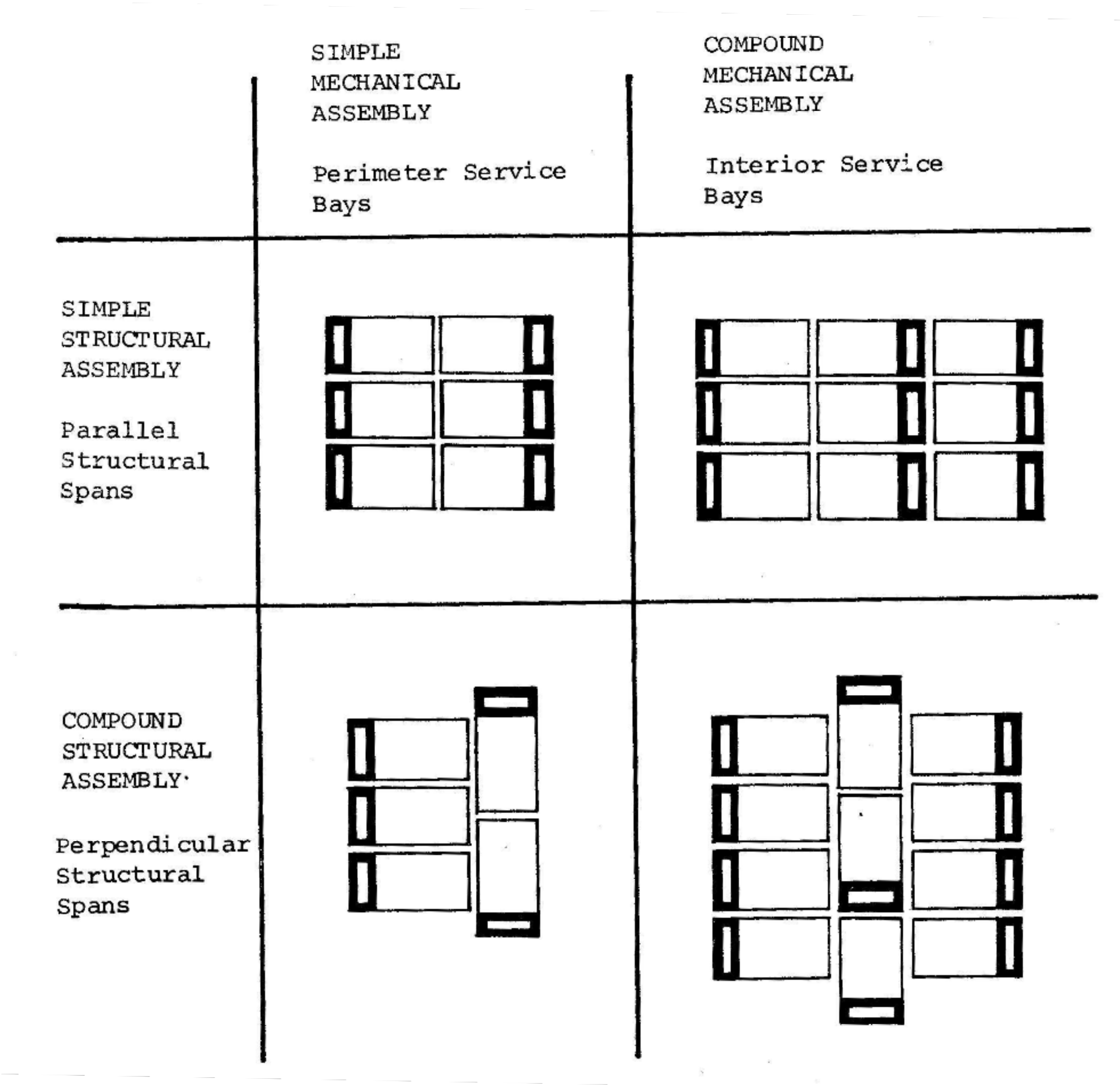
251.2 ALTERNATIVE CONFIGURATIONS

Utilizing the three classification headings discussed in Section 251.1 above, a table of configurations can be developed which quickly compares a number of configuration options and thereby speeds the initial design development. Figure 250-2 illustrates the classification framework applied to a number of design configuration alternatives.

In the chart, groups of configurations occur in vertical columns, each of which is a development of one basic assembly pattern of bed care service modules. Some columns could be extended to illustrate larger configurations, just as other basic assembly patterns could be shown. However, this chart is intended as a demonstration of the way configurations may be classified within the constraints of the system, rater than a complete catalog of system configurations.

The configurations in the chart are diagrammatic so that basic assembly patterns and characteristics can be illustrated.

Figure 250-1. SIMPLE AND COMPOUND ASSEMBLIES



LEGEND FOR FIGURE 250-2

Space Modules

Additional Space

Service Bay for Bed Care Service Module

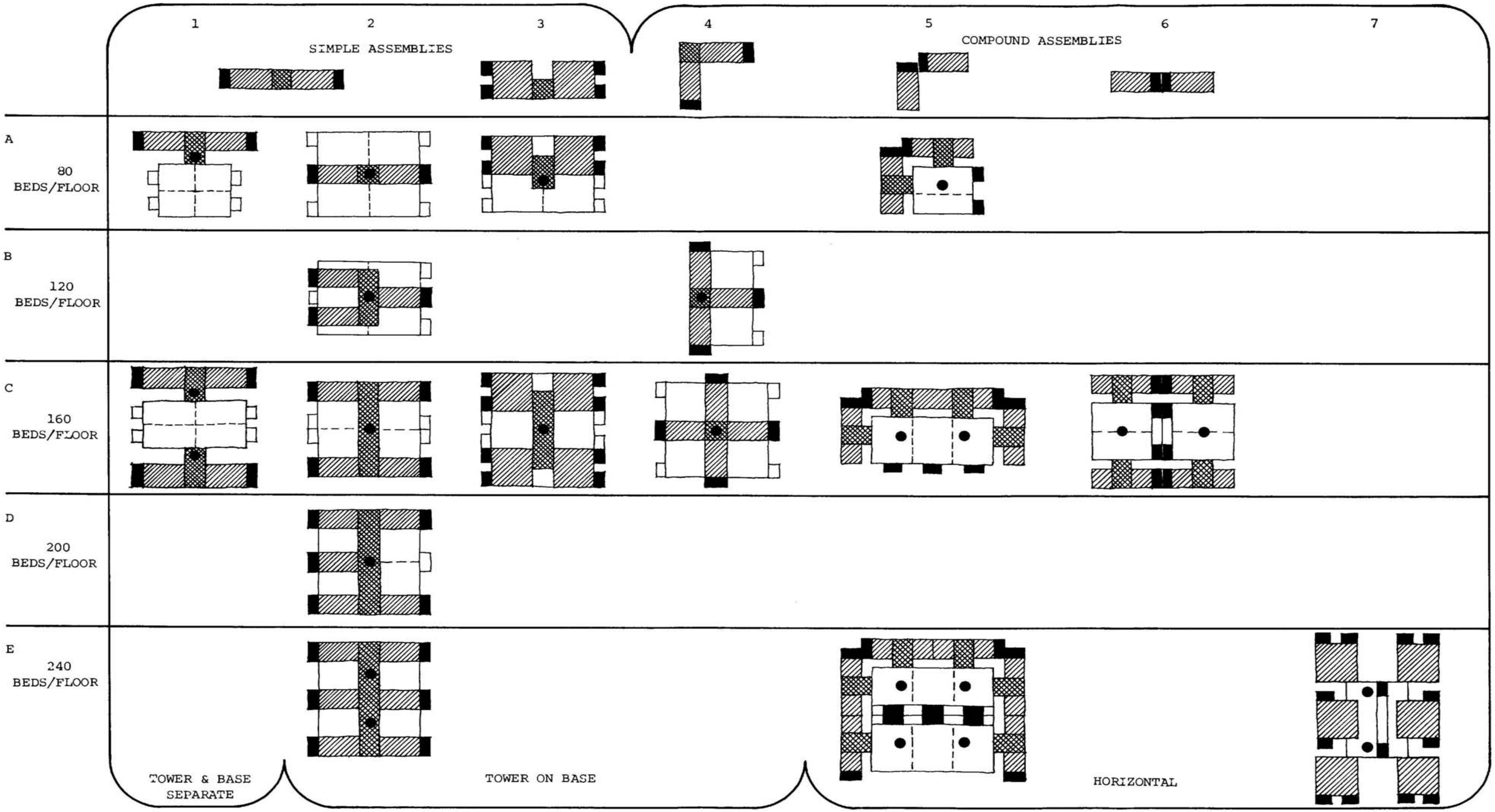
Service Bay for Support Service Module

Vertical Transportation

Service Module containing Support

Note: Service Module containing Bed Care Functions is composed of Space Modules and Additional Space

Figure 250-2. EXAMPLES OF CLASSIFIED CONFIGURATIONS



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251.3 ASSEMBLY CHARACTERISTICS OF THE SERVICE MODULE

The assembly characteristics of the service module are primarily established by:

1. The structural subsystem

2. The service bay

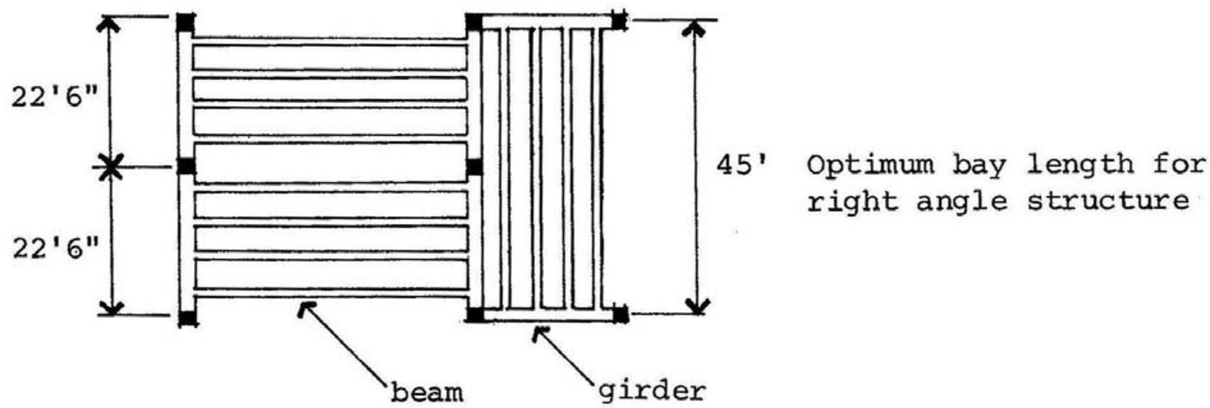
3. The space module, when the service module occurs in the bed-care portions of the hospital.

251.3.1 The Structural Subsystem

Those features of the structural subsystem which most markedly affect the assembly of modules are the structural bay, the shear wall, and the thermal expansion or seismic separation joint.

1. The Structural Bay

The constant width and variable length of the structural bay produce offset column lines when two space modules or service modules adjoin at right angles. This problem can best be resolved through the use of the 45' span, although the modular structural bay lengths create a regular condition in any case. (See Sections 316.4 and 721.1.2 for further discussion.)



2. Shear Walls

Configurations are affected in several ways by the use of shear walls to resist lateral forces.

The 160’ height limit on all configurations is established by the practical limit of the shear wall.

In large buildings shear walls often occur in interior locations because of their relationship to expansion or separation joints. Any shear walls, in addition to those in the service bay, should occur at the service module boundaries to ensure that the service zone is unobstructed. (See Section 316.2 for further discussion.)

3. Expansion and Separation Joints

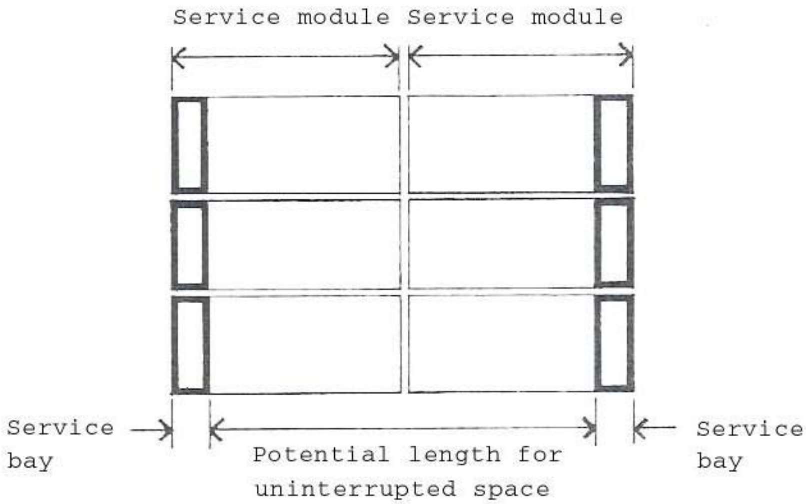
Large buildings should be broken by thermal expansion joints so that dimensions in any direction do not exceed 300 feet (less in areas of large temperature variation). The separation created by an expansion joint often means that shear walls are necessary at that location to assure lateral stability, thereby forming a barrier along the line of the separation. Shear walls are similarly required at seismic separation joints. If the expansion or separation joint can be located on the border of a service module or fire section, the effect of this barrier can be minimized. (See Section 316.1.)

251.3.2 The Service Bay

In the service distribution system, the only aspect which plays a major role in developing configurations is the arrangement of service bays.

1. The Typical Condition

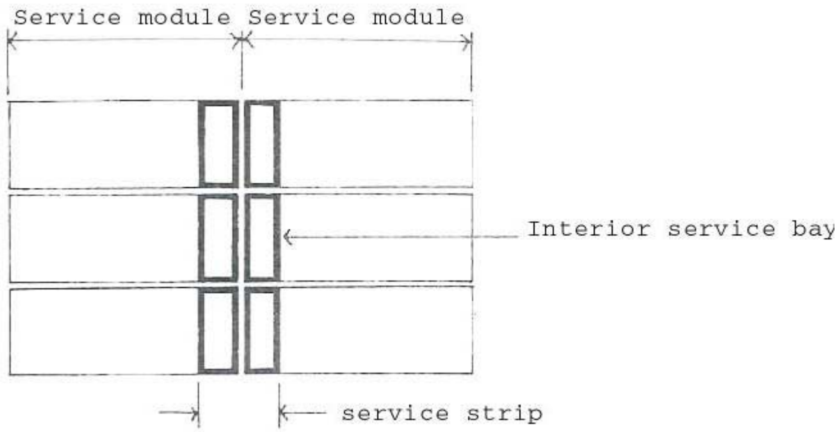
   The service bay typically should have at least one exterior face to facilitate equipment installation and allow a direct fresh air intake. This pattern of perimeter service bay locations provides for the potential of large uninterrupted spaces which are twice the length of one service module, exclusive of the service bay.



2. The Service Strip

An interior service bay often becomes necessary in a configuration where the size or the organization of service modules is such that some portion cannot be served from an exterior service bay.

When the strategy of an independent air-handling unit for each service module is extended to an interior service bay location, an alternative fresh air supply must be found. More importantly, the problems of installation and replacement of mechanical equipment are significantly greater.



A service strip is defined as any series of adjacent service bays, some of which are interior. The service strip occurs often in compound configurations, and must be accommodated by a special strategy.

Three alternate strategies have been developed for the use of a service strip. However, the detailed resolution of this condition must be accomplished on a project-by-project basis. (See Section 735.1.2 and Figure 730-5 for demonstration of the service strip in the Building Schematic Design.)

a. The air-handling unit is located adjacent to the service module, and air is ducted to the air-handling unit, either through a vertical shaft or horizontally through the service zone. (See Figure 250-3.)

b. The air-handling unit is placed in a remote location such as the roof while the electrical room and the main plumbing risers remain in their normal location. Supply and return air are ducted to and from the service module and the air-handling unit. (See Figure 250-4.)

c. The air-handling unit, and all auxiliary pumps and fans, are located at the service zone level. This would require an increased service zone height. (See Figure 250-5.)

The choice of one of the three alternates for an individual configuration would largely rest on specific programmatic and functional requirements, but Alternate b. best provides for replacement and maintenance of mechanical equipment. Alternates a. and c. would severely complicate the problem of replacing large equipment. Additionally, Alternate c. would require a modified ceiling structure to accommodate the mechanical equipment in the service zone and to deal with the resultant acoustic problems.

A service strip would require a special structure, since the alternates for planning this zone do not suggest a basic design which would suffice for all cases. (See Figure 316.5.)

251.3.3 The Space Module

1. Aspect and Attachment

   When the service module contains bed-care functions, its assembly characteristics are largely dictated by the space module requirements for aspect and attachment to other space or service modules.

Figure 250-3. **SERVICE STRIP ALTERNATE STRATEGY: AIR HANDLING UNIT ADJACENT TO SERVICE MODULE WITH DUCTED SUPPLY**

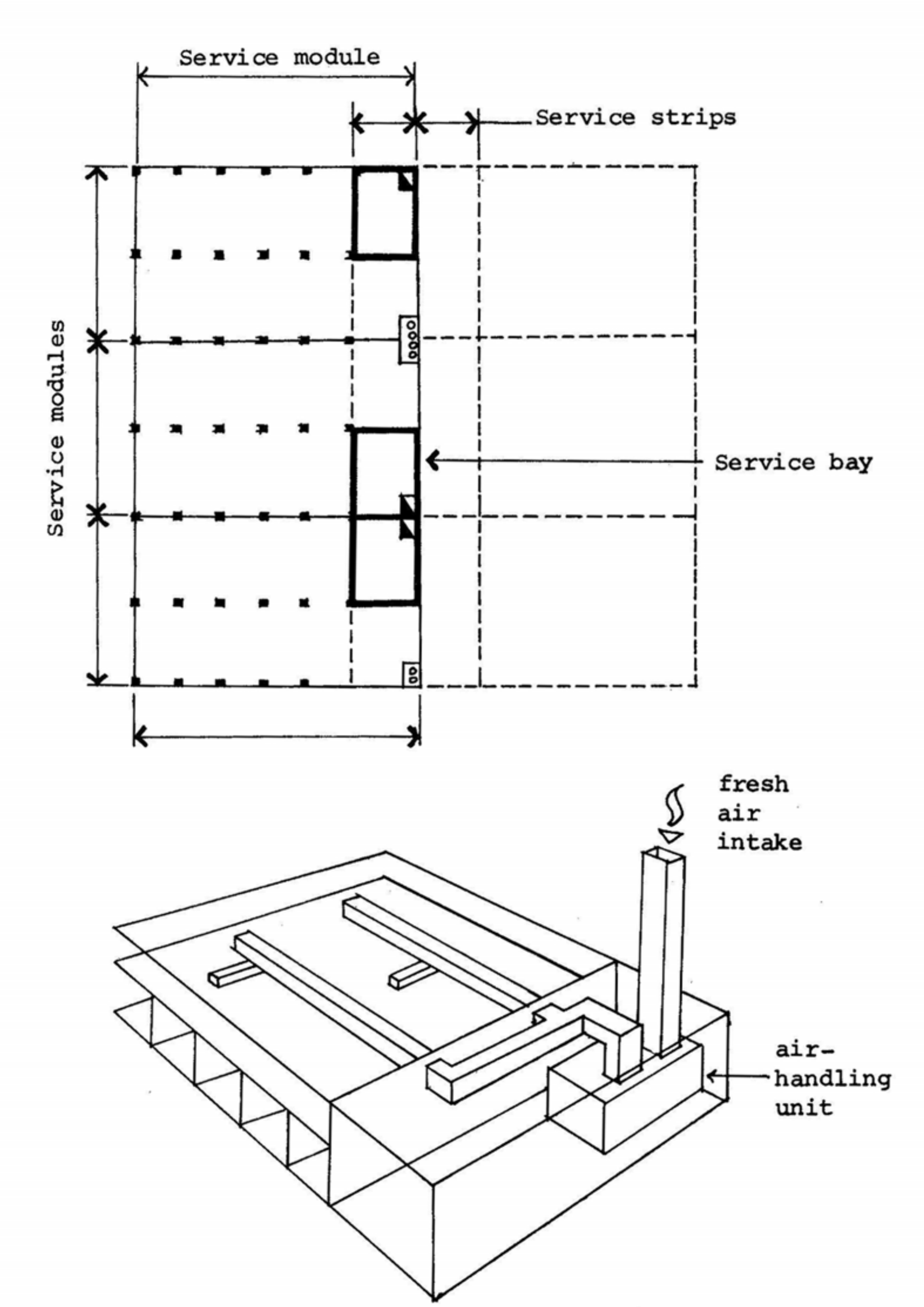


Figure 250-4. SERVICE STRIP ALTERNATE STRATEGY: AIR HANDLING UNIT LOCATED ON ROOF

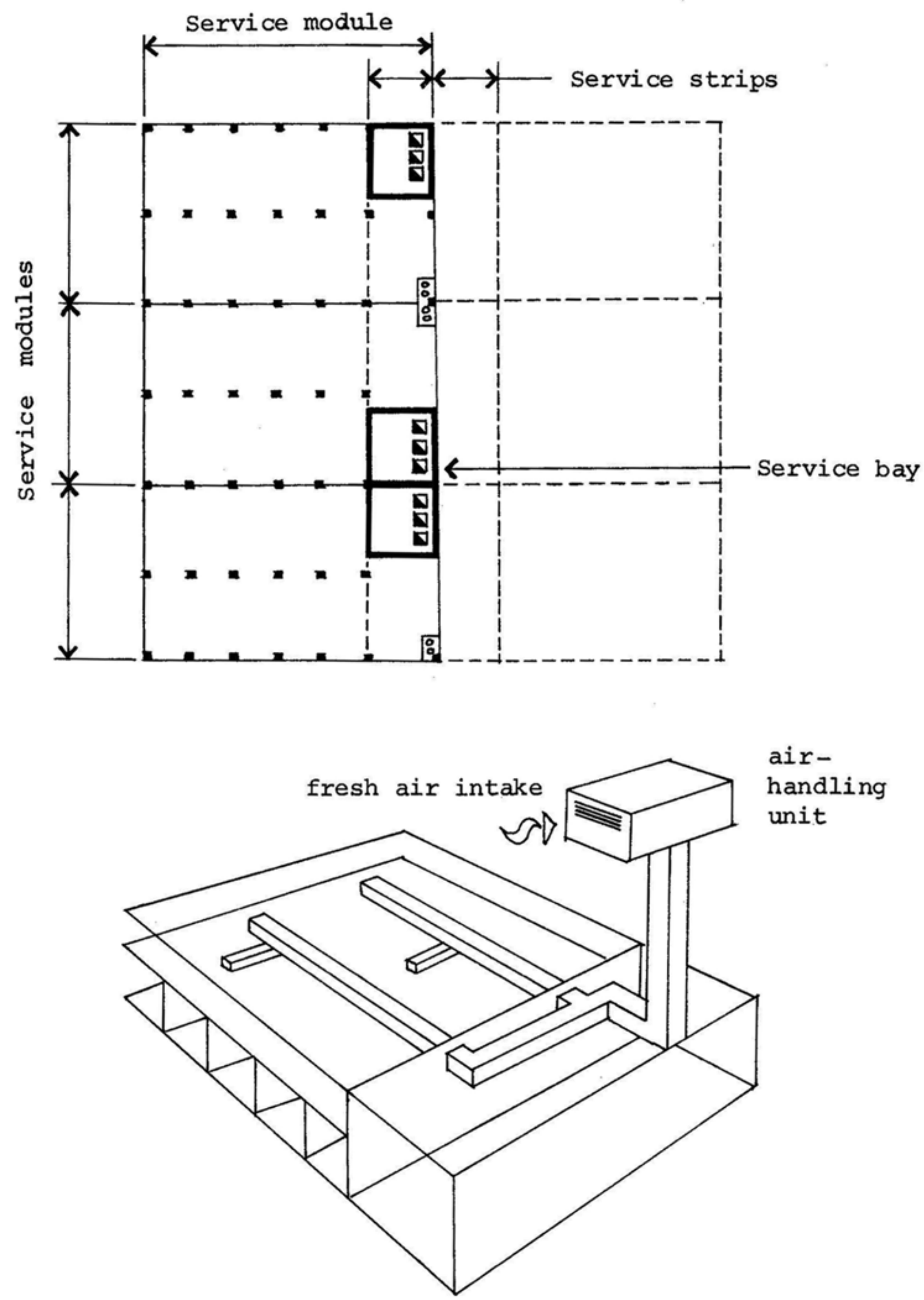
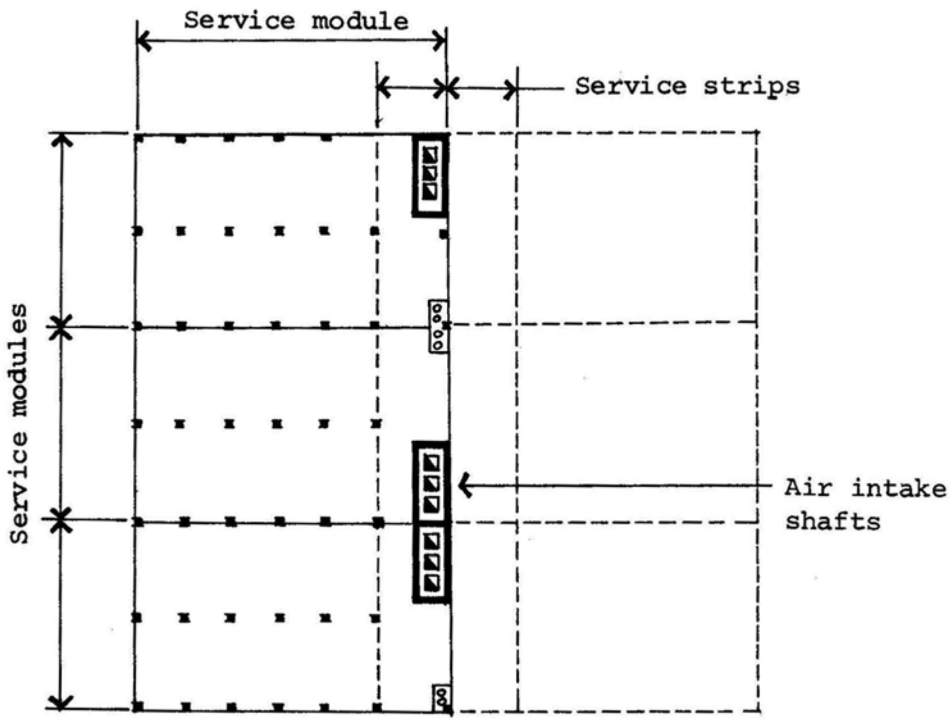
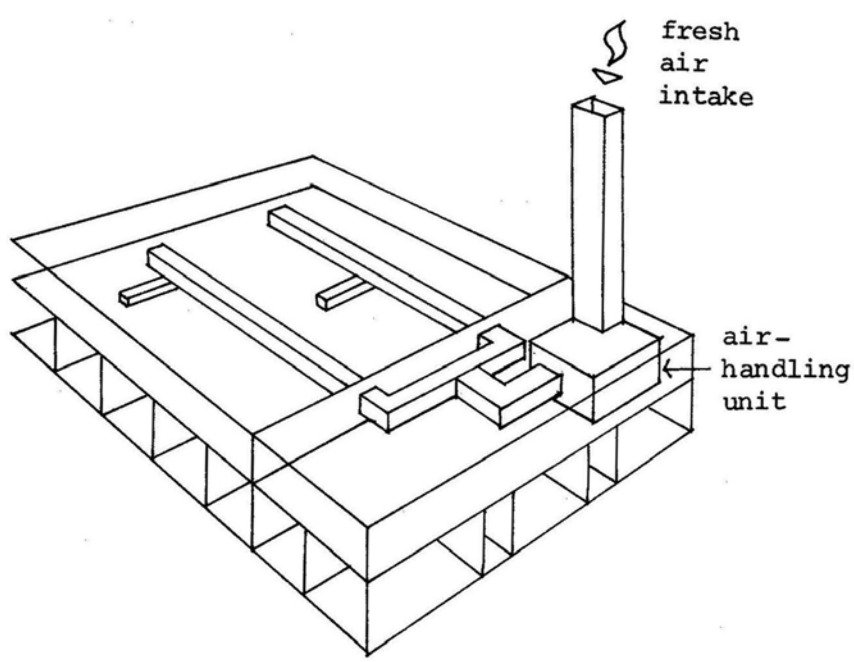


Figure 250-5 . SERVICE STRIP ALTERNATE STRATEGY: AIR HANDLING UNIT LOCATED IN SERVICE ZONE WITH DUCTED SUPPLY





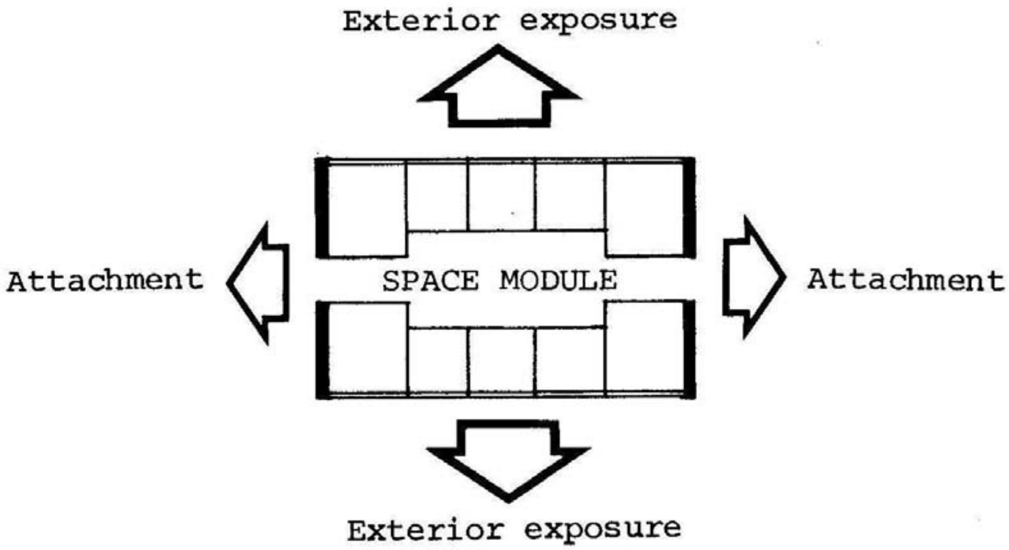


Figure 250-6 illustrates the assembly characteristics of two basic types of space module: the two-aspect 20-bed module and the four-aspect 40-bed module.

2. Orientation and Access

The orientation of the service modules containing bed-care functions can also significantly influence the planning of the rest of the hospital. For example, in a tower on a base configuration, the orientation of the nursing tower can determine the assembly of service modules in the base and limit the location of major access points on the ground level.

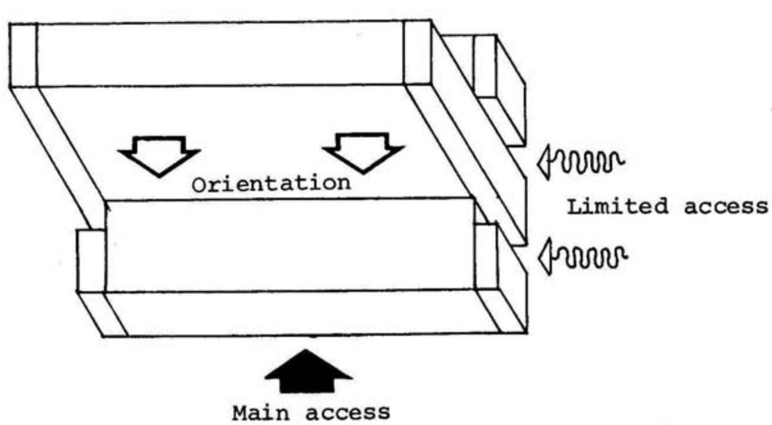
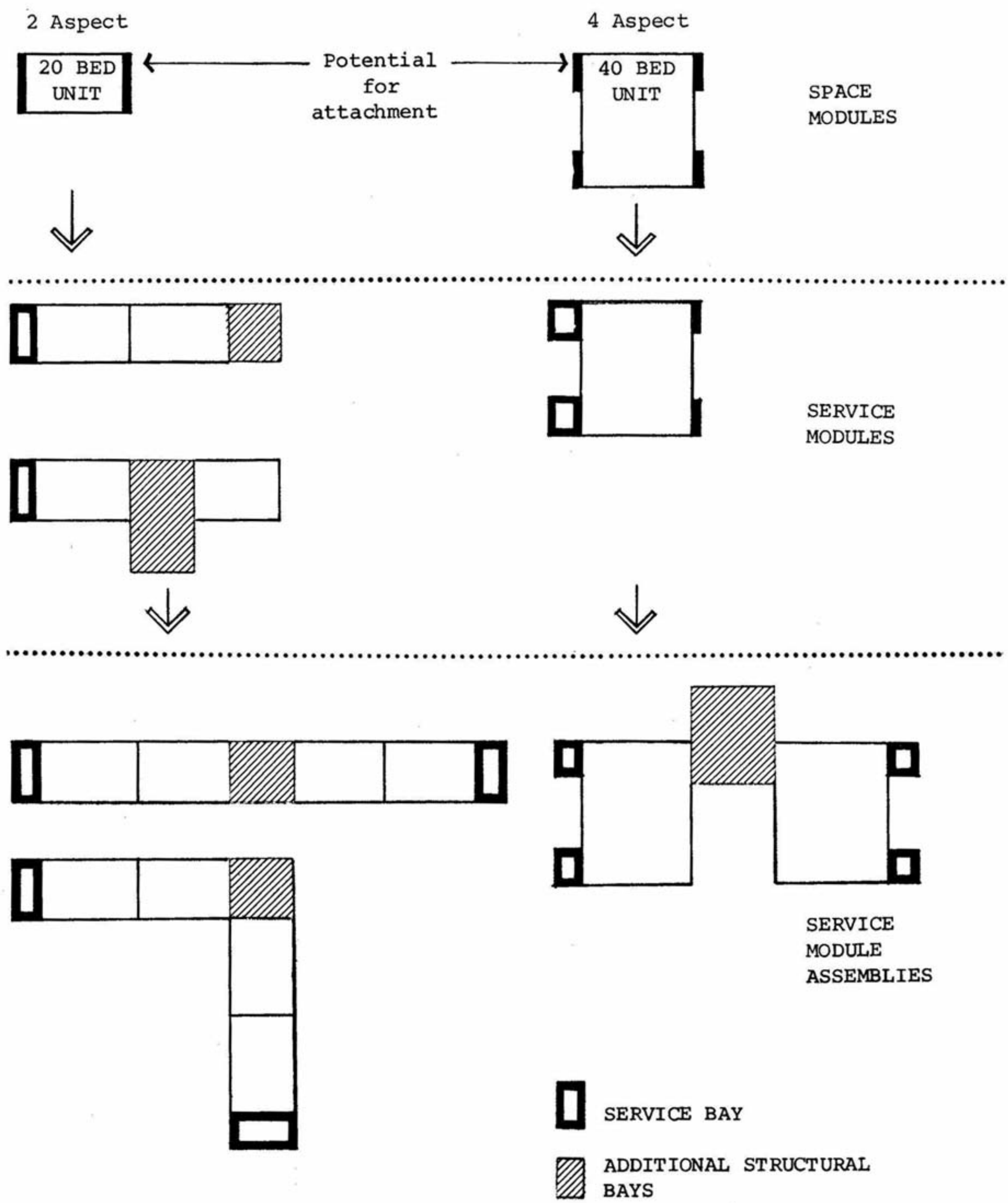


Figure 250-6. ASSEMBLY CHARACTERISTICS OF THE SPACE MODULE AND SERVICE MODULE



251.3.4 In the general case, the service module has no external exposure requirement, and can be assembled in a very direct pattern. Using rectangular modules, three sides of the module are available for attachment or access and the modules can be combined, incrementally, in two directions.

Figure 250-7 illustrates this general assembly pattern. This diagram also points out the general configurations which have service strips. A dotted line on the diagram gives an indication of the types of configurations in which an expansion joint becomes necessary.

The assembly of service modules in the support areas is very much a process of adjusting the service module shape and boundaries to the programmatic requirements of the hospital. Detailed resolution of the service module configuration is an integral part of the design process, therefore specific statements about the assembly characteristics are not relevant in all cases. (See Section 735.1.2 for discussion of service modules in the Building Schematic Design.)

251.4 ASSEMBLY CHARACTERISTICS OF THE FIRE SECTION

Configuration studies are generally initiated through the assembly of space modules or service modules, but the service module and fire section are so interrelated that the fire section becomes a significant consideration. (See Section 240: Fire Sections)

The basic assembly characteristics of the fire section are:

1. Its area must not exceed the 20,000 sq. ft. limit set by current fire safety practice, and,

2. It follows a simple geometry which is derived from the service module; the boundaries of the fire section are coincident with the boundary of the service modules contained within it.

251.5 SUMMARY OF CONSTRAINTS

A summary of principal assembly characteristics is presented in Figure 250-8. These are keyed to the simple and compound assembly patterns and emphasize the special characteristics which may occur in a compound configuration. The figure also provides a general checklist of characteristics for any additional design configuration studies.

Figure 250-7. SERVICE MODULE ASSEMBLY CHARACTERISTICS

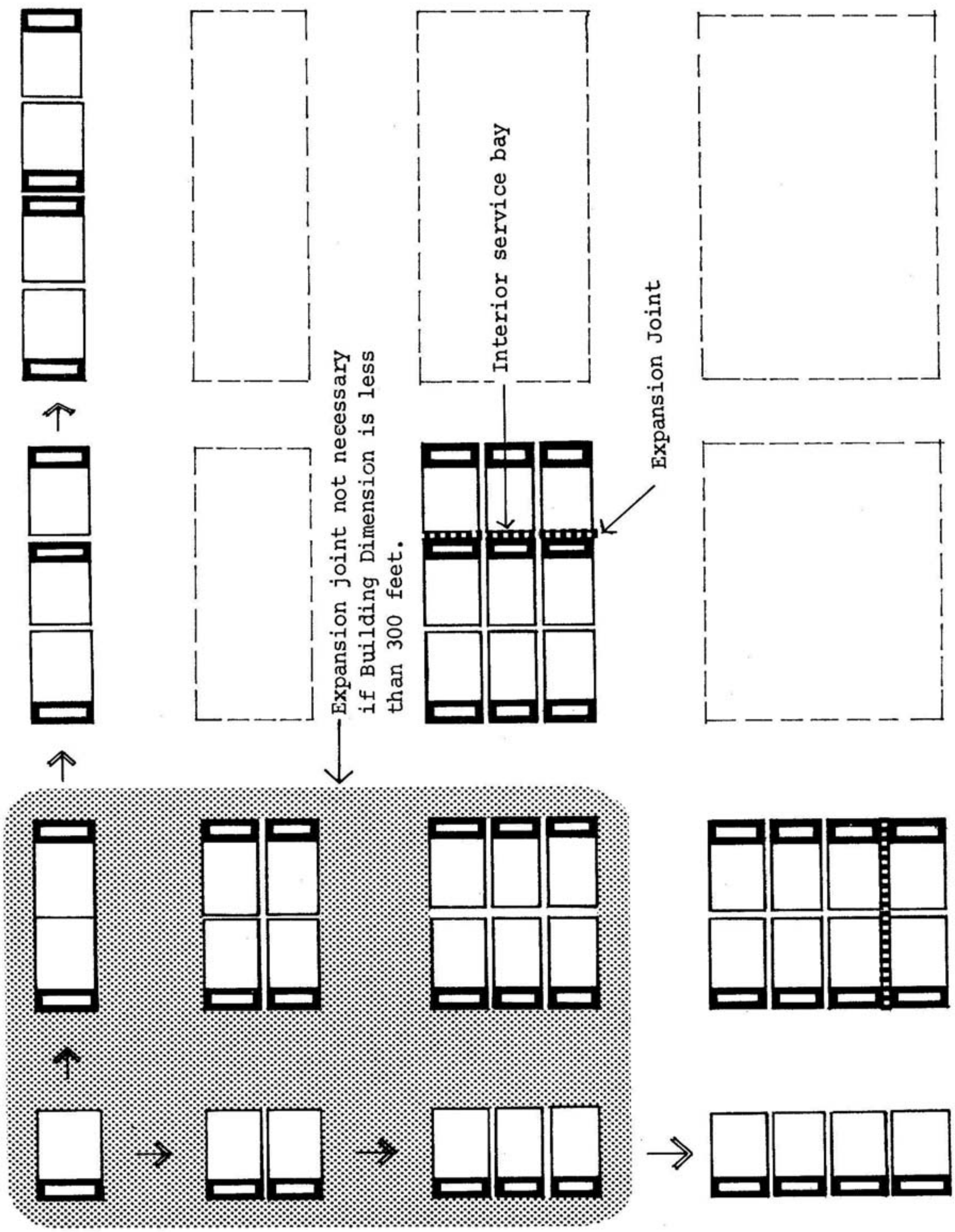


Figure 250-8. SUMMARY OF ASSEMBLY CHARACTERISTICS

	SIMPLE ASSEMBLIES	COMPOUND ASSEMBLIES		
		RIGHT ANGLE STRUCTURE	SERVICE STRIP	300' DIMENSION
STRUCTURAL SUBSYSTEM	▪Structural bays with constant width - 22'6" and variable length from 40'6" to 58'6" at 4'6" increments ▪All spans are directionally consistent ▪Height of shear wall limited to 160'	▪Reconcile structural direction change (best accomplished with 45' span)	▪Special structural strip	▪Possible need for additional shear walls
MECHANICAL SUBSYSTEM	▪At least one service bay for each service module ▪The service bay occurs on perimeter ▪Maximum length supply duct is approximately 150'		▪Adequate fresh air supply ▪Access to air-handling unit for installation and maintenance	
SPACE MODULE	▪Access to the space module through additional structural bays ▪Orientation of the bed-care areas			
SERVICE MODULE	▪10,000 sq.ft. limit exclusive of service bay if two are combined in fire section ▪Aspect, if used for bed care ▪Length limited by mechanical supply and service zone height	▪Secondary subzones must change direction		▪Provide expansion joint
FIRE SECTION	▪20,000 sq.ft. limit ▪No crossing of service module boundaries			

300 THE BUILDING SUBSYSTEMS

310 STRUCTURE

311 BASIC DESIGN (Figure 310-1)

The structural subsystem is designed to accommodate service modules in a variety of building configurations. It includes a framing system for vertical loads and a shear wall or braced frame system for lateral force resistance. A general design approach is described for the structure of the service bays where the configurations and dimensions are not predictable. The configurations and dimensions of the rest of the service module are predictable, however, and a more detailed basic design has been developed. The basic design is limited to the structure above grade; it does not include items such as foundations, retaining walls or exterior walls (See Section 317.2).

311.1 FRAMING SYSTEM FOR VERTICAL LOADS

311.1.1 Typical Structural Bays

The basic framing system consists of columns, girders and beams in structural bays approximately two to three times as long as they are wide. The length of the bays is in the span range of forty to sixty feet, the reasons for which are discussed in Section 721.1.1. The bays are spanned in the long direction by closely spaced beams of minimum economic depth, and the beams are supported by, or cantilevered from, girders of similar depth. The use of short primary members with long secondary members results in a shallow layer of structure. The roof is framed in a similar manner, but takes into account different loading criteria. The rationale for the selection of this type of system is discussed in Section 721.2.

This framing system can be utilized in the vast majority of the functional areas of the hospital. It does not apply to service bays and certain functional areas with exceptionally high live loads or special configuration requirements which are listed in Table 310-1. The structure in these areas must be designed by the project A/E as required by the specific conditions.

311.1.2 Service Bays

The configuration of the service bays will vary but will typically result in a simple beam and slab floor system, framed as necessary for the layout.

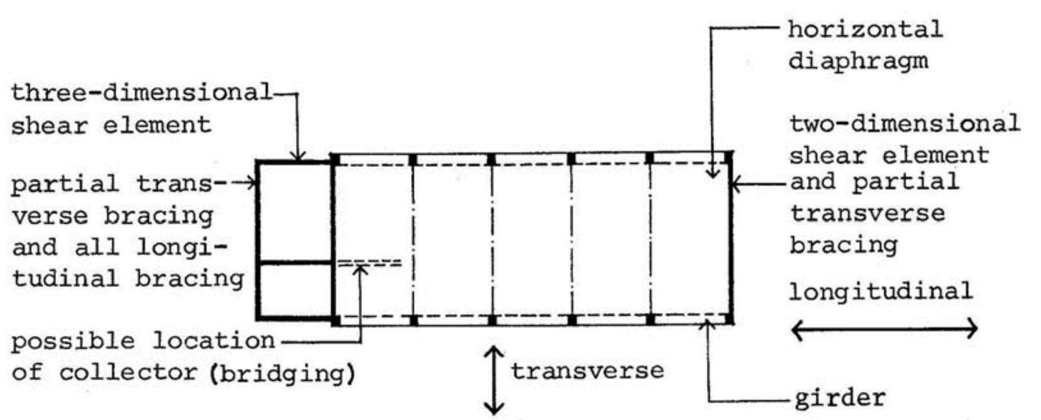
Vertical loads will be transferred to the foundations through the solid walls which typically surround the service bay.

311.2 LATERAL FORCE RESISTING ELEMENTS

Resistance to lateral forces is by shear elements which may be concrete walls and/or braced frames (usually steel). These elements occur only at the perimeter of service modules and, in some cases, their required locations may be the major determinant of the size of these modules. The shear elements are provided in two forms:

1. Two Dimensional. Walls in one direction.

2. Three Dimensional. Box-like towers containing walls in two directions which enclose service bays, elevator towers and other permanent elements, occurring at the perimeter of the service modules. The towers may be capable of providing resistance in two directions. In the longitudinal direction, lateral forces are typically transmitted to the shear elements through girders or collectors as indicated in the following diagram.



The solid wall and/or braced frame system of resisting lateral forces has been selected for the reasons which are enumerated in Section 721.3.

311.3 RELATIONSHIP BETWEEN MAIN STRUCTURAL MEMBERS
(Figure 310-2)

The relationship between the main structure members is illustrated in Figure 310-2. These relationships and the rationale are as follows:

1. The perimeter girder is in the same plane as the beams. The clear space below the perimeter girder facilitates access to the service zone above the ceiling during construction and major alterations.

2. The interior girder is below the beams. This allows for a continuous clear space across the building for service distribution between the beams and also simplifies beam continuity problems.

3. The beams are offset from the column centerlines. The offset beams create a clear zone for drains to drop through the slab in the vicinity of the column centerline where pipe drops frequently occur (e.g., at a shared stack between back-to-back toilets). The offset beams also simplify beam continuity problems.

4. The faces of the columns and girders need not be in the same plane. In no case, however, should the width of the girder be less than the abutting column dimension.

5. Shear elements may be located only at the boundaries of service modules. In some instances, the required locations for shear elements may determine the limits of the service modules. Future expansion of the building should not be jeopardized by the location of shear elements.

6. To ensure uniform patient bedroom widths, the “inside” face of the transverse shear element should not project beyond the column centerline. The other face should not project beyond the outside face of the column.

7. Longitudinal shear elements should preferably be aligned with perimeter girders, i.e., girders directly connected to the horizontal diaphragm.

311.4 PERMANENT AND ADAPTABLE COMPONENTS

The entire structure is conceived as permanent for the life of the building, with the exception of a topping slab which is removed as required to depress floor mounted fixtures and to take up the differences in thickness of various floor finishes typical in hospitals. The topping slab is placed over a bond breaker so that, in the case of future alterations, the permissible depth of slab removed is evident. The structural slab must also be capable of accepting changes in the location of those small elements which penetrate it, as described in Section 313.5.4, Paragraph 2.

Figure 310-1. BASIC DESIGN OF STRUCTURAL SUBSYSTEM

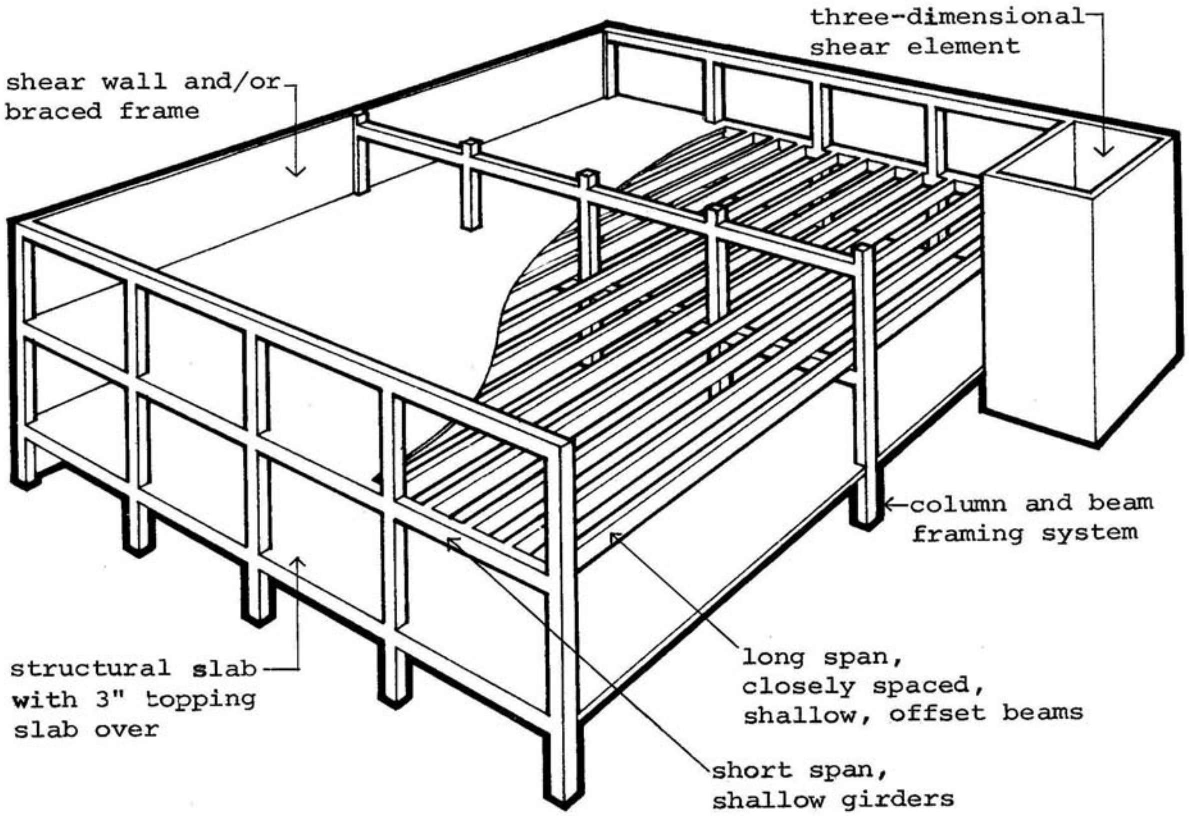
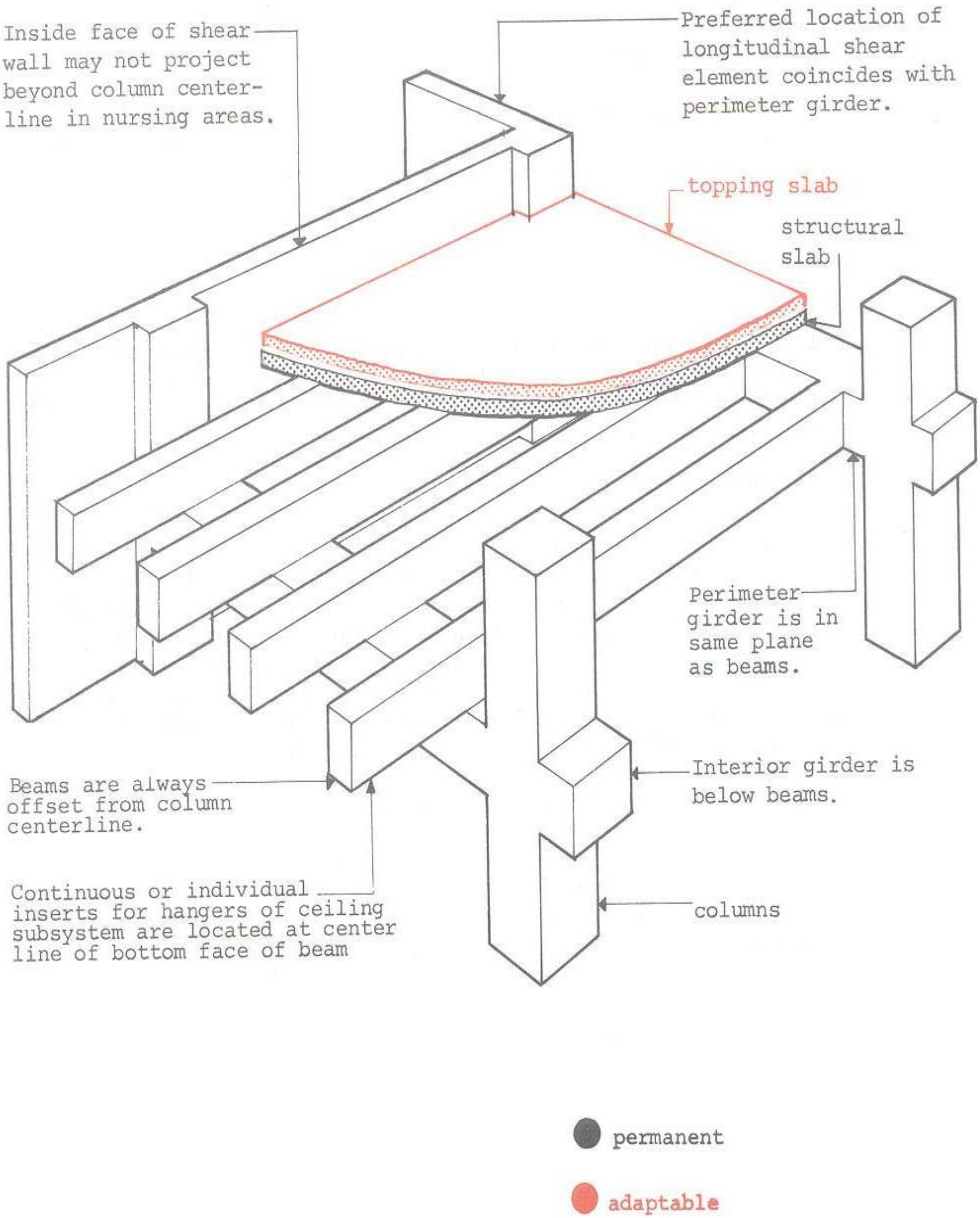


Figure 310-2. RELATIONSHIP BETWEEN MAIN STRUCTURAL MEMBERS



312 GENERIC DESIGN OPTIONS

The four systems described below are options for the framing of the service modules exclusive of the service bays. The service bays and the shear elements will typically be cast-in-place concrete, though steel may be used in conjunction with Option 2.

312.1 PRESTRESSED CONCRETE BEAMS, CAST-IN-PLACE

Columns, girders and slabs are cast-in-place reinforced concrete. Beams are post-tensioned pan joists. Under most conditions this system will give the lowest first cost.

312.2 STEEL

Columns, girders and beams are steel. Slab is cast-in-place reinforce concrete. Beams are in composite action with the slab. In some cases, the shorter erection time of steel may offset its higher labor and material cost.

312.3 PRESTRESSED CONCRETE BEAMS, PRECAST

Columns and girders are reinforced concrete, either precast or cast-in-place. Beams are precast, prestressed concrete. Slab is cast-in-place reinforced concrete. Precast members will be appropriate only for a limited range of situations. They should be considered when spans are relatively short and building height is relatively low. Precast columns and girders are not recommended in high seismic load zones.

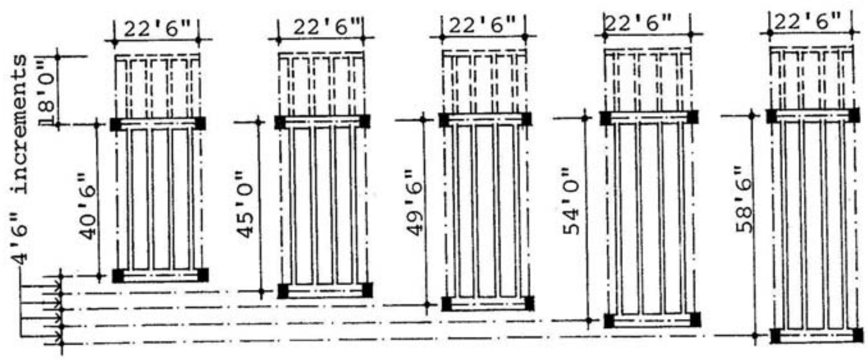
312.4 REINFORCED CONCRETE, CAST-IN-PLACE

Columns, girders, beams and slab are cast-in-place reinforced concrete. This system may be applicable for the shorter spans, but the depths required to control deflections in general make it undesirable.

313 DIMENSIONS

313.1 STRUCTURAL BAYS

The column and beam framing system of the Prototype Design includes five structural bay sizes, all of which are 22'6" wide. The lengths range from 40'6" to 58'6", in 4'6" increments. In addition, the length of the bays may be extended by 18'0" cantilevers.



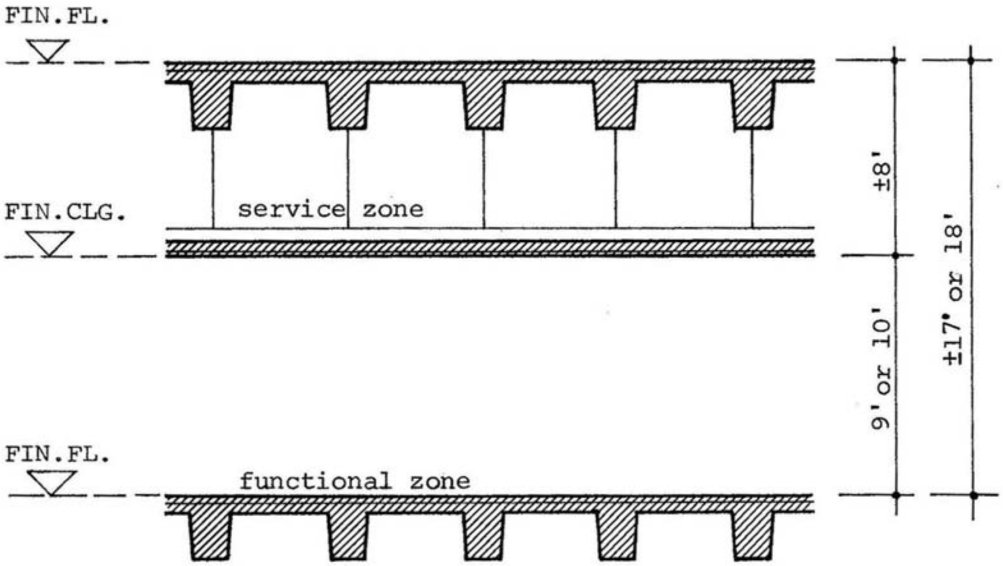
These bay sizes were developed in conjunction with the planning requirements of nursing areas and were then tested for their applicability to the design of the support areas of the hospital. (See Section 710.)

The Prototype Design also includes one other type of structural bay, called the service bay. (See Section 220.) The service bay does not have predetermined configuration or dimensions.

313.2 FLOOR-TO-FLOOR HEIGHT

The nominal floor-to-floor height varies between approximately seventeen and eighteen feet. It includes a recommended floor-to-ceiling height of nine feet in the nursing areas, or ten feet in the support areas, plus an allowance for a service zone above the ceiling.

The service zone is approximately eight feet high overall, and extends from the finished ceiling to the finished floor above. The exact height of the service zone is a function of the specific design selected for the ceiling, the structure and the services distribution.



The basic design will enable a two-story space to be achieved by omitting an intermediate floor over a limited portion of the building. The structural acceptability of the location of such a two-story space must be verified by the A/E.

313.3 BUILDING HEIGHT

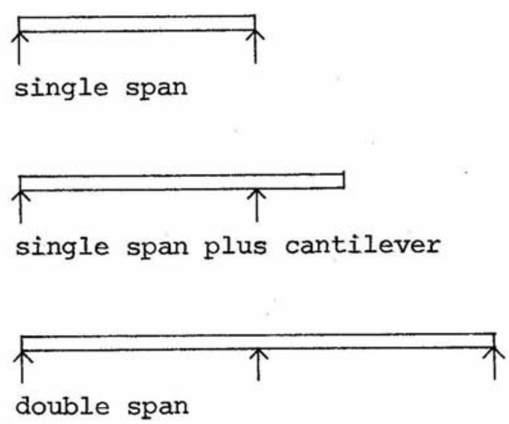
On the basis of the floor-to-floor heights described above, the structural system is appropriate to a range of building heights from two to nine stories above ground.

The Uniform Building Code lateral design requirements change for buildings over 160 feet in height, so for simplicity this height has been used as a limit.

If required, towers over 160 feet in height may be built, but they would require varying degrees of change to the basic structural system depending upon seismic zone, local design wind pressures, and site conditions. See Section 721.4 for discussion of requirements for buildings over 160 feet.

313.4 BUILDING WIDTH

In the space modules, a range of building widths from 45’0” to 117’0” is provided by using the five spans and the one cantilever in the three ways illustrated in the following diagram. Only twelve of fifteen possible combinations are used; two are not included because they offer no additional planning possibilities and one - 58’6” single span - is not used because it is considered to be excessively long for a single span.



The 45'0" , 49'6" and 54'0" beams are used as single spans.

The 40'6" , 49'6", 54'0" and 58'6" beams are used with the 18'0" cantilever on one end.

All five long span beams are used as continuous symmetrical double spans.

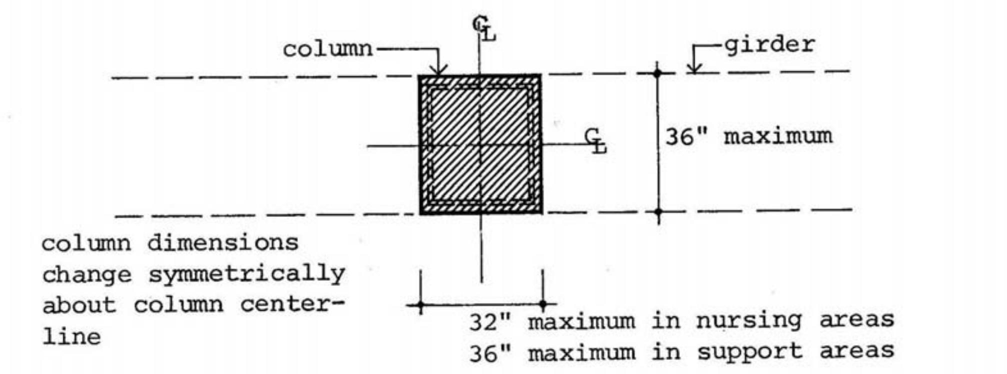
In the support areas of the hospital, any number and combination of spans, with or without one or two cantilevers, may be used to provide a greater range of building widths in 4’6” increments. (See Table 220-2.) All columns must be continuous down to the foundation.

313.5 STRUCTURAL MEMBERS

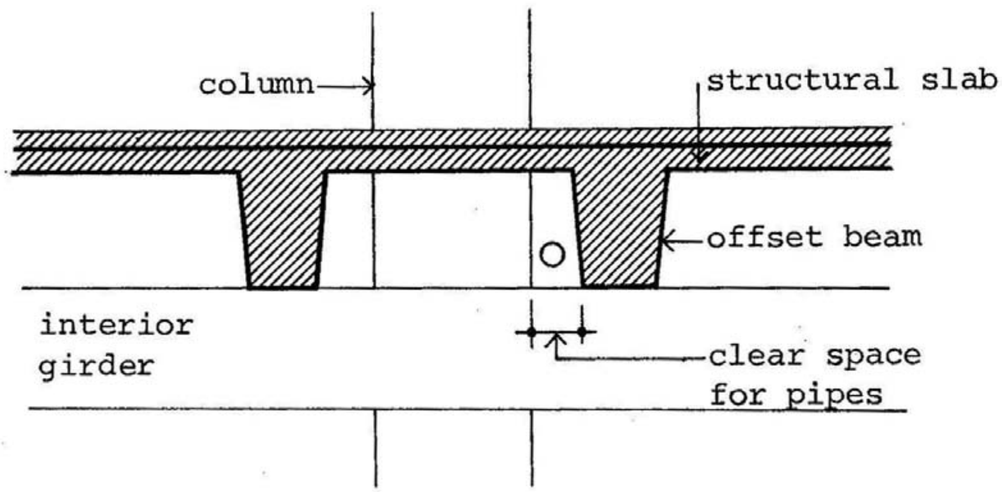
The structural members must be designed to support the loads described in Section 314. The dimensions given define a dimensional envelope within which any particular structural design can be accommodated. The dimensional envelope is defined to expedite preliminary design and facilitate precoordination with other integrated subsystems.

313.5.1 Columns

The layout of the patient rooms and sanitary zones shown in Section 230 are based on a maximum column size of 32” x 36”.



On upper floors, the column cross section may be reduced symmetrically about the column centerline. On the lower floors of eight and nine story buildings, the column cross section may be increased symmetrically about the column centerline to a maximum of 36" x 36". This will require coordination with the plumbing subsystem in that the clear space for pipes passing between the face of the column and the offset beam will be limited where beams are 4'6" on center.

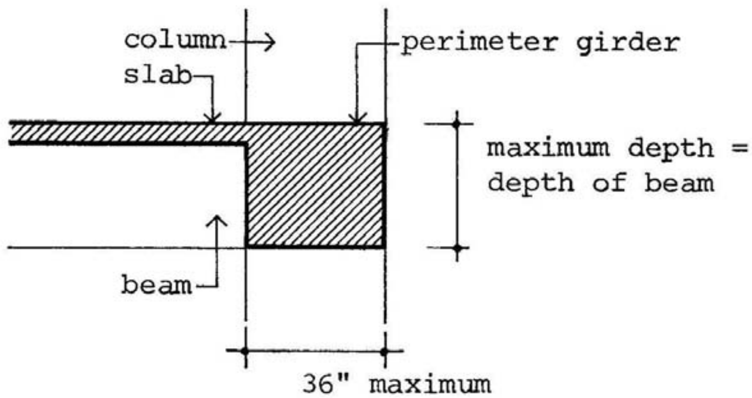


313.5.2 Girders

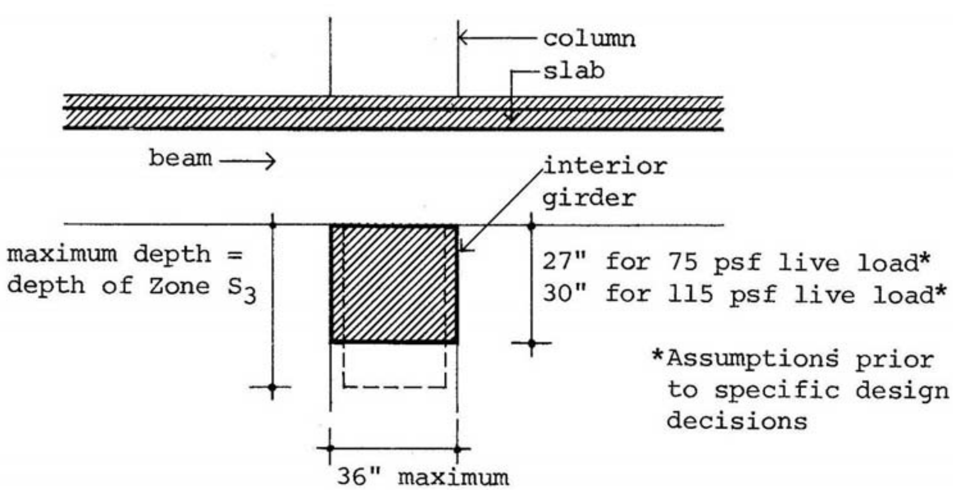
1. Span. The girder span is equal to the structural bay width and is always 22'6" centerline to centerline of columns. This dimension is based on a 4'6" dimensional discipline for bedroom widths. (See Section 230.)

2. Cross-Section. For the same live load conditions, the cross section of the various girders should not change throughout the height of the building.

The width of the girders may not exceed 36" and should not be less than the abutting column dimension. The depth of the girders may not exceed the depth of the zones in which they occur. (See Section 224.1.) On this basis, the maximum depth of the perimeter girders will be equal to the depth of the beams.

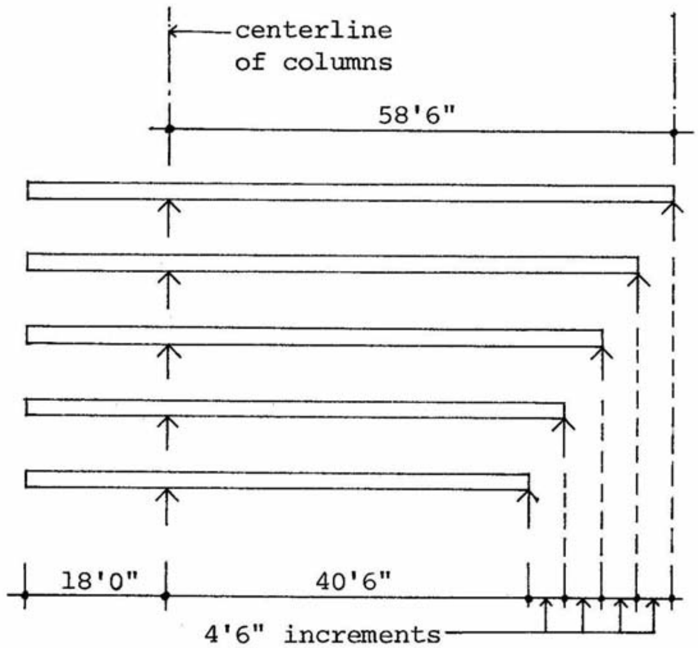


On the basis of a 36" width, the depth of the interior girders is not likely to exceed 27" in the case of a 75 psf live load and 30" in the case of a 115 psf live load. These dimensions should be used for preliminary planning and until the actual depth of zone S3 has been determined. Where the actual depth of zone S3 on a particular project turns out to be greater than 27" or 30", the dimensions of the interior girder may be adjusted accordingly if economies result.

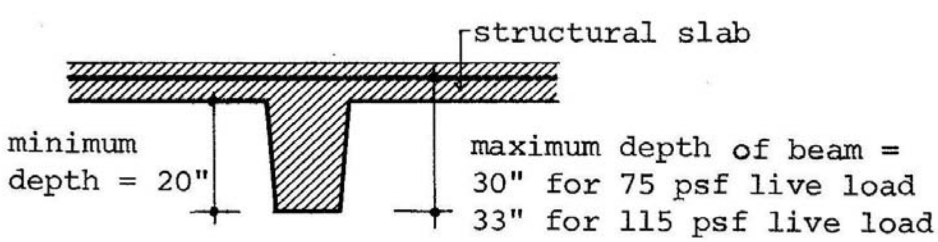


313.5.3 Beams

1. Span. The beam spans are equal to the structural bay lengths and range from 40'6" to 58'6" in increments of 4'6" measured from centerline of column to centerline of column. In addition, beams may be cantilevered 18'0". The modular nature of the beam spans is discussed in Section 721.1.2.



2. Cross-Section. The beam cross-section will generally be affected by choice of material, span, beam spacing, degree of continuity and sequence of construction. The depth, including fireproofing, is not likely to exceed 30" in the case of the 75 psf live load, or 33" where the live load is 115 psf.



To facilitate definition of the plumbing zone (S2), the dimension between the bottom of the slab and the bottom of the beam should not be less than 20" -- the clearance required by drains, including traps and falls. (See Section 353.2)

3. Beam spacing. The beam spacing will vary with the material selected. A predictable and limited set of conditions is created if the framing of each bay is identical. Therefore, any beam spacing dimension should be a simple fraction of the bay width of 22'6". Suggested spacings range from one-fifth to one-third the bay width, namely 4'6" or 5'7-1/2" center to center in concrete, and 7'6" center to center in steel. The larger beam spacings will permit larger penetrations through the structural slab (See Section 313.5.4, Paragraph 2).

313.5.4 Structural Slab

1. Depth. The structural slab depth will vary between 4" and 5-1/2". The depth will depend on required fire rating, density of concrete, span length of slab, diaphragm requirements and type of steel deck (where applicable).

2. Penetrations. The floor slab may be penetrated by gravity drains and other comparatively small items such as vertical service shafts for materials handling. Structural limitations on the location of these penetrations are as follows:

   a. At opening configuration:

      (1) Penetrations which fit between the beams can be located anywhere required.

      (2) Larger openings may require bearing walls or other special design. Their location may also be limited by the requirements of the horizontal diaphragm (See Section 316.2).

   b. At a later date:

      (1) Cored holes up to 24" diameter may be located anywhere between beams.

      (2) Larger openings will probably require local reinforcement. Their location may also be limited as described above.

Penetrations are limited not only by structural considerations but also for planning reasons. Penetrations which require bearing walls or continuous enclosures such as shafts should interfere as little as possible with the free area established in both the functional and service zones. For instance, in the nursing areas, vertical service shafts should never be placed within space modules. Their location must also be carefully coordinated with the organization of the service distribution so that they do not disrupt the passage of main horizontal distribution lines in the service zone. For this reason, the preferred location for such elements (e.g., elevator shafts) is outside the service module or at the perimeter furthest away from the service bay.

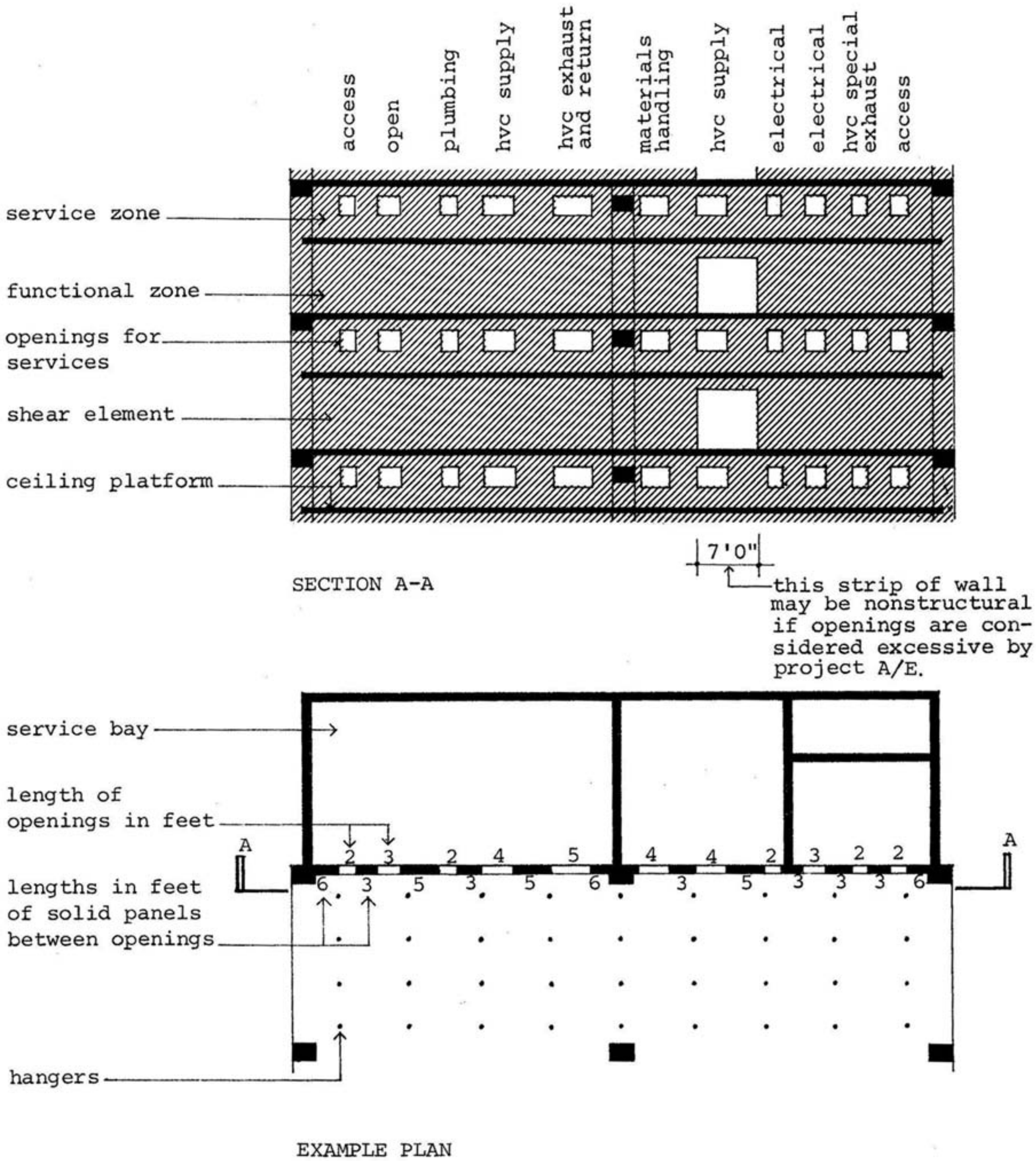
1. Depressions. A three-inch topping slab of lightweight concrete will accommodate all depressions required in the floor for floor-mounted fixtures and floor drains. Items such as prefabricated audiometric rooms which have a floor thickness greater than 3" will necessitate a ramped threshold to take up the difference in floor levels. At opening configuration, the structural floor slab may be depressed if necessary, provided that the same limitations described in Paragraph 2 above are observed.

313.5.5 Shear Elements

1. Size (plan length and thickness). The required plan length and thickness of shear elements is a function of building height, geographic location and extent of other elements in the building which will resist horizontal forces. The maximum dimensions will result from design for UBC earthquake zone 3, the zone of greatest earthquake susceptibility. The level of lateral loads obtained using UBC regulations for this zone are roughly equivalent to the wind loads for the 45 or 50 wind-pressure areas.

2. Penetration through shear resisting elements. Figure 310-3 illustrates the organization of typical penetrations for service distribution elements that are likely to occur in the solid wall separating a typical service bay from the rest of the service module. In the functional zone, an opening, approximately seven feet wide by seven feet high will accommodate the door between the stairs and a relocatable corridor.

Figure 310-3. **TYPICAL SET OF OPENINGS IN SHEAR WALL BETWEEN SERVICE BAY AND REST OF SERVICE MODULE**



In accordance with general principles which limit the location of penetrations through concrete shear walls, these penetrations are organized as follows:

a. The edges of the shear wall are free of penetrations. The minimum width of this edge is approximately 3'6".

b. The penetrations are aligned vertically and horizontally to allow a regular reinforcing pattern.

c. Where the size and spacing of openings is such that the wall does not act as a single element, that part of the wall is eliminated as a potential shear resisting element.

d. The spaces between the penetrations are more or less equal, and in the range of three feet.

e. The combined widths of all the openings in one row is not more than 50% of the plan length of the shear element.

f. The combined height of all openings above each other is not more than 50% of the height of the shear element.

The principles described above apply to concrete shear walls. The openings in diagonally braced frames are limited only by the size and location of the members themselves.

314 LOADING

314.1 VERTICAL LOADS

314.1.1 Vertical loads are a combination of dead loads and live loads. The dead loads include the weight of the permanent structure, the ceiling, partitions, topping slab, floor finishes, and mechanical loads. Mechanical loads include ducts, pipes and temporary construction loads but exclude the weight of the equipment. Live loads include all other weights which will be applied to the structure.

314.1.2 The structural design of the framing system for the Prototype Design will be based on two categories of live loading. The first will permit a uniform live load of 75 psf, mainly in the nursing areas; the second will be based on a uniform live load of 115 psf, in the support areas of the hospital. For convenience, these two categories are termed Class 75 and Class 115 design loading respectively. Changes in class of design loading should always occur at logical places in the structure such as over girders or at the boundaries of fire sections. Preferably, only one class of design loading would be used on any one floor of the hospital.

314.1.3 Certain facilities which may be included in the hospital may actually be required by code to have live load capability in excess of 115 psf. For instance, the National Building Code requires card file rooms to have 125 psf live load capability. These areas are often interspersed with others having requirements lower than 115 psf, so they can generally be balanced to fit within Class 115 design loading.

314.1.4 A concentrated load of 2500 pounds over a three by three-foot area in any hundred square feet can be accommodated by both Class 75 and Class 115 loading. The framing system will also be able to accommodate certain higher concentrated loads applied over limited areas. By incorporating structural devices such as demountable slab strongbacks (placed beneath the slab and between the beams), it should be possible for an A/E under certain conditions to accommodate these higher concentrated live loads without changing the system. Items generating these higher loads are listed in Table 310-1 under the category of Modified Class 115 Design Loading. The conditions under which higher loads may be accommodated are dependent upon the specific plan, the beam spans chosen, and the degree of interference with the service distribution elements which would result (See Section 224).

Table 310-1. DESIGN LIVE LOADS

Design Live Load	Functional Area	Types of Equipment
Class 75	Nursing areas	
Class 115	Support areas except as listed below	
Modified Class 115	Dietetic Service	Refrigerator, dish-washer, baking oven, exhaust vent, ice-making and storage.
	Deep Therapy	Cobalt accelerators, etc
	Diagnostic Radiology	Tomograph table
	Central Sterile	Automatic cart washer, sterilizer, storage tank
	General	Addressograph, record retriever, power file, vault, trash compactor
	Animal Research	Concrete cages
	Nuclear Medicine	Radio-isotope Equipment
Special Loading	Physical Medicine and Rehabilitation	Hubbard Tank, therapy tank and pool
	ENT Service	Audiometric room
	Laundry Warehouse and Storage Pool Shops Auditorium with stage Service bays	

Table 310-2. SUMMARY OF VERTICAL DESIGN LOADS

Source of Load	Design Loads in Service Zone (Ceiling Design)	Design Loads on Floor (Slab Design)	Total Design Loads on Framing System (Beam, Girder, Column Design)
Uniform Dead Load (1)			
Structure		Applicable DL	Applicable DL
Ceiling	Applicable DL		Applicable DL
Mechanical	15	15	15
Partitions		25	25
Topping slab		25	25
Floor finish		5	5
Uniform Live Load			
Nursing area	25	60	75 (2) (3)
Support area	25	100	115 (2) (3)
Concentrated Loads	100 lb. in any 100 sq. ft.	2,500 lb. Over a 3'x3' area in any 100 sq. ft.	

(1) To be calculated by the project A/E.

(2) Reducible on girders and columns according to applicable codes.

(3) Service zone live load is reduced to 15 psf in combination with floor live load.

314.1.5 All areas where uniform live loads exceed 115 psf and which are beyond the limits of the Modified Class 115 Design Loading category must be designed by the A/E as required by the specific conditions. The live loads in these areas are listed in Table 310-1 under the category of Special Loading. They include the service bays, where the suggested uniform live load is 150 psf.

The design live loads to be applied in various functional areas of the hospital are listed in Table 310-1.

314.1.6 The roof must be designed in accordance with the governing roof live loading criteria of the particular region as required by local building codes. These loads must be increased as necessary where mechanical equipment is located on the roof.

314.2 LATERAL LOADS

The structure must be designed to withstand the governing lateral wind and/or seismic loading criteria of the particular region as required by local building codes.

315 OTHER DESIGN CRITERIA

315.1 FIRE PROTECTION

The structure must be of fire-resistive construction in accordance with the National Fire Protection Association (NFPA) and the Uniform Building Code (UBC).

315.2 DEFLECTIONS

No limit is set upon deflection beyond standard engineering practice, but for compatibility with other subsystems, the floor design with the smallest deflection is preferred. Prestressed concrete or composite steel construction are recommended to meet this criterion.

315.3 TOLERANCES

Tolerances must be in accordance with VA Construction Standards and Master Construction Specifications.

315.4 ACOUSTICS

The structure in combination with the ceiling must provide ratings of STC 50 and INR +5 between floors. The ratings of the wall between the service bay and the remainder of the service module must be STC 55 and INR +10. (See Figure 320-9.)

Walls and columns must not reduce the vibration isolation provided by floors by acting as flanking paths.

316 SPECIAL CONSIDERATIONS

The items included under this section deal generally with structural design issues which may be raised when service modules are assembled into buildings.

316.1 BUILDING SEPARATIONS (Figure 310-4)

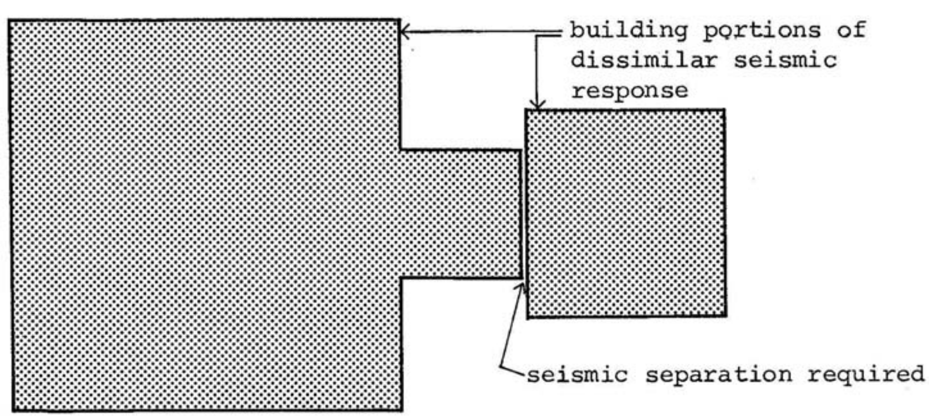
The assembly of service modules into buildings may result in configurations which require that the structure be made discontinuous at certain locations. This may result from one or both of two conditions.

316.1.1 Excessive Length of Building.

Expansion joints are required where buildings exceed approximately 300 feet in length. These must be located to accommodate changes in building length due to shrinkage or temperature variation. Expansion joint locations are a function of anticipated local temperature changes and will generally be less than 300 feet apart.

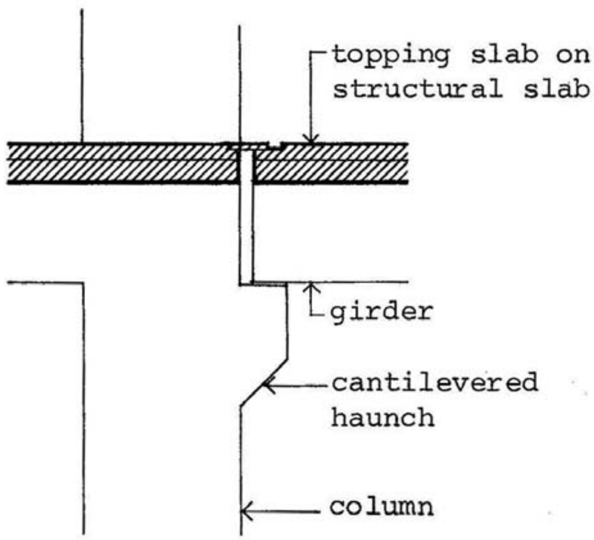
316.1.2 Portions of Building having Dissimilar Seismic Response.

Seismic separations are required where the configuration of the horizontal diaphragm (floor slab) forms a “weak link” between building portions of dissimilar seismic response.

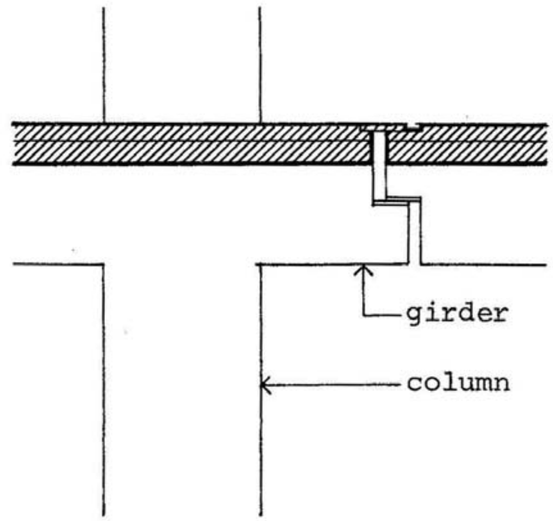


The relationship of building separations to structural members is shown in Figure 310-4. Building separations perpendicular to the beams may be located as required.

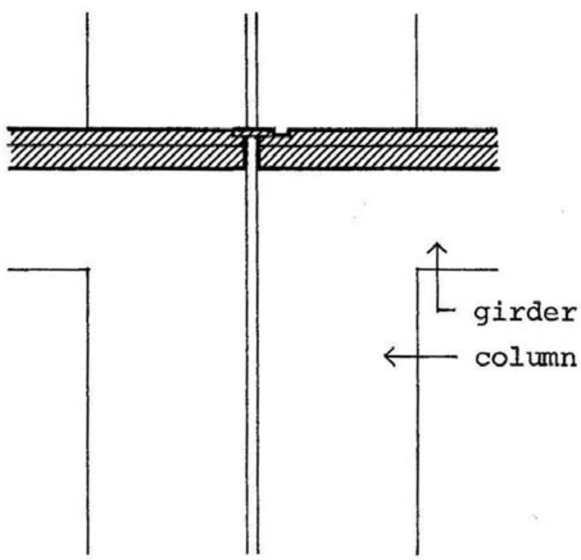
Figure 310-4. BUILDING SEPARATIONS



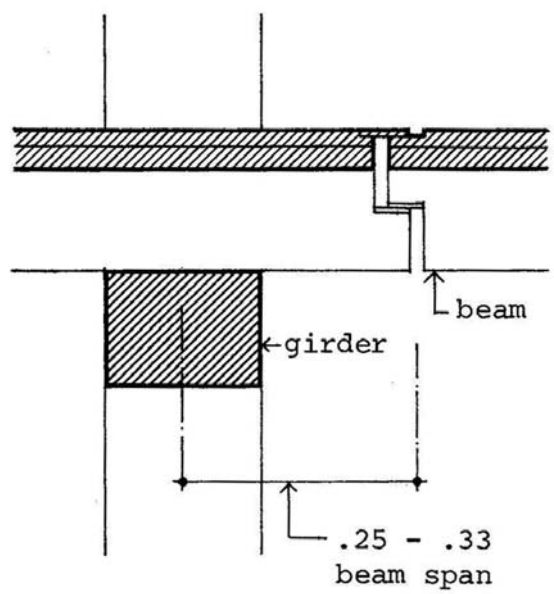
ELEVATION SHOWING EX-
PANSION JOINT THROUGH
GIRDERS: ALTERNATE A



ELEVATION SHOWING EX-
PANSION JOINT THROUGH
GIRDERS: ALTERNATE B



ELEVATION OF GIRDER
SHOWING EXPANSION JOINT
AT DOUBLE COLUMN



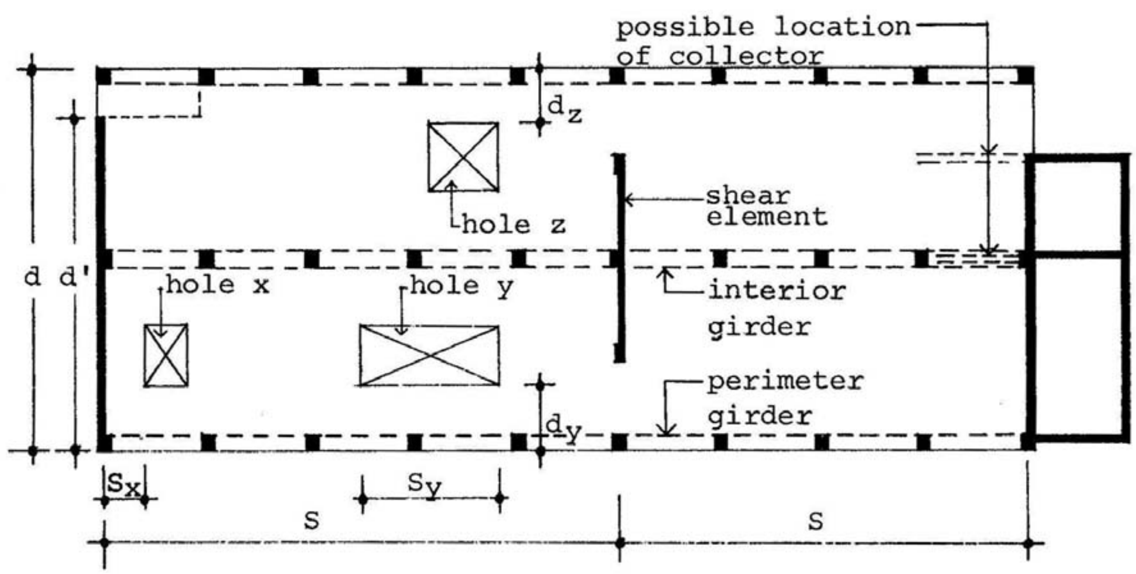
ELEVATION SHOWING EXPANSION
JOINT THROUGH BEAMS

Building separations parallel to the beams should occur close to the face of columns. The girder on one side of the separation may be carried on a cantilevered haunch or the girder may be cut at an acceptable location. Double columns may be required in areas of high seismic loading.

When building separations occur, the structure on either side must be designed as independent structural units, each braced by longitudinal and transverse shear elements.

316.2 LOCATION OF SHEAR ELEMENTS

The location of shear resisting elements is dependent on the building configuration and on the location of building separations. For instance, shear elements must be located with reference to the location of large openings in the diaphragm, such as two-story spaces, courtyards, etc., and so that all independent structural units are braced in both the transverse and longitudinal directions. To be effective, shear elements should be located so that the maximum ratio of the distance between them to the width of the horizontal diaphragm is 3:1.



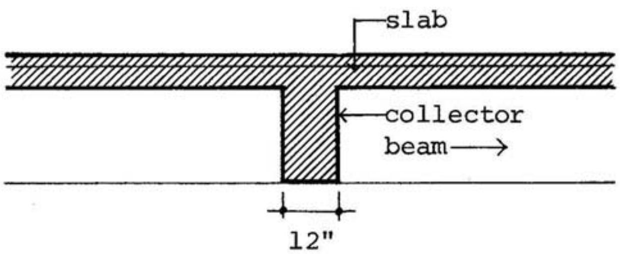
$S/d \leq 3$ (use d' where offset occurs)

S_x = Minimum distance of hole x from shear element = $\pm$ 4'0"

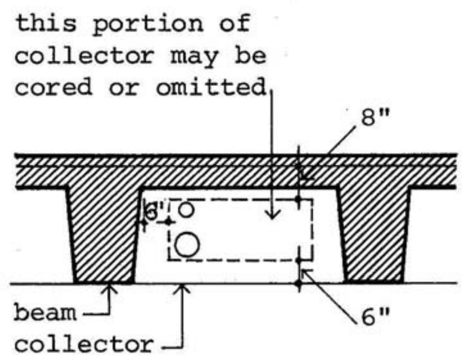
d_z = Minimum distance of hole z from edge of diaphragm = $\pm$ 4'0"

S_y = Maximum dimension of opening y is limited so that $s_y/d_y \leq 3$

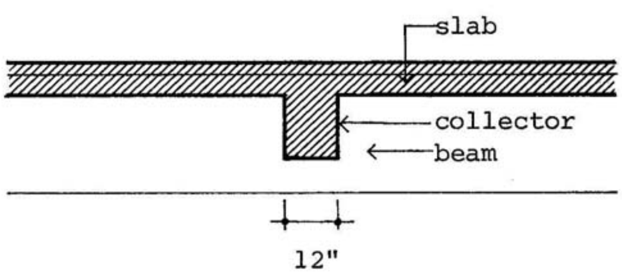
Figure 310-5. EXAMPLES OF COLLECTORS FOR LATERAL FORCES



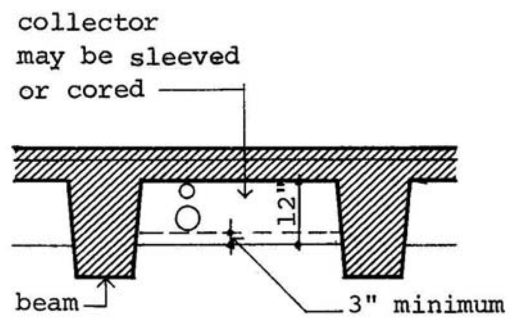
SECTION: ALTERNATE A



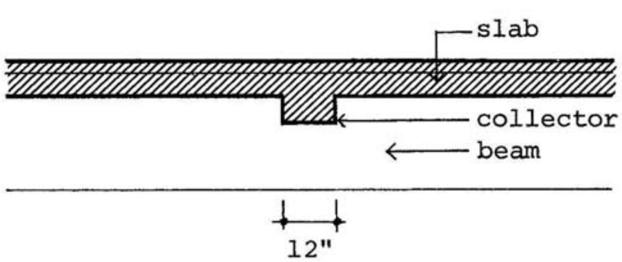
ELEVATION: ALTERNATE A



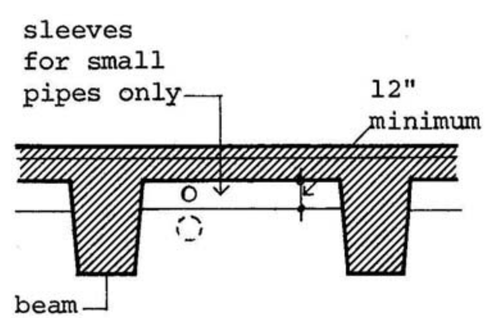
SECTION: ALTERNATE B



ELEVATION: ALTERNATE B



SECTION: ALTERNATE C

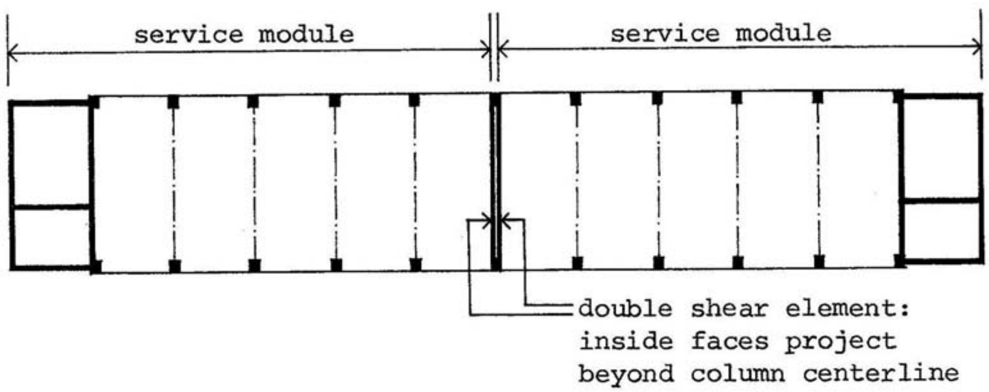


ELEVATION: ALTERNATE C

In some instances, it will not be possible to align longitudinal shear elements with perimeter girders and collectors may be necessary. These collectors can take several forms, examples of which are shown in Figure 310-5. The design of collectors must take into account the location of elements of the plumbing subsystem which occur in the same zone, namely S2. (See Section 224.)

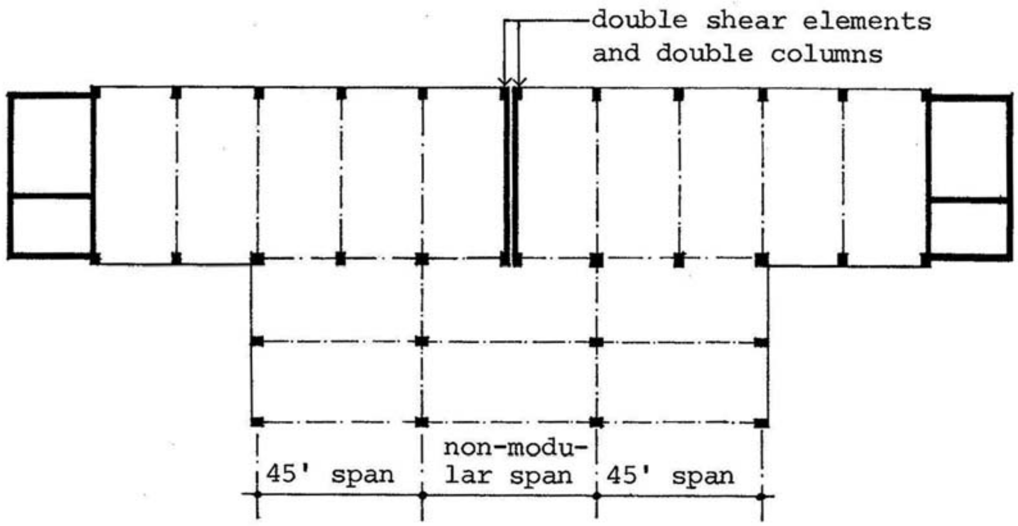
316.3 DOUBLE SHEAR ELEMENTS

Under certain circumstances, double shear elements may be required where two service modules abut. If double columns are not introduced at the same time, the face of the shear element will project beyond the column centerline, reducing the width of one or two bedrooms per service module.



Where double columns are introduced, other modifications to the standard dimensions may result. For instance, when a change of direction in framing is introduced at the same time as double columns, a non-modular bay width may result.

These minor deviations from standard dimensions may result not only from the introduction of double columns or shear elements but also from a variety of other unpredictable circumstances which may arise when service modules are assembled into various building forms. In most cases, deviations of this type will not be serious. For instance, the non-modular beam span falls within the acceptable range of forty to sixty feet and does not interfere with the basic dimensional discipline of the structure.



316.4 CHANGE OF DIRECTION IN FRAMING (Figures 310-6 and 310-7)

With certain building configurations, it will be necessary to change the direction of the structural framing members through ninety degrees. The structural design will be simpler if the beam span involved is 45’0”, since this is an exact multiple of the bay width. In this case, the intersection of the two girders takes place at a typical column location. (See Figure 310-6.) If the beam span is not a multiple of the bay width, the design of the framing is simplified if an additional column can be located at the junction of the perpendicular girders. (See Figure 310-7.) If columns cannot be accommodated at these points, then the girders in one direction must be designed to carry the concentrated load of the girders in the opposite direction. This increase in load varies from 20-50% above the typical girder load. In this case, the typical girder dimensions must be increased approximately as follows:

1. 50% width increase, or
2. 25% depth increase, or
3. a combination of width and depth increase.

Figure 310-6. ACCOMMODATION OF CHANGE OF DIRECTION OF FRAMING SYSTEM WHEN BEAM SPAN IS 45 FEET

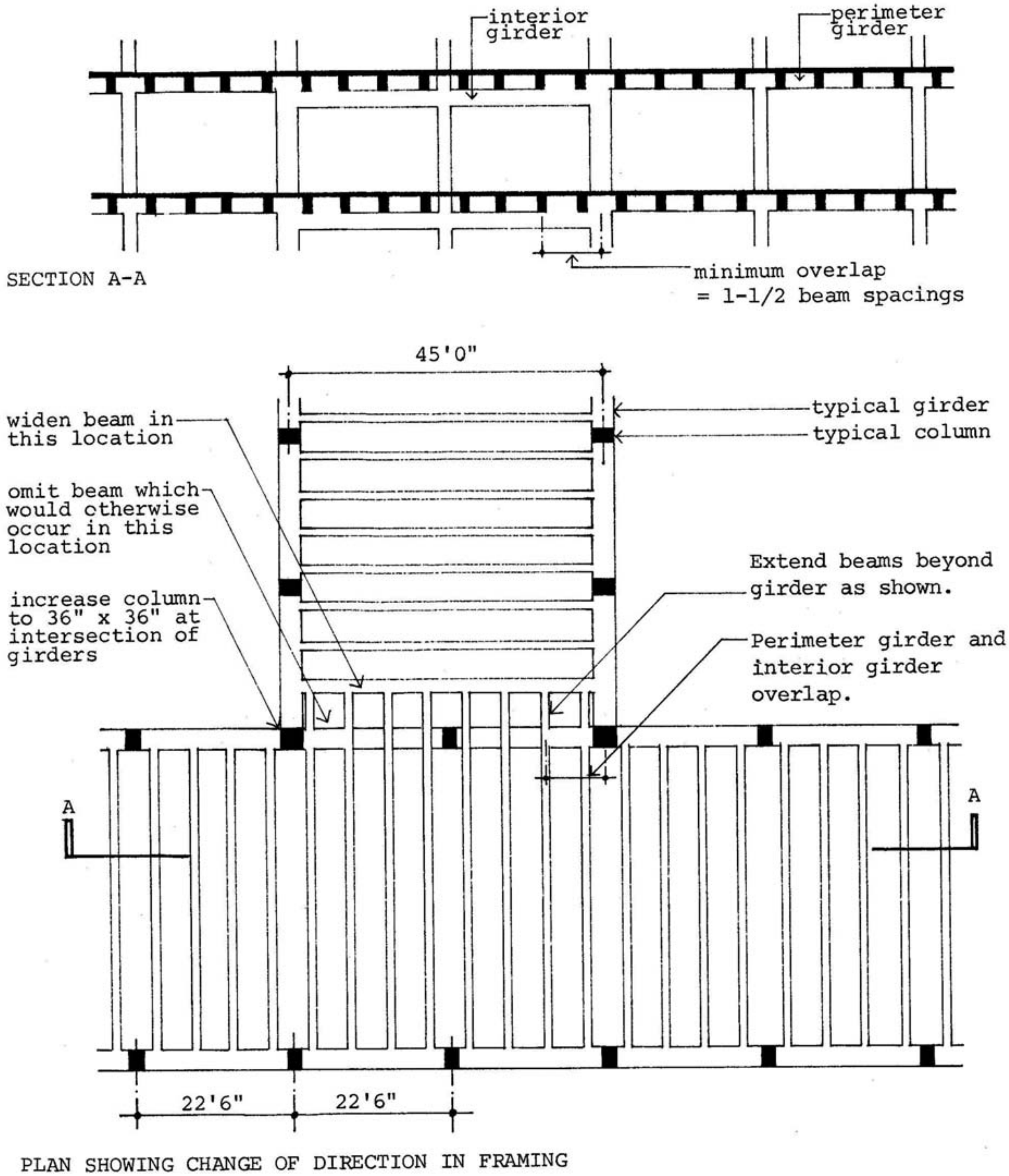
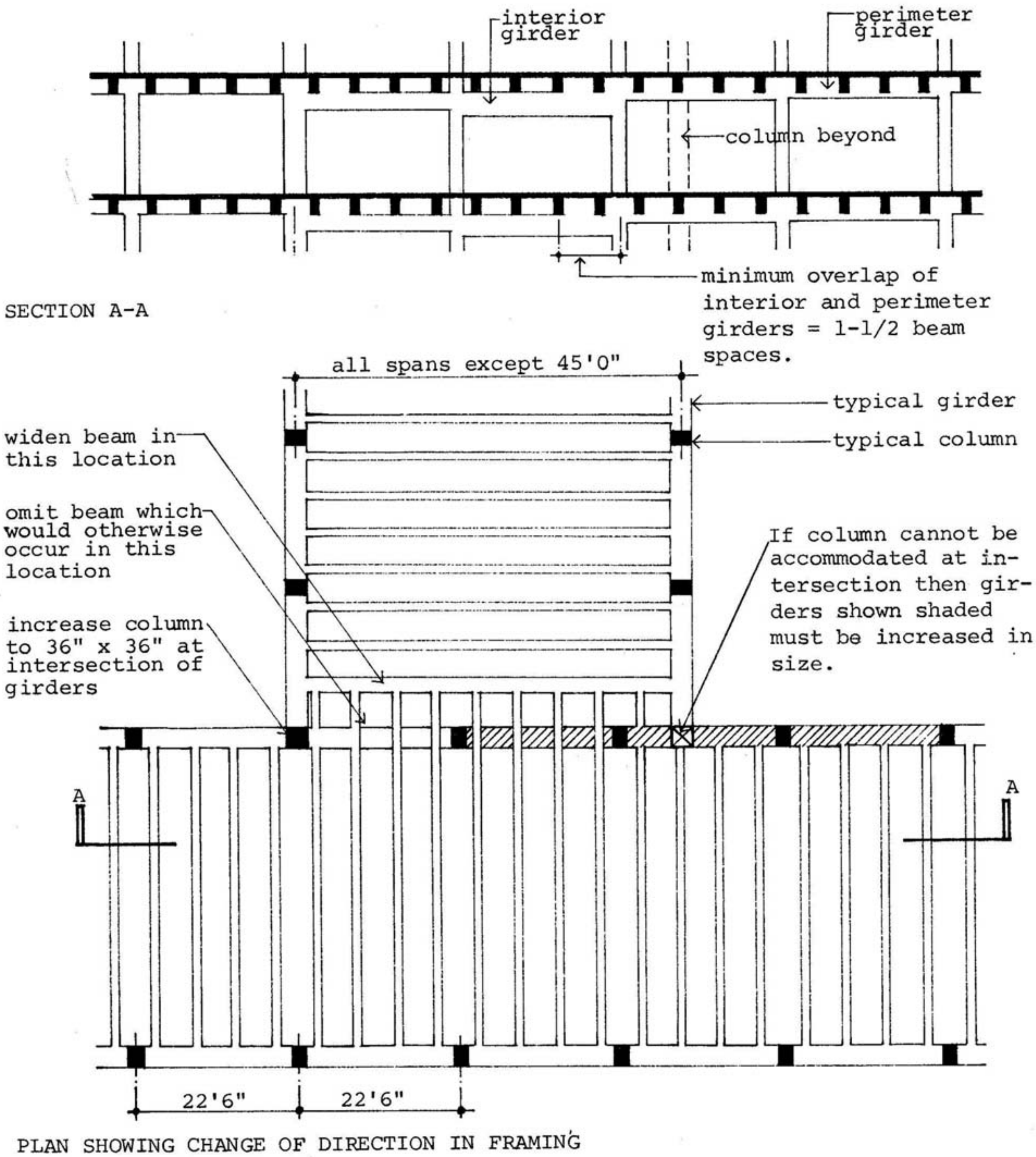


Figure 310-7. ACCOMMODATION OF CHANGE OF DIRECTION OF FRAMING SYSTEM WHEN BEAM SPAN IS NOT 45 FEET

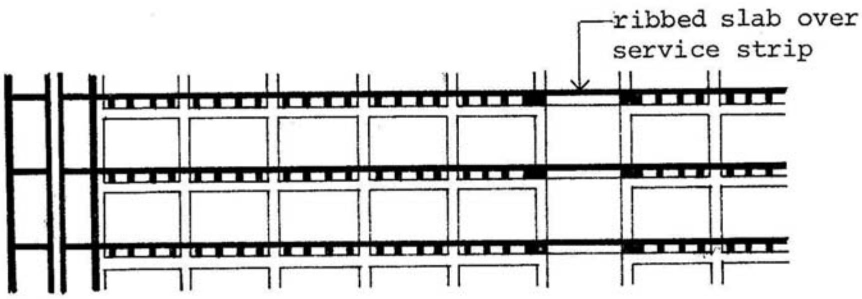


316.5 FRAMING OF SERVICE STRIPS (FIGURE 310-8)

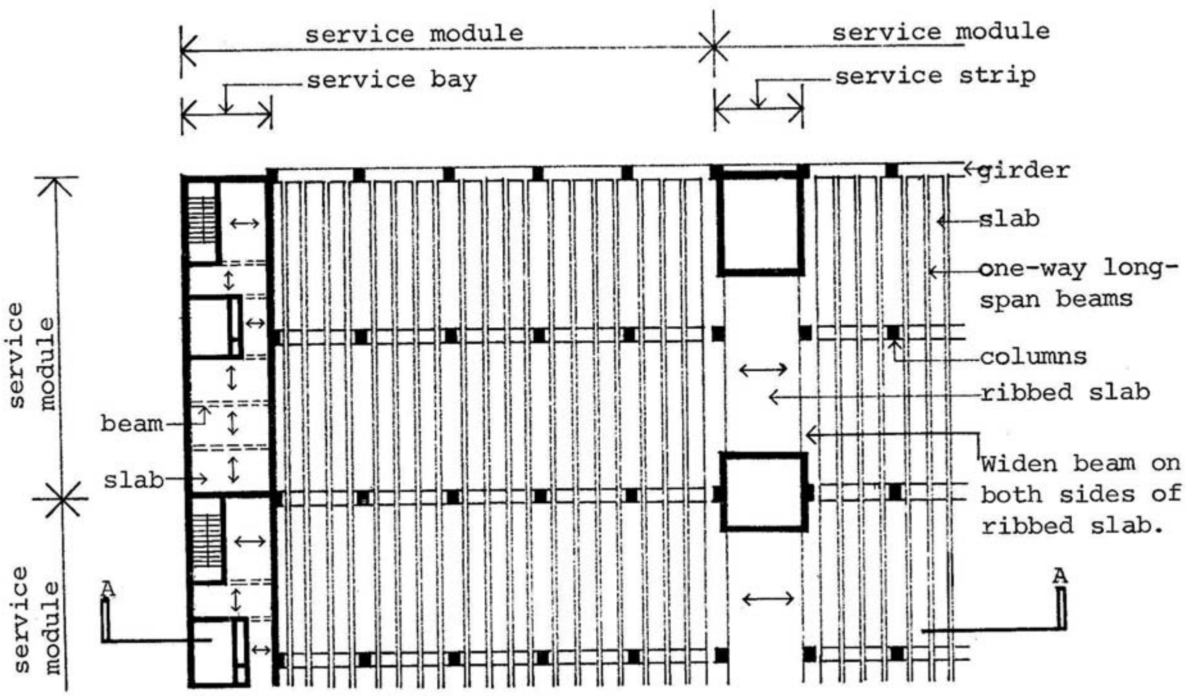
When a design incorporates interior service bays, the assembly of the service modules into a building may sometimes result in a continuous service strip, containing both the interior service bays and functional areas. The configuration of this service strip will determine the nature of the structural framing.

In some cases, the framing over the functional area may be the typical column and beam framing of the Prototype Design. In many instances, however, a simple beam and slab or a ribbed slab may be preferable in order to keep the structure as shallow as possible so as not to conflict with the services distribution. The framing for a typical configuration incorporating a service strip is illustrated in Figure 310-8.

Figure 310-8. FRAMING SYSTEM FOR PORTION OF FLOOR WITH SERVICE STRIPS



SECTION A-A



PLAN SHOWING PORTION OF A FLOOR
INCORPORATING SERVICE STRIPS

317 TARGET COSTS

317.1 RANGE

The cost of the components included in the structural subsystem should range between $8.00 and $10.45 per square foot of framing, or $8.60 and $11.30 per OGSF of building. (ENR Building Cost Index = 960.) For a discussion of these costs, see Section 751.2.1.

317.2 SCOPE

317.2.1 Included

1. Horizontal: primary and secondary spanning members at floors and roof including girders, beams, slabs and topping slabs;
2. vertical: columns and loadbearing walls;
3. lateral bracing;
4. passive fire protection of structural components;
5. provision for structural discontinuities; and
6. attachments for ceiling-platform hangers.

317.2.2 Excluded

1. Foundations;
2. slabs on grade;
3. retaining walls;
4. projections above structural roof members such as fascias, penthouses and parapets;
5. canopies;
6. exterior walls;
7. stairs, except where their enclosures acts as vertical support and/or lateral bracing;

8. components of other subsystems, such as tracks, supporting frames and lateral bracing for operable partitions, and hangers for the ceiling and HVC subsystems;

9. attachments for other subsystems, other than attachments for the ceiling hangers; and

10. fire protection of other subsystems.

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320 Ceiling

321 BASIC DESIGN (Figures 320-1 and 320-2)

The ceiling subsystem consists essentially of a continuous walk-on platform suspended by hangers from the structural beams, with a finished ceiling applied to or suspended from the underside. The platform is hung a sufficient distance below the structural slab so that a horizontally accessible service zone is created above it. Except for two-hour fire barriers, and certain smoke barriers, all partitions stop at the ceiling-platform which is one-hour fire resistive. The height of the platform above the floor is constant in each major segment of the hospital. (The rationale leading to this basic design is discussed in Section 722.)

Ideally, the platform, the supporting framework and the finished ceiling would be one thin sandwich. However, no single material or product is presently available which answers all the design and performance requirements; the ceiling subsystem must therefore be regarded as an assembly of at least four different components, the basic characteristics of which are described below.

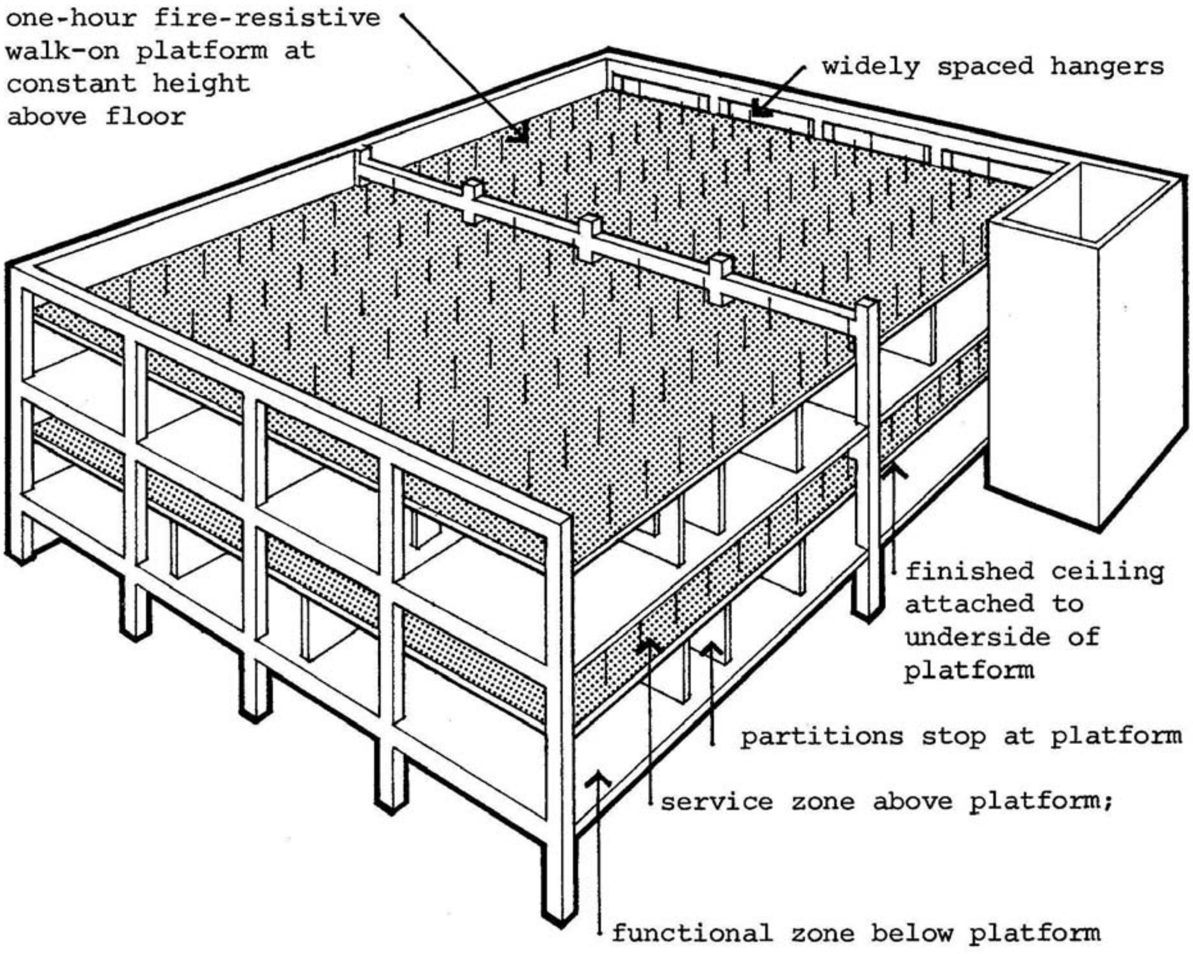
321.1 HANGERS

Compared with hanger spacings of conventional ceilings, the steel hangers are widely spaced. They are approximately 1/2”-3/4” in diameter and are attached along the centerline of the bottom of the structural beams. The recommended spacing is such that each supports a maximum of approximately fifty to sixty square feet of platform. The hangers are likely to be used to delineate the secondary subzones in the service zone above the ceiling so the spacing should be coordinated with these subzones. (See Section 224.2.)

Hangers may be attached to steel beams by means of welded studs, and to concrete beams by means of continuous or individual inserts cast into the beams. Hangers are attached to the horizontal supporting framework of the platform via adjustment devices for leveling purposes.

For most combinations of materials and details likely to be selected for the ceiling-platform-framework assembly, sufficient diaphragm action can be developed to transfer all partition lateral loads to the structure and to support the ceiling under seismic loading.

Figure 320-1. BASIC DESIGN OF CEILING SUBSYSTEM



When this is not the case, bracing the hangers with one diagonal member in approximately every fifth bay in each direction will suffice. Preference should be given to those designs which do not require diagonal bracing.

321.2 SUPPORTING FRAMEWORK

To allow use of a wide variety of short-span platform materials, an intermediate framework is required between the platform and the hangers. The platform may span over the framework or may be hung from it, depending upon the nature of the material used. The latter solution is preferred since this reduces the effective overall depth of the ceiling structure. Provision may need to be made for penetration of the framework by service distribution components located in this zone. The extent of such penetrations is minimized if the direction of the main elements of the framework (ribs, joists, etc.) is perpendicular to the structural beams.

321.3 PLATFORM

The platform must meet many of the performance requirements stipulated for the total ceiling assembly with regard to strength, fire resistivity, acoustics, etc. Besides its major function of providing a working platform both during construction and for maintenance and alterations, it must distribute all lateral loads from the partitions to the structure, or to the diagonal braces if it is not used as a diaphragm. Since there is no planning grid, the partitions must be able to be fixed to any point of the platform which should therefore be flush on the underside. Similarly, there must be as few limitations as possible to the location of penetration for services. Cutting and patching holes in the platform must be easy. The platform must provide one-hour fire resistance and an acoustic flanking path barrier if the finished ceiling does not perform these functions.

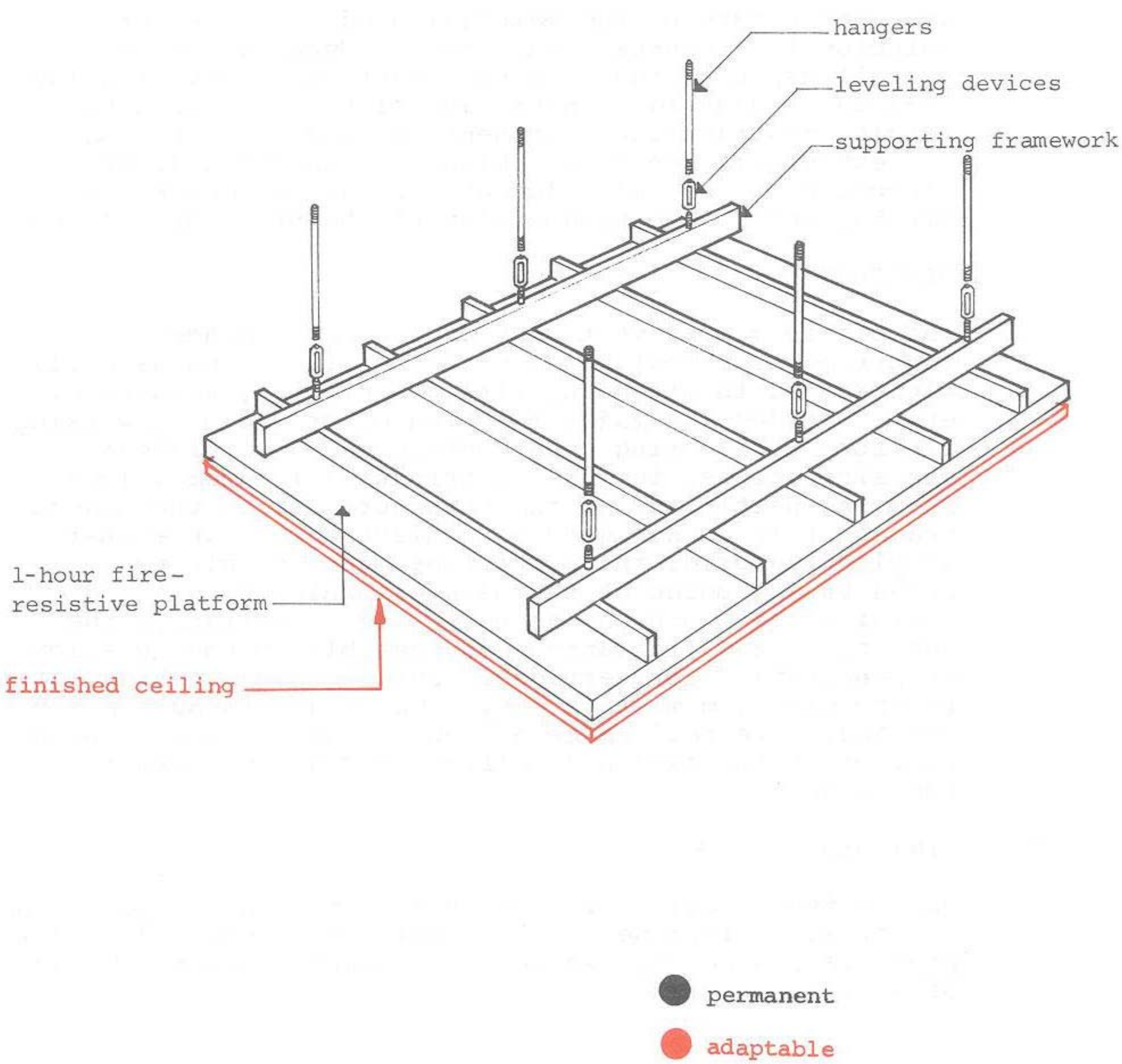
321.4 FINISHED CEILING

The finished ceiling is attached to the underside of the platform. A finished ceiling without an exposed grid is preferred, since spaces are not organized on the basis of a planning grid.

321.5 PERMANENT AND ADAPTABLE COMPONENTS

The hangers and the platform, together with any necessary supporting framework, are permanent components, whereas the finished ceiling is considered adaptable.

Figure 320-2. CEILING COMPONENTS



322 GENERIC DESIGN OPTIONS

There are several groups of products which meet the requirements of the basic design. Where performance of any two groups is equivalent, preference will be given to lowest cost, both direct and indirect. Indirect costs result from the greater depth and/or weight of one product as compared with another, and from any added costs incurred through construction scheduling considerations.

322.1 PLATFORM

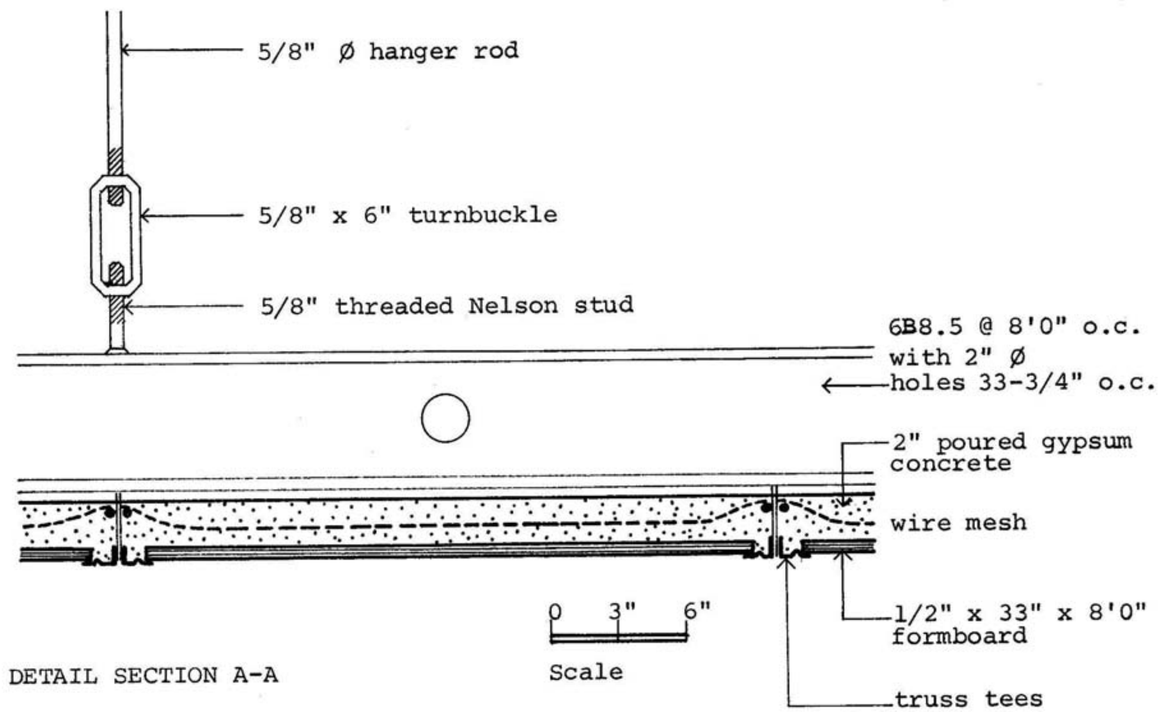
The platform closely resembles conventional roof deck systems in many of its performance requirements. Generic design options which generally meet the performance criteria for the platform include the materials and/or assemblies listed below.

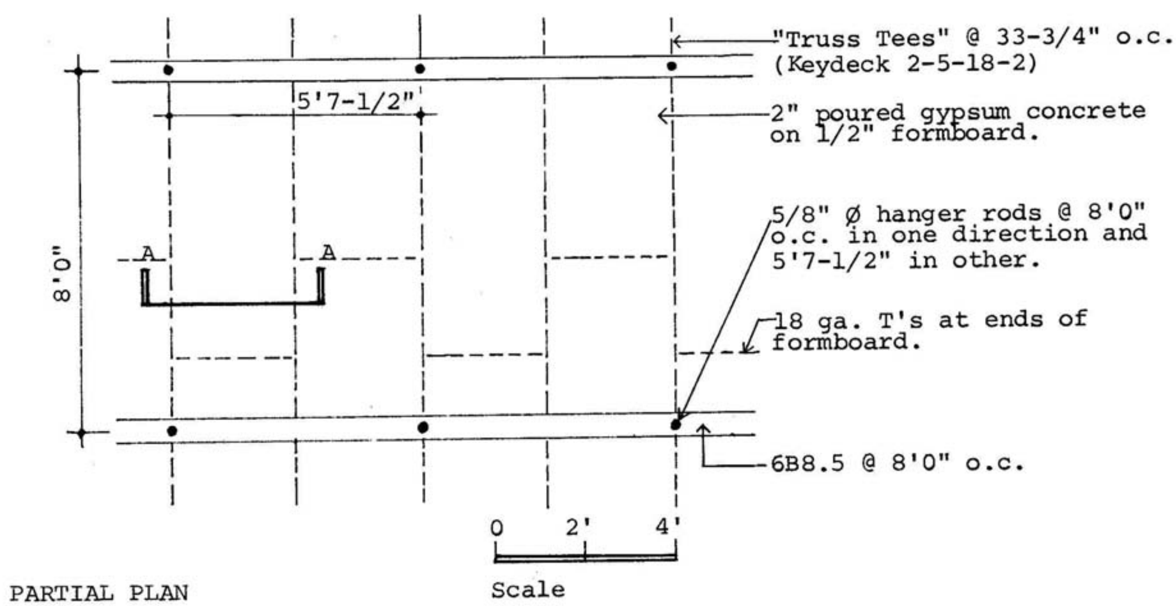
322.1.1 Poured Reinforced Gypsum on Steel Tees (Figure 320-3)

1. Advantages and Disadvantages. Of the various firerated roof-ceiling or roof deck systems presently available, poured reinforced gypsum appears to be the most appropriate. It is the least costly of the generic design options. It is light in weight, and it is easily cut and patched. In typical roof decks, when holes are made within the 32” tee spacing, no reinforcing is necessary, and when holes are repaired the deck is restored to full strength. It has ICBO approved diaphragm shear values over 1,000 plf and UL two-hour fire rating. (For further discussion of fire safety, see Section 326.)

   The main disadvantage of this option is that, although the gypsum deck is strong enough to be walked on and used as a working platform an hour or less after it is poured, it will not dry out completely for at least thirty days under favorable conditions and as much as sixty to ninety days under unfavorable conditions. This need not present a scheduling problem unless it is essential for a finished ceiling to be applied soon after the deck is poured, which is unlikely. If it is necessary to apply the finished ceiling before the deck has thoroughly dried out, there should be no problem if the top surface of the platform is left unsealed and free to dry out from the top. If scheduling permits, a breather type hardener may be applied immediately to the top surface of the gypsum to prevent dusting and increase the wear resistance.

Figure 320-3. EXAMPLE OF A POURED REINFORCED GYPSUM PLATFORM





The application of the finished ceiling should be delayed until it has been determined with the aid of a moisture meter that the gypsum deck is sufficiently dry.

Some minor dusting may be caused by abrasion of the walk-on surface; this is not considered to be a problem.

The disadvantages of poured gypsum are not considered to be critical if the ceiling system is properly detailed and if the scheduling implications are recognized.

2. Treatment of Walk-on Surface. The application of a sealant against water penetration is not considered necessary. A hardener may be applied to the top surface of the poured gypsum deck to increase its wear resistance; this is mainly dependent upon scheduling. Any product used should be of the type which allows the gypsum deck to breathe. An example of such a product is Pensco True-Seal, an acrylic resin normally used on exposed aggregate concrete to prevent dusting. (Manufacturer: Federal International Chemical Company, San Carlos, California).

   U.S. Gypsum also manufactures a breather type hardener for gypsum. It is a sand and gypsum product called Mastical, which is thicker, heavier and more costly than the acrylic resin. U.S. Gypsum is presently developing a breather-type sealant against water penetration for use over Mastical. This product may be applicable for use on the top surface of the gypsum deck.

3. Specific Design. An example of a specific platform design using poured reinforced gypsum is shown in Figure 320-3. This specific design assumes a structural beam spacing of 5’7-1/2”, half of which is 33-3/4”. The truss tees have therefore been laid out on a module of 33-3/4” instead of the standard 32-3/4”. According to U.S. Gypsum, there would be no premium for this increased formboard width when a minimum quantity of 40,000 square feet is ordered, and there would be no other adverse effects other than the fact that a deviation in detail might affect the existing fire rating.

The spacing of the tees is based on the assumption that the layout of partitions and penetrations through ceilings will be greatly simplified if the platform grid and the structural grid are made to coincide, since they are so close. However, this is not essential.

When partitions occur parallel to and between two truss tees, it may be necessary to fix 16-gauge straps between the tees at approximately 3’0” on center for fixing heavy doors or partitions carrying heavy loads such as lead lining.

322.1.2 **Precast Lightweight Concrete** (Figure 320-4)

Precast lightweight concrete panels would meet the performance requirements for platform strength, acoustic isolation and fire safety. However, special consideration in joint details would be necessary to eliminate the need for diagonal bracing in seismic zones. Special equipment is necessary to make holes, and patching to full original strength is difficult. Both the direct and indirect costs (greater weight) are higher than those of poured reinforced gypsum.

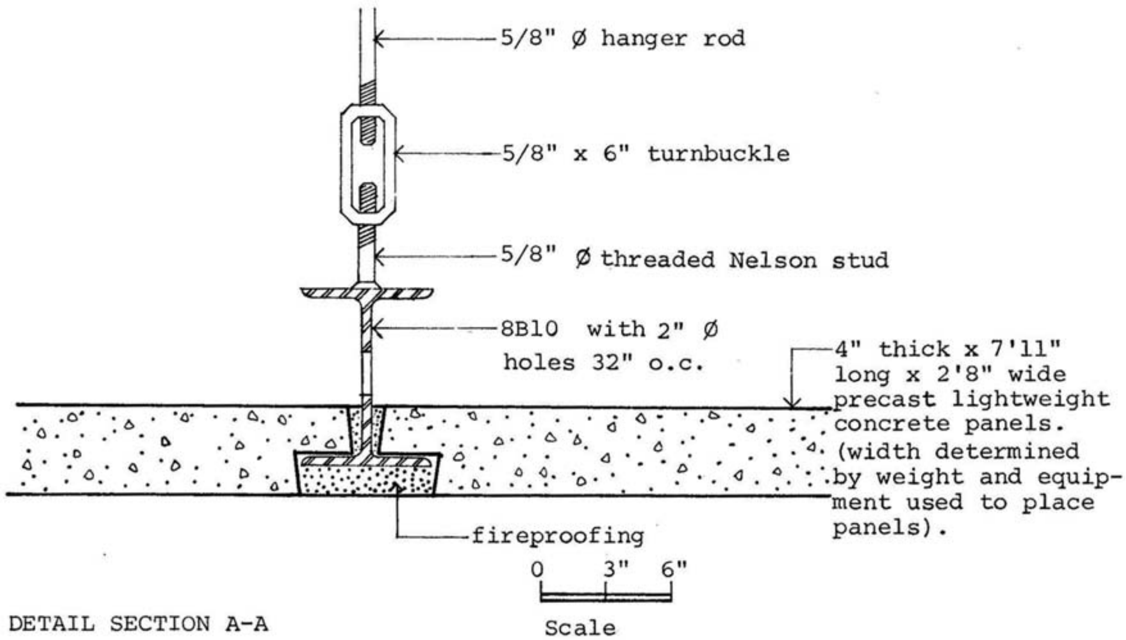
322.1.3 **Dry Gypsum Systems** (Figure 320-5)

Dry gypsum systems are not quite as economical as poured reinforced gypsum, but they would eliminate the drying out time required for poured gypsum. An example of a dry gypsum system is illustrated in Figure 320-5. This system utilizes 1”x24”x8’0” laminated “coreboard” panels, similar to U.S. Gypsum’s “shaftwall”. The system is currently under development by U.S. Gypsum. If testing is undertaken for diaphragm action and for fire resistivity, and if these are successful, it may be that the coreboard system becomes the preferred option in the future.

322.1.4 **Fire Protected Metal Decks** (Figure 320-6)

Included in this category are assemblies using corrugated steel decks or expanded metal panels which meet the strength requirements of the platform, and materials suspended below the metal deck to satisfy other requirements such as sound attenuation and fire resistivity. This latter material might be a proprietary fire-rated ceiling system or simply two layers of 5/8” gypsum board and appropriate sound insulation. The major disadvantages are the overall depth required, the difficulty in repairing holes and the need for diagonal bracing between hangers.

Figure 320-4. EXAMPLE OF A PRECAST LIGHTWEIGHT CONCRETE PLATFORM



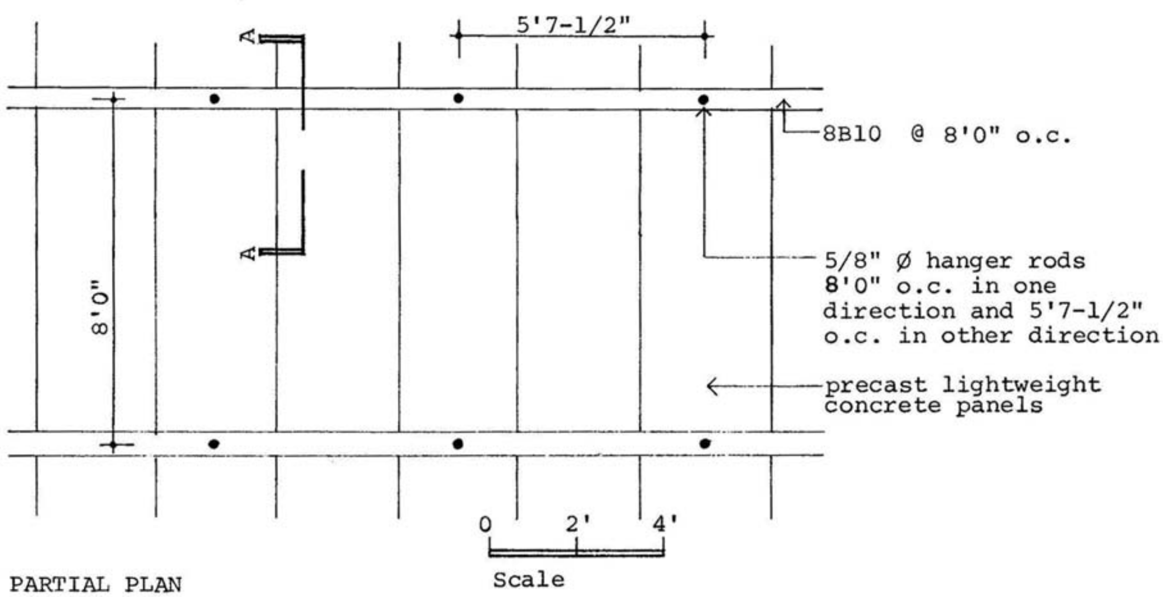
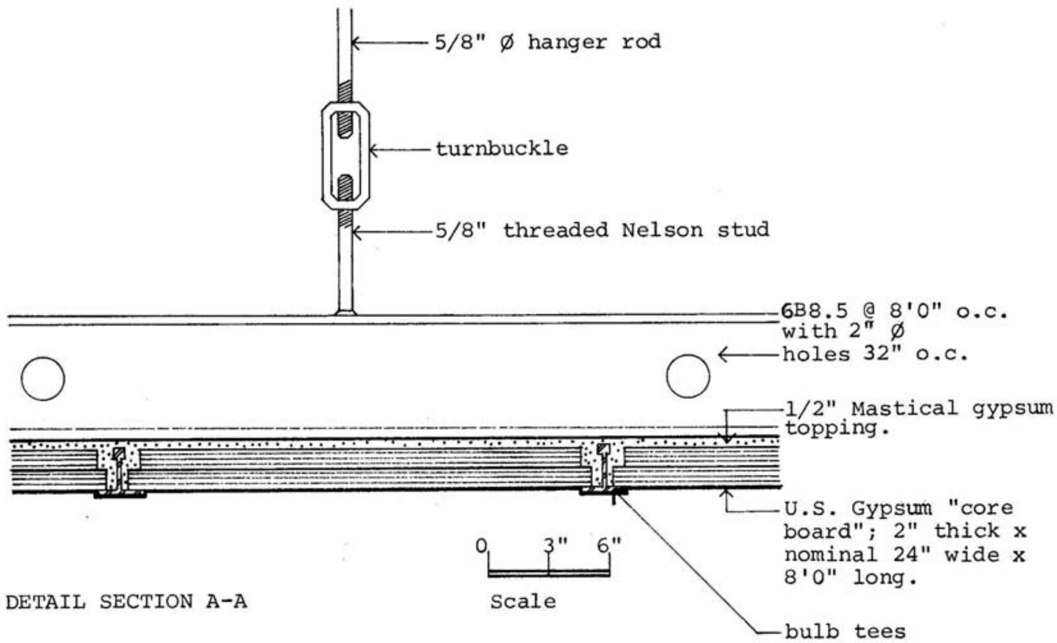


Figure 320-5. EXAMPLE OF A DRY GYPSUM PLATFORM: U.S. GYPSUM "CORE BOARD"



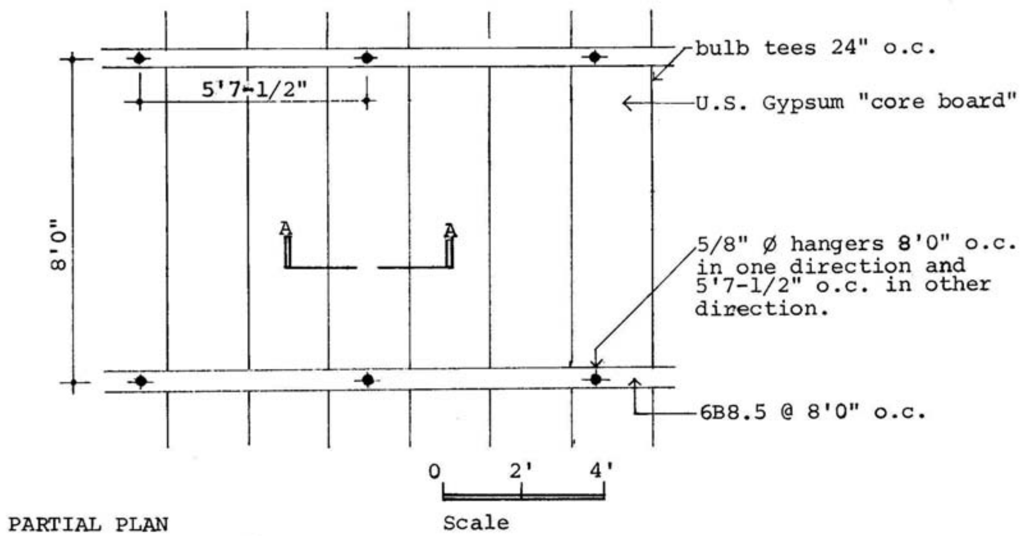
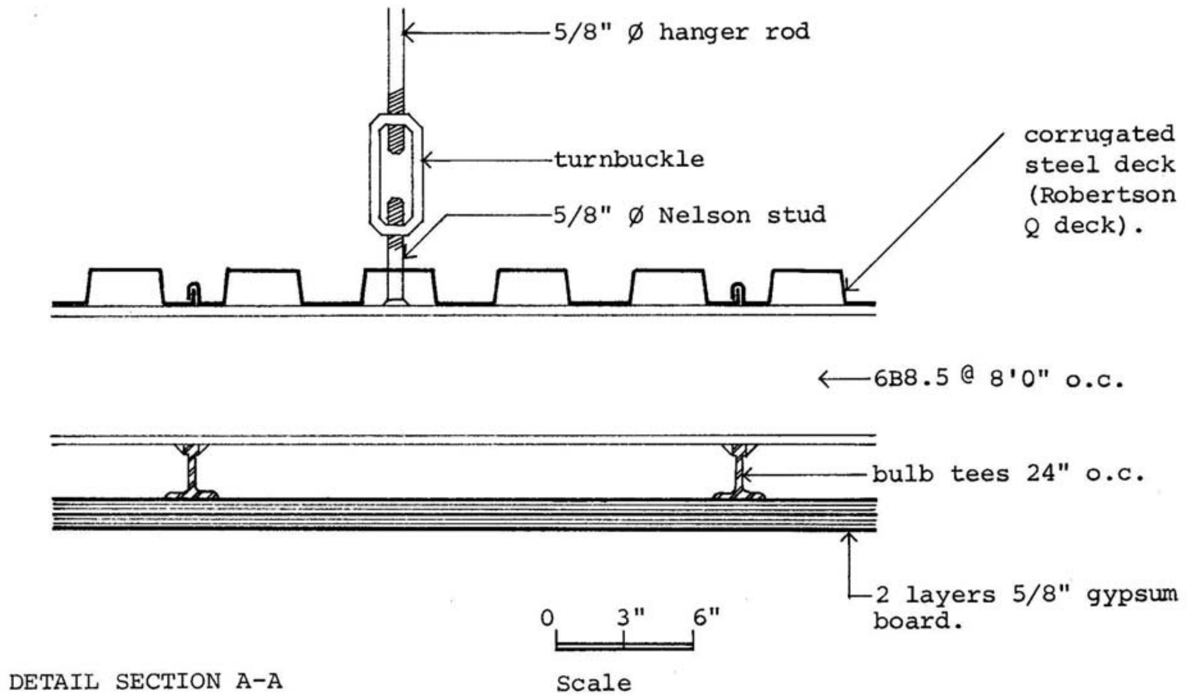
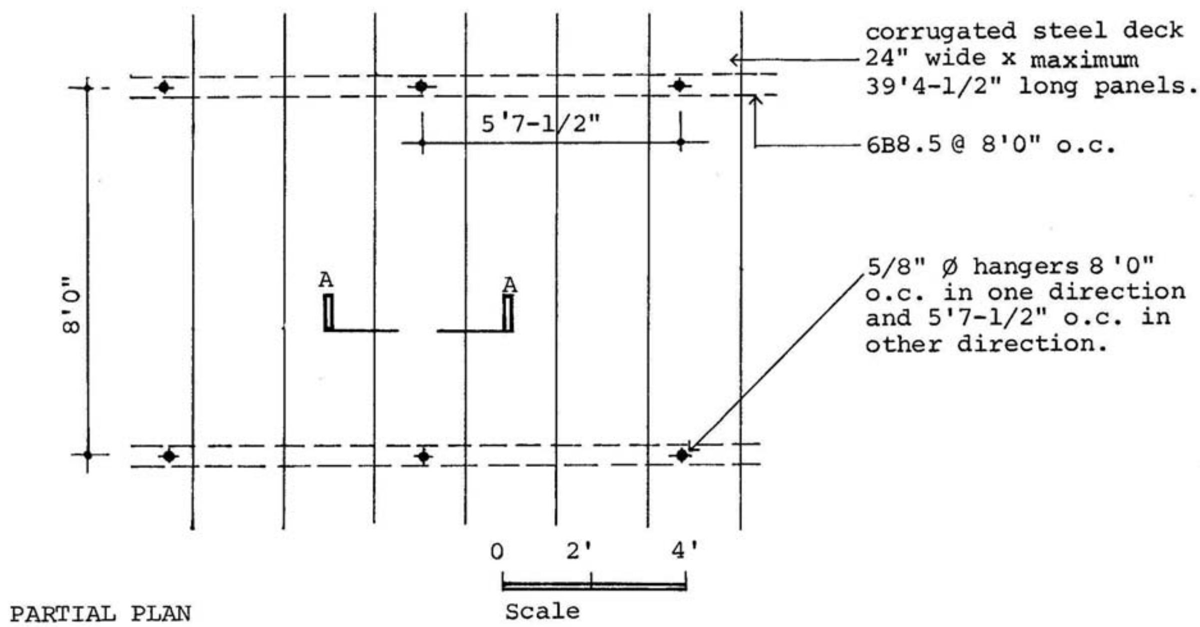


Figure 320-6. EXAMPLE OF A FIRE PROTECTED METAL DECK PLATFORM





322.2 FINISHED CEILING

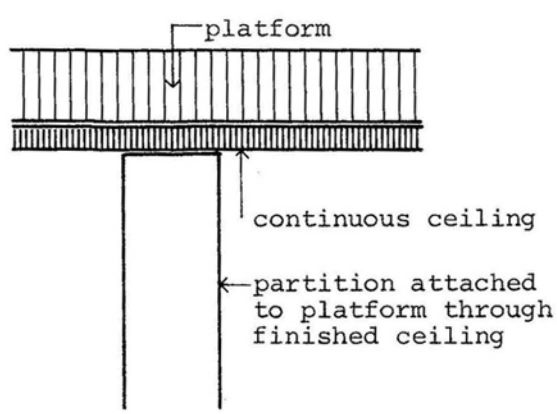
The three generic design options for the finished ceiling will permit the use of most conventional ceiling materials. Two types of product are not recommended, however; these are products involving wet trades (such as plaster) and those with exposed grids. (See Section 321.4.)

Each of these options offers different advantages, but the rest of the system is basically unaffected by the selection. Certain options may be used in combination provided they involve partitions of the same height.

322.2.1 Option 1: Continuous Ceiling, Directly Applied to the Underside of the Platform

In those areas of the hospital where there is no requirement for a variety of surface finishes for the ceiling, where the acoustic rating required between most of the adjoining spaces with acoustically absorbent ceilings is no more than STC 40, and where relocation of partitions is likely to occur frequently, this detail is the preferred option, since it is the least costly both in terms of first cost and for alterations.

The finished ceiling is glued to the underside of the platform and the partition head is fixed to the platform through the finished ceiling.



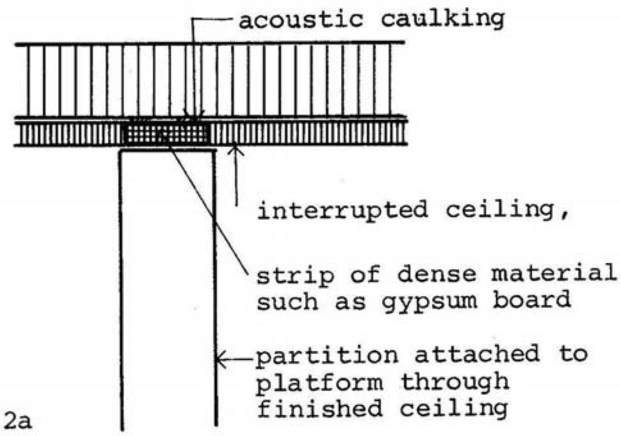
Certain combinations of ceiling and platform options will present minor problems. For instance, fixing partitions to a poured reinforced gypsum platform through a glued-on finished ceiling will present problems in that the partition will sometimes be fastened to the steel tees and sometimes to the poured gypsum deck, necessitating different types of fasteners. Since it is not possible to see where the steel tees occur behind the glued-on ceiling, and since there is no single dimensional grid applicable to all the subsystems (which would establish easily the location of the steel tees), the installation of the partitions will be slightly more complex than if the underside of the platform is all the same material (such as reinforced lightweight concrete). This difficulty is increased during alterations if additional reinforcement for heavy doors, etc., is required at the platform level above the finished ceiling. (See Section 322.1.1, Paragraph 3.)

For this reason, a mechanical fastening would be better than gluing. At present, however, there is no mechanical fastening available which would enable the finished ceiling to be fixed as close to the platform as is possible with glue. Mechanical fastenings presently require 3/4" minimum between the platform and the finished ceiling, whereas dabs of glue take only 1/8". This space of 3/4" or more makes it necessary to interrupt the finished ceiling, not only to achieve acoustic ratings greater than STC 40 but also to enable one hour partitions to be stopped at the rated platform. Continuous ceiling finishes are therefore presently limited to glued-on ceilings.

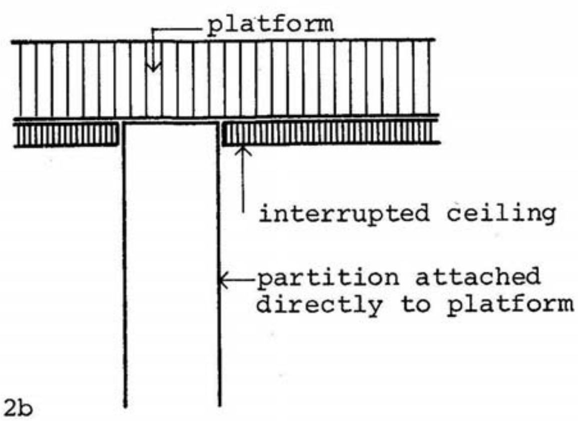
322.2.2 Option 2: Interrupted Ceiling Directly Applied to the Underside of the Platform

Where acoustic ratings greater than STC 40 are required between adjoining spaces, acoustic tile ceilings will need to be interrupted and a flanking path barrier inserted. This may be done in two ways. Option 2a, which incorporates a strip of dense material above the partition, could be used in conjunction with Option 1, since the heights of the partitions are the same in these two options.

If more than approximately 50% of the partitions require strips at the head, then the cost and inconvenience of this detail will rule in favor of Option 2b, to be used throughout.



2a



2b

With Option 2b, the finished ceiling is interrupted by the partition itself.

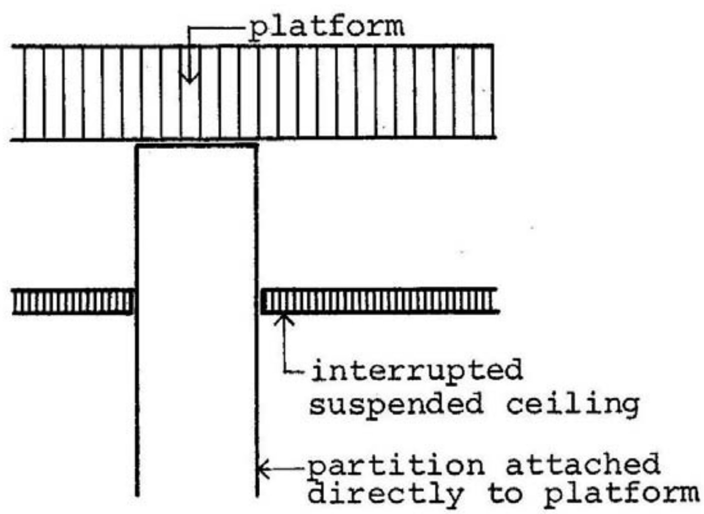
Option 2b costs more than Option 1, but has several advantages. It provides better fixing of the partitions head to the platform; it provides better acoustic isolation; it readily permits different finishes to be utilized in adjoining spaces; it covers the perimeter relief detail required at the partition head (See Section 331.3); it permits the ceiling finish to be applied at a later date than Option 1, thereby avoiding scheduling problems which might arise in connection with the dryingout time for the platform. (See Section 322.1.1.)

Option 2b would be used in conjunction with any mechanically fastened finished ceilings. The metal runners would be fixed to the underside of the platform in a regular, continuous grid, interrupted as necessary by the head channel of the partitions. This regular grid would facilitate future alterations, especially if used in conjunction with a totally accessible ceiling system (such as Armstrong's Accessible Tile System, which could occupy as little as 2-1/4" in depth).

Accessibility is highly desirable, not only because it facilitates alterations but also because it enables maintenance of the acoustic seal at the head of the partition.

322.2.3 Option 3: Interrupted Finished Ceiling Suspended from the Platform

This option provides the same advantages as Option 2b described above and would probably be used only in conjunction with it, in those few spaces where recessed lighting or equipment is an essential item.



The added space between the platform and the finished ceiling should preferably not be used for service distribution elements which should be exposed for easy access above the platform.

323 DIMENSIONS (Figure 320-7)

There are only a few generalized rules concerning the dimensions of the ceiling subsystem. Many of these have already been described in connection with the basic design; they are summarized in this section for convenience.

323.1 HEIGHT OF FUNCTIONAL ZONE

The height of the platform above the floor is constant at least in each fire section and preferably throughout each floor. The functional zone (i.e., finished floor to finished ceiling) varies from a recommended height of nine feet (mainly in the nursing areas) to a recommended height of ten feet in the support areas of the hospital.

323.2 HEIGHT OF SERVICE ZONE

The platform is suspended below the structural slab at a sufficient distance to create a service zone approximately eight feet high. (See Figure 220-6.)

323.3 DEPTH OF CEILING STRUCTURE

A design which minimizes the overall depth of the ceiling structure is preferred. A depth of ±4” excluding the supporting framework is assumed for preliminary planning purposes. (See Figure 220-6.)

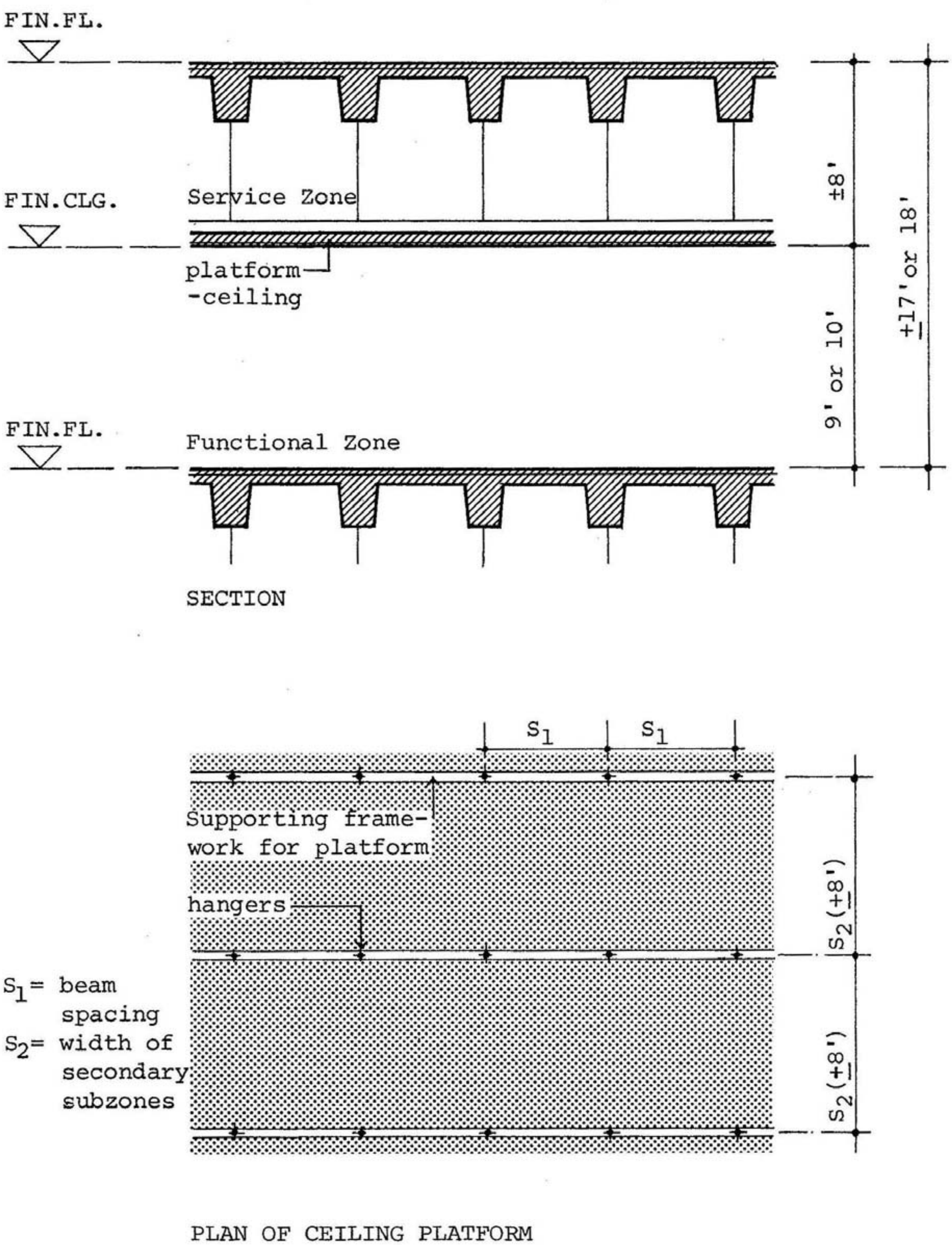
323.4 MODULE

There is no planning grid to which the ceiling subsystem must conform; partitions can be attached to any point of the platform, though the location of structural beams presents some constraint. (See Section 333.4.) Their location will also be limited by the structural grid of the ceiling subsystem which will make certain portions impenetrable by services. For this reason, the dimensions of the ceiling structure should be coordinated with those of the structural beams where possible. (See Section 322.1.1, Paragraph 3.)

323.5 HANGER SPACING AND DIAGONAL BRACING

Each hanger supports a maximum of approximately fifty to sixty square feet of platform. The structural beams will determine the hanger spacing in one direction. This spacing will be 4’6”, 5’7-1/2”, or 7’6”. The width of secondary subzones for service distribution will probably determine the

Figure 320-7. CEILIING DIMENSIONS



spacing in the other direction. (See Section 224.2.) Where diagonal bracing is required, it should be located in approximately every fifth space between hangers in both directions.

323.6 SPACING OF MAIN MEMBERS OF SUPPORTING FRAMEWORK

The main members of the framework which supports the platform are typically hung perpendicular to the structural beams and are spaced to accommodate secondary subzones (approximately eight feet on center).

324 LOADING

324.1 IMPACT

All permanent components of the ceiling subsystem (including any fireproofing, and other surface finishes) must be resistant to impact resulting from the activities of workmen and maintenance personnel in the service zone.

324.2 VERTICAL LOADS

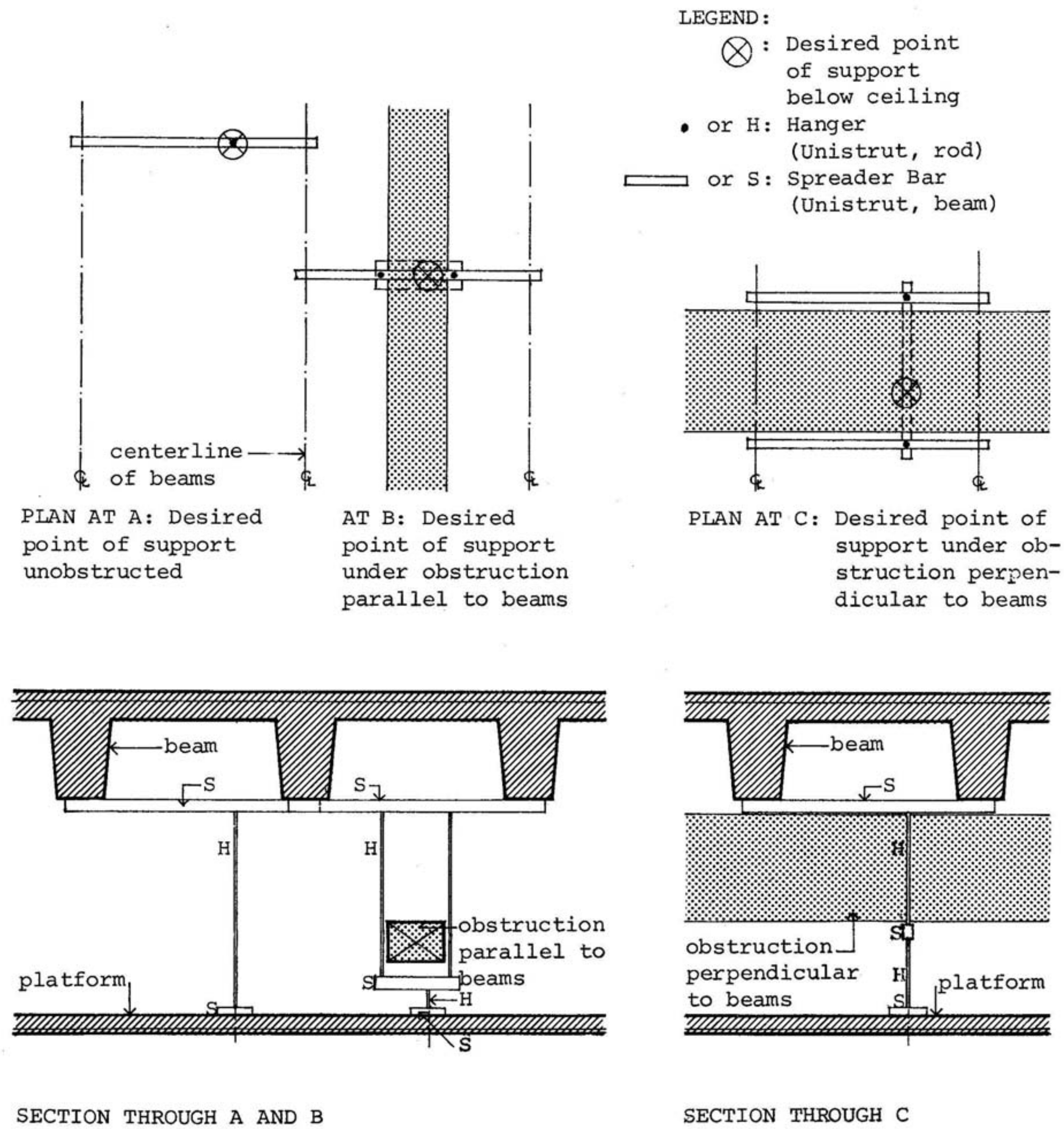
The design mechanical load for the ceiling subsystem is 15 psf. This is sufficient to support part of the service distribution components and light ceiling mounted items such as light fixtures and cubicle tracks. Besides the 15 psf mechanical load, an additional 25 psf live-load capacity must be provided for construction or maintenance workmen and for temporary construction loads during initial construction or remodeling. This extra 25 psf capacity also allows for local concentrations of mechanical equipment and local ceiling-hung concentrations in the range of 100 pounds in any 100 square feet. Heavier equipment must be supported by the floor below or hung directly from the structure above. (See Figure 320-8.) Exact capacities for ceiling load concentrations will depend on the individual design.

The ceiling should also be capable of withstanding upward point loads of at least 25 pounds over a six-inch square area without appreciable deformation.

324.3 LATERAL LOADS

The ceiling is not required to contribute to the lateral force resistance of the structure, but it must transmit all lateral forces developed in partitions, as well as within the ceiling itself, to the structure. (See Section 334.2.) Design which do not require diagonal bracing in order to transmit the lateral loads are preferred.

Figure 320-8. METHOD FOR SUPPORT OF CEILING-MOUNTED EQUIPMENT FROM STRUCTURE ABOVE



325 ACOUSTICS (Figure 320-9)

325.1 COMBINED FLOOR AND CEILING

The combined floor and ceiling construction should provide ratings of STC 50 and INR +5 between floors. The higher ratings of STC 55 and INR ±10 which are required between service areas and patient rooms (Hill-Burton standards) are not applicable to the floor/ceiling construction, since the planning rules of the Prototype Design always separate the service bay from the rest of the service module by means of a two-hour wall, and the ceiling over the functional space is interrupted at this wall. The planning rules also preclude the placement of a service bay over functional space on the floor below.

Since there is no acoustic data currently available for assemblies of a type similar to the Prototype Design, the acoustic performance of the combined floor and ceiling can only be estimated. It is expected that both the impact isolation and the airborne sound isolation from floor to floor will be satisfactory, assuming a fairly dense structure for the platform.

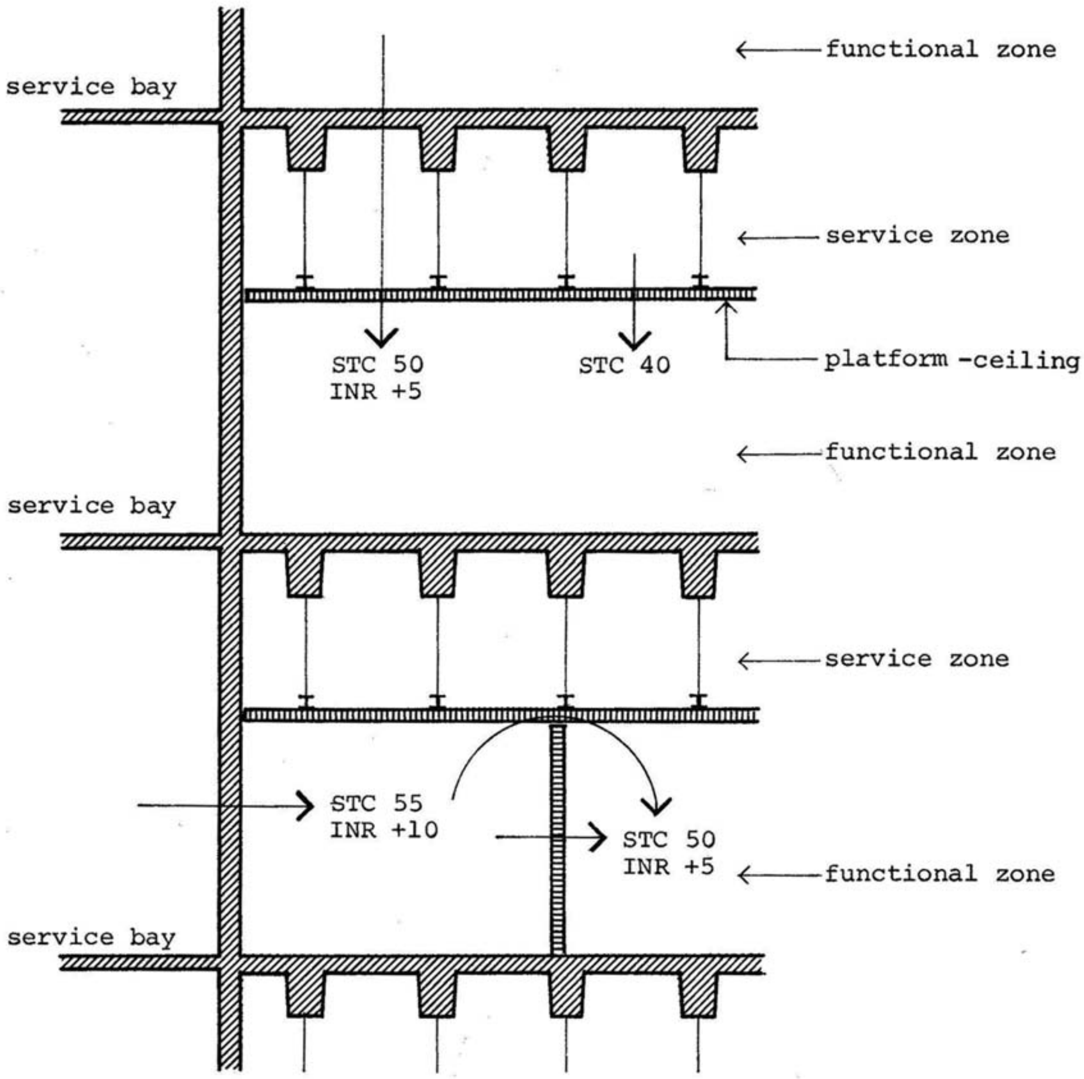
325.2 COMBINED PARTITIONS AND CEILING

The ceiling construction must not reduce the sound isolation provided by the partitions. The combined partition and ceiling construction must provide STC ratings as high as 50. In order to achieve this high level of performance in the field, the joint between the partitions and the ceiling must be carefully detailed, installed, and supervised. The degree of supervision during construction can seriously affect the acoustic performance of the system. The joint should be detailed so that acoustic seals are relatively accessible for inspection and repair.

325.3 PLATFORM

Materials must be selected in reference to the maximum noise level to be allowed in patient bedrooms and other critical areas. The platform should provide a minimum of STC 40 to protect habitable spaces from noise generated by activity or equipment in the service zone. It is not expected that the platform alone will provide good impact isolation from the floor below, but since the service zone will be infrequently occupied, this is not expected to present any serious problems. Vibration and noise producing items in the service zone should be isolated from direct contact with the ceiling by resilient mounts.

Figure 320-9. ACOUSTIC CRITERIA FOR VARIOUS ASSEMBLIES



In those spaces where sound isolation between the platform and the floor below is critical, the finished ceiling can be separated from the platform by means of resilient clips.

325.4 FINISHED CEILING

The lower surface of the ceiling should have an absorption capacity between NRC .60 and .80 in many areas of the hospital. Where continuous, glued-on finished ceilings are used, a high sound-attenuating material (such as USG Aurotone Tile) with a ceiling sound transmission class of 45-49 should be specified to reduce sound transmission over the partition from room to room.

326 FIRE SAFETY

One of the key characteristics of the system is that, with the exception of two-hour fire barriers, no partitions may penetrate the ceiling even though they may be required to have a fire resistance rating of one hour (as at corridors) or to be smoke barriers. Another critical design feature of the system is the planning requirement that all partitions (except two-hour rated) must be relocatable. The total ceiling, therefore, must be designed to provide the same degree of fire, smoke and fume resistance as the one-hour rated partitions, even though at this time there is no ceiling (as opposed to a floor or roof and ceiling assembly) with an official one-hour rating. A rating is given by the appropriate authorities on the basis of a fire test, and no fire tests have yet been carried out on ceilings as separate entities. Ceilings are presently tested only in their fire protective capacity as part of a floor or roof and ceiling assembly, not as a fire separation element.

In the absence of official ratings, the ceiling subsystem design will be accepted by the appropriate VA authorities (Safety and Fire Protection Staff, Engineering Service, DM&S) if they are of the opinion that it would be structurally sufficient and reasonably smoketight in the event of a fire. For convenience, such a ceiling design is referred to as a one hour rated ceiling. Suitable protection of the ceiling hangers may need to be provided, however. This may take one of several forms. The hangers themselves may be fireproofed, or the openings in the ceiling-platform may be protected by fire dampers, or the functional zone may be sprinklered. The preferred method may vary in different functional areas and/or in different geographical locations where code and cost considerations may influence the choice.

The ceiling must be non-combustible and its materials must not produce noxious or toxic fumes. Maximum flame spread rating of the materials is 25, and maximum smoke-developed rating is 50.

327 OTHER DESIGN CRITERIA

327.1 DEFLECTION

The suspension system for the platform must incorporate leveling devices to take up deflection from structure or ceiling dead loads. For compatibility with partitions, actual expected live-load deflection from combined live loads on the structure and ceiling subsystems should produce deflections compatible with the partition/ceiling junction detail; typically, ½" can be accommodated. (See Figure 330-3.)

327.2 TOLERANCES

Tolerances must be in accordance with VA Construction Standards and Master Construction Specifications.

327.3 SURFACE CHARACTERISTICS

It must be possible to glue or mechanically attach any conventional finished ceiling to the underside of the platform.

The walking surface of the platform must have a finish, or capability of receiving finish materials with the following characteristics:

1. Sufficient resistance to abrasion and impact to permit maintenance personnel to walk on the surface without affecting the structural integrity of the platform and without generating a dust problem.

2. Sufficient resistance to moisture so that accidental leaks in pipes will not cause structural failure.

3. Easily penetrated and repaired.

4. See Section 325 and 326 for acoustic and fire safety criteria.

327.4 ADAPTABILITY

The platform and suspension system are regarded as permanent parts of the building, whereas the finished ceiling, which may require a wide latitude of performance, is an adaptable component. Adaptability of the platform is, therefore, primarily a question of access to, and support of certain components of other subsystems, as well as the finished ceiling.

327.4.1 Penetrations

Although access to the service zone is primarily horizontal, a reasonable degree of vertical access must also be provided for convenience of engineering personnel and for introduction of equipment. During construction it must also be possible to leave out large areas of the platform temporarily so that primary trunk ducts, etc., can be brought into the service zone.

It must be easy to penetrate the ceiling to relocate or add service distribution components. There should be as little restriction as possible in the locations of these penetrations. When services are relocated, it should be easy to patch unused openings.

327.4.2 Support of Adaptable Items

The platform should provide substantial backing for a variety of ceiling finishes which can be applied, cleaned, repaired, removed or changed without significant damage to the base material. It must also provide support for a wide range of ceiling-mounted items such as cubicle tracks, IV hangers, TV consoles, etc., in a manner allowing simple cutting and drilling of holes as they are installed and patching when they are removed. The ceiling framework should not place undue restrictions on the location of partitions; ideally there would be no restrictions.

328 TARGET COSTS

328.1 RANGE

The total cost of the ceiling subsystem will range between $2.50 and $4.55 per square foot of ceiling, or $2.10 and $3.85 per OGSF of building. (See Section 751.2.2.)

328.2 SCOPE

328.2.1 Included

1. Complete suspended ceiling system, including:
2. hangers, braces, edge connectors and trim;
3. leveling devices;
4. access panels; and
5. any materials or devices required to obtain a fire rating of one hour for the ceiling subsystem. (See Section 326.)

328.2.2 Not Included

1. Lighting fixtures;
2. fixture mounting devices;
3. attachments and hangers for service distribution elements;
4. welded studs or inserts in structural beams for attaching ceiling hangers;
5. air diffusers, grilles; and
6. special insulation or shielding.

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330 Partitions

331 BASIC DESIGN (Figures 330-1 and 330-2)

331.1 TWO-HOUR PARTITIONS

Fire sections and vertical shafts must be bounded by two-hour fire barriers. Those barriers that are non-loadbearing, interior partitions are included in this subsystem. They extend from the floor to the underside of the structural slab above. All other performance characteristics are the same as described below.

331.2 OTHER COMPONENTS OF THE PARTITION SUBSYSTEM

Except for two-hour partitions and certain smokestop partitions, all components of the partition subsystem extend from the floor to the ceiling-platform, and are the same height on any one floor. Included are all types of non-loadbearing interior partitions, interior door sets and glazed units.

All components must provide a wide range of performance in terms of impact resistance, finishes, ease of relocation, fire resistance and acoustics. To maintain the fire resistance and acoustic performance, and to facilitate access to services, service distribution lines should not be located within the partitions but should be surface mounted wherever feasible. The factors governing where to surface mount the services are discussed in Section 337.3.3.

In some instances, it will be necessary to enclose the surface-mounted services with furring. (See Section 332.2.1.) The furring should be extended to the ceiling but kept free of the floor so that maintenance of floors is facilitated. Furring may be site fabricated or shop fabricated depending on the degree of repetition and the numbers required.

331.3 HEAD DETAIL

Because of the long structural spans involved in the Prototype Design, the detail at the head of all components of the partition subsystem must accommodate deflection by incorporating a “perimeter relief runner” detail. In addition, the head detail must not degrade the acoustic and fire safety performance of the partitions. Fire-rated head details will be required for all rated partitions, and these details should be matched in appearance by the detail at the head of all other components of the subsystem. Rated perimeter relief runner details are illustrated in Figure 330-3.

331.4 PERMANENT AND ADAPTABLE COMPONENTS

Two-hour partitions are permanent. All other components of the partition subsystem are considered adaptable.

Figure 330-1. BASIC DESIGN OF PARTITION SUBSYSTEM

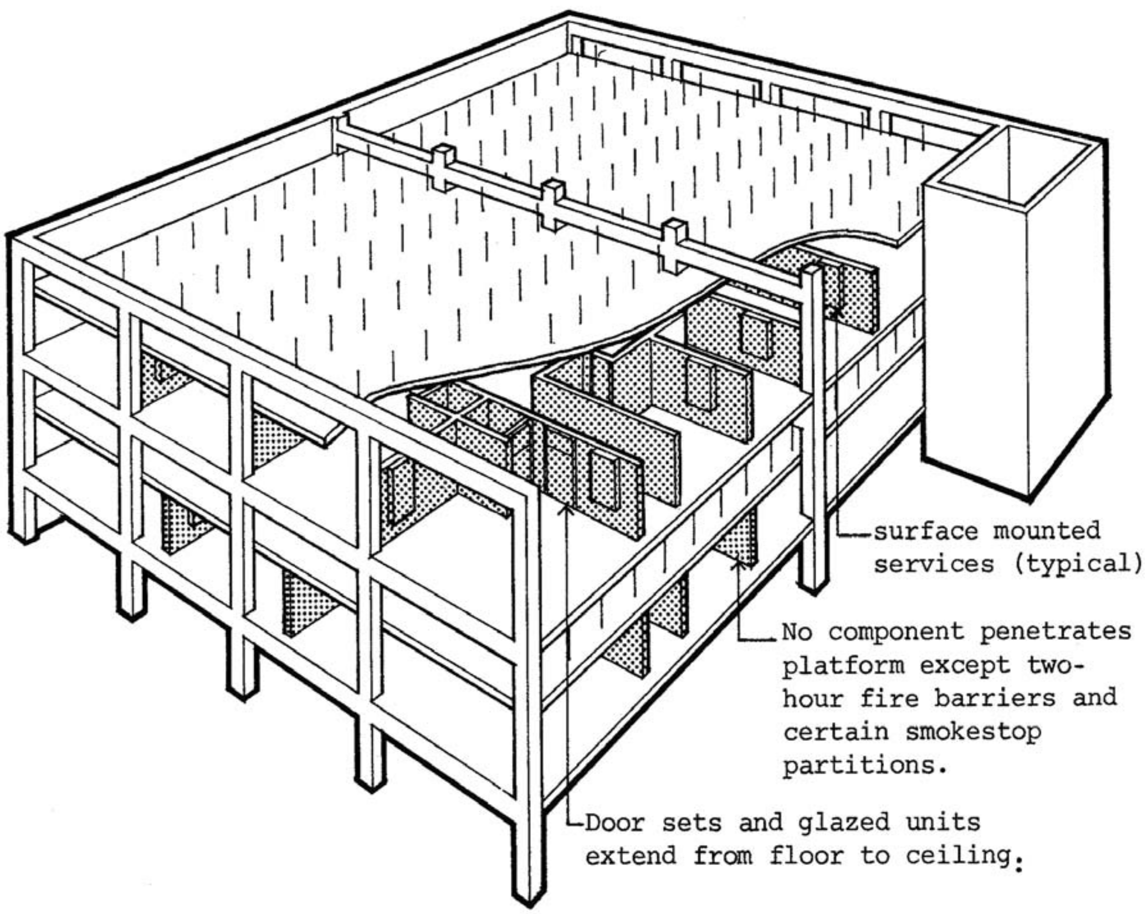


Figure 330-2. COMPONENTS OF PARTITION SUBSYSTEM

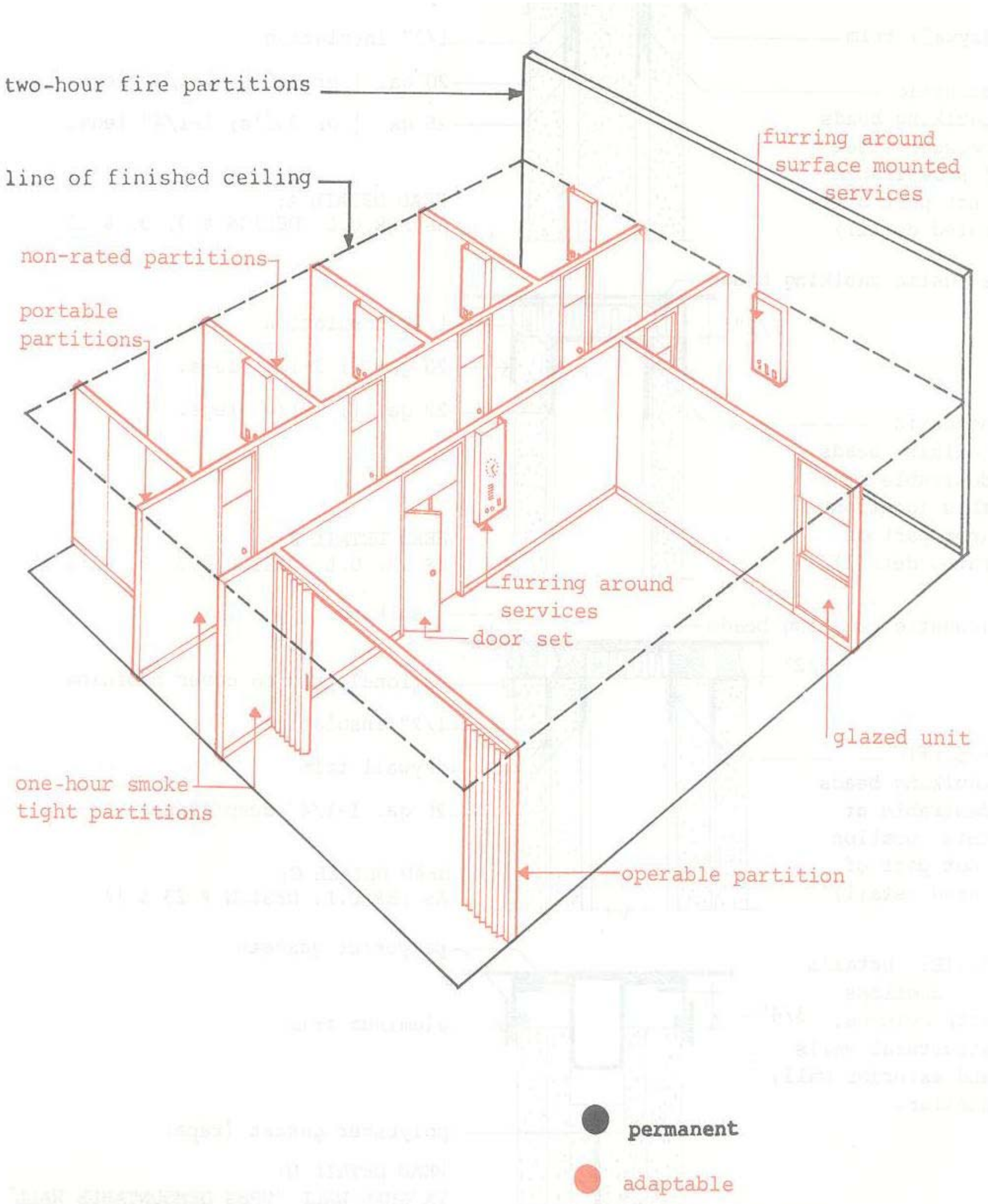
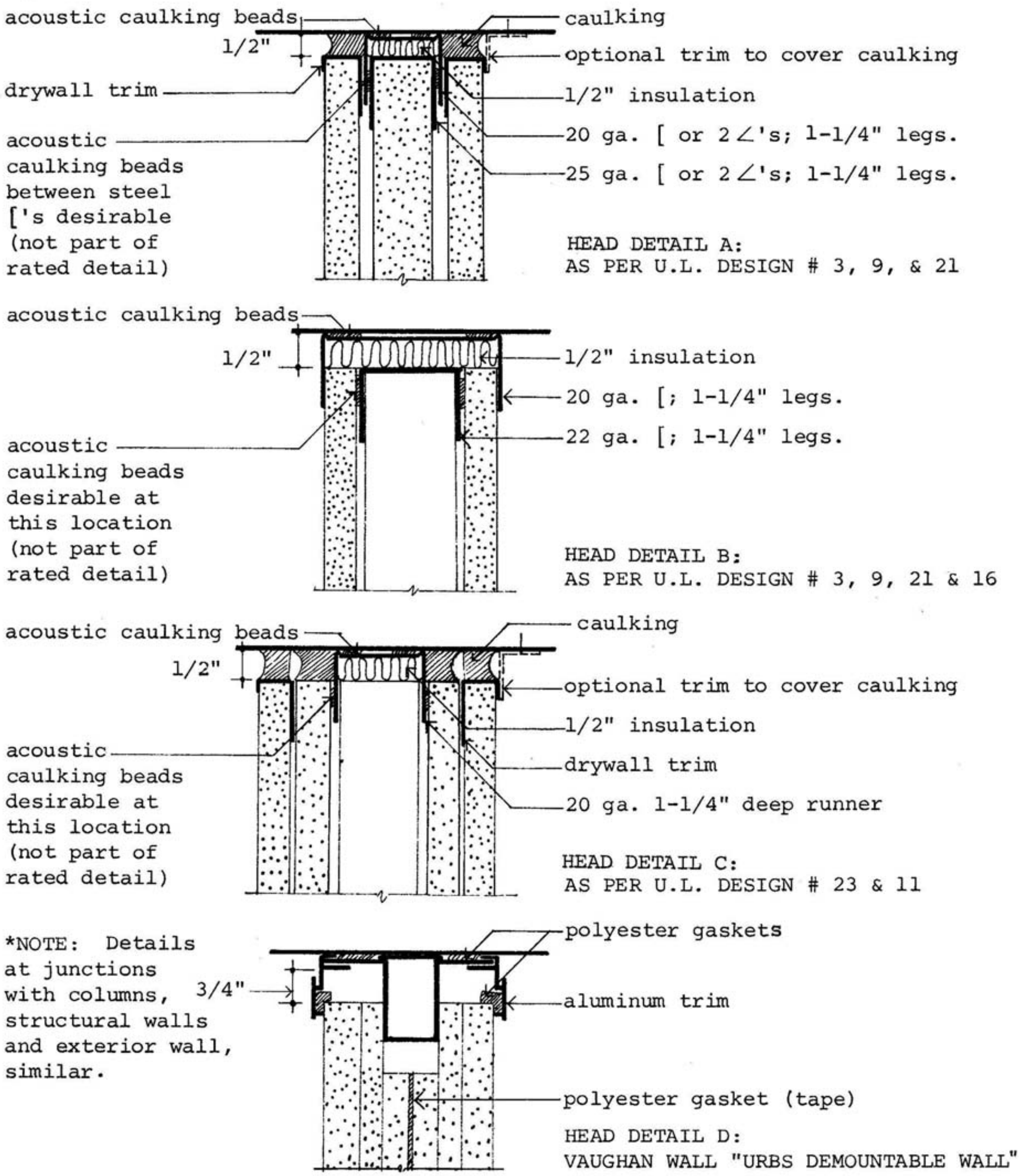


Figure 330-3. EXAMPLES OF RATED PERIMETER RELIEF RUNNER DETAILS AT HEAD OF PARTITION



332 GENERIC DESIGN OPTIONS

332.1 MATERIALS AND CONSTRUCTION

332.1.1 Fixed and Relocatable Partitions

The preferred options for fixed and relocatable partitions are gypsum board on metal studs (Option 1) or laminated gypsum board (Option 2). These provide the highest level and the greatest flexibility of performance when compared with other partition types. (See Section 723.3.) They are capable of meeting any reasonable strength requirement, of accepting any required finish and may be either jointless or panelized, each of which may have advantages in relation to different functional areas of the hospital.

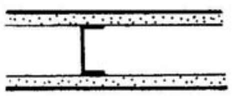
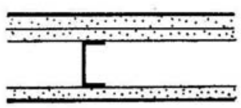
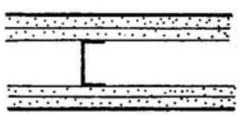
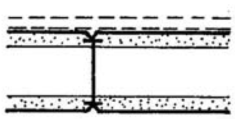
Panelized partitions are generally proprietary, whereas the jointless types are available either as proprietary or non-proprietary systems. Proprietary systems typically have a higher first cost. The advantage of a proprietary system is that all details have been precoordinated and tested so that the level of performance is known and is not as dependent on the quality of supervision during construction as the non-proprietary types. This is particularly important where acoustic, fire safety and deflection criteria must all be met by the same detail, as is the case at the head of the fire rated partitions. At least one proprietary system - by Vaughn Interior Walls, Inc. - has such a detail which has been rated one hour by the University of California, tested for a high level of acoustic performance (STC 50), and designed to provide as much as ¾" tolerance to take up deflections. (See Figure 330-3, Detail D.)

There are several specific design options available in each of the two preferred generic categories. These are illustrated in Figures 330-4 and 330-5 and discussed in Section 336.

332.1.2 Operable and Portable Partitions

These are available in a wide variety of types and properties. Where sound isolation is required, the partition should provide a positive seal when partitions are closed. For this reason, as well as for asepsis, those types which use mechanically activated bottom-edge drop-seals and no floor track are recommended. This allows some tolerance for movement of the building structure.

Figure 330-4. PARTITION GENERIC DESIGN OPTION 1: GYPSUM BOARD ON METAL STUDS

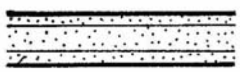
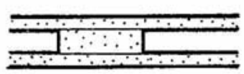
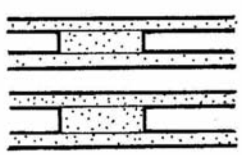
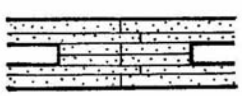
Types Available	STC Rating[1]	Similar UL Design # & Fire Rating[2]	UL Design Has Rated Perimeter Relief Detail[3]	Examples of Similar Proprietary Partitions
a. 	37-43	#2,1-hr	no	
b. 	41-49			
c. 	45-54	#23,1-hr #11,2-hr	yes yes	<u>VAUGHAN WALL "URBS Fixed Wall</u>." 1-hour rated with tested perimeter relief detail by the University of California.
d. 	36-50			<u>U.S.G. "Ultrawall</u>." 1-hour rated by the University of California (8/18/67). No tested perimeter relief detail. Available demountable or fixed; progressive or non-progressive.

1. The higher STC ratings for each basic design are achieved by adding sound attenuation blankets, by varying the dimensions of the various members, and by increasing the number of perimeter acoustic caulking beads.

2. U.L. designs are all class E-1. These designs specify every detail of the tested partition, including dimensions of each component. Other variations of the basic type also exist.

3. See Section 331.3.

Figure 330-5. PARTITION GENERIC DESIGN OPTION 2: LAMINATED GYPSUM BOARD

Types Available	STC Rating[1]	Similar UL Design # & Fire Rating[2]	UL Design Has Rated Perimeter Relief Detail	Examples of Similar Proprietary Partitions
a. 	36	#9,1-hr #3,2-hr #21,2-hr	yes yes yes	VAUGHAN WALL "2-1/4" Solid Wall." This design has been 1-hour rated (without perimeter relief detail) by the University of California (5/2/65).
b. 	36	#15,1-hr #16,1-hr	yes yes	VAUGHAN WALL "Chase Wall." This design has been 1-hour rated (without perimeter relief detail) by the University of California (11/1/66).
c. 	45-50	#24,2-hr	no	VAUGHAN WALL "Double Sound Wall" 2-hour rated.
d. 	45-51	#7,2-hr (Class D-2) #14,2-hr (Class D-2)	yes yes	VAUGHAN WALL "URBS Demountable Wall." 1-hour rated with tested perimeter relief detail by University of California 9/12/68.

1. The higher STC ratings for each basic design are achieved by adding sound attenuation blankets, by varying the dimensions of the various members, and by increasing the number of perimeter acoustic caulking beads.

2. U.L. designs are class E-1 except where noted. These designs specify every detail of the tested partition, including dimensions of each component.

A standard of quality and performance for the various products may be established by reference to the leading manufacturers, many of whom support a certification program (NSSEA) which combines acoustical and operating requirements.

332.2 TYPICAL METHODS FOR HOUSING SERVICES

The appropriate method of housing services in different functional areas is discussed in Section 337.3.3. This section describes the available options. Specific products are discussed in Section 780.

332.2.1 Surface Mounted Services

1. Services are exposed. This category includes items such as surface-mounted electrical raceways designed to be exposed.

2. Services are contained within proprietary enclosures and hung on the partition, (e.g. patient wall systems and lavatory consoles).

3. Services are surface mounted on the partitions and enclosed with furring. Figure 330-6 illustrates two ways of furring around services using materials and details that match the basic partitions. The metal angles at the corners of Type 2 permit easy access to the services and protect the vulnerable corners of the furring against damage.

Method 1 can be used where only a few items are involved, such as switch drops or electrical supply to power outlets. If several drops are required within one space, it may be preferable to drop only once and run a horizontal raceway at an appropriate level. Method 2 should be used where a cluster of different services can be grouped into a local area, e.g. at a patient bedside or a treatment room. Method 3 is an alternate for method 2 where reduced costs are critical, or where appropriate proprietary enclosures do not exist.

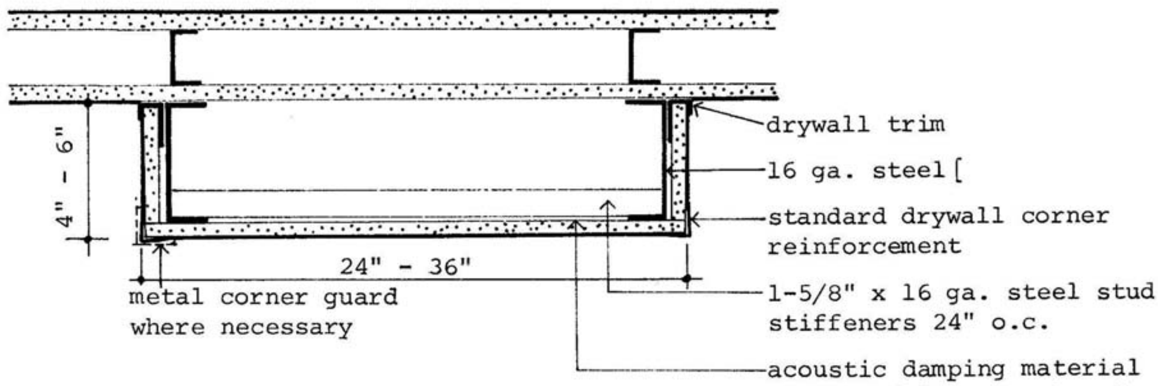
332.2.2 Services Within Partitions

1. In stud space.

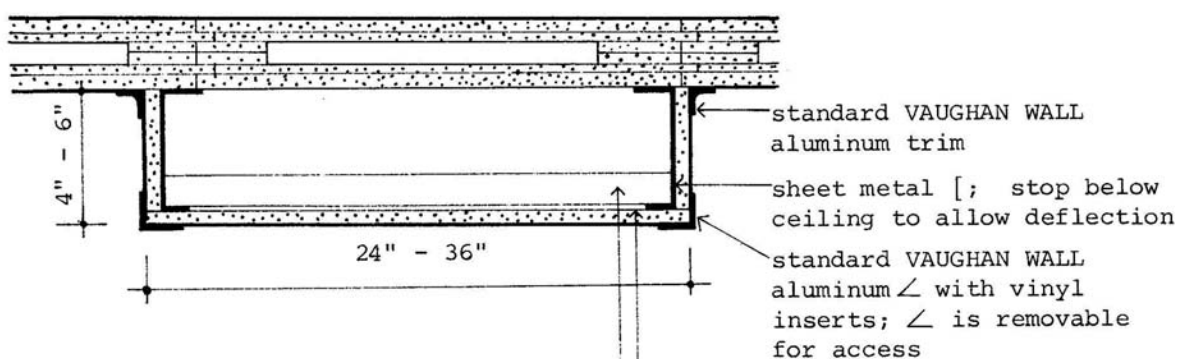
2. Between double partitions.

3. In prefabricated “plumbing walls”.

Figure 330-6. FURRING AROUND SURFACE-MOUNTED SERVICES



TYPE 1: PLAN SHOWING FURRING TO MATCH STEEL STUD AND GYPSUM BOARD PARTITIONS.



TYPE 2: PLAN SHOWING FURRING TO MATCH VAUGHAN WALL PARTITIONS.

333 DIMENSIONS

333.1 HEIGHT

All components of the partition subsystem (except two-hour fire rated partitions) will stop at the ceiling-platform, which will have a uniform height throughout each fire section and preferably throughout each floor. Nursing areas have a nominal floor-to-ceiling height of nine feet. The support areas have a nominal floor-to-ceiling height of ten feet. The exact height of the partitions is a function of the particular detail selected for the partition/ceiling interface. (See Section 322.2.)

333.2 THICKNESS

Thickness of partitions may vary as required for loading, fire safety, and acoustic criteria. On the basis of loading criteria and typical construction, the recommended minimum width of metal studs (Option 1) is 3-5/8”, whereas the minimum thickness of laminated gypsum partitions is 2-1/4”. (See Section 334.3.) Relocatability of door frames is facilitated if all partitions are the same thickness.

333.3 DOOR SIZES

Door frames extend from floor to ceiling, surrounding standard height doors with transom panels over. The nominal width of door openings will vary between two and eight feet. The maximum size single leaf permitted is dependent on the weight of the particular door because the lateral load introduced by doors, and impact from door slamming, must be accommodated by the ceiling subsystem.

333.4 CONSTRAINTS ON PARTITION LOCATION

No specific partition module or planning grid is required. In many areas of the hospital, a modular partition system with exposed joints will be unacceptable because of aseptic requirements. However, partitions should be located so that plumbing drains do not coincide with structural beams or perimeter girders. Also, the drops for services associated with partitions should not conflict with the structural members of the ceiling-platform. An implied dimensional discipline for partition layouts results from these considerations.

334 STRENGTH

334.1 IMPACT

Surface and projecting corners of all components must be designed to withstand high impact in those locations where impact typically occurs, e.g., corridors. A reasonable degree of resistance to impact is achieved by providing two layers of gypsum board, by rails or by covering projecting, vulnerable corners with metal angles. Proprietary systems are often designed with this metal angle as a standard item.

334.2 LATERAL LOADS

All lateral stability of the basic partitions, frames for doors, etc., will be provided by attachments to floor and ceiling. (In those instances where the capacity of the ceiling is exceeded, additional supports from the structure above will be required.) Lateral loads on the partitions should be calculated at 10 pounds per square foot. Deflection for lateral load of 5 pounds per square foot should be limited to 1/360 of the partition height. Forces introduced by doors and impact from doors must also be taken into account in the design of the partitions and the door sets.

334.3 VERTICAL LOADS

Partitions must be capable of supporting vertical loads from equipment weighing at least 100 pounds per lineal foot of wall, with the load applied 6 inches out from one face of the partition. Heavier loads will be floor supported where possible. In areas where heavier loads are typically wall supported, e.g., X-ray rooms, the partitions in that department will be designed to carry loads up to 200 pounds per lineal foot of wall applied 12 inches out from one face of the partition. To achieve this higher loading capacity, gypsum board on metal studs is required.

334.3.1 Gypsum Board on Metal Stud Partitions

The following table is provided as a basis for the design of steel stud partitions in various areas of the hospital.

Stud Size, inches	Stud Gauge	Maximum Loading, lbs/lineal foot	Distance of load from partition face, inches
3-5/8	25	100	6
3-5/8	20	200	6
4 6	18 25	200	12

The stud gauge and size are based on the following assumptions:

1. 10' high partitions
2. studs placed on 24-inch centers
3. regular strength steel (Fy = 33,000 psi)

334.3.2 Laminated Gypsum Board Partitions

The table below is based on tests furnished by U.S. Gypsum Company and Vaughn Interior Walls, Inc., and is provided as a guide to the selection of laminated gypsum partitions.

Wall Type (See Figure 330-5)	Maximum Loading, lbs/lineal foot	Distance of load from partition face, inches
2-1/4" Solid Wall	200	6
2-1/4" Chase Wall (single or double)	200	6
3" Urbs Demountable Wall (Sound Wall)	100	6

These wall capacities are based on:

1. 10' high partitions
2. modulus of elasticity = 245,000 psi
3. allowable bending stress = 200 psi

334.3.3 Connections

For the range of loads stipulated, typical connections at the floor and at the ceiling are adequate and the capacity of the basic ceiling design is sufficient.

334.4 ATTACHMENTS

334.4.1 Gypsum Board on Metal Stud Partitions

Generally, except to support very light objects such as room thermostats, no fasteners should be used without horizontal rails or back-up plates, unless they are attached directly to the studs. Surface mounted horizontal rails are far more adaptable that back-up plates though the issue of asepsis may eliminate this option in some areas. The rails may be proprietary or specially designed. Back-up plates can be installed in the conventional manner, i.e., as required to support each predetermined piece of equipment, or it may be economically feasible to install continuous horizontal back-up plates at one or two predetermined heights. The latter method is preferred in that it would facilitate the installation or relocation of equipment at a later date, without the need to cut into the partition face. The required number, size and height of continuous back-up plates will vary in different functional areas of the hospital. The design of the back-up plates is best integrated with the interior elevations of a particular project so that convenient heights and sizes can be determined in relation to typical wall hung equipment in the various functional areas. The sizes of the back-up plates which could be used for various loads are as follows:

1. If the plate acts alone, i.e., if it is located behind the gypsum board, use 3” x 16-gauge if pullout is less than 15 pounds between each stud. (A pullout force of this magnitude could result from supporting on the partition an eight-foot high by twelve-inch deep cabinet weighing 200 pounds per horizontal foot.)

2. For the same force, a 3” x 25-gauge plate may be used if it is located between two thickness of gypsum board, i.e., if it acts in conjunction with the gypsum board. This option may also be used in conjunction with laminated gypsum board partitions.

3. Use a 1-1/2” deep x 16-gauge channel notched around the steel studs (and screwed to them) if the pullout is up to 200 pounds between each stud. (A 200-pound pullout force corresponds to the force from a 45 degree bracket supporting a weight of 200 pounds per foot.)

   The back-up plates should be in 4’0” lengths so that if necessary, it would be possible to adjust their height behind each 4’0”-wide sheet of gypsum board.

334.4.2 Laminated Gypsum Board Partitions

All attachments should be made with sheet metal screws with 1-1/2” embedment. These screws have a pullout capacity of approximately 50 pounds and a shear capacity of approximately 100 pounds. In the non-solid walls, screws must be placed to coincide with the 6-inch filler ribs.

335 ACOUSTICS

335.1 PARTITIONS

The need for resistance to airborne sound transmission through partitions varies between STC 35 and STC 50. (See Section 510 and 520.) The requirement for STC 55 between mechanical spaces and patient rooms is typically provided by a concrete wall which separates the service bay from the rest of the service module.

The STC of the partitions can be varied by the number and thickness of layers of gypsum board and the inclusion or omission of sound attenuation blankets. (See Figures 330-4 and 330-5.)

Laboratory ratings for sound isolation in general are consistently higher than the performance found in actual field installations. Factors which contribute to poor field performance include “flanking” transmission paths through and around the partition (namely through joints and penetrations, inadequate ceiling and perimeter detailing, etc.) and poor workmanship. Proper construction details at the perimeter of the partitions and close field supervision are extremely important.

All openings and construction joints should be well caulked and sealed airtight, and there should be no penetrations through the partitions. Any gap or hole quickly deteriorates the performance of a partition. This can be shown by the following example:

For a partition having a sound attenuation value of 40 decibels, a .1% opening, i.e., a .04 inch crack around a 3’ x 7’ door in an 8’ x 10’ wall, will result in that partition having a net attenuation of 30 decibels. For partitions having greater sound isolation, the same size opening will have a greater effect in reducing its isolating characteristic.

335.2 DOORS

Where sound isolation is critical, doors should be selected having sound isolation ratings equivalent to the partitions in which they occur. A 3’ x 7’ door with STC 30 placed in an 8’ x 10’ wall with STC 50 would result in a composite rating of approximately STC 36. The cost premium for doors with acoustic ratings above STC 25-30 is significant, however, so the benefit of their use should be carefully weighed.

Suitable gasketing at head, jamb and sill is also required to meet acoustical ratings. This will generally improve the sound rating by approximately 3 decibels. Undercuts and louvers must not be permitted where there is any concern for acoustical privacy.

335.3 FURRING AROUND SURFACE MOUNTED SERVICES

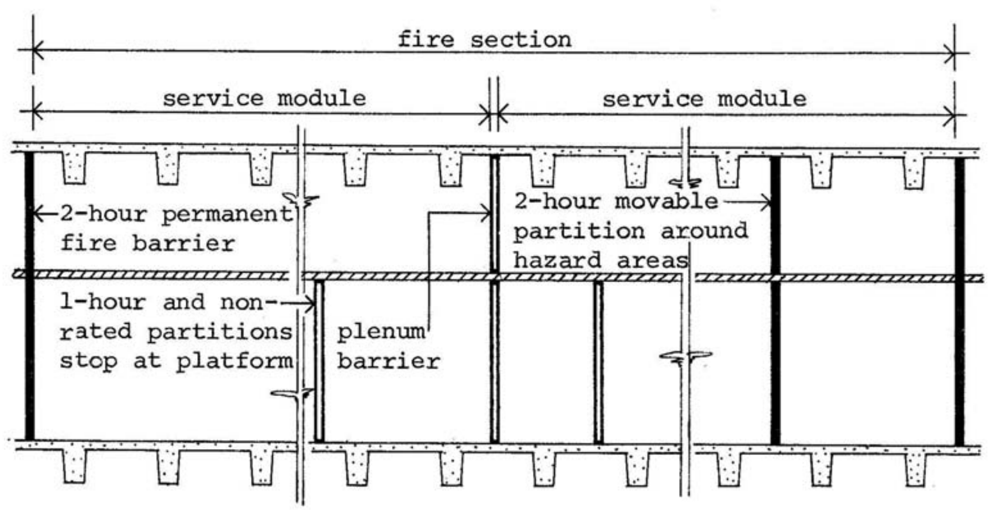
It is necessary to avoid coupling the noise energy from plumbing fixtures, etc., into partitions and furring. Transmission of this noise and vibration can be reduced by use of resilient devices. The enclosure around the surface mounted services should be stiffened and acoustically dampened to minimize noise radiation.

336 FIRE SAFETY

All partition components must be non-combustible. Materials must have a maximum flame spread rating of 25 and a maximum smoke developed rating of 50. When burnt, materials must not produce noxious or toxic fumes.

Partitions surrounding vertical shafts and defining fire sections must be two-hour rated and must extend from slab to slab. Two-hour slab-to-slab partitions may also be required around special hazard areas such as engineering shops, supply areas, etc. To facilitate change, these particular two-hour partitions should be constructed in two sections interrupted by the continuous ceiling-platform.

One-hour partitions, including smokestop partitions, will be required at corridors and other locations defined by code. These need not extend beyond the one-hour rated ceiling-platform. However, each service zone above the ceiling should be designed as a smoke-tight compartment, and "plenum barriers" should be installed where required.



To maintain adaptability, it is important that one-hour corridor and smokestop partitions can be easily relocated by conversion of existing non-rated partitions into rated partitions.

336.1 GYPSUM BOARD ON METAL STUD PARTITIONS (Figure 330 – 4)

Currently, UL Class E-1 partition Design No. 2 (5/8” gypsum board on either side of metal studs at 2 on center) is an acceptable one-hour partition with the exception that it has not been tested with a perimeter relief runner detail at the head.

It is recommended that a partition of similar construction be tested with a suitable relief runner detail in order than an economical partition equivalent to one hour can be provided throughout the hospital.

UL Design No. 23, which incorporates a relief runner detail, is acceptable as a one-hour partition. This partition, however, requires a double layer of wall surface material on each side. In addition, it has a maximum vertical span of 9’0”.

UL Design No. 11 is rated for two hours with a relief runner detail. This also requires two layers of wall surface material. The vertical span of this design is acceptable for the range of required ceiling heights.

Until a partition constructed of one layer of gypsum board on each side of metal studs with a suitable relief runner detail has been approved, the corridor and smokestop partitions must consist of UL No. 11 or UL No. 23. Other partitions should be capable of conversion to meet these standards.

336.2 LAMINATED GYPSUM BOARD PARTITIONS

There are several UL one- and two-hour rated partition designs which have been tested with relief runner details at the head. (See Figure 330-3.) Similar proprietary systems are not all UL tested, however. For instance, Vaughn Interior Walls’ products are tested by the University of California. These may be accepted by local fire marshals for individual projects.

337 OTHER DESIGN CRITERIA

337.1 CONTROL JOINTS AND DETAILS

The junction of all components of the partition subsystem with other subsystems must incorporate appropriate tolerances while maintaining acoustic and fire safety characteristics. All details must be carefully designed and controlled to minimize dirt traps and facilitate maintenance.

337.2 SURFACE CHARACTERISTICS

Partitions and all furring must be capable of receiving any typical finish found in hospital buildings. This includes a variety of paints, cement enamel, vinyl wall covering and glazed ceramic tile (See Functional Space Requirements). The preferred generic design options will accommodate all these finishes, including thin set ceramic tile, which can be applied to water-resistant gypsum board. In wet areas, however, ceramic tile must be applied to plaster on expanded metal.

Joints in the partition surface must be minimized in those areas where asepsis is a problem. This requirement is easily accommodated by the preferred options.

337.3 ADAPTABILITY

Except for two-hour partitions defining fire sections and enclosing vertical shafts, all components of the partition subsystem are adaptable.

337.3.1 Relocation

The basic design of the partition subsystem aims to make the assembly and relocation process sufficiently simple that change is facilitated and in some cases can be undertaken by the regular hospital engineering staff. The uncoupling of the subsystems will permit removal of the partition components without significant damage to adjacent components or disrupting of services to adjacent spaces. The uniform height of partitions and the fact that they have no holes cut in them will facilitate reuse. Panelized partitions will be more easily relocated and are recommended in those areas where frequent change is anticipated and where asepsis is not critical.

337.3.2 ACCESS

The need for access into the partition will be minimized by surface mounting the services whenever feasible. (See discussion below.) The need for access to those services covered by furring will vary and the furring details should be selected accordingly. In some cases the ease of cutting and patching the gypsum board or of replacing it will offset the higher first cost of providing more accessible covers.

337.3.3 Factors Affecting the Surface Mounting of Services

The strategy used to house services will vary from one functional area to another and from one project to another. It will be affected by several factors, including the cost and availability of suitable proprietary enclosures.

Other factors that will affect the strategy of service distribution within the functional zone include the following considerations:

1. Aseptic Environments. Projecting surfaces are a hindrance to the achievement of asepsis required in special areas such as surgery and central sterile supply.

2. Security Areas. Access to items which could prove hazardous if misused (e.g. surface-mounted electrical raceways) should be limited in areas such as psychiatric wards.

3. Housekeeping. The details of any objects projecting from walls must be carefully considered in relation to standard VA housekeeping methods. For instance, it is desirable to keep all projecting objects free of the floor to facilitate cleaning; and where wall surfaces are frequently washed down, the surfaces of objects hung form that wall should also be easily washable.

4. Corridor Projections. In accordance with code requirements, projections in corridors would necessitate increased corridor widths, at least locally where groups of services are required.

5. Acoustic Performance. Surface mounting is strongly recommended where the acoustic performance of a wall is critical, such as between two examination rooms.

(See Section 335.1.) Conversely, walls without the same critical acoustic requirements may contain services within them without jeopardizing the required performance.

6. Rate of Change of Services. Where the rate of change of services is not expected to be any greater than that of the partitions (e.g. room thermostats, or switch drops) and where other performance characteristics are not jeopardized, services may be housed within partitions.

7. Costs. An example showing the installation cost of surface mounting services compared with housing them in partitions is described in Section 780. Installation costs for surface mounting are greater but alteration costs are reduced because services can be changed more simply and quickly (with minimum disruption in the functional area) and because materials can be reused.

338 TARGET COSTS

338.1 RANGE

The total cost of the partition subsystem will range between $31.75 and $56.00 per lineal foot of partition, or $3.33 to $5.88 per OGSF of building. (See Section 751.2.3.)

338.2 SCOPE

338.2.1 Included

1. All full height (i.e., floor-to-ceiling and floor-to-structural slab) interior, non-loadbearing partitions including fixed, relocatable, operable and portable types;
2. interior door sets required in the above partitions, including doors, transoms over, and floor-to-ceiling frames;
3. hinges and sealing devices required for the above doors;
4. furring around surface mounted service distribution lines;
5. furring around interior columns and shear walls as required;
6. interior glazed units including glass and solid panels, and floor-to-ceiling frames;
7. baseboard and trim (except bases integral with floor);
8. support for wall-hung casework and equipment such as fire extinguishers and hose reel cabinets; and
9. finishes required on above items, including both field and factory applied.

338.2.2 Not Included

1. Load bearing, exterior and shear walls;
2. special insulation or shielding;
3. tackboards and chalkboards;

4. plumbing, electrical or other service distribution lines, raceways and terminals housed within or mounted on partitions;

5. wall-hung casework, shelving and equipment; and

6. door hardware, except hinges and sealing devices.

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340 Heating • Ventilating • Cooling

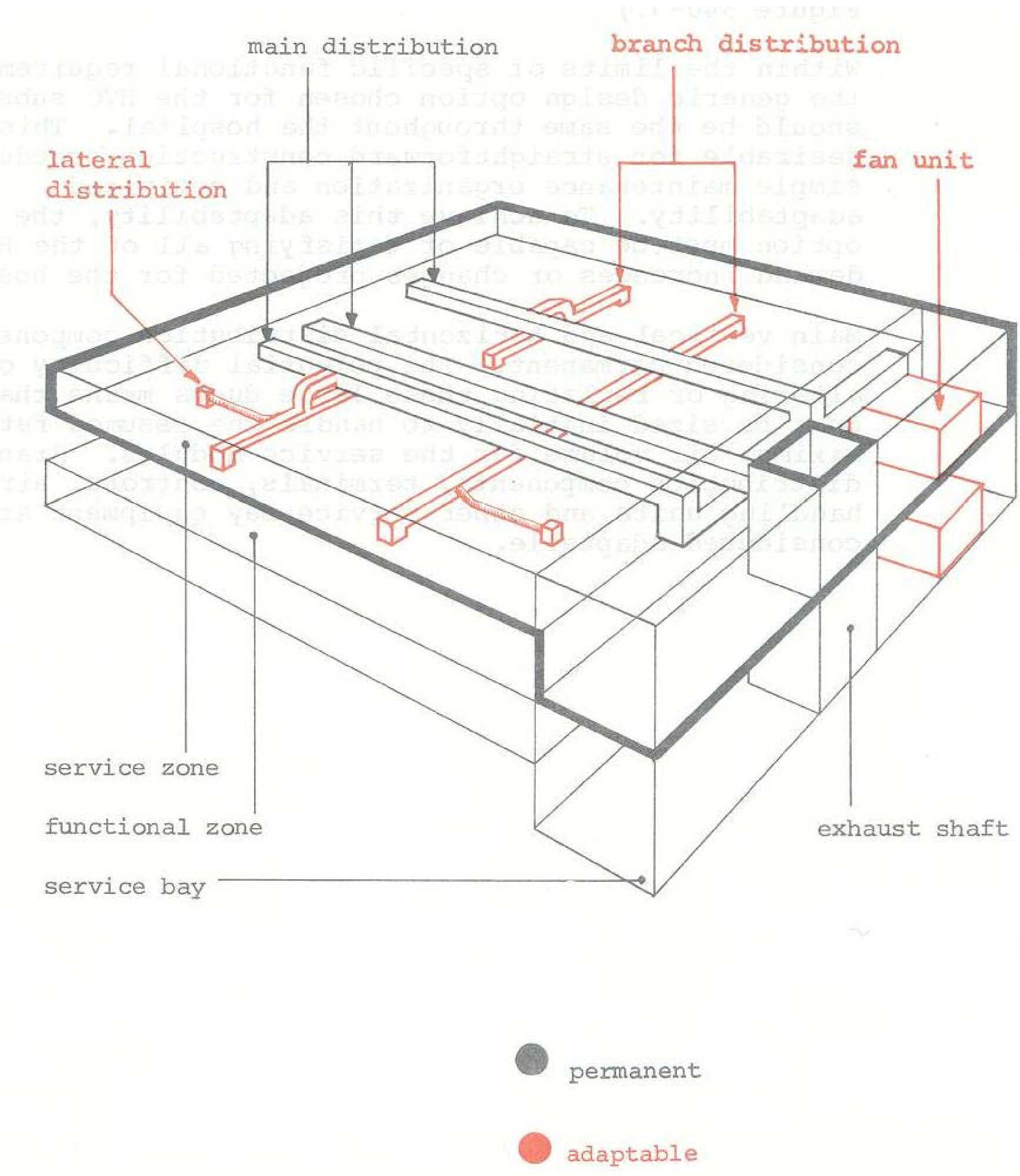
341 BASIC DESIGN

The HVC subsystem design is based on ducted air systems, with each fan unit zoned to supply one service module within the hospital. The fan unit will be placed in the service bay and the ductwork will pass horizontally through the service zone to provide downfeed service via ceiling registers to the functional zone below. (See Figure 340-1.)

Within the limits of specific functional requirements, the generic design option chosen for the HVC subsystem should be the same throughout the hospital. This is desirable for straightforward construction scheduling, simple maintenance organization and optimized adaptability. To achieve this adaptability, the chosen option must be capable of satisfying all of the HVC demand increases or changes projected for the hospital.

Main vertical and horizontal distribution components are considered permanent. The potential difficulty of altering or replacing these large ducts means that they must be sized initially to handle the assumed future maximum air volume for the service modules. Branch distribution components, terminals, controls, air-handling units and other service bay equipment are considered adaptable.

Figure 340-1. BASIC DESIGN OF HVC SUBSYSTEM



342 GENERIC DESIGN OPTIONS

The following are the subsystem options for HVC. A fuller discussion of these choices is given in Section 724.1.

342.1 SUPPLY SYSTEMS

The two major alternatives for supply are low- or medium-pressure terminal-reheat, and the dual-duct mixing-box systems. The only qualification is that close humidity control required for certain areas of the hospital would be difficult to achieve with a dual-duct system, unless total air cooling and humidifying is employed.

Where climatic conditions require it, a mixed system which combines hot water convectors for building perimeter auxiliary heating with a single-or dual-duct system for heating and cooling, is a prime variation.

342.2 RETURN AND EXHAUST SYSTEMS

The system must be capable of handling from 25 to 100 percent outside air. Both return and general exhaust can be extracted through the service zone by either duct or plenum. In the latter case the effects of system leakage and fire hazard need to be taken into account. The fans to the system would be placed in the service bay mechanical room. Special exhaust ducts will be required variously in each service module ducted through the service bay to fans on the roof. They will handle a range of conditions from sets of individual toilets to large areas such as isolation suites.

343 ORGANIZATION

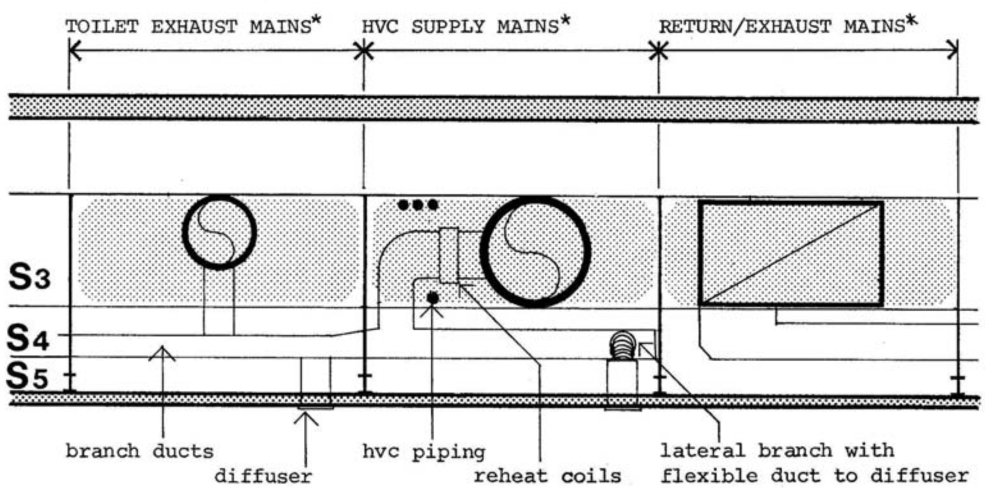
The special organization of the service zone and the service bay are discussed in Sections 223 and 224, and the following description defines the relationship of the HVC subsystem to this organization.

343.1 SERVICE ZONE

343.1.1 Subzones

The subzones affected by the HVC subsystem are S3, S4 and S5.

Figure 340-2. TYPICAL SUBZONE ORGANIZATION FOR HVC DISTRIBUTION: SECTION



*** Channels within subzone S3.**

The depth of S3 will be governed by the requirements of the main supply and return/exhaust ducts. This depth can be expected to be of the order of 36”. (This figure is obtained from the duct size calculation described in the Section 344.2 below.) The ducts will be hung directly below the beams.

The S4 subzone will contain the branch ducts which will dictate its vertical dimension. This can be expected to be of the order of 16” including clearance around the ducts. As far as possible, only one branch duct should be run between any pair of ceiling hangers (the hangers placed on beam center lines could be from 4’6” to 7’6” apart.) This will improve access for ceiling penetration below the ducts for other services.

Offsets from the branch ducts to diffusers will be made by flexible duct connections. Regulations limit the length of these connections to twelve feet, which should easily prove sufficient. These flexible ducts would run in the S5 subzone, and if the latter is dimensioned at about 12” in height, will allow ducts up to 10” in diameter with their plenum boxes.

Branches for any special exhaust ducts should also follow the same principle and run between separate hangers from supply branches, and using flexible ducts for offsets.

If a plenum return/exhaust system is used, return air boots will be required at the diffusers. With fire dampers, the boots will project 17” above the bottom face of the ceiling, for an 18” x 18” unit. But as the boots replace a ducted system they can be lined up clear of the supply branches as though a return duct were present.

343.1.2 Channels

The supply duct mains will be divided generally into two in each service zone to reduce the problem of duct size and reduce the lengths of the branch ducts. The two channels for these ducts will be approximately at the third points of the cross section, with the subzones for exhaust/return ducts usually between them. (See Figure 340-3.) The supply ducts and the terminal heaters with supply pipes, or the mixing boxes, will be in the HVC supply channels at the S3 level.

The equipment will be placed on the same side of the ducts at each branch take-off to facilitate installation and maintenance and, with the terminal heaters, allow straight runs of supply and return pipes. (See Figure 340-2.)

The horizontal dimension required to accommodate these supply ducts and their equipment will be the dominant factor influencing the spacing of the ceiling hangers defining these subzones.

343.1.3 Plenum Barrier

In case of a fire section containing two service modules and where the return or exhaust systems use the service zone as a plenum, a plenum barrier must be constructed between the adjacent service zones. This will allow the plenums on either side to be utilized independently.

343.2 SERVICE BAY

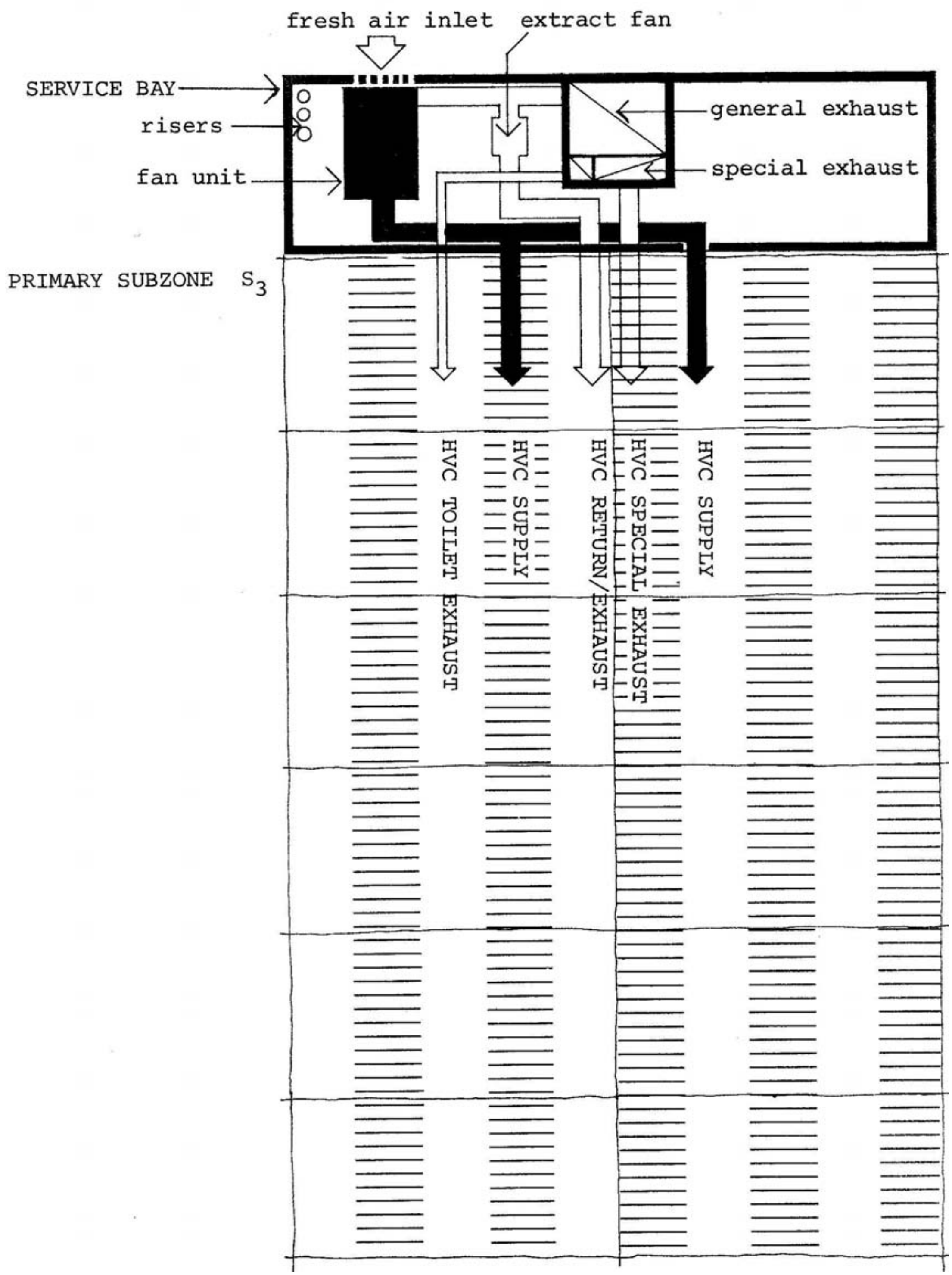
343.2.1 General

The service bay contains three groups of components of the HVC subsystem. The first is the air-handling equipment and associated header ducts. The second is the exhaust ducts and shafts. The third is the piping risers including steam and condensate, heating hot water and return, and chilled water and return. These will probably be grouped with risers for the plumbing subsystem to the module. (See Figure 340-3.)

The size of spaces and the arrangement of components should be such that the largest potential units are comfortably accommodated, and any change to the equipment, such as from all-exhaust to a return air system, can be as straightforward as possible. Also, the position of the components should be convenient for the corresponding supply and exhaust secondary subzones in the service zone. The header to the two supply main ducts must be placed within the service bay. This will avoid the constriction of service distribution that would occur if the crossover were made in the service zone itself.

The mechanical room is the control center for the service module HVC system.

Figure 340-3. SERVICE BAY AND CHANNELS: PLAN



343.2.2 Internal Service Bays

As discussed under Section 223.2.2, the overall layout of the hospital could cause some service bay positions to be entirely internal. This would mean for the HVC subsystem, either ducting down outside air to the fan units or removing the fan units to the roof of that stack of service bays. The latter alternative is considered preferable. It would preserve the ease of access for replacement of the fan units and allow simpler routine maintenance on the grouped fans. To preserve the independence of the service module, each would still be served by its individual unit and ductwork. This alternative also replaces the original mechanical room with an area reserved for supply shafts. These could be considerably smaller in bulk than the mechanical room leaving more floor area free to provide circulation connections to the functional zones on either side. This solution will require extra supply ductwork and the larger fan motor horsepower required for the longer distribution as compared with the exterior service bay arrangement.

344 DESIGN CRITERIA

344.1 HVC LOAD DISTRIBUTION

In order to systematically handle the HVC subsystem it is necessary to make assumptions about the general load distribution pattern in a hospital. The variables of air quality and return/exhaust alternatives are discussed later, but the first consideration is the supply load.

Hospitals will vary in c.f.m. per square foot required because of climate, configuration, etc., but the overall pattern of distribution is likely to remain the same. Figure 340-4 illustrates the pattern found in the design of one hospital which is considered typical.

In general, a majority of spaces and departments will require 6 to 8 air changes per hour which requires 1 to 1.5 c.f.m. per square foot with a ten-foot floor-to-ceiling height. Several departments will require up to 15 air changes, or 2.5 c.f.m. per square foot; some individual rooms, such as operating rooms, will also go as high as 30 air changes, or 5 c.f.m., but this would average down considerably over the total area that one fan unit would be serving, to about 2.5 c.f.m. As shown on Figure 340-4, laundries and kitchens will tend to considerably exceed these figures, therefore space modules handling these functions will probably require non typical air systems and fan units.

In recent years, there has been a tendency to boost the number of air changes as well as increased filtration required throughout the hospital to improve asepsis, maintain pressure differentials more adequately and speed up the response of the system to room temperature change. These higher values, sometimes quoted from 10 to 20, and even up to 30 air changes, would increase the figures quoted above and have to be taken into account in the design assumptions.

344.2 SERVICE MODULE REQUIREMENTS

A major factor in sizing service modules is the capacity of available pre-packaged air-handling units. Figure 340-5 is a diagram of the c.f.m. per square foot capacity of three typical units plotted against various service module sizes. The 35,000 c.f.m. unit is about the largest packaged unit available.

Figure 340-4. TYPICAL HVC LOAD DISTRIBUTION

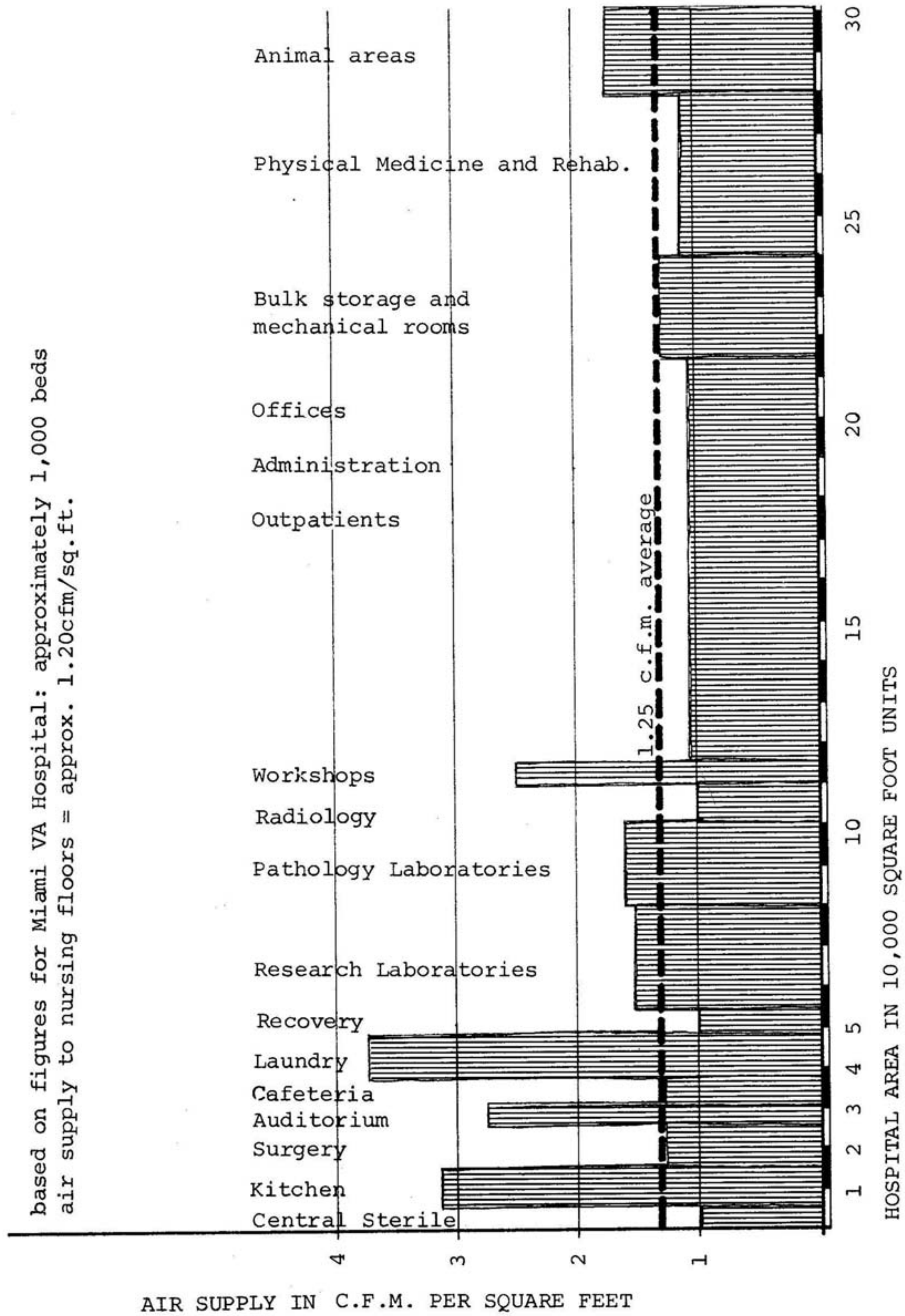
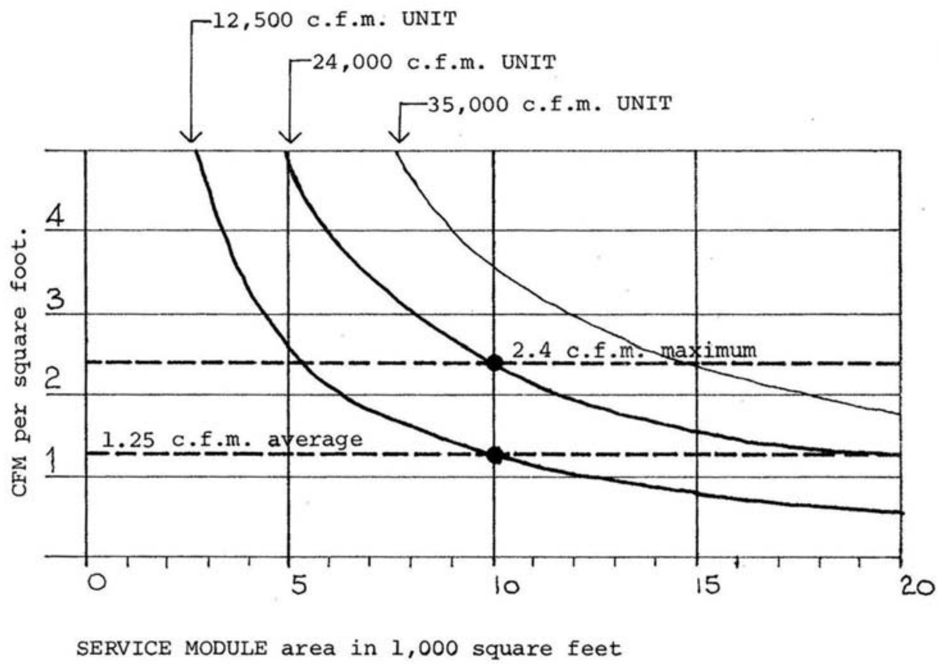


Figure 340-5. AIR-HANDLING-UNIT CAPACITIES



A mechanical room designed to house a 24,000 c.f.m. unit would provide the maximum air-supply requirement quoted above of 2.4 c.f.m./square foot to a service module of 10,000 square feet. The smaller unit rated at 12,500 c.f.m. placed in the same mechanical room would provide the average area requirement of 1.25 c.f.m. to the same 10,000 square feet module. As Figure 340-5 shows, it would be possible to increase the size of the service module to 15,000 square feet, using the two larger units, but this would leave little capability for dealing with increased future demands. At 10,000 square feet, the largest fan unit would be also able to handle the laundry and kitchen areas in most schemes.

Three items related to the HVC subsystem are to be considered permanent: the mechanical room size and locations, the openings for ducts in the shear wall in size and location, and the supply and return/exhaust duct mains in the service zone. On the basis of a set of load assumptions similar to those in Section 344.1 above, the maximum size of these elements can be calculated.

For instance, a 10,000 square foot service module with a 2.4 c.f.m. maximum design load would require two eight square foot supply branch ducts, two shear wall openings 4' x 3' and two openings for general exhaust and special exhaust of 5' x 3'. The mechanical room would be sized for the maximum 24,000 c.f.m. unit. These sizes would become standard for all service modules throughout the hospital.

344.3 VARIABLE CHARACTERISTICS

In addition to the range of load demands in c.f.m. to the various departments in the hospital, the subsystem must be capable of satisfying various space design conditions.

A typical range would be:

CHARACTERISTIC	MINIMUM	MAXIMUM
Design temperature	70 degrees F.	80 degrees F.
Relative humidity	30 percent	60 percent
Filtration	35 percent	95 percent
Air motion	10 f.p.m.	35 f.p.m.
Recirculation	0 percent	75 percent

Also special areas may require particular modification for odor control, and other areas may need pressure differentials between adjacent spaces, or adaptation of the system to use disinfectant devices for critical asepsis control.

As each service module will be primarily served by one fan unit and recirculation system, the module's performance characteristics would have to be set at the highest value required for its particular functional zone. This would suggest that in the range of possible service module sizes of 10 to 15,000 square feet, it would be preferable to take the lower value as optimum, to reduce the area affected by expensive requirements. In principle, all the permanent components of the HVC subsystem should be designed and laid out to potentially handle the worst case characteristics comfortably.

344.4 FIRE SAFETY

In general, the HVC subsystem presents problems no different from traditional systems as far as fire safety is concerned. This is true of the plenum return system suggested here, where, as in a tradition plenum design, the detection and control of fire and smoke must be considered carefully.

There is one feature of the subsystem which could lead to a simplification of normal fire strategy. The clear identification of each service module, with its own HVC supply and return, in a particular fire section means that it may be possible to limit emergency HVC measures to only the affected fire section in the case of fire.

344.5 ACOUSTICS

The general organization of the service module places all noise generating equipment in the subsystem within the service bay. This isolation should be reinforced by the use of isolation bases for equipment, choice of efficient equipment with minimum sound levels, and sound absorbent lining in the mechanical room. But the most important feature is the acoustic sealing of all service openings in the shear wall between the service bay and the service zone. Sound transmission through the ductwork should be restrained by duct linings and sound traps in critical functional areas. To provide adequate duct length to diffusers for reduction of sound transmission, functional areas adjacent to a service bay should be served from branch ducts approximately two hanger spacings away from the shear wall and the diffusers connected by flexible ductwork.

Sound transmission via the plenum, where one is used, should be restrained by mufflers in the return air boots in critical areas.

344.6 ACCESSIBILITY

Generally, all components of the subsystem should be designed and located so that routine maintenance and repair and minor alterations will cause minimal disturbance to the hospital functions, and also facilitate construction accessibility. Major repairs and alterations must be possible with minimum down time and without interference to more than the area of functional space requiring the change.

344.7 ADAPTABILITY

1. Air-handling equipment must be capable of incremental modification to accommodate future changes in performance requirements. It must be convenient for total replacement or modification.

2. Distribution systems must provide reasonably oversized main components to accommodate considerable variation in air volumes over the life of the building. They must be capable of addition and subtraction of branch components without requiring elaborate rebalancing of the whole system. Rebalancing after future alterations, as well as at initial installation, must be efficient, accurate and stable. Flexible ductwork should be considered for branches serving terminals which are specifically expected to be relocated. Future expansion of the hospital should be possible with minimum interruption of mechanical service to the existing building.

3. Terminals should be capable of modification or simple replacement to provide changes of performance in special areas, or throughout large areas, within the range of performance levels described in this section. Individual terminals must be removable for repair or replacement without disrupting or seriously unbalancing any other part of the system.

4. The control system should be designed for convenient and rapid modification to accommodate alterations in plan arrangement or in performance requirements of the mechanical equipment, including reassignment of terminals to thermostats and relocation of thermostats.

345 TARGET COSTS

345.1 RANGE

The HVC target cost range is $4.00 to $6.50 per OGSF. The lower end is the estimated cost of a decentralized single-duct terminal-reheat system, with plenum exhaust/return, and without a supplementary perimeter convector system. The upper end of the range would be appropriate for a dual-duct mixing-box system, and includes ducted exhaust/return and perimeter convectors. See Section 751.2.4 for further discussion of costs.

345.2 SCOPE

345.2.1 Included

The complete heating-ventilating-cooling system for the entire hospital beyond the central plant, including:

1. Decentralized mechanical equipment, such as air-handling units complete with humidifiers, filters, coils and related apparatus;
2. distribution systems, such as ductwork, piping and accessories;
3. general exhaust, toilet exhaust and special exhaust systems, such as for kitchens and fume hoods;
4. plumbing equipment and piping required exclusively for the HVC subsystem;
5. electrical equipment and wiring required exclusively for the HVC subsystem;
6. terminals and terminal devices, such as reheat coils, zone humidifiers, registers and ceiling diffusers;
7. control systems, including smoke detectors;
8. hangers, attachments and sleeves; and
9. thermal and acoustic insulation and vibration isolation.

345.2.2 Not Included

1. Central plant equipment, such as boilers, chillers and cooling towers;
2. plumbing and electrical equipment and distribution not required exclusively for the HVC subsystem;
3. grilles and louvers in the exterior wall;
4. special equipment for controlled environment rooms, refrigerators, hyperbaric chambers, etc.;
5. hoods for kitchens and laboratories; and
6. site work and utilities.

350 Plumbing Distribution

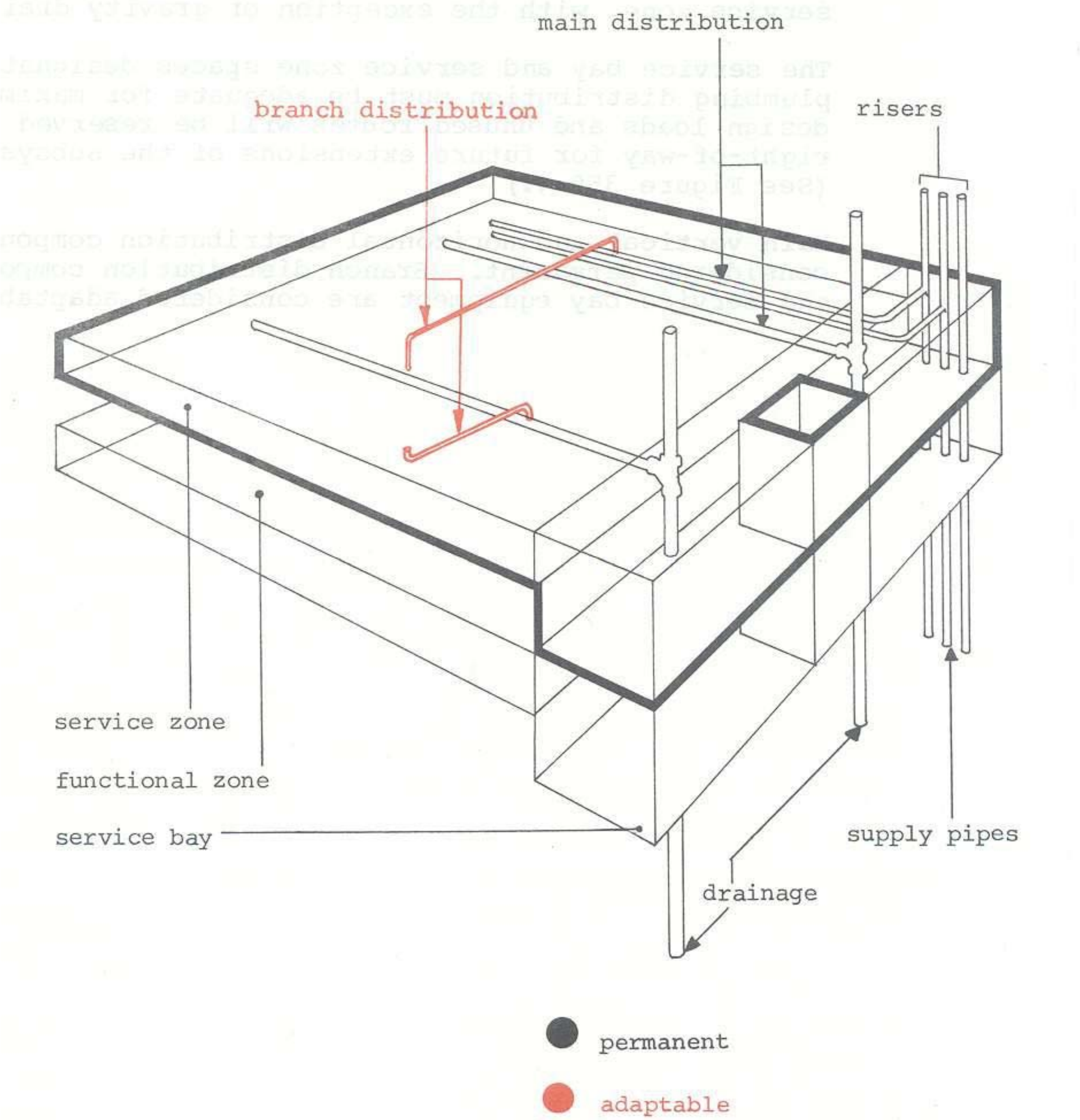
351 BASIC DESIGN

The plumbing subsystem will be organized to follow the general pattern of service distribution to and within the service modules. The main risers will be grouped in the service bay and all distribution to the service module will be horizontal through the service zone. All plumbing to the functional zone will be downfed form the service zone, with the exception of gravity drains.

The service bay and service zone spaces designated for plumbing distribution must be adequate for maximum design loads and unused routes will be reserved as a right-of-way for future extensions of the subsystem. (See Figure 350-1.)

Main vertical and horizontal distribution components are considered permanent. Branch distribution components and service bay equipment are considered adaptable.

Figure 350-1. BASIC DESIGN OF PLUMBING DISTRIBUTION SUBSYSTEM



352 ORGANIZATION

The spacial organization of the service zone and the service bay are discussed in Sections 223 and 224, and the following description defines the relationship of the plumbing subsystem to this organization.

352.1 SERVICE ZONE

352.1.1 Subzones

The main distribution will be run in subzone S3 and all branches will be located in S2. The pressure pipe drops to the functional zone will make any required offsets in the S5 subzone. The range of trap and fall dimensions for the branch drains are discussed in Section 353.2, and with the required structural beam depths will form the criteria for the depth of the S2 subzone (See Figure 350-2).

352.1.2 Channels

The plumbing mains will be horizontally distributed in a reserved subzone located on the same side of the service zone as the plumbing shaft. In areas of heavy demand, such as nursing units, supplementary runs of medical gases for instance can be run on the opposite side of the zone. The main drain will in any case be divided to run on each side of the girder in the service zone (See Figure 350-3).

The plumbing channels will be organized to carry the maximum design distribution in terms of number and size of pipes. Sleeves for the drains will be located in the shear wall at the lowest point in the subzone.

352.2 GENERAL

Plumbing services not initially required in a service module will have capped-off tees and valves in the plumbing risers. All control valves to any services will be placed at the main in the service bay to concentrate controls. The only exceptions will be the control valves to hazardous gases such as oxygen. These must be placed in the functional zone, fed from the service zone. Typical locations might be a corridor in a nursing unit, or the operating room of a surgical suite. The main distribution pipes should be provided with valved tees at increments along their length for potential branch piping.

Any pumps, motors or other plumbing equipment required for a particular service module will be placed within the mechanical room in the service bay.

Figure 350-2. TYPICAL SUBZONE ORGANIZATION FOR PLUMBING DISTRIBUTION: SECTION

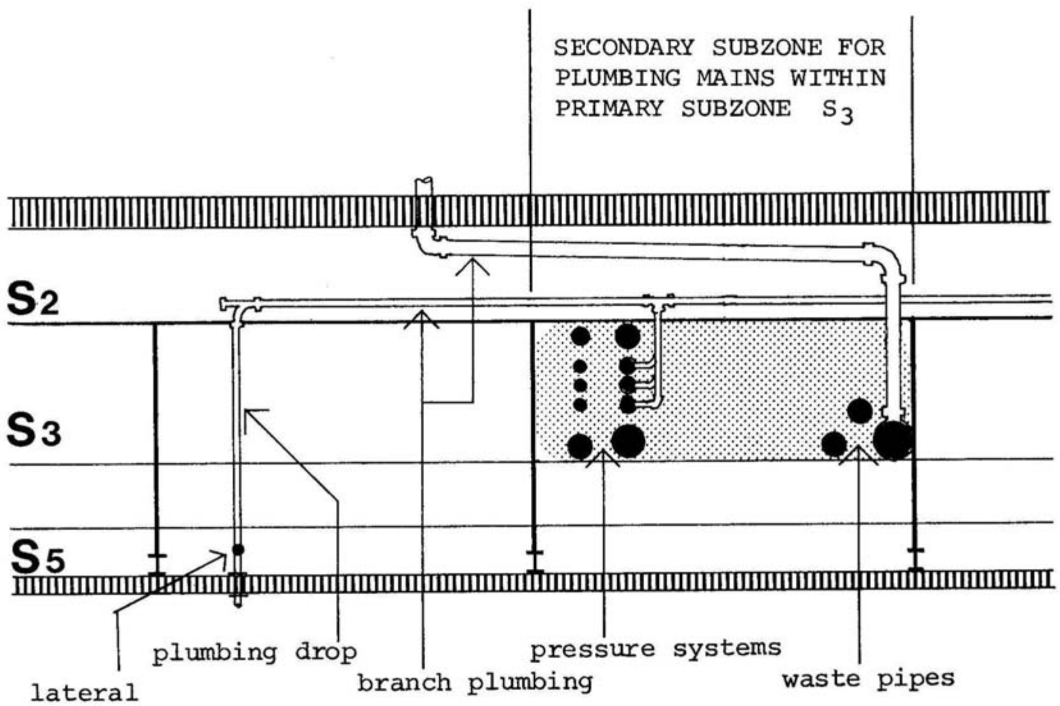
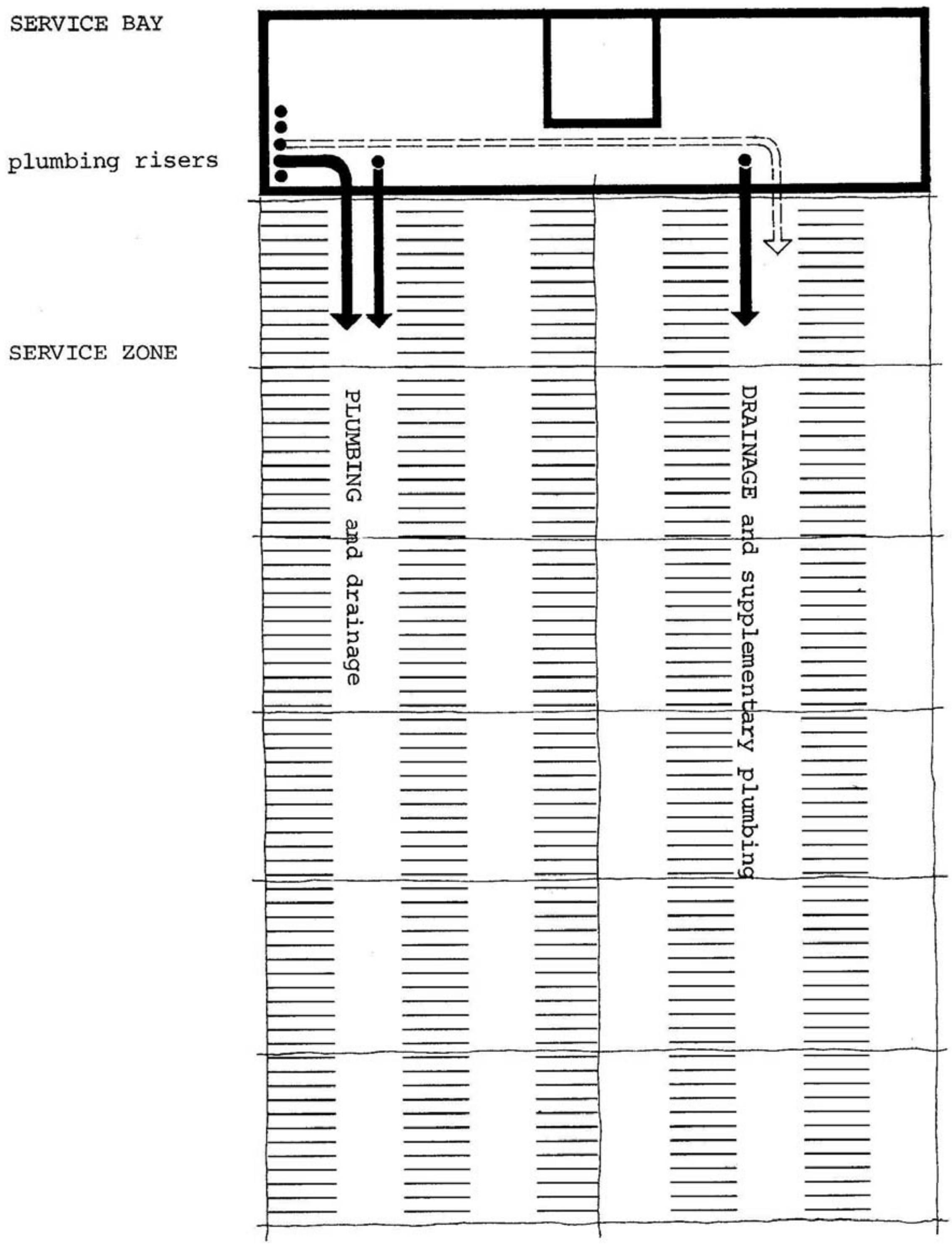


Figure 350-3. CHANNELS FOR PLUMBING DISTRIBUTION: PLAN



353 DESIGN CRITERIA

353.1 GENERAL

The plumbing subsystem may be required to provide a maximum demand load anywhere in the hospital, during the building lifetime. Therefore, space allocated to vertical risers and rights-of-way for distribution should be sized for the maximum potential demand. Main risers and main distribution runs when installed should also be sized to the maximum. The major component of plumbing costs is labor, therefore the oversizing of these permanent elements will not significantly increase overall costs. Branch distribution piping could be oversized but, because of the lower diversity of smaller pipes it is not really necessary since a shut-down for replacement of these local runs would cause disturbance only to a relatively small area of the functional zone.

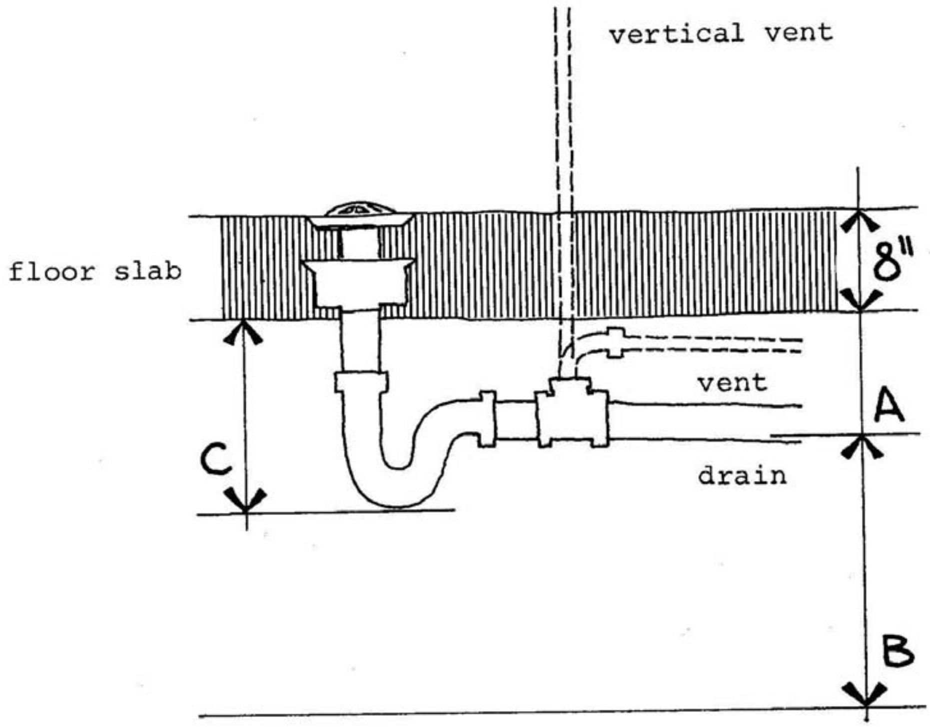
Of all the services in a hospital, plumbing is probably one of the most affected by change; especially cold water services as new users continually create heavier demands. Heaviest service load demands are typically domestic water and soil and waste systems in the nursing units, laundries and kitchens while the greatest diversity of services is found in laboratories, dental clinics and surgery.

353.2 FLOOR DRAINS

The critical plumbing dimensions for the S2 subzone is the depth required for floor drains, traps and falls. Assuming an eight-inch floor slab thickness, the following table shows the range of possible dimensions in inches for standard fittings from the bottom of the floor slab to the bottom of the pipe (dimension A in Figure 350-4).

	Drain Size		
Drain Type	2”	3”	4”
floor drain with vertical vent	3	6	8
floor drain with horizontal vent	9	10	10
floor sink with vertical vent	4	8	12
floor sink with horizontal vent	10	12	14

Figure 350-4. FLOOR DRAIN DIMENSIONS



To these dimensions must be added the potential maximum fall of the drain (dimension B in Figure 350-4). Assuming one main drain run between each pair of girders, the minimum structural span of 40'6" would require a maximum fall of 10-1/8", and the maximum span of 58'6" would require 14-5/8", at ¼" fall per foot run. On this basis the maximum depth of the subzone would be 28-5/8". But this would allow the extreme case of a floor sink with horizontal vent at the furthest position from the main drain. However, these sinks, and such a run, would be extremely rare. Also, most drains will be standard two-inch floor drains or sinks, therefore a subzone depth of the order of 20" to 24" will usually be sufficient. This range would also comfortably contain the depth necessary for any trap (dimension C in Figure 350-4).

In the calculations for space required by drainage, any structural members that are necessary for transferring lateral forces transversely across the beams will need to be taken into account. (See Section 316.2 and Figure 310-5.)

353.3 ACOUSTICS

The layout and detailing of the plumbing distribution should be organized to minimize noise transference problems. Potentially noisy or vibrating piping should be secured by isolating hangers and not be allowed to induce noise into surrounding services or construction. The proposed oversizing of pipes will lower velocities and thus further reduce noise problems.

353.4 FUNCTIONAL ZONE

Generally plumbing to the functional zone will be surface-mounted on partitions to allow for ease of change without partition damage or loss of acoustical seal. This surface mounting may be achieved by furring out of partition components or the use of separate prefabricated enclosures. The latter include lavatory units, service containers and service walls (such as those used in nursing units in combination with electrical outlets), and prefabricated bathrooms. Where concentrated plumbing loads justify them, prefabricated plumbing walls may be used. (See Sections 322.2 and 780.)

353.5 ACCESSIBILITY

All components should be designed and located so that routine maintenance and repair and minor alterations will cause minimal disturbance to patients and will not interrupt hospital activities. Major repairs and alterations must be possible with minimum down time for the space in which they occur, and without interrupting hospital activities in adjacent spaces.

354 TARGET COSTS

354.1 RANGE

The cost target range for plumbing distribution is $2.00 to $3.00 per OGSF, averaging about $2.30. These figures are slightly higher than the cost base, but are considered justified by a much greater capacity for future change than is the case with conventional design and construction. See Section 751.2.5 for further discussion.

354.2 SCOPE

354.2.1 Included

Complete plumbing subsystem for the entire hospital beyond the central plant, including:

1. Pressure lines: domestic cold water, domestic hot water, natural gas, steam, distilled water, compressed air, sprinklers and standpipes;

2. medical gases: oxygen, medical compressed air, suction and nitrous oxide;

3. gravity lines: soil, waste, condensate, vents and stormwater; and

4. equipment: pumps, motors, storage tanks, etc., which are not part of the central plant and are required for plumbing distribution

354.2.2 Not Included

1. Central plant such as boilers, hot water generators, storage and control tanks, meters, etc.;

2. electrical work required in connection with plumbing distribution equipment;

3. distribution required exclusively for the HVC subsystem such as chilled water, heating hot water and steam for humidifiers and heat exchangers; and

4. site work.

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360 Electrical Distribution

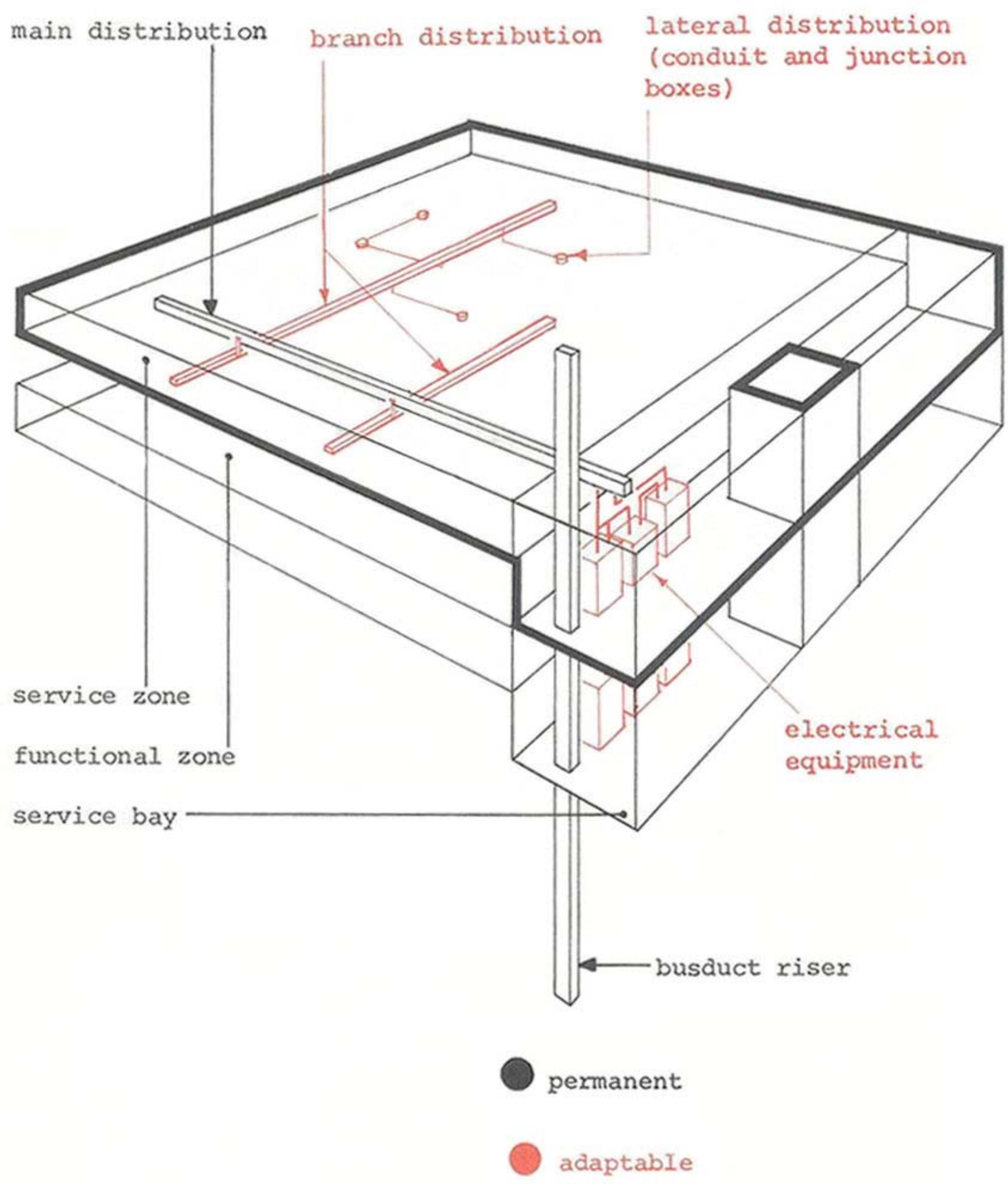
361 BASIC DESIGN

The electrical distribution subsystem will provide power to the hospital at 480Y277 volts and 208Y120 volts in both normal and essential distribution networks. The latter includes emergency and critical distribution.

Distribution from the substation and the main risers will use busducts to achieve the largest potential diversity of service. The main risers will always be contained within the service bays. Horizontal distribution through the service zone will generally use wireways, conduit and cable, except in local heavy load areas where a busduct might again be used. All equipment associated with a service module, such as transformers, branch circuit panels, etc., will be placed in an electrical room in the service bay. This room will also house equipment for the communications systems, the distribution of which will generally follow a similar route to the electrical subsystems. All distribution to the functional zone will be downfed from the service zone. (See Figure 360-1.)

Main vertical and horizontal distribution components are considered permanent. Branch distribution components and service bay equipment are considered adaptable.

Figure 360-1. BASIC DESIGN OF ELECTRICAL DISTRIBUTION SUBSYSTEM



362 ORGANIZATION

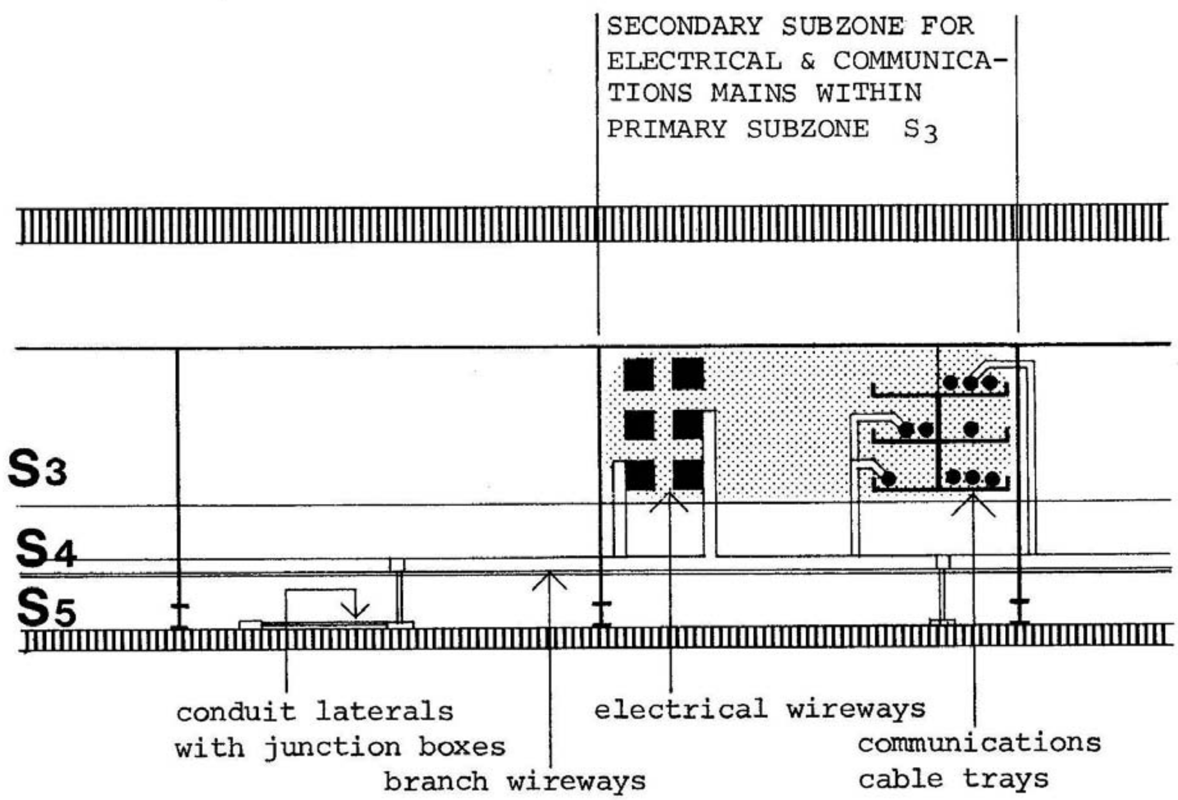
The spatial organization of the service zone and service bay are discussed in Section 223 and 224 and the following description defines the relationship of the electrical subsystem to this organization.

362.1 SERVICE ZONE

362.1.1 Subzones

From the main distribution in subzone S3, the electrical and communication branches will run in subzone S4 in wireways or conduit. The final runs of the conduit and junction boxes for power and lighting will be in subzone S5, between the ceiling strongbacks.

Figure 360-2. TYPICAL SUBZONE ORGANIZATION FOR ELECTRICAL DISTRIBUTION: SECTION



362.1.2 Channels

The electrical and communications mains will be horizontally distributed in a channel located on the same side of the service zone as the service bay electrical room. Similarly to the plumbing subsystem, in areas of heavy demand such as nursing units or radiology, a supplementary supply main should be run down the opposite side of the module.

The space reserved for electrical main distribution and branches will be based on the maximum load capacity potential of the service module.

362.2 SERVICE BAY

The service bay will contain the electrical room with all equipment for electrical distribution and communications for the service module. This will include all the transformers and the branch panel boards for the 208Y120 volt circuits. The branch circuit runs from these panel boards will not be the most economic, but positioning the panels centrally either in the functional zone or in the service zone would lead either to obstructions during plan changes in the first case, or to a lack of direct access in the latter, and also unnecessarily complicate the problem of industrial safety in the service zone.

The only exception to the centralizing of equipment in the service bay will be the isolation transformers and panel boards for the ungrounded circuits for surgery and ICU areas. They might be located in the functional zone and their location would only change as surgical suite layouts varied. Other transformers are associated with the various networks but are generally provided with the equipment requiring that particular modified supply, for example the voltage transformers for radiology equipment.

The 480Y277 volt distribution will be transformed down to 208Y120 volts at the service bay.

363 DESIGN CRITERIA

363.1 LOAD DISTRIBUTION

The overall strategy of the electrical network is largely governed by load distribution patterns. The following schematic diagrams illustrate the loading pattern of a typical hospital. Figure 360-3 represents the percentage distribution of total load in the electrical systems at two existing Veterans Administration hospitals. This data appears representative for current hospitals of the order of 500 beds.

No attempt was made in the diagram to differentiate between normal and essential distribution as these tend to vary in proportion with local engineering practice and codes. But Figure 360-3 shows that the percentage of the 480Y277 volt system which is transformed and supplied at 208Y120 volts to be approximately 25% of the total load.

The categories that are responsible for most of the continually increasing electrical demand in hospitals are generally those shown in this diagram for the 208Y120 volt distribution. When functional areas such as laboratories expand within a hospital, their heavier than normal environmental requirements also boost the electrical load demand for HVC.

363.2 AVERAGE LOAD DISTRIBUTION

The majority of functional areas within the hospital are supplied with power in two of the categories shown in Figure 360-3, the transformed power at 120 volts (25% of total load) and fluorescent lighting (12% of total load). The figures given for these areas are 4.4 and 2.4 watts per square foot respectively. Therefore it can be assumed for the purposes of general design that a load of 6.8 watts per square foot is the appropriate mean.

Figure 360-4 is a breakdown in detail of the functions which take significantly higher loads and therefore represent design maximums. The high loads demanded by kitchens and laundries would require special busduct supply and should be located close to a substation.

Figure 360-3. LOAD DISTRIBUTION BY PERCENTAGE OF TOTAL LOAD

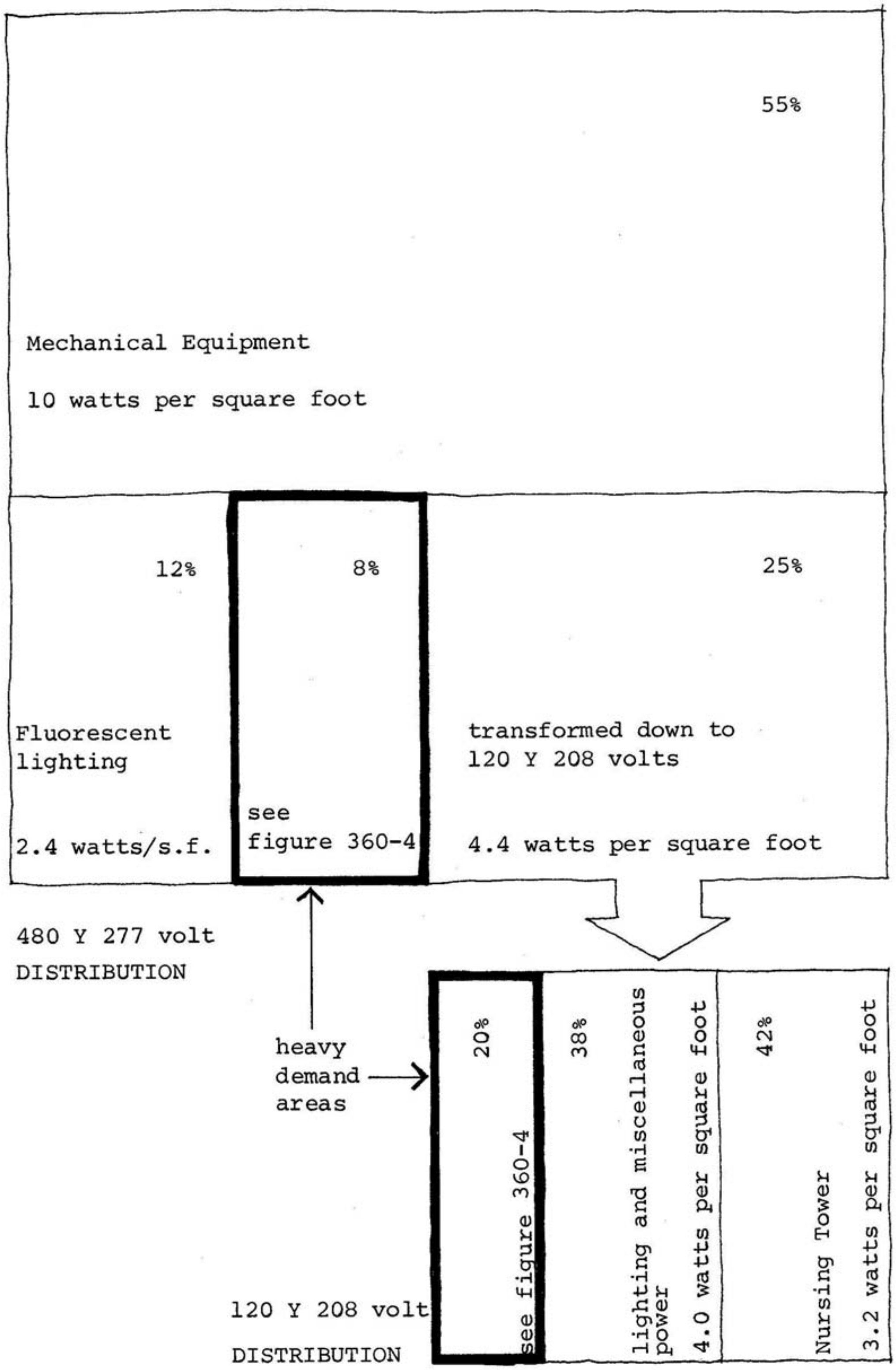
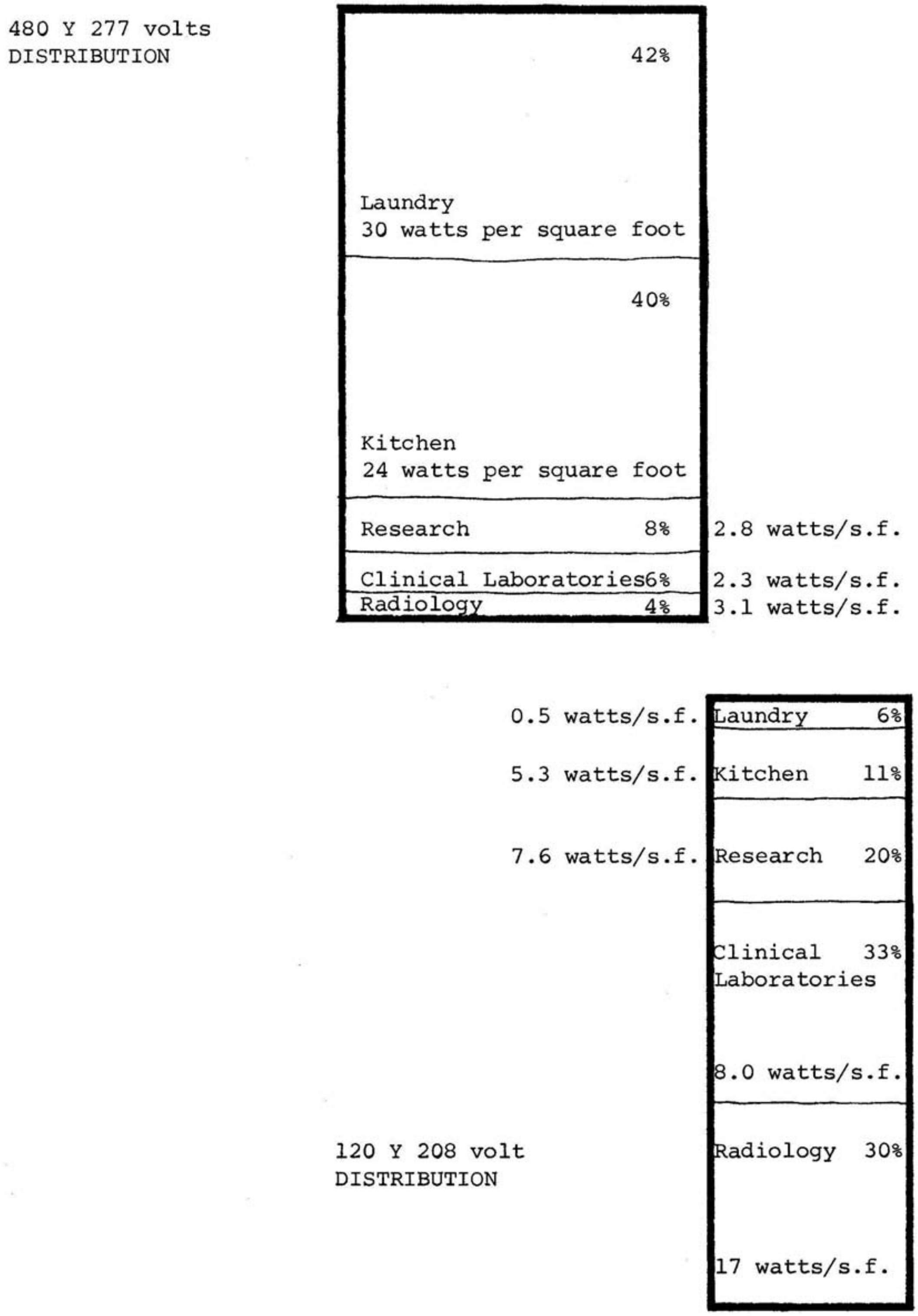


Figure 360-4. LOAD DISTRIBUTION IN HEAVY DEMAND AREAS



363.3 DISTRIBUTION NETWORK

The location of the substation and main switchboard in the distribution system is a primary consideration. VA standards prefer substations to be external, or close to the exterior of the building. But close relationship to heavy demand functions for economy of distribution is also required. Proximity to the motor control centers for central plant equipment, elevator motors, pumps, etc., would suggest central locations in basements or on the roof, but in either case, ease of access for maintenance and replacement must be achieved.

The major horizontal and vertical feeders from the main switchboards to the service modules would be largely permanent installations, with the horizontal feeder distributed at the substation level. The requirements of ease of change or relocation of load output make it necessary to use busducts as extensively as possible for these feeders. The busducts must be completely accessible throughout their length as required by code.

Electrical codes are based on the assumption that the maximum voltage in a standard distribution system will be 300 volts to ground. Therefore three-phase 480Y277 volts would be the expected maximum busduct supply. Also, because of the economic principle of distributing at the highest possible voltage before transforming down, this supply would be minimum.

The optimum capacity for any busduct in the system should be considered as 1600 amps which is generally the most economical size in terms of amps per dollar. Above this size, busduct cost rises disproportionately to current rating. Also, the cost of switch-gear associated with a rating above 1600 amps increases considerably. Where a stack of service modules required a capacity of greater than 1600 amps, it would be desirable to duplicate 1600 amp busducts than go to one with a higher rating not only from the standpoint of economics but also selectively of switchgear.

A 1600 amp busduct could serve 20 service modules of 10,000 square feet at the average load distribution value of 6.8 watts per square foot.

Distribution to these ten service modules would be most easily achieved by a vertical busduct riser via a stack of service bays to avoid penetrating fire section walls horizontally. Duplication of busducts would allow significantly higher loads per square foot.

The main distribution in the service zone will be made with wireways. Their increase in cost over conduit is far outweighed by the ease of addition or deletion of wires in future changes. All connections from the wireways to junction boxes or fittings will be made by conduit.

363.4 SERVICE MODULE REQUIREMENTS

A service module of less than 15,000 square feet would not allow the most economic use of electrical components. Using standard sized and rated electrical equipment which is easily obtainable off-the-shelf is a key requirement.

Branch circuit panels, using two section panels with 225 amp busing, and 75 KVA transformers could easily handle up to 20,000 square feet, especially where the demand load is divided between normal and essential networks. Thus a 75 KVA transformer could handle two 10,000-square-foot service modules at the 4.4 watts per square foot required for the 120Y208 volt service. Additional panels and transformers could be added within the service bay as required.

363.5 FUNCTIONAL ZONE

In general, electrical distribution into the functional zone will be surface mounted on partitions, either housed in separate prefabricated components or in furred out extensions of the partitions. (See Sections 332.2 and 780.)

There are many approaches to prefabricated components. They basically represent an attempt to rationalize the diversity of location and type of service outlet required, especially where frequent change is expected. The more elaborate forms, such as patient room consoles or service walls, are often difficult to use effectively because of the haphazard way services are usually designed and installed in current hospitals. The organized and preplanned approach of the Prototype Design should improve this situation. Early assessment of potential demands, even without detailed specification of outlets, should allow for more reasonable and systematic development of such appliances.

In areas where there is a heavy diversity of services, concentration of the outlets together with the plumbing distribution into consoles or service walls is recommended. The console may take the form of a partition-mounted unit, such as an ICU bedhead unit, or a ceiling-hung unit such as those used in operating rooms or laboratories.

In areas requiring minimal servicing, like offices or clinics, the outlets usually must be spread around a room. In this kind of layout, full use should be made of equipment such as electrical distribution poles and surface mounted raceways, the latter both horizontal and vertical. Some components could combine electrical supply and communications circuits. Floor distribution grids within the topping slab can be used where required, for radiology table supply for instance.

363.6 ACCESSIBILITY

All components should be designed and located so that routine maintenance and repair and minor alterations will cause minimal disturbance to patients and will not interrupt hospital activities. Major repairs and alterations must be possible with minimum down time for the space in which they occur, and without interrupting hospital activities in adjacent spaces. Switchboards, circuit breakers and transformers must be readily accessible for convenient maintenance and replacement, and for emergencies.

363.7 ADAPTABILITY

The distribution network should be reasonably oversized and/or provided with excess area to handle future change in demand. It should also be laid out so that it can be logically extended into any future expansion of the building. The various networks must be zoned so that temporary loss of supply through maintenance or alterations will affect only a local area.

364 TARGET COSTS

364.1 RANGE

The electrical distribution subsystem is not expected to cost more than the prices given in the cost base. This means that a target cost range of $2.00 to $2.50 per OGSF is appropriate. See Section 751.2.6 for further discussion.

364.2 SCOPE

364.2.1 Included

All three-phase normal and essential power distribution subsystems, including:

1. All transformers, distribution switchboards, circuit panels, busducts, wireways, conduit, cable trays, hangers, cable, wire, connectors, junction boxes, terminal boxes, etc., as may be required for the complete distribution system, and

2. convenience outlets, receptacles and switches.

364.2.2 Not Included

1. Central equipment such as substations, generating equipment, meters, etc.,

2. equipment and wiring required exclusively for the HVC subsystem,

3. building equipment such as elevators, fan units, etc.,

4. local equipment and their motors and transformers, such as for radiology, cold rooms, etc.,

5. communication equipment and signal distribution networks such as clocks, nurse call, computer network, security, etc.,

6. lighting fixtures,

7. distribution system to exterior of buildings and landscape, and

8. site work.

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370 Coordination Checklist

In developing specific designs for the integrated subsystems, it is imperative that each decision be made in the context of its possible effects on the characteristics of all other subsystems. The following checklist is intended to serve as an inventory of compatibility considerations. Table 370-1 summarizes the particular considerations applicable to each subsystem.

1. The vertical loads of the ceiling must be supported from hangers attached only to the center of the bottom of beams. Since the spacing of ceiling hangers is thereby set in one direction by beam spacing, hanger spacing in the other direction is likewise affected due to the limited tributary ceiling area which can be supported by each hanger. That is, as the beam spacing is increased (eg, by using a steel structure rather than concrete), the ceiling hanger spacing along the beams must be decreased. Hanger spacing in both directions directly affects the organization of the service zone into secondary subzones. (See also item 23 below.)

   The detail of the connection between beams and ceiling hangers will vary with the material selected for the structure. With a concrete structure, a continuous supporting channel could be cast into the bottom of the beams and used for the attachment of service distribution components as well as ceiling hangers. This would be impractical with steel because of fireproofing requirements. (It is not intended that the structure and ceiling be fire rated together as an assembly.) (See Section 321.1.)

2. The acoustic separation between one floor and the next is provided by the combined effects of flooring, structure and ceiling. (See Section 325.1.)

3. Lateral forces in the partitions must be transmitted to the structure via the ceiling as well as directed to columns, shear walls and the floor. Thus the ceiling must be attached to columns and shear walls to properly transmit these forces. However, the ceiling is assumed to not contribute to the lateral resistance of the structure. (See Section 324.3.)

4. All connection details between structural, ceiling, partition and exterior wall components must be designed with due regard to the dimensional and construction tolerances and to the acoustic separation and fire protection requirements of each.

5. Structural design must include a load factor for relocatable partitions as well as permanent partitions. (See Table 310.2.)

   The detailed design of the partition system must provide for furring around columns, shear walls and exterior walls where required.

6. Gravity drains are the only component of service distribution which feed through the floor. Since services should not penetrate beams, careful consideration must be given to beam sizing, spacing and location to impose the least possible restriction on the location of drains. Since plumbing fixtures are usually located on partitions, a restriction on the location of drains is also a restriction on the location of those particular partitions. (See Sections 225.3 and 333.4. See also item 14 below.)

7. The structure must provide adequate support and efficient passage for all service components, with minimum penetration of structural components. No service component may penetrate any structural component except shear walls and floor slabs, and such penetration may occur only via openings specifically provided for that purpose by the structural system. (See Sections 313.5.5 and 316.2.) All penetrations must be carefully detailed with regard to acoustic and fire separation requirements. No service components which could ever require access for any reason may be completely enclosed by structural components.

   Dimensions of service bays must be adequate to house all required mechanical and electrical equipment, and all required vertical service distribution components, including plenum shafts, with allowance for expansion. (See Section 223.)

   If accelerated scheduling techniques are being used, structural design should be expedited to allow the earliest possible bidding of site work and foundations. Service distribution strategy must be sufficiently developed to have determined, or to allow reasonable assumptions about, special foundation requirements, utility services and central plant or station locations.

8. Detailed design of the HVC system requires knowledge of, or assumptions about, glass area and shading factor of the exterior wall, and insulation value of the exterior wall and roof. These characteristics will effect not only HVC operating cost, but also duct size and thus the depth of the service zone and floor-to-floor height.

9. Exterior walls not an integral part of the structure may be curtain walls or infill panels. The inside face of the exterior wall may fall anywhere between the inside and outside faces of the columns, thus allowing some adjustment of bedroom floor area within the planning modules.

   A weight of 50 pounds per square foot of exterior wall was assumed for prototype structural design.

10. The weight of flooring and roofing are load factors in structural design. To the greatest practical extent, floor recesses should be accommodated by a non-structural topping slab, which is also a load factor. (See Section 313.5.4 and 314.1.1.)

11. No casework, furniture, fixtures or equipment may be built into the structure. Very heavy equipment may require special structural design, and to the maximum practical extent should be located on lower floors or in special non-system areas of the building. (See Section 314.1.5.)

12. The ceiling must be designed to support some equipment of moderate weight. (See Section 324.2.) Heavier equipment requiring overhead support may be attached directly to the structure above. A method for providing this type of support at any desired point is illustrated in Figure 320-8.

13. Ceiling materials and design should allow for simple partition head attachment, and for efficient relocation of partitions without major damage to these materials. (See Section 321.3.) It is not intended that partitions support any loads from the ceiling, so head details must allow for ceiling deflection as well as transmission of lateral forces. (See Section 331.3.)

14. The ceiling supporting framework should be designed to minimize restrictions on locations of service drops, HVC terminals and lighting fixtures. Restrictions on service drop locations are also, in effect, restrictions on the location of partitions, fixtures and equipment. (See Section 225.3 and 333.4.) Service penetrations must be detailed to maintain the acoustic and fire separation characteristics of the ceiling. (See Section 321.3.)

15. The service zone should be so organized that horizontal access via the service bays will suffice for the greatest possible number of maintenance, repair and replacement tasks. Distribution components requiring a greater degree of access than can be provided in this manner will require suitable access panels in the ceiling. (See Section 224.3.) As far as practical, these panels should be located in areas other than those normally used by patients or having critical aseptic requirements, and outside of main circulation routes. The exterior wall should provide removable spandrel panels at the service zone levels for additional accessibility during major alternations. (See Section 463.)

16. If the service zone is to be used as a return/exhaust plenum, the ceiling and spandrel panels must be reasonably airtight. (See Section 342.2.)

17. Forced-air registers should be located exclusively in the ceiling, and supplementary perimeter convectors, if required, should be located exclusively on the exterior wall. (See Sections 341 and 342.) The only mechanical components that should normally be located in or on partitions are thermostats and their control lines. Certain exceptions to the location of registers may be necessary, such as in surgeries. Perimeter convectors must not be so enclosed in the exterior wall that they cannot be readily removed for maintenance or replacement. All surface must be conveniently accessible for cleaning by standard VA housekeeping procedures.

18. The connection details between the ceiling and the exterior wall and between partitions and the exterior wall must allow for any foreseeable deflection in the exterior wall due to wind loads.

19. To enhance the adaptability of both the partitions and the service distribution subsystems, service distribution lines and terminals in the functional zone should be surface mounted to the maximum practical extent. For a discussion of various methods of enclosing surface-mounted services, and the situations in which an internal location may still be required, see Section 337.3.3. Similarly, lighting on the ceiling should be surface mounted.

    All enclosures of surface-mounted services, as well as HVC terminals and controls, should be visually compatible with each other and with the type of casework, furniture and equipment planned for the hospital. Likewise, the location of these services and terminals must not interfere with the typical placement of casework and furniture.

20. Partitions enclosing vertical shafts must have a two-hour fire rating, and an STC rating appropriate for the surrounding spaces and the level of noise generated within the shaft. Adequate access to the interior of the shafts must be provided for purposes of maintenance and alternations. (See Sections 331.1 and 335.1.)

21. Partition base details and selection of flooring materials will depend on whether partitions are scheduled to be installed before or after flooring. (See Section 463.)

22. A wide variety of casework, fixtures and equipment may be supported by partitions, the nature of the connection varying with load. (See Sections 334.3 and 334.4.)

23. The organization of the service zone into primary and secondary subzones of specific dimensions and arrangements must be appropriate to the size, turning radii, terminal frequency and access requirements of the horizontal distribution components of the HVC, plumbing, electrical, materials handling and communication subsystems. It must also allow for a reasonable amount of expansion, and the addition of future services. (See Section 224.)

Table 370-1. COORDINATION CHECKLIST INDEX

Integrated Subsystems	Checklist Item Numbers
Structure	1,2,3,4,5,6,7,8,9,10,11,12
Ceiling	1,2,3,4,12,13,14,15,16,17,18,19,23
Partitions	3,4,5,6,13,14,17,18,19,20,21,22
Heat/Vent/Cool	7,8,14,15,16,17,19,20,23
Plumbing distribution	6,7,8,14,15,19,20,23
Electrical distribution	7,8,14,15,19,20,23

Non-Integrated Subsystems	Checklist Item Numbers
Foundations	7
Exterior wall	4,5,8,9,15,17,18
Transportation	7,14,15,19,20,23
Communication	7,14,15,19,20,23
Flooring	2,10,21
Roofing	8,10
Casework, fixtures and equipment	11,12,14,19,22

400 PROCEDURE

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410 Introduction

This volume, the Design Manual, is intended to be a basic document for the VA and for A/E contractors working on systems hospitals. The Manual describes the Building System Prototype Design, and in this section, suggests a general procedure by which it may be utilized in a building project. The intent of this section is to provide an outline guide, both for VA staff and for A/E contractors, to the use of the Manual by all parties concerned in the design of a VA system hospital.

It must be stressed that there is no substitute for a thorough understanding of the content of the Design Manual by all participants of a building design team. The nature of the Design Manual is such that it cannot be compressed or organized into a step-by-step book of instructions. Each participant must use the materials in the way most appropriate to his area of responsibility. Only he can decide the precise way to use the material, because only he is familiar with his role in the design process, and the impact on that role of the concepts presented in this manual.

This outline guide, however, relates the concepts of the Prototype Design to a typical design process. The design process is divided into three broad phases: problem analysis, design development, and contract documents. The problem analysis phase is the analysis of the VA master plan. The design development phase consists initially of studies of building configuration and building schematic design which are comparable to the typical VA block plan layout phase. The essential difference between a building schematic design and the typical VA block plan layout is that the building schematic design contains a significantly greater degree of detail in terms of the structural and mechanical aspects of the building organization; in fact, considerably more detail than the typical VA preliminary drawings. This degree of engineering detail allows, if desired, an early start to working drawings while the preliminary drawings that show detailed room layouts are being completed. The contract documents phase is comparable to the VA working drawing phase. The discussion of these phases (Sections 420, 430, and 440) are deliberately kept general so that the participant, whether he be VA staff member or A/E contractor, can relate these phases in detail of his own activities and terminology.

Two major activities, cost estimating and construction scheduling, are crucial to all three phases, and are discussed at greater length in Sections 450 and 460. For purposes of the outline guide, the design process is assumed not to include accelerated scheduling or construction management. (See Sections 761 and 762 for descriptions of these special procedures.) The activities discussed are limited to those considered essential to provide all necessary information and decisions for each succeeding phase. No attempt is made to specifically define sequence, simultaneity, cycling, or feedback of the activities since these conditions will vary from project to project.

The Prototype Design provides the designer with strong basic concepts in terms of the planning modules and the building subsystems which make up these planning modules. The use of planning modules and integrated subsystems imposes a discipline that must be learned and experimented with. Their assembly is a design activity, dependent for its success on the skill of architects and engineers. Thus, the rules for their assembly can only be suggestive, not absolute.

There is nothing inherent in the Prototype Design that prevents or modifies current VA procedures; that is, the design development of block layouts, preliminary plans and working drawings in sequence. However, the Prototype Design permits parallel development of architectural and engineering design and thus an earlier start for the latter than in the conventional VA project. Specifically, detailed structural, mechanical and electrical design can proceed on the basis of the building schematic design which indicates general departmental arrangements, but not room layouts. The schematic design indicates the nature and disposition of the various planning modules. Engineering considerations will simultaneously influence, and the influenced by, the nature of the planning modules. The Design Manual stresses early engineering involvement and makes mandatory a thorough knowledge of the Design Manual on the part of all engineering participants. This knowledge cannot be limited to the particular discipline of the engineer concerned, for system integration demands a much deeper interdisciplinary understanding than is usual in conventional design.

420 Problem Analysis

421 SYSTEM APPLICABILITY

421.1 PROGRAM (MASTER PLAN) ANALYSIS

421.1.1 System Exclusions

One of the initial tasks in the program analysis is to identify those program areas that may be better satisfied without using the discipline of the Building System prototype Design. Such areas may include the central mechanical plant and laundry which might be housed in an industrial type of building at a lower cost than in the main hospital building. Other areas may include psychiatry and nursing home care. These may be detached and housed in single story structures for which the essentially multi-story characteristics of the system are inappropriate.

421.1.2 System Variations

Similarly, it is necessary to identify those functional areas which must be in the main building but which conflict with aspects of the Building System Prototype Design. These conflicts may be floor-to-ceiling heights, loads, etc., and may require some limited modifications to the Prototype Design in certain locations. These potential modifications can then be incorporated into the general design approach; for example, the location of the gymnasium and swimming pool at the end of the service module remote from the service bay in order not to disrupt the service distribution in the service zone.

421.1.3 Adequacy of Current Space Module Catalog

The adequacy of the current space module catalog can also be determined relative to the general nursing unit program requirements. A greater emphasis, say, on the provision of one-bedrooms, may indicate a need to develop new space modules.

421.2 SITE ANALYSIS

The potential influence of climatic, topographic, access, orientation, seismic and subsoil characteristics on building form and height must be considered in terms of the Prototype Design. For instance, service bays represent substantial planning elements which, in conjunction with bed-care service module orientation, may restrict perimeter access.

Also, the structural system is appropriate to a range of building heights from two to nine stories above ground; on small sites taller buildings may be required, necessitating certain modifications to the basic structural system. (See Section 721.4.)

421.3 CODE ANALYSIS

Applicable current codes and regulations must be studied to identify implications for planning and sub-system design. For example, as noted in Section 240, fire safety codes and regulations are subject to constant review and change. Current requirements must be analyzed in order to determine the appropriate fire safety strategy in terms of exit distances, size of fire sections, sprinklers, smoke barriers, etc.

422 COST AND TIME CONSTRAINTS

422.1 BUDGET ANALYSIS

Funds allocated to the project must be analyzed to determine the degree of refinement appropriate for detailed design, for example, in the study of alternative building schematic designs, or the consideration of innovative components for the ceiling-platform system. Estimated functional area cost must be applied to programmed departmental areas to determine where adjustments might best be made to fit the budget.

Reasonable cost targets for both integrated and non-integrated sub-systems must be set. This must be done in the context of the particular characteristics of the local building industry. See Section 450 for further discussion of cost estimating.

422.2 SCHEDULE ANALYSIS

Schedule requirements must be examined to evaluate the desirability and feasibility of various approaches to accelerated scheduling. See Section 761 for a discussion of this subject. (See Section 460 for a general discussion of construction scheduling within conventional procedures.) If phased bidding is to be used, a construction manager is recommended. Construction management is discussed in Section 762.

430 Design Development

431 BUILDING CONFIGURATION (PRELIMINARY BLOCK LAYOUT STUDIES)

431.1 GENERAL BUILDING CHARACTERISTICS

The study of building configurations establishes a basic building design concept which defines the general characteristics of the building in terms of massing, height, location on site, overall organization, growth potential, etc., and which is an essential preliminary to establishing block layouts.

The use of planning modules enables the designer to interrupt the program requirements at the level of gross area allocations and desirable departmental relationships and to quickly translate these requirements into a number of alternative configurations. These configurations can then be related to the site and their comparative merits evaluated against considerations of access, views, orientation, topography, soil conditions, etc. Thus, all the relevant design factors can be brought together and reconciled on a broad conceptual level at a very early stage.

431.2 SPACE MODULE SELECTION

431.2.1 Basic Considerations

The space module in conjunction with the structural subsystem and the service bay (Section 251.3) defines the assembly characteristics of the service module in the bed-care portion of the hospital. Space module selection and the development of configuration options should be pursued simultaneously. Building program definition at this stage may be legitimately quite sketchy, containing only enough information to establish gross configuration.

The general medical and surgical (GM&S) nursing unit should be used as the basis of selecting the appropriate space module types. This is due to the large proportion of the bed-care program represented by these units and their high degree of organizational predictability.

The considerations identified below may be applied in various sequences, and some may need to be applied in several cycles as the selection process narrows. The relative importance of the considerations will vary with the conditions encountered on each specific building project. An example of one application is contained in Section 733.

431.2.2 Sanitary Zone

(Refer to Sections 232.6 paragraph 2 and 232.8, and Space Module Summary Sheet Figure 230-8.)

431.2.3 Internal Organization

(Refer to Section 232.5 and Space Module Summary Sheet Figure 230-8.)

A decision must be made as to the desirability of providing staff work spaces and other supporting facilities directly adjacent to patient beds. This determines the choice of double-loaded corridor or core type plan.

431.2.4 Space Module Support Capability

(Refer to Section 232.6 paragraph 4 and Space Module Summary Sheet Figure 230-8.)

Bedroom and corridor widths are fixed. Therefore, total space module width will be determined by the sanitary zone width and - in other than double-loaded corridor solutions - the core area required for support capability directly adjacent to patient bedrooms. The architect, by selecting a sanitary zone width and determining program requirements for those functions directly adjacent to patient beds, can select the proper structural span by referring to the Summary Sheet, which identifies the area available in each space module for direct care support space.

Where a 40-bed unit is composed of two 20-bed space modules, the core area available in each space module must equal one-half the area required by direct-care support. Also, core areas are not directly comparable to required net areas, as they include partition thicknesses and columns. The space module selected should therefore possess a core area slightly greater than the required direct-care support area. It also may be advisable to provide some additional core area to allow for future increase in direct-care support requirements. This area can be used for ancillary functions initially. Increasing core size will also increase nurse travel distances, however.

431.2.5 Internal Space Module Capability

(Refer to Catalogue of Space Module Capabilities Section 233.)

Once one or more space modules have been selected on the basis of requirements for typical GM&S units, they must be tested against the program for other functional units. Certain space modules will be more suitable for large open areas such as intensive care units or particular organizations required for psychiatry.

431.3 CONFIGURATION OPTIONS

431.3.1 Building Height Relative to Beds per Floor

The bed-care program can now be expressed in terms of numbers of space modules. (See Section 734.1.) The total number of space modules can then be organized into alternative nursing floor configurations based on the assembly capabilities of the respective module types, the number of beds per floor and the height limit of the structural sub-system. (See Section 313.3 and 734.2)

431.3.2 Additional Space

(Refer to Section 232.4.)

Given the appropriate space modules, the selected sanitary zone option, and the size and number of nursing floors, the space program must be studied and gross space allocations made in order to determine the extent of additional space necessary to achieve a balanced set of functions on each floor, an optimum set of relationships within given constraints, and a suitable organization of the major circulation and transportation elements. Inevitably, some degree of discrepancy will exist between this gross space allocation and the original space program.

The extent of area provided by the additional bays on each floor is obviously more critical with a tower on a base type of configuration than with a horizontal type of configuration where there is more opportunity for other hospital functions to conveniently utilize any excess additional space.

431.3.3 Service Modules

(Refer to Section 220)

Gross space allocation is now established for the alternative configurations. As stated in Section 221.1, the service module is the most significant of all the planning modules in that it combines and coordinates all the interrelated characteristics of the building organization; namely, function, structure, service distribution and fire safety. At this stage, the dimensional and assembly characteristics of the space modules are manipulated and reconciled within the structural and mechanical characteristics of the service module. Simultaneously, the fire section boundaries are examined to ensure that they respond to the layout and organization of the central support functions of the hospital. Each floor can then be divided into the appropriate number of service modules. Once derived, the layout of service modules sets the number and disposition of service bays. The alternative configurations can be organized as suggested on the example classification chart in Figure 250-2. This provides a useful first estimate of the significantly different types of configurations which are feasible for the particular site. For example, the orientation of the bed-care and service modules in a simple tower-on base configuration can be a major determinant of the disposition of the building which, because of the rows of service bays, may have significant implications in terms of access and growth. (See Section 251.3.3. paragraph 2.) Fundamental seismic considerations may also be a major determinant in building configuration development.

431.3.4 Detailed Configuration Development

The most promising configuration options can then be taken to a more detailed level where the service modules are studied relative to the other building divisions, such as the functional units, the fire sections and the structural units in terms of building separations and possible locations of shear walls. (See Section 735.1.2.) Concurrently, circulation patterns and transportation systems relative to desired functional relationships and site constraints are considered in more detail to determine, for example, the effect of the location of vertical transport elements on the structural shear resistance strategy. Comparative cost analyses of the favored options may be undertaken to confirm the choice of configuration.

431.3.5 Block Plan Concept

The block plan concept to be developed and refined in schematic design will be that building configuration which satisfies and resolves all the requirements of program, budget, site and system discipline in the most effective manner. Many modifications to the block plan concept may occur in the schematic design stage when requirements are considered at a more detailed level, but typically these modifications will occur within the framework of the general building characteristics established.

It may be that two or three equally satisfactory schemes may all have to be taken to the more detailed levels of schematic design before the final selection can be made.

It is also possible that none of the configuration options are sufficiently satisfactory in which case new space modules and/or new configuration options may have to be developed.

432 BUILDING SCHEMATIC DESIGN (BLOCK LAYOUTS)

432.1 PLANNING

Matching exact departmental area requirements to service module and fire section boundaries is the key activity in this phase. Departmental requirements for proximity and growth capability must be carefully considered in establishing the arrangement of vertical and horizontal circulation elements. The site plan must be completely coordinated with internal circulation patterns in terms of vehicular approaches, parking, emergency access and connections to existing buildings.

432.2 BUILDING SUB-SYSTEMS

Generic design options for the structural, ceiling and heating-ventilating-cooling subsystems must be evaluated and selected during this phase. (The plumbing and electrical sub-systems do not have generic design options, and the selection of a partition option can be postponed until after start of working drawings.) Critical dimensions, such as beam spacing, service bay size and shape, shear wall and construction joint locations, and the sizes of shear wall and diaphragm penetrations, must be established. (See Sections 313 and 316.) Floor-to-floor and overall building heights can then be determined on the basis of the functional zone and service zone heights required.

Available building products must be evaluated to allow development of a movement systems strategy as well as a rational selection of generic design options for the integrated subsystems. If new product development seems appropriate, the feasibility of satisfactorily completing a product development program within the scope of the project budget and schedule must be studied. (See Section 764.)

432.3 COST AND TIME

Alternative construction process strategies must be examined in the context of the current schedule, and the schedule revised if necessary to optimize the process. Cost estimates must be prepared to assist in this analysis, as well as in the final selection of a specific design configuration, building subsystem options, and a transport system strategy.

432.4 PRELIMINARY DOCUMENTS

Preliminary planning in terms of detailed room layouts can proceed on the basis of the building schematic design. Concurrently, the start of working drawings and outline specifications can also proceed. Design effort at this stage should focus on the development of information and decisions necessary for the earliest possible start of final contract documents, engineering as well as architectural. Note, for example, that, although detailed room layouts within departments are not required for the start of working drawings, it will be necessary to finalize the overall fire safety strategy in order to locate smoketight compartments, select active and passive fire protection devices, etc.

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440 Contract Documents

441 COMMUNICATION

Working drawings and specifications appropriate to the unique characteristics of the Prototype Design are absolutely essential to the successful application of the system. Many of the presumed advantages will remain hypothetical if the system rules are not presented explicitly and clearly. Prime contractors can be informed in pre-bid conferences on how to exploit system characteristics in their scheduling, but they will have to work with the prices given to them by the many subcontractors whose major source of information will be the plans and specifications. If the documents fail to adequately express the real situations the various trades can expect to find in the field during systems construction, their prices will be based completely on their customary estimating procedures, and might actually include an additional contingency factor for non-conventional work.

It is particularly important that the system rules be made credible and enforceable through appropriate wording in the General Conditions, and by reference in each section of the specifications to that wording. For example, if a subcontractor who will have to install certain service distribution lines above the ceiling late in the construction sequence can not really be sure that a “reserved zone” will in fact be available to him when he arrives on the job, he can not be expected to figure this potential time-saving convenience in his price. Attention should be given to details which tend to make the system “self-enforcing”. In the reserved zone example given above, it would be helpful to the contractor, subcontractors, the supervising engineer and inspectors if the various primary and secondary zones were clearly indicated during construction by appropriate marks, tags, signs, color codes, etc., on the structure and ceiling hangers, with the plans and specifications clearly keyed to these indicators.

442 SIMPLIFICATION

One of the advantages offered by the Prototype Design is the standardization of many features which in conventional design and construction present a confusing multiplicity of variable conditions. Each integrated subsystem offers opportunities for greatly reducing the number of variations: regular column spacing, uniform ceiling height, a single partition type for practically all situations, a single type of mechanical system used throughout regardless of zoning, etc. Furthermore, the organization of the building into service modules of simple repetitive geometry allows the standardization of main service distribution layout for most services. This attribute of the Prototype Design can be used to simplify contract documents as well as construction, operation and alteration.

For example, key plans can be drawn in which the building is presented as an assembly of service modules, with an identifying number for each module and an indication of which modules are identical in the organization of main distribution. A typical plan and section for each group of modules can indicate the particular subzoning rules which apply to that group. The detailed service zone plan of each individual module can then be quite symbolic, since much of the dimensional information will be standardized and shown on the "master" drawing for the group.

Functional zone plans (architectural drawings) can be keyed to the same scheme of subdivision by service module. It may in fact be practical to provide each trade or subcontractor with drawings which show only the work within this scope, overlaid on a standard "shell" drawing showing of each module, in addition to coordination drawings showing the major features of all subsystems. (See Section 740 for examples of what such drawings might be like.)

443 PRODUCTION

To reduce the time required for the production of contract documents to a minimum, it will be necessary to proceed with structural, mechanical and electrical detailed design and working drawings on the basis of “empty” service modules, that is, modules of specific dimensions to which general functions, departments or parts of departments may be tentatively assigned, but which as yet have no room layouts. The architectural drawings which establish precise layouts must be developed in parallel with the engineering drawings, rather than prior to them as in conventional practice. This head start is very important to engineering design because of the special effort that is required to properly work out the detailed service distribution strategy, particularly the subzone organization of the service zone. Service systems design in turn requires very close coordination with structural design on matters of service bay size, shear wall penetrations, etc.

In a sense, this calls for some reversal of normal procedures in which architectural design may be worked out in considerable detail before even basic engineering design is considered. The intent of the Prototype Design is to allow parallel design development “across the board”, with all disciplines proceeding from the general to particulars in a coordinated manner. The idea is that coordination is most efficient and effective when it takes place at equivalent levels of detail, and as an integral activity in the design process.

The key system device for this purpose is the service module used as a “building block” for schematic design. Each module has an inherent structural and service distribution pattern. Thus, when preliminary planning procedures produce an architectural schematic design, they “automatically” establish basic structural, mechanical and electrical designs. This assumes, of course, that the appropriate engineers have been involved directly in the preliminary planning process.

444 VA STANDARDS

All subsystems are to be designed in accordance with applicable VA Construction Standards, and should utilize VA Standard Details and Master Construction Specifications to the maximum practical extent. The Prototype Design conflicts with these standards in only a few minor respects. (See Section 550.) However, development of detailed subsystem designs in accordance with overall system objectives will require some new details and specifications. For instance, the VA Master Construction Specifications do not currently include sections which would adequately cover the unique aspects of the ceiling subsystem such as the platform and supporting framework. Appropriate specifications will have to be developed after a generic design option is selected. Even when the standard details and specifications are applicable, they must be carefully reviewed, and modified if necessary, to ensure complete consistency with the system design

450 Cost Estimating

451 SUBSYSTEM COSTS

During the programming and design of a systems hospital, periodic cost estimates will have to be made for budget control purposes, more or less at the same stages as in a conventional project, and more or less to the equivalent level of detail for each stage. The principal distinction in the systems case will be the structuring of cost summaries around the specific subsystems defined by the Prototype Design, as distinct from the more conventional breakdown along trade and subcontract lines. The function of this organization of cost data is to allow more effective cost/performance tradeoffs to occur during detailed design development by relating each set of targets and estimates to a specific set of building performance characteristics.

The subdivision of the building into relatively independent service modules permits the further structuring of cost figures on a per module basis. To a certain extent, major changes in program or budget during preliminary planning or detailed design can be handled by the addition or subtraction of service modules, leaving the rest of the scheme intact, or by constructing some modules as empty “shells” to be completed as funds become available.

452 TARGET COSTS

The “target” costs given at the end of the description of each integrated subsystem, and discussed in more detail in Section 751.2, are rangers that represent the least and most each subsystem can be expected to cost depending on the generic design options chosen and the complexity and quality of the detailed design. All cost figures are in dollars per outside gross square foot of building area (OGSF), are based on a stated scope, include general contractor’s and subcontractors’ overhead and profit, and are derived from costs prevailing in the San Francisco area at a national ENR Building Cost Index of 960.

As soon as a generic design option is selected for a particular subsystems, a more accurate determination of the appropriate target costs is possible. If these selections can be made during preliminary planning, the more realistic targets can be applied to cost estimates of various alternative schematic designs, thus rendering the identification of the optimum design more reliable. At the latest, structural, ceiling and HVC generic design options should be selected early in the design development phase.

In addition to the OGSF figures given, target costs in subsystem units are provided for ceiling and partitions. Thus ceiling costs can be estimated on the basis of total ceiling area, rather than building area, and partition costs can be estimated from linear foot calculations.

453 FUNCTIONAL AREA COSTS

The cost base (Section 530) includes an analysis of the costs of the integrated subsystems in two VA hospitals, broken down by functional areas. Structure is not included because its cost can be assumed to be equally distributed throughout.

Cost variations between functional areas are generally quite similar for the two buildings, suggesting their use in refining cost estimates during design development. It could be assumed that the distribution of cost variations will be approximately the same for any VA hospital with a similar set of departments.

The main impact of the Prototype Design on these proportions is to reduce the range of variation in costs by reducing the range of variation in subsystem characteristics. This “leveling out” of functional area differences must be taken into account in applying cost base data to cost estimates of systems construction.

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460 Construction Scheduling

461 DESIGNING FOR CONSTRUCTION

If construction is to proceed as quickly and efficiently as possible, the detailed design of the building must be deliberately oriented toward a carefully considered sequence of assembly. Since the development of a detailed construction strategy is a prerequisite to the final selection of generic design options for structure, ceiling and HVC, or at least must occur as one aspect of that selection process, it is a subject of concern from the very beginning of the design development phase.

Subsystem design and choice of materials must take into account all factors influencing the efficiency of the total construction process, such as:

1. labor content:

   a. trades required;
   b. skills required;
   c. trade schedules;
   d. on-site vs. off-site work;

2. transportation, storage and handling,

3. erection sequence and phasing among other subsystems,

4. simplicity of installation,

5. interface conditions between subsystems, such as tolerances, connectors and mutual access,

6. relative independence of installation of each subsystem,

7. working drawing lead time,

8. working drawing complexity,

9. shop drawing requirements,

10. field change capability,

11. possible trade union objections,

12. projected availability of materials and proprietary components,

13. supervision and inspection requirements,

14. support and workspace usable for installation of other subsystems, and

15. contingency stockpiling or overordering.

462 INTERSTITIAL SPACE

Those characteristics of the Prototype Design which allow simplification of contract documents are also intended to simplify construction. (See Section 440 above.) In addition, the system relies on the use of carefully dimensioned and organized “interstitial space” for significant reductions in construction time. The following characteristics summarize the basic design of the service zone. (See Section 224 for details.)

1. The ceiling system provides a continuous platform throughout the entire service zone, capable of supporting workmen plus a reasonable amount of materials and equipment.

2. The horizontal structure consists of shallow beams and girders, rather than trusses, thus avoiding conflict between service distribution components and truss diagonals.

3. The clear height between the walking surface of the platform and the underside of the structural slab between the beams provides full headroom for working in a standing position.

4. Only shear walls and two-hour partitions penetrate the ceiling-platform and run from slab to slab. All other partitions stop at the ceiling, thus providing open space of up to 20,000 square feet, the maximum size of a fire section. (Large fire sections may be subdivided by smokestop partitions between service modules of about 10,000 square feet each.)

5. The service zone is organized into a set of subzones, each exclusively reserved for a specific class of distribution components. Major equipment is located in the service bays at the functional zone level, not in the service zone.

463 TYPICAL SEQUENCE

The following outline suggests a possible sequence for starting major overlapping phases in the assembly of a systems hospital:

1. Sitework, foundations and erection of structure procedes in a conventional manner.

2. Attach ceiling hangers to beams to define subzone boundaries. Start internal service modules first, if there are any.

3. Assemble large distribution components on each floor and raise into final position. Piping and other materials supplied in long sections can be placed in temporary storage racks in the service zone at this time.

4. Install main vertical distribution components and large pieces of equipment in the service bays.

5. Install two-hour partitions.

6. Install the exterior wall, omitting appropriate spandrel panels at the service zone level for the continued delivery of material.

7. Install the platform, omitting appropriate panels for access. (This might also be started prior to installation of the exterior wall.)

8. Install all remaining distribution components above the ceiling while installing the topping slab and partitions below. (Flooring might be installed before the partitions.)

9. Install all remaining heavy building equipment, including elevators and materials-handling systems.

10. Conduct final tests on all operating systems.

11. Complete enclosure of the service zone by installing omitted panels of the platform and exterior wall.

12. Install finishes, casework, fixtures and remaining equipment. (This includes flooring if not already installed.)

13. Conduct final inspections and move in.

Glossary

Most of the words defined below are basic building systems terminology. For those of wider usage, the particular meaning for building systems is given. A few terms are peculiar to this project.

ADAPTABILITIY. the ability to respond to, or be readily adjusted to, changing conditions.

ADDITIONAL SPACE. portions of service modules in the patient bedroom areas constructed with the building system but not part of a space module.

ANNUAL OWNING COST. total owning cost computed as an annual expenditure.

AREA OF REFUGE. a fire section considered as a horizontal exit for an adjacent fire section.

ASSEMBLY. 1. a group of attached components considered collectively. (Example: a pre-hung door.) 2. a design configuration composed of a specific arrangement of service modules.

BEDROOM ZONE. a plan zone at the building perimeter, sized to accommodate patient bedrooms.

BUILDING CONFIGURATION. a specific three-dimensional arrangement of building forms. (Example: a tower on a base.)

BUILDING SCHEMATIC DESIGN. single line scale drawings defining the size and arrangement of the major areas in a building and the building configuration, used as a basis for design development.

BUILDING SUBSYSTEM. one of the coordinated groups of components, each performing a major function, which combine to form a building system.

BUILDING SYSTEM. 1. any specific building production process or method. 2. any set of coordinated building components intended for application as a group.

COMPATIBILITY. the state of functional, economic and aesthetic coordination between two or more systems or components.

COMPONENT. a part, or assembly of parts, in a system.

COMPOUND ASSEMBLY. a design configuration in which the structural framing changes direction, and/or some service bays are completely internal.

CONSTRAINT. a condition establishing a limit on the nature or effectiveness of a system or activity.

CONVENTIONAL DESIGN AND CONSTRUCTION. existing traditional building methods as they are currently applied.

COST-BENEFIT ANALYSIS. the comparison of alternatives in terms of the anticipated performance and cost of each.

COST EFFECTIVE. 1. comparing favorably to other alternatives in a cost-benefit analysis. 2. providing desired performance at a comparatively low cost.

CPM. critical path method.

CRITICAL PATH. the particular linear path through a work schedule network determining the shortest time within which all work can be completed.

CRITICAL PATH METHOD. a scheduling technique for the identification and control of activities on the critical path.

DESIGN CONFIGURATION. a general building plan type, illustrated by a diagrammatic plan.

DESIGN CRITERIA. various performance requirements, dimensional rules, descriptions of typical and special conditions, and the like, serving as guidelines in the development of a detailed design from the basic system design.

DESIGN DETERMINANT. an independent variable, or general class of such variables, encountered in a design problem, which influences the selection of alternative solutions or the characteristics of a particular solution. (Examples: program, site, budget, codes.)

DIMENSIONAL COORDINATION. 1. the selection of dimensions to allow exact fit. 2. the use of a common set of dimensions.

DOWN TIME. that part of the life span of a system or component during which it is malfunctioning or out of operation.

FAST-TRACK. an accelerated scheduling technique characterized by the overlapping of activities traditionally performed in linear sequence, requiring early commitment to general decisions, but allowing postponement of detailed decisions.

FEEDBACK. information on the current effectiveness or an ongoing process of activity, applied to its control or modification.

FIRE SECTION. one of at least two areas on a building floor separated by two-hour smoketight assemblies and of such size and configuration that they serve as mutual horizontal exitways.

FIRST COST. 1. contract cost. 2. debt service.

FLEXIBILITY. 1. adaptability. 2. having alternatives.

FUNCTIONAL SPACE. 1. a habitable room or area not assigned exclusively to building equipment. 2. space within the functional zone.

FUNCTIONAL SPACE REQUIREMENT. a characteristic a particular functional space must have to satisfy a user need or an applicable regulation or standard.

FUNCTIONAL UNIT. a group of rooms interrelated by shared activities or processes. Usually implies close proximity. (Examples: nursing unit, intensive care unit.)

FUNCTIONAL ZONE. the horizontal layer of space between the top of a finished floor and the bottom of the finished ceiling immediately above.

GENERIC DESIGN OPTION. one of a limited number alternative general types of solution allowed within the basic design of a particular building subsystem.

HVC. heating-ventilating-cooling.

INTEGRATED SUBSYSTEM. any of the pre-coordinated sub-systems specifically within the scope of a particular building system.

INTEGRATION. See SYSTEMS INTEGRATION.

INTERFACE. 1. a common boundary between two systems or components. 2. a boundary detail designed to maintain a specified relation between adjacent systems or components.

INTERSTITIAL SPACE. unfinished or non-habitable space utilized for building service subsystems, of sufficient size to accommodate workmen and permit maintenance and alteration without disruption of activities in functional spaces. The term usually refers to the space between a ceiling and the floor above. See SERVICE ZONE.

LEAD TIME. the length of time preceding an event which must be allowed for all prerequisite activities if the event is to have reasonable chance of occurring as scheduled.

LIFE COST. total owning cost during life span.

LIFE SPAN. 1. the period between the manufacture of a system or component and the time at which its annual owning cost exceeds the annual owning cost of a replacement. 2. the period between the manufacture of a system or component and the time at which it can no longer meet the needs of its user. 3. the shorter of the two above periods.

LONG TERM COST. total owning cost over a specified period of time, typically a theoretical life span.

MODULAR. 1. having commensurable dimensions. 2. capable of arrangement with exact fit in more than one sequence or direction. 3. composed of or containing predetermined dimensional and/or functional units such as repetitive structural bays or service modules.

MODULAR COORDINATION. dimensional coordination utilizing commensurable dimensions.

MODULE. 1. the common divisor of a set of commensurable dimensions. 2. a dimensional pattern restricting the location of a specified building component. 3. a unit of space defined by a special set of dimensional and/or functional characteristics.

NON-INTEGRATED. outside the design scope of a particular building system.

NON-SYSTEM. non-integrated.

NON-SYSTEM ASSUMPTION. an assumption about a characteristic of a non-integrated component used in the design of integrated components.

OGSF. outside gross square foot, a unit of total floor area.

OPENING CONFIGURATION. the original design configuration of a building or building subsystem developed in response to its original program.

OPTIMIZE. 1. to maximize desirable characteristics and/or minimize undesirable characteristics. 2. to establish functional and economic balance among the performance characteristics of two or more systems or components.

PERFORMANCE CRITERION. a performance parameter so quantified or described that a system or component can be examined or tested for compliance.

PERFORMANCE PARAMETER. a variable characteristic for which a specific value, range of values, or general comparative level must be established to describe a system or component in terms of desired performance.

PERFORMANCE REQUIREMENT. a statement to the effect that a certain system or component must comply with a certain performance criterion or set of criteria.

PERFORMANCE SPECIFICATION. a performance requirement stated in a legal form to serve as the basis for bidding by manufacturers or contractors on their own designs, often including a detailed test procedure, or reference to a recognized test, by which compliance may be established.

PLANNING MODULE. a one-story high unit of building volume with specific dimensional and functional characteristics.

PLAN ZONE. a plan area of constant width extending from end to end, or side to side, of a building or a planning module. See BEDROOM ZONE, SANITARY ZONE AND SERVICE STRIP.

PREFABRICATON. the on-site or off-site advance manufacture of building systems and components traditionally fabricated in-place during installation.

PRIMARY SUBZONE. a horizontal subdivision of the service zone, reserved exclusively for distribution lines oriented in a specific direction relative to the structure.

PRODUCT. a material, component or system manufactured off the construction site.

PROTOTYPE DESIGN. a basic system design establishing the performance and dimensional limits within which alternative detailed designs may be produced to accommodate specific conditions at various times and places.

RANGE. the limits between which a performance parameter may be required or allowed to vary, stated as a criterion.

RESERVED ZONE. a specified region within a building volume assigned to the exclusive use of one subsystem or limited set of subsystems, or to a specific function. See FUNCTIONAL ZONE, SERVICE ZONE, PRIMARY SUBZONE AND SECONDARY SUBZONE.

SANITARY ZONE. a plan zone between the patient bedrooms and the corridor in a nursing unit, sized to accommodate lavatories, toilet facilities, etc.

SECONDARY SUBZONE. a vertical subdivision of a primary subzone, reserved exclusively for the distribution lines of a specific service subsystem or group of subsystems.

SERVICE BAY. a structural bay specifically designed to provide for mechanical and electrical rooms and/or various kinds of vertical shafts, located at the perimeter of a service module and typically enclosed in shear walls.

SERVICE MODULE. a planning module containing, and served by, an independent horizontal distribution network, typically including its own air-handling unit.

SERVICE STRIP. a plan zone containing internal service bays.

SERVICE ZONE. the horizontal layer of space between the bottom of a finished ceiling and the top of the finished floor immediately above. See INTERSTITIAL SPACE.

SIMPLE ASSEMBLY. a design configuration in which all structure is framed in the same direction, and all service bays are external.

SPACE MODULE. a subdivision of a service module in a patient bedroom area, which can be internally organized in various ways to accommodate a range of functions, and which can be incorporated within a variety of design configurations.

SUBSYSTEM. 1. a system considered as a component of a larger or more general system. 2. any component, or group of components, which has internally the characteristics of a system. (Example: the distribution components of a mechanical system.)

SUPPORT AREA. all hospital areas outside the bed-care area.

SURGE SPACE. 1. space assigned to functions whose location within the building is relatively non-critical, and placed adjacent to space assigned to functions whose location is relatively critical, such that expansion of the latter can occur by displacing the former. 2. a zone of functional space at the boundary of two departments which is assigned to the departments in a proportion which may vary over time.

SYSTEM. a set whose elements (termed components) are organized toward a common objective, and are characterized by interdependence in their individual contributions to that objective.

SYSTEMS ANALYSIS. examination of the effects of the interactions between the components of a system on the individual performance of those elements and on the total performance of the system.

SYSTEMS APPROACH. a strategy of problem definition and solution which emphasizes the interaction between problem elements and between the immediate problem and its larger context, and which specifically avoids traditional methods of independent or ad hoc treatment of the various elements.

SYSTEMS INTEGRATION. 1. the combination of a group of relatively independent parts into a coordinated whole to improve performance through controlled interaction. 2. the joint use of a component by two or more systems.

TOTAL OWNING COST. the sum of all costs, regardless of funding source, attributable to owning a building, or a particular system or component within a building. Owning cost is typically broken down into first, operating, maintenance, alteration and replacement costs.

TRADE-OFF. choice between alternatives based on evaluation of differences in characteristics such as cost, performance, appearance, etc.

UNCOUPLING. a planning or design activity involving the disconnection or disentanglement of components to alleviate interference or provide clarity.

UNIT. 1. a structurally independent assembly performing a specific function or range of functions. 2. a functionally related set of people, equipment, spaces, missions and activities considered collectively for planning and administrative purposes. See FUNCTIONAL UNIT.
3. a module.

USER NEEDS. those conditions the users of a building consider necessary or desirable as environment and support for their activities, without particular reference to how such conditions are to be provided.

USER REQUIREMENTS. 1. user needs. 2. performance requirements established directly by a user.

DATA BASE

VOLUME 2

Volume Two, the Data Base, contains information on user needs, functional requirements, costs of existing hospitals, labor unions, and laws and regulations. It is intended to serve in conjunction with the Design Manual during application of the system to a specific building project.

500 DATA BASE REQUIREMENTS

550 LAWS AND REGULATIONS

510 Generalized Needs and Requirements: Total Hospital

511 INTRODUCTION

511.1 The following is a generalized set of user needs and functional requirements for hospitals having a range of sizes, a variety of nursing and supportive or ancillary units and a range of relationships between these elements. It is intended that these will provide:

1. a basis from which subsystem performance requirements can be formulated;

2. a basis against which space organization and component selection trade-offs can be measured; and

3. a basis from which the Veterans Administration may, if it desires, develop a comprehensive statement of current and future needs as a guide for those responsible for the design and construction of VA hospitals.

In this section users needs have been distinguished from functional requirements. User needs are illustrated by a description of the activities necessary to perform a given function and the resulting environmental context. Functional requirements are derived from these needs and can be defined as user related building performance criteria. The generalized needs and requirements in this section relate to the performance of the building system as a whole and may be used for the evaluation of individual system projects.

Section 520 illustrates a more detailed development of needs and requirements for a particular area of the hospital, the bed care portion. This level of detail is beneficial in providing a means of communication between the VA and an A/E in the design of individual projects.

The material presented in this section and Section 520 has been obtained from discussions with persons functioning in many capacities in VA and community hospitals, extensive discussions with medical and administrative personnel at the Veterans Administration Central Office (VACO) and a survey of relevant literature.

Any user need statement will, in time, become obsolete. It is recommended that these statements be periodically revised to maintain a relevant body of information for the Veterans Administration and its architect-engineer contractors. (See Section 630).

512 USER NEEDS FOR THE TOTAL HOSPITAL

Certain user needs common to all of the hospital are highlighted in the following sections: growth and change, maintenance, building management, fire safety, asepsis, materials handling and transportation, and communications.

512.1 GROWTH AND CHANGE

512.1.1 Change is inherent in the practice of medicine. Currently, hospitals must respond to changing operational and social needs as well as those of medicine. Traditionally, the ability to respond to change has been, for all practical purposes, frozen during the period necessary to plan and construct a hospital. This pattern is no longer desirable. Hospitals must be capable of responding to changing needs at any time before or after occupancy.

A building's configuration determines, to a large extent, the limits of its subsequent ability to adapt. Shape and the location of fixed (permanent) elements are particularly important in the nursing tower portion of the hospital where many activities require perimeter exposure and where patterns of space organization are relatively rigid.

The performance of non-replaceable elements, such as the building structure, also limits future adaptability. Hospitals are normally not demolished because they cease to function as basic shelter; most are adequate to house people comfortably and safely. Rather, demolition is the result of the inability to meet changing user needs to a degree, which is totally unacceptable.

Long before the demolition point is reached, most hospital buildings impose constraints which result in sub-optimal performance. It is highly desirable to minimize the constraint imposed by the building upon the activities and environment contained therein.

512.1.2 National medical care patterns are currently undergoing close scrutiny at the highest levels of government. It is probable that, as a result of this examination, reorganization of the national health care system will affect all health facilities, including those of the VA. It is also likely that this will result in substantial change in the current pattern of inpatient and outpatient utilization. Development of a strategy for growth and change is therefore considered fundamental to the long-range effectiveness of a hospital building system for the VA.

512.1.3 Non-nursing areas of the hospital may be contrasted with nursing areas with regard to growth and change. In nursing areas:

1. The frequency of change is less than in non-nursing areas.

2. The type of change is more predictable.

3. Growth is apt to be in functional unit increments, so existing units are not affected.

4. The density of services is considerably less than many non-nursing areas, consequently service change is also less.

In the supporting areas of the hospital, growth and change assume a quite different character. Procedures, both medical and industrial, are more sophisticated. Therefore, change for technological reasons is apt to more frequent and more demanding of services. In addition, activities in these areas are apt to be of a more critical nature, and thus are less capable of being disrupted during change. Expansion of any element in the hospital ”base” is apt to affect other areas. Significant growth of a department is often not merely additive, but also requires a partial reorganization of existing spaces. In addition, growth may require modification or relocation of adjacent departments. This is particularly true in large base units seen in most current VA hospitals.

512.1.4 In addition to growth and change of existing departments, the supporting medical service units must be able to accommodate the introduction of additional treatment modalities. In recent years, we have seen the introduction of cardiac catheterization, inhalation therapy, pulmonary function evaluation and other new diagnostic and treatment functions requiring new departments or space in existing departments.

512.2 MAINTENANCE

512.2.1 Maintenance activities are conducted on both a routine preventative and an as-needed basis. Activities include all repairs and alterations not requiring the services of an outside contractor. The primary objective of building maintenance is to provide an optimum medical and operational environment at all times.

512.2.2 Maintenance needs and building adaptability are closely interrelated as the following examples illustrate:

1. Adequate work space provided to allow for future change also facilitates routine and emergency maintenance.

2. An ability to replace major equipment items is necessary for proper building performance and efficient maintenance and, in addition, it provides for future upgrading to meet changing requirements.

512.3 BUILDING MANAGEMENT

512.3.1 Primary objectives of the building management program are hospital-wide asepsis, an attractive milieu, and patient and staff comfort. This is achieved through technical cleaning procedures and frequent bacteriological monitoring. The ability to provide prompt and thorough performance of housekeeping activities is vital to establishing a high level of care.

512.3.2 The selection of floor, wall and ceiling materials has an important affect on building management cost as well as on the ability to obtain an appropriate environment.

512.4 FIRE SAFETY

512.4.1 One of the most controversial subjects in building design today is that of fire safety. Codes currently in effect are under criticism from many directions. They are alleged to favor safety of property over safety of life, to be based on experience with low rise buildings and inappropriate for high rise, to provide inadequate protection from smoke as compared to fire, and to be based on the unrealistic principle of complete building evacuation. The majority of patients who die in hospital fires succumb to asphyxia, not burns. The rate at which bedridden patients can be evacuated vertically from the upper floors of a high rise nursing tower precludes clearing of the building as a means to safety.

The process of code writing rarely derives from scientific analysis of how buildings burn. The testing of building components to establish fire ratings is expensive, of doubtful relevancy, and in fact impossible for many assemblies due to limitations in test furnace capabilities.

The amount of combustible material in VA Hospitals is now under very tight control, and is much lower than code imposed requirements assume.

A very significant portion of the cost of a building is attributable to the elaborate precautions required by the codes. And in spite of the cost and the precautions, many authorities regard modern buildings as unsafe.

512.4.2 The state-of-the-art in fire protection engineering is quite adequate to increase safety while reducing costs. The Veterans Administration, not being legally constrained to follow codes, is in an excellent position to apply modern techniques. The building system under development should make full use of these new approaches. In fact, as a prototype it should set the pace for future development.

512.5 ASEPSIS

512.5.1 “At present, there are no clearly defined standards for asepsis in any area of the hospital. The problems of asepsis have been frequently studied with little agreement as to results. Mr. A. Samdo, in March 1968 issue of Modern Hospitals, is able to state: ‘The thoroughly documented evidence of airborne infection make it clear that the principal function of a hospital air conditioning system is not mere personal comfort but instead control of airborne pathogens.‘ At the same time, the U.S. Public Health Service in Publication 930-C-15 quotes the work of Rommelkamp in stating, ‘. . . . an evaluation of total room ultraviolet irradiation in operating theatres has shown that although total counts of airborne bacteria may be reduced up to 63%, the overall incidence of post-operative infection was not changed. Thus, at least in this study, which involved 14,854 operations, the airborne route of infection was not considered important.’ These two statements may not be completely contradictory but they do show the lack of agreement of this subject.”

In isolation environments, a technique of hand washing and gown changing should be used. Face masks and sterile gloves may also be required in some instances.

In addition, air locks have been employed occasionally to maintain an aseptic barrier.

To maintain an acceptable level of asepsis, certain conditions or activities should occur. These include:

1. Frequent cleaning, particularly of floors and other horizontal surfaces which may collect dust and moisture droplets.

2. Periodic windows (or germicidal fogging) of walls and semi-concealed areas where pathogenic colonies may grow.

3. Proper techniques by staff members to avoid cross contamination between rooms (or patients) and to avoid circulating unnecessary dust and moisture particles while conducting their assigned tasks.

4. Pathogenic control of ventilation air through a program of periodic inspection and replacement (or cleaning) of air filters plus periodic germicidal cleaning of duct work and terminals.

5. The organization of service systems or equipment to minimize entry by maintenance personnel into the patient environment and particularly to avoid the opening of concealed spaces which may harbor uncontrolled pathogenic colonies, for example the removal of a “lay-in” ceiling tile in a patient’s room to reach a valve or change a filter.

512.6 MATERIALS HANDLING AND TRANSPORTATION

512.6.1 Supply and Disposal Systems

1. Trends

   These systems along with the transportation system have for many years been a major determinant of hospital organization and configuration.

   Hospital supplies may be categorized as either reprocessed or disposable. As hospital based labor costs increase, fewer items will be reprocessed in the hospital; however, in certain instances, groups of hospitals are likely to organize joint industrialized plants to reprocess supplies. Out-of-hospital processing usually implies increased storage capability either in individual departments or, more often, at a central location.

Increasing labor costs have also resulted in an increased use of disposables. This has simplified quality control and reduced hospital based labor for many procedures. Use of disposables has also increased the demand for soiled material storage in individual departments and led to renewed interest in trash chutes, particularly the pneumatic type.

Supply and disposal systems will continue to change at a rather rapid rate for the foreseeable future. It is imperative therefore that space configuration and building organization be highly adaptable with regard to these systems.

2. Current Systems

The following summarizes the general patterns of supply and disposal in use today. A considerable degree of variation and many combinations of the systems described may be found.

a. Recycled Items

(1) Linen

(a) Process. Processed in the hospital or at a central facility.

(b) Delivery. Delivered to departments by cart or occasionally in a tote box, usually on a 12 or 24 hour schedule.

(c) Clean Storage. Usually stored on a delivery cart or transferred to shelving. Often bed linen is delivered directly to the patient's room.

(d) Soiled storage. Usually held in plastic bags in a central location on the unit or deposited in a trash chute.

(2) Disposable (consumed) Items

(a) Food

(1) Delivery. Delivered by heated or unheated cart or by tray conveyor.

(2) Clean storage. No clean storage, except when a system of precooked food and a microwave reheat system on each unit is used. This requires refrigerated storage.

(3) Soiled storage. Usually no soiled storage; trays are picked up on a cart for immediate transfer to the dietary area.

(b) Drugs

(1) Delivery. Usually delivered by cart, tote box or dumbwaiter; normally, each 24 hours. Specially requested drugs are carried by hand or delivered by tote box, dumbwaiter, pneumatic tube or, recently, by monorail.

(2) Clean storage. Stored in a central area or in nurse servers (on patient units).

(3) Soiled storage. Unused drugs are returned after patient discharge by one of the above mentioned means.

(c) Medical supplies. See a (2), (b) above.

(d) Administrative supplies

(1) Delivery. Usually delivered on a request basis by hand, tote box, dumbwaiter, pneumatic tube or, recently, by monorail.

(2) Storage. Stored in various administrative areas on shelving or in drawers.

(3) Disposal. In waste containers for periodic pick up.

512.6.2 Materials Handling and Transportation Systems

1. Trends

   Transportation systems have, to large a degree, been the major determinent of hospital configuration. The “cottage” hospital gave way to the “tower on the base” when the elevator was introduced (and mechanical ventilation became available). The introduction of vertical conveying systems reinforced this form of vertical configuration, and, particularly, the close grouping of functional units around a vertical distribution shaft.

   Recently, the availability of horizontal/vertical systems has caused a re-examination of the vertical hospital concept. In addition, the application of cost/benefit analysis techniques involving transportation systems has given impetus to a reevaluation of hospital configuration and distribution systems in general.

   Transportation systems are inherently inflexible in the quantity of goods they can carry, the paths which they follow, and their method of terminal distribution. In addition, many are slow, most are noisy, and almost all require highly skilled maintenance at frequent intervals. The introduction of horizontal/vertical systems have only served to compound problems of inflexibility, noise and maintenance. Current experience indicates that simplicity and reliance on manually guided systems provides a desired degree of adaptability. The cost benefits of more sophisticated transport systems have yet to be established.

2. Current Systems

   a. Elevators. Satisfies the entire range of vertical hospital transportation requirements. Particularly suitable for wheelchair or stretcher patients or large carts. Not efficient for large numbers of people moved in a short period of time. Vertical capability only.

   b. Dumbwaiters. Used for high speed transportation of small items (usually requested items). Vertical capability only.

c. Escalators. Particularly efficient for transporting large numbers of people for a relatively few floors vertically. Diagonal capability only.

d. Tote box conveyors. Efficient for transportation of small items to many floors, particularly when combined with an ejection device. Not suitable for large bulky items. Vertical and horizontal capability.

e. Tray conveyors. Suitable for mass distribution of items where a sender and receiver are in constant attendance. Horizontal and vertical capability.

f. Pneumatic tube (small). Suitable for irregular distribution of small amounts of paper or packages. Horizontal and vertical capability.

g. Pneumatic tube (large). A means of distributing large (20”), prepackaged, non-breakage items. Current experience is insufficient to allow proper evaluation. Horizontal and vertical capability.

h. Chutes. Efficient and effective if properly maintained. Vertical capability with limited horizontal movement.

i. Monorail (large). Possibly suitable for distribution of large items on a request basis. Horizontal and vertical capability.

j. Monorail (small). Efficient for distribution of paper, records, x-rays, drugs, etc. Horizontal and vertical capability.

k. Automated carts. Uses special elevators and a pre-programmed horizontal route. May require special distribution corridors. Horizontal and vertical capability.

l. Motorized carts. High degree of horizontal flexibility. Can be used to transport several large carts simultaneously. Requires a person in attendance.

512.7 COMMUNICATIONS

Hospital communication systems are essential to efficient operation and quality medical care. A wide range of technological innovation in this field is probable over the next few years.

Currently, communications comprise the area of greatest frequency of change in the hospital.

513 FUNCTIONAL REQUIREMENTS FOR THE TOTAL HOSPITAL

513.1 Introduction

Functional requirements define user related building performance criteria. As such they are major determinant of the building system and provide a framework against which the system should be evaluated. These requirements are supplemented with the constraints of component characteristics, building codes, VA regulations, construction trade standards, cost criteria, etc, all of which are additional building system determinants.

The requirements in this section are based on particular activities or sets of activities which are thought to establish building system performance criteria. Since individual activities are transitory, the building subsystem performance requirements derived from these functional requirements will in many cases exceed the requirements for individual activities in order to accommodate probable future needs.

513.2 ADAPTABILITY AND GROWTH REQUIREMENTS

513.2.1 The opening configuration and initial building performance should represent only one option of total building capability.

The initial phase normally achieves the highest level of user need satisfaction. While subsequent alterations usually result in a lesser degree of need satisfaction as a consequence of constraints imposed by an established configuration and by component performance limits, the building system should minimize the effect of these constraints.

513.2.1 The building system should allow for growth and change in an economical manner with minimum disruption to ongoing activities and in a way which will achieve desired performance.

513.2.2 The building system should permit the following types of growth and change:

1. relocation of furnishing or equipment;
2. change of utility services;
3. change of occupancy;

4. relocation of building components, e.g. partitions;

5. major demolition and reconstruction of building components; and

6. expansion of the facility.

512.2.3 The building system should provide for convenient accessibility to and a rational organization of service subsystems.

The most frequent demand for change in hospitals involves services. The keys to efficient service alteration are accessibility and rational organization of distribution routing. Accessibility implies sufficient work space as well as reasonably convenient access. The organization of routing implies preplanned zoning of the service space to preclude interference of distribution sub-systems. Such preplanning can make better use of space currently wasted and can provide for future expansion on a rational basis.

Current problems are, in part, the result of an attitude toward building design characterized by designation of service space as “non-assignable” and therefore deserving of reduction to an absolute minimum. This has proved to be false economy in the context of long term costs, but the attitude persists because of the presumed high first cost of providing services with their own functional space sized, designed, and laid out according to their own requirements. The growing density of services in a modern hospital makes it mandatory to include a thoroughly planned and programmed service space as an integral part of basic building design. A cost effective way of providing this space must be found.

513.2.4 The building and its systems should be capable of unanticipated growth.

513.3 REQUIREMENTS AFFECTING THE CONFIGURATION OF FUNCTIONAL UNITS

513.3.1 Definition

Functional units are defined as assemblies of rooms, closely linked by interrelated activities. A functional unit is often identical to an administrative department such as “surgery” or “radiology”.

513.3.2 Area Requirements

The building system should be capable of accommodating functional units which vary in size.

In contrast to nursing area functional units, non-nursing functional units vary widely in size. In addition, the same unit will often vary in size from one facility to another, depending upon the relative number of beds served, outpatient load, degree of medical specialization, etc. An example range of areas can be seen in Table 510-1.

513.3.3 Perimeter and Aspect Requirements

The building system should provide for the introduction of natural light where required.

Perimeter length and aspect characteristics are of paramount importance in nursing units in order to achieve sufficient natural light for patient bedrooms. In non-nursing areas, these factors are secondary to the achievement of an optimal organization of functional units.

Generally, natural light is advantageous in rooms where diseases affecting skin color, e.g., jaundice, might be diagnosed, in dental treatment areas where tooth enamel color must be evaluated, and in psychiatric areas. In addition, natural light is desirable in corridors and waiting spaces to provide relief from the uniformity (monotony) which pervades most major institutions. The introduction of natural light into corridors can also provide a sense of orientation often missing in large institutions.

513.3.4 Dimensional Requirements

1. Dimensional Discipline

    a. The dimensional discipline of the building system should be compatible with the required organization of functional units.

       Nursing and non-nursing functional units have been examined to identify consistent patterns of organization which might be sufficiently extensive to justify a new structural discipline. The following features relating to the internal organization of nursing areas are outstanding:

Table 510 – 1. GROSS DEPARTMENTAL AREAS

Department	Approximate Gross Area* Cleveland 800 Beds	Lexington 370 Beds	Columbia 480 Beds
Admission & Outpatient Service	31,941	5,145	2,941
Audiology		1,415	1,224
Canteen	8,813	7,073	7,863
Cardiopulmonary Lab	3,212	3,183	2,351
Central Service	7,119	4,663	4,413
Chaplain Service	4,382	3,053	3,192
Conference Rooms	1,625		
Contract Division	435		348
Credit Union	290		261
Dental Clinic	4,051	3,119	2,349
Dietetic Service	20,970	10,335	18,104
Director, Professional Services	935		
EEG Clinic	486	819	819
EENT Clinic (or ENT Clinic)	3,110	1,439	583
Engineering Division	6,900	5,813	6,163
Eye Clinic			682
Fiscal Division	2,625	218	1,363
Gastroenterology Unit		1,073	
General Clinics	11,238	1,691	2,255

* Gross area figures based on programmed net areas from Master Plan Documents for indicated hospitals multiplied by an estimated net/gross factor.

Table 510-1. GROSS DEPARTMENTAL AREAS

Department	Approximate Gross Areas* Cleveland 800 Beds	Lexington 370 Beds	Columbia 480 Beds
GU Clinic	2,494	1,228	1,269
Hematology Unit		725	
Hospital Director's Suite		2,842	5,097
Housekeeping Division	8,432	3,631	5,786
Inhalation Therapy		406	174
Laundry			5,410
Library Service		2,415	2,716
Lockers, Lounges, Toilets & Showers	18,965	8,651	8,567
Main Lobby	2,563	463	1,181
Manager's Suite	1,378		
Medical Illustration Lab	3,002	1,878	2,030
Medical Incinerator	165		165
Medical Record Librarian	869		
Medical Service Administration	711	1,146	566
Mental Hygiene Clinic		1,969	
Miscellaneous Activities	1,863	1,233	1,392
Nursing Service Education and Training	1,827	1,813	1,813

* Gross areas figures based on programmed net areas from Master Plan Documents for indicated Hospitals multiplied by an estimated net/gross factor.

Table 510-1. GROSS DEPARTMENTAL AREAS

Department	Approximate Gross Area* Cleveland 800 Beds	Lexington 370 Beds	Columbia 480 Bed
Nursing Unit Facilities	203,781	100,040	132,821
Orthopedic Brace Shop	1,668		
Orthopedic Clinic	1,834	2,008	1,566
Pathology & Allied Sciences Service	16,458	12,651	11,854
Pathology Reference Lab	725		
Personnel Division	1,560		1,189
Pharmacy	2,406	1,775	1,806
PM & R Service	16,559	8,392	25,243
Plastic Eye Clinic	885		
Psychiatric Admin. & Teaching Service	1,247	1,088	827
Psychology Service	1,102	2,567	2,567
Quarters – OD & Residents	2,524	2,524	2,524
Quarters – Relatives of Ill Patients	675		
Radioisotope Unit		983	
Radiology Service	12,943	5,242	5,156
Recovery Room (Surgical)	2,220	1,500	1,200
Registrar Division	17,875	5,302	5,071
Research Service	25,762	17,400	36,250

*Gross area figures based on programmed net area from Master Plan Documents for indicated hospitals multiplied by an estimated net/gross factor.

Table 510-1. GROSS DEPARTMENTAL AREAS

	Approximate Gross Area*		
Department	Cleveland 800 Beds	Lexington 370 beds	Columbia 480 Beds
Service Organizations	290		348
Social Work Service	2,563	1,598	2,736
Special Service	13,397		
Supply Division	188		1,363
Surgical Service	13,059	10,749	8,570
Vocational Counseling Service	667		
Voluntary Service		928	1,088
Warehouse	1,320	1,254	7,381
Women Patients' Laundry			150
TOTAL	492,109	254,789	340,787

*Gross area figures based on programmed net areas from Master Plan Documents for indicated hospitals multiplied by an estimated net/gross factor.

1. The nursing tower consists of generally repetitive elements (functional units).

2. These functional units are often consistent in size and arrangement from one hospital to the next.

3. They have particular requirements for aspect (outlook) and perimeter to area ratios.

Consequently when viewed in the context of the total hospital, the nursing tower portion is somewhat unique.

In the case of non-nursing functional units it is quickly apparent that no consistency of plan organization exists between functional units. Each was optimized in response to the medical and operational needs of a particular set of activities. It is unlikely, therefore, that any non-nursing unit or combination of units will become a generator of a new dimensional discipline (See Section 513.3.2).

Structural and mechanical subsystems will both impose dimensional discipline. Of these, the structural discipline is generally most critical in relation to internal functional unit organization. The mechanical discipline, i.e., the mechanical service module, should be sufficiently large so as to encompass most departments, and thus remain independent of any particular internal organization.

b. The dimensional discipline of the building system should provide for a generalized building performance capable of accommodating a range of activities in any given space.

2. Unobstructed Area Requirements

The building system should be capable of accommodating unobstructed areas where required.

Functional units have been examined to determine individual spaces in which a clear, column-free area is required. A list of these spaces is itemized in Table 510-2.

As this list indicates, certain large areas must be column-free. Although relatively few in number, they must be accommodated within the building system. For other areas, it is obvious that any reduction in the number of permanent elements such as columns reduces constraints in planning.

In addition to considering large spaces, non-nursing areas have been reviewed to determine inherent relationships between spaces which might not be compatible with structural column locations. There appears to be no relationship which could not be adjusted in a minor way to accommodate a structural discipline.

3. Critical Dimension Requirements

   In addition to unobstructed areas, hospitals activities have been reviewed to determine whether any were dependent upon critical minimum or maximum ergonometric space dimensions. In the case of nursing areas the repetitive nature of spatial requirements is apt to generate a similarly repetitive structural response. In the review of non-nursing activity requirements these dimensions were not in most cases the generators of a dimensional discipline. Hence it is assumed that no dimension in these areas is so critical that it can not be adjusted to accommodate the nursing area structural discipline given the presence of a reasonable structural span. Rather, the problem is identical to conventional planning in that spaces can be “made to fit” the established discipline.

4. Floor To Ceiling Height Requirements

   Most activities in the hospital, particularly those in bed care areas can be accommodated with a 9’-0” ceiling height. However, there are some non-nursing areas that require additional height or have heights specified by VA Standards. An example list is included in Table 510-3.

Table 510-2. SPACES REQUIRED TO BE COLUMN FREE

SPACE	SHOULD BE COLUMN FREE
Autopsy	yes
General Storage	no
Laboratory	no
Maintenance Shops	no
Mechanical Rooms	yes
Research Laboratories	no
Medical Illustration Studio	yes
Processing and Delivery	no
Audiology Classroom	yes
Operating Rooms	yes
Locker Rooms	no
Surgical Recovery	yes
PM & R Pool	yes
PM & R Treatment Areas	no
Chapel	yes
Libraries	no
Clerical Areas `	no
Conference Rooms	yes
Kitchen and Dining Areas	no
Retail Stores	no
Main Lobby and Waiting Areas	no
Pharmacy	no
Ambulance Garage	yes
Records Storage	no
Patients' Clothing Storage	no
Day Rooms	no
16-bed Patient Rooms	no
Laundry	no

Table 510-3. MINIMUM CEILING HEIGHTS

9'-6":
- General Operating Rooms *
- X-ray Rooms (general) *
- Physical Therapy
- Audiometric Testing
- Therapy Pool

10'-0":
- Kitchen *
- Laboratories *
- Utility Shops *
- Animal Labs *
- Laundry Receiving and Issue *
- Physical Medicine and Rehabilitation *
- Bowling Alley *
- Storage

10'-6"

12'-0":
- Laundry Work Space (11'-9" to underside of ducts)
- Transformer *
- High Voltage Switch Gear *
- Emergency Generator (11'-0") *
- Warehouse * (11'-0" to underside of ducts)
- Garage Vehicle Storage *
- Radiographic Rooms (certain brands of equipment require 10'-6" to 10'-8")
- Trash Room *

* VA Standard Details or Construction Standards
Indications are that certain of above ceiling heights may not necessarily be required. A careful re-evaluation of these standards is suggested.

513.3.5 Internal Organization Requirements

The building system should satisfy the internal organization requirements of functional units.

The general objectives of the building system which relate to the internal organization of functional units are:

1. To satisfy user needs and the corresponding detailed performance requirements.

2. To provide the ability to achieve the widest possible range of internal organizations of functional units.

513.4 REQUIREMENTS AFFECTING THE CONFIGURATION OF THE TOTAL HOSPITAL

Major building configuration variables include:

1. the type and number of functional units to be accommodated,

2. the interrelationship of these units,

3. the relationship to elements outside or partially outside the hospital which require association with one or more functional units,

4. the organization of the hospital as a whole, with all primary operational requirements, including all movement and support systems, and;

5. site considerations and other governing constraints, which apply to the specific project.

513.4.1 General Options for Organization

The building system should accommodate all basic configuration options which are commonly in use or which would offer significant advantage should they be used.

All VA hospitals examined to date could be categorized as “tower on a base”; that is, nursing unit “towers“ stacked on a base consisting of non-nursing functions. This configuration is perhaps the most typical organization for hospitals in the United States today.

Recently, other configurations have been put forth. Foremost among these are: (1) the nursing “tower” adjacent to a non-nursing “base” (articulated tower), (2) nursing units and non-nursing functions interspersed on each floor (low block, pavilion or high block), and (3) a nursing tower adjacent to separate industrial and medical support units (articulated tower). These options are discussed more fully in Section 250.

The four organization options described above represent basic types. Undoubtedly, there are others, each type has hundreds of variations developed in response to site conditions, the constraints of existing related buildings, variations in administrative policy, etc. With this variety, it is clearly impractical to define a rigid hospital organization around which a building system could be developed. In certain cases, it may be possible to identify configurations which optimize medical or operational efficiency. History indicates, however, that operational factors which generate “optimum” solutions change in time, and a different “optimum’ is created. The building system will remain a valid, self-improving system only so long as it can accommodate all “optimum” options proposed.

513.4.2 Relationship Between Functional Units

1. The building system, should be capable of accommodating a wide range of operational patterns.

   Relationships within the hospital are determined by both operational and physical requirements.

   The operational relationships which most affect configuration are those of transportation or movement. These may be categorized as (1) patient movement, (2) staff movement, and (3) material movement. Each category must be evaluated in terms of (a) the characteristics of the object being moved, (b) the frequency of movement, and (c) the urgency of movement. Materials handling systems are closely interrelated with the organization of distribution and receiving stations and the type of movement equipment provided. A highly mechanized distribution system may allow relationships which would be undesirable in a hospital with manual distribution systems. Or, a highly organized and compact “vertical” hospital may be optimum for patterns of distribution and equipment which would be quite inefficient for a “horizontal” hospital. No one pattern can fit all circumstances.

The nature of the operational relationships between functional units in the hospital today is such that it is frequently possible to group certain units in order to maximize building efficiency. This is particularly true of the “industrial” functions such as laundry, kitchen, processing and distribution, storage, etc. In certain instances, these functions have been totally detached from the hospital complex and constructed as an industrial building in a remote location.

While operational relationships are of prime importance in determining initial building configuration, it is also important to consider the physical relationships generated by optimizing building component organization. Examples of such component organization include certain mechanical and electrical services, accommodation of unusually heavy floor loads, unusual floor-to-ceiling height, etc.

In addition to factors of operational efficiency and optimization of building component organization, physical relationships are influenced by a need for future expansion of functional units. It is desirable to locate complex areas with high growth potential adjacent to elements with minimum service demands or next to exterior walls. In the former case those areas which are displaced may be economically relocated as other areas expand. Factors of growth and change are discussed more fully in Section 513.2.

It is apparent from the above discussion that the physical relationships between functional units cannot be generalized in any precise way. The operational relationships in each facility are to some extent unique and transitory. New medical techniques, new materials handling systems, altered pattern of labor cost, etc., result in a need to change relationships between functional units. In most instances, there is latitude to adjust methods of operation to suit a desired configuration. In one sense, then, hospital design is a trade-off between suitable patterns of operation and an optimum configuration.

2. The building system must provide the capability to achieve a desired initial configuration.

513.4.3 Building Height Limitations

The building system should accommodate a reasonable range of building heights.

Height is a function of site size and site utilization. It is also often influenced by administrative policies such as the distribution of supplies or by medically desirable relationships. There currently is a trend to optimize horizontal relationships between nursing and non-nursing units. The resulting buildings do not often exceed nine stories in height. In large vertical hospitals, however, where distribution centers are stacked, a height in excess of nine stories is sometimes necessary.

From the VA projects examined to date, there is no apparent disadvantage in limiting the height of the system to nine stories. It is recognized, however, that in a minority of cases, an extremely small site would necessitate a taller structure.

513.4.4 Materials-Handling and Transportation

1. The building system should allow the widest possible options in the selection of materials handling and transportation systems. Furthermore, an ability to accommodate a change or an addition to these systems should be provided where possible, i.e., it should allow the introduction of horizontal and vertical distribution systems either in initial construction or as a subsequent addition.

   A survey of available materials handling systems indicates the following example characteristics which should be accommodated within the building system. Such accommodation must also include acoustical characteristics, effect on sensitive electronic equipment, e.g., electron microscopes, and constraints on future adaptability.

EXAMPLE CHARACTERISTICS OF MATERIALS HANDLING SYSTEMS

SYSTEM	WEIGHT CARRIED (POUNDS)	MINIMUM CLEAR OPENING IN STRUCTURE VERTICAL*	HORIZONTAL*
Elevator	4,000	8.0’ x 9.5’	
Dumbwaiter	800	4.0’ x 4.5’	
Totebox Conveyor	425	3.5’ x 5.0’	
Self-guiding Cart	1,525	5.0’ x 5.0’	4.0’ x 6.5’ high
Monorail Cart	1,000	5.0’ x 5.0’	5.0’ x 7.5’ high
Monorail Totebox	30	1.5’ x 1.5’	1.5’ x 2.0’ high

* Rounded up to nearest ½ foot.

2. The building system should maximize areas of free space by grouping vertical and horizontal transportation elements near other permanent elements, or on the boundaries of open areas.

   Certain exceptions to this may occur in supporting units where it is essential to deliver supplies directly to a work station, e.g., delivery of sterile supplies to an isolated surgery supply area.

513.5 ENVIRONMENTAL REQUIREMENTS

513.5.1 Air Quality Requirements

Specific air qualities for the various functional units should meet the requirements of the various applicable VA Construction Standards. Some of these standards are presently under revision or development using data contained in recently completed VA Air-Conditioning research studies. In general, most functional unit requirements are for a temperature range of 70 - 80ºF with a mean temperature of 76º $\pm$ 2 and a relative humidity range of 30 - 60%.

513.5.2 Acoustical Requirements

1. The building system should provide a range of acoustical separation from STC 30 to STC 55 and an impact rating up to INR +10.

   It is evident that the acoustical performance of each element in the acoustical shield must be at least equivalent to the total STC desired. In most hospitals, inconsistencies in the selection of materials, detailing or supervision result in actual acoustical values substantially less that those of individual components. It is essential that the detailing of floor, wall ceiling joints and penetrations be consistent with the major acoustical components selected.

2. While attenuation and absorption values for each space must be selected on an individual project basis, it is possible to generally define the acoustical factors to be accommodated in individual spaces. Four categories have been identified:

   1. Noise Generator: Equipment or people within the space create sufficient sound to disturb activities in adjacent spaces.

   2. Quiet Required: Activities within the space are such that they would be disturbed by sounds from adjacent spaces.

   3. Privacy Required: Activities within the space are such that intelligible conversation should not be heard in any other space.

   4. Absorption Required: Activities within the space are such that they would be disturbed by sounds generated within the space itself.

   Criteria for the selection of attenuation and absorption characteristics for rooms in the hospital will vary from project to project. Program variables such as the selection of a particular item of equipment in a utility room or the use of pillow speakers in patient rooms will substantially affect acoustical requirements. Background (ambient) noise generated from external sources such as an adjacent freeway or internal sources such as the mechanical ventilation system will help to mask the intelligibility of sounds and may modify acoustical requirements.

Table 510-6 is a sample list of spaces, which fall into one or more of the above categories. It has been selected to represent almost all activities occurring within the hospital.

3. Table 510-7 indicates a generalized set of STC sound resistance performance criteria for nursing unit spaces, which have been developed from a detailed study of needs and requirements. These should be modified for individual projects to accommodate the variables mentioned above.

513.5.3 Lighting Requirements

1. Natural Lighting Requirements

   See Section 513.3.3

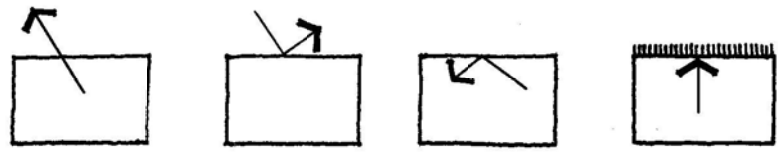
2. Artificial Lighting Requirements

   The building system should be capable of accommodating all types of lighting systems commonly found in hospitals.

   Although lighting is not apt to be a major determinant of the building system, accommodation for various lighting components must be considered. A careful review of activity requirements indicates that surface mounting of fixtures is acceptable for a large majority of spaces. In rare instances, however, recessed lighting may be desired. For example, areas where the patterns of air movement are critical and might be disrupted by projecting ceiling mounted lights, e.g., in surgery or a laminar flow room. Also, in areas where cleanability is a major and difficult task, such as the kitchen, recessed lights may minimize maintenance chores.

   Variation in lighting levels and fixture location are more ranging in non-nursing areas, than in nursing areas. An operating room lighting layout, for example, must be carefully designed to ensure a shadow-free pattern. This may necessitate fixtures both parallel and perpendicular to the secondary ceiling support system. In addition to general illumination, ceilings and partitions must accommodate a wide variety of special fixture types. Examples include surgical lights, examination lights, positioning lights in radiation therapy areas, dark room lights, etc.

Table 510-4. ACOUSTICAL REQUIREMENTS



Room Name or Type	Noise Generator	Quiet Required	Privacy Required	Absorption Required
Mechanical Room	X			X
Rooms with Pneumatic Tube Stations	X			X
Shop	X			X
Kitchen	X			X
Conveyor Dispatch Rm.	X			X
Rooms with heavy motors (walk in refrigerator, etc.)	X			
Supply Processing Work Room	X			X
Storage	X			X
Clerical Office	X			X
Administrative Office		X	X	
Physician's Office		X	X	
Clinical Laboratory	X			X
Research Laboratory	X			X
Animal Holding Area	X	X	X	X
Operating Room		X	X	
X-Ray Room		X	X	
Audiometric Testing Rm.		X	X	X
Group Therapy Room	X	X	X	X
EEG Room		X		
Therapy Pool	X			X
Dental Clinic		X	X	
Exam. & Treatment Rm.		X	X	
Corridor Inpatient Area	X			X
Other Corridors	X			X
Waiting Area	X			X
Conference & Meeting Rm.	X	X	X	X
Dining Area				X
Retail Store				X
Library		X		X
Chapel		X		X
Patient Bedroom	X	X	X	X
Patient Toilet	X			
Nursing Station	X		X	X
Day Room	X			X
Intensive Care Unit		X	X	X

Table 510-5. SOUND TRANSMISSION RESISTANCE BETWEEN NURSING UNIT SPACES, STC.

	Patient bedroom	Nurses station	Toilet	Bathroom	Utility room	Dayroom	Doctors office	Conference room	Visitors waiting	Corridor	Mechanical room	Treatment room	Kitchen	Aides closet	Laboratory	Storage
Patient bedroom	45															
Nurses station	40	0														
Toilet	45	35	35													
Bathroom	45	35	35	35												
Utility room	45	35	35	35	0											
Dayroom	55	40	40	40	40	45										
Doctors office	40	45	50	50	40	45	40									
Conference room	45	50	45	50	50	40	50	45								
Visitors waiting	40	40	45	40	35	35	50	45	0							
Corridor	40	35	35	35	35	35	50	45	0	45						
Mechanical room	55	55	50	50	40	45	55	55	50	50	0					
Treatment room	35	45	45	45	45	45	50	45	45	45	50	45				
Kitchen	35	40	40	40	0	40	50	40	40	40	45	40	0			
Aides closet	40	40	35	35	0	35	40	40	40	35	40	35	0	0		
Laboratory	40	40	40	40	35	40	45	45	40	35	45	40	35	40	35	
Storage	40	40	40	40	35	35	40	40	35	35	0	40	0	0	0	

Reference: Hill - Burton
and BSD/SMP

513.5.4 Requirements for Finishes

1. The building system should accommodate those floor, wall, and ceiling finishes commonly found in hospitals.

   Where acceptable performance can be obtained, it is desirable to standardize materials and finishes throughout the hospital in order to simplify, and thus speed, the construction process and to facilitate later changes in room function. The standard or preferred finishes are: resilient tile flooring, painted gypsum board mounted on metal studs and acoustic tile ceilings. It is apparent that these finishes are not appropriate for tile ceilings. It is apparent that these finishes are not appropriate for certain hospital functions. The following discussion indicates the areas in which other materials should be considered.

2. Required Floor Finishes

   The preferred floor finish is resilient tile. However, resilient tile flooring applied to a concrete slab is generally considered inappropriate where heavy loads, frequent wetting, stringent asepsis, high acoustical absorption or particular visual effects desired. In addition, it is often omitted in areas where its features of cleanability and appearance cannot be justified for reasons of costs. In some instances resilient sheet material may be preferred to resilient tiles. However, if the flooring is applied after the installation of partitions, sheet-flooring cost will be considerably more than tile. In addition, patching of sheet flooring is somewhat more difficult. Areas where other flooring materials should be considered include:

FUNCTIONAL REQUIREMENT	FLOOR	BASE
Heavy Loads, Wet (Example: kitchen)	Quarry tile or industrial flooring	Integral, same as floor
Heavy Loads, Dry (Example: general stores)	Hardened concrete or industrial flooring	Resilient
Aseptic (Example: surgery)	Sheet resilient	Integral, same as floor
Frequently Wet (Example: patients' shower room)	Ceramic tile or sheet resilient	Integral, same as floor
Conductive (Example: surgery)	Conductive Sheet resilient	Integral, same as floor
Acoustical Absorption (Example: meeting room)	Carpet	Resilient
Special appearance (Example: lobby)	Carpet	Resilient or same as floor

3. Required Wall Finishes

   Selection of wall materials should be based on speed of installation, ease of removal and reusability as well as functional performance. The preferred wall, gypsum board with a panted finish, has acceptable installation and removal characteristics and provides satisfactory performance for most hospital functions. In addition, this wall can be upgraded in performance either initially or at a later date by replacing the gypsum board surface and applying ceramic tile or special coatings. Functions for which other than paint on gypsum board may be appropriate include:

FUNCTIONAL REQUIREMENT	**MATERIAL**
Continuously Moist (Example: dishwashing area)	Ceramic tile on plaster
Frequently Moist (Example: patient bath or shower room)	Thin set ceramic tile on waterproof gypsum board
Aseptic (Example: surgery)	Special coatings
High Noise Absorption (Example: boiler plant)	Acoustically absorbent material on concrete block
High Impact (Example: engineering shops)	Concrete block with appropriate finish
Lead Shielded, Above Normal Thickness (Example: x-ray therapy)	Paint on plaster

4. Required Ceiling Finishes

Ceiling finishes may be restricted to relatively few materials. Acoustical tile is preferred and is acceptable for most hospital functions. A cleanable (plastic film) tile should be selected for all applications if budget permits. Functions which require other than acoustical tile include:

FUNCTIONAL REQUIREMENTS	MATERIAL
Aseptic (Example: surgery)	Painted gypsum board on plaster
Frequently Moist (Example: wheel chair shower)	Painted plaster
High Cleanability (Example: kitchen)	Vinyl coated acoustic or metal pan
High Noise Absorption (Example: boiler plant)	Special acoustical material
Continuously Moist (Example: cart wash area)	Paint on plaster
Lead Shielded, Above Normal Thicknesses (Example: x-ray therapy)	Paint on plaster
Minimum Acoustical Need (Example: general storage)	Exposed structure or gypsum board

513.5.5 Asepsis Requirements

1. A reasonably aseptic environment should be maintained in all areas frequented by patients and in work areas used by staff having contact with patients or preparing material for delivery to patient areas. Additional controls must be exercised in areas frequented by patients with infectious diseases (isolation) or those with a decreased level of resistance to infection (reverse isolation).

2. In order to maintain an acceptable level of asepsis, certain conditions or activities should occur. These include:

    a. Pathogenic control of ventilation through a program of periodic inspection and replacement (or cleaning) of air filters plus periodic germicidal cleaning of duct work and terminals.

    b. The organization of service systems or equipment to minimize entry by maintenance personnel into the patient environment and particularly to avoid the opening of concealed spaces which may harbor uncontrolled pathogenic colonies, for example, the removal of a “lay-in” ceiling tile in a patient’s room to reach a valve or change a filter.

513.5.6 Maintenance Requirements

1. Where possible, compatible surfaces should be selected for all nursing units. Alterations of a minor nature should not create excessive dust or other potential housekeeping problems. Surface materials should be replaceable with an ability to match seams, textures and colors throughout the building's life span.

   The selection of floor, wall and ceiling materials has an important affect on building management cost as well as on the ability to obtain an appropriate environment. Change of surface materials may require different cleaning compounds, equipment or techniques.

2. Routine equipment servicing should not interfere with ongoing activities and disruption caused by emergency repairs should be minimized.

   Methods of reducing equipment down-time and the extent and nature of the activities affected by individual items of equipment are important considerations in achieving the stated objective. Maintenance needs and building adaptability are closely interrelated as the following examples illustrate:

   1. Adequate work space provided to allow for future change will also facilitate routine and emergency maintenance.

   2. An ability to replace major equipment items is necessary for proper building performance and efficient maintenance and, in addition, it will provide for future upgrading to meet changing requirements.

   3. Service distribution networks may be partially redundant to minimize activities affected by repairs. Redundancy also facilitates alteration and extension of services.

   4. Repairs or minor alterations must not be made in a way which will reduce the capability for future change. A system discipline, once established, must be respected by maintenance personnel as well as independent contractors.

513.6 FIRE SAFETY REQUIREMENTS

The building system should meet the following basic requirements:

1. Early detection of smoke and fire.

2. Containment of smoke and fire with minimum disruption of other patient care activities.

3. Rapid evacuation of threatened areas with minimum disturbance to patients.

4. Maximum safety for patients and staff plus reasonable protection of property consistent with cost effective criteria.

5. Protection of fire fighting personnel and facilitation of suppression activities.

513.7 UTILITY SERVICE REQUIREMENTS

513.7.1 Plumbing Distribution Requirements

All hospital activities have been reviewed to determine the types of plumbing distribution required for each. These requirements are illustrated in Table 510-8.

513.7.2 Electrical Distribution Requirements

The electrical distribution subsystem should meet the requirements for:

1. the types of service delivered to each functional unit and

2. the generalized power requirements for functional units by system type. These requirements are illustrated in Table 510-9.

Table 510-6. PLUMBING DISTRIBUTION REQUIREMENTS

	Soil	Normal Waste	Acid Waste	Radioactive Waste	Vent	Water Supply	Gas	Steam	Hot Water	Distilled Water	Deionized Water	Compressed Air	Vacuum	Oxygen	Medical Air	Nitrous Oxide
Auditorium	X	X			X	X			X							
Canteen	X	X			X	X	X		X							
Central Service	X	X			X	X		X	X	X	X				X	
Clinics	X	X			X	X			X				X	X	X	
Dental Service	X	X			X	X	X		X				X	X	X	X
Dietetic-Dining	X	X			X	X	X	X	X							
Dietetic-Kitchen	X	X			X	X	X	X	X							
ECG Lab	X	X			X	X			X					X		
EEG Lab	X	X			X	X			X							
Hemodialysis Unit	X	X			X	X			X	X			X	X	X	
Inhalation Therapy	X	X			X	X			X					X	X	
Laundry	X	X			X	X			X			X				
Library Service	X	X			X	X			X							
Lobby	X	X			X	X			X							
Medical Illustration	X	X	X		X	X			X							
Nuclear Medicine	X	X		X	X	X	X		X					X		
Lockers, Lounges, Toilets & Showers	X	X			X	X			X							

Table 510-6. PLUMBING DISTRIBUTION REQUIREMENTS (Continued)

	Soil	Normal Waste	Acid Waste	Radioactive Waste	Vent	Water Supply	Gas	Steam	Hot Water	Distilled Water	Deionized Water	Compressed Air	Vacuum	Oxygen	Medical Air	Nitrous Oxide
Nursing Units	X	X			X	X			X				X	X	X	
Office Functions	X	X			X	X			X							
Pathology Clinical Lab	X	X	X		X	X	X	X	X	X	X		X	X	X	
Pathology Morgue	X	X			X	X	X		X	X	X	X				
Pharmacy	X	X			X	X			X	X	X	X			X	
PM & R	X	X			X	X			X							
Pulmonary Function	X	X			X	X			X					X	X	
Radiology	X	X			X	X			X					X		
Recovery	X	X			X	X			X				X	X	X	
Research Labs	X	X			X	X	X	X	X	X	X	X	X	X	X	
Residents' Quarters	X	X			X	X			X							
Storage	X	X			X	X			X							
Surgical Service	X	X			X	X		X	X				X	X	X	X
Workshops	X	X			X	X			X			X				
Mech. Equip. (HVC)	X	X			X	X		X	X							

Table 510-7. ELECTRICAL POWER DISTRIBUTION REQUIREMENTS

	Power (Watts Per Sq. Ft.)			
	480/277V		208/120V	
	Lighting	Other	Lighting	Other
Auditorium	0.5	-	9	8
Canteen	2.4	14	0	6
Central Service	2.4	0.5	0	4
Clinics	2.4	0	0	4
Dental Service	2.4	0	0	4
Dietetic –Dining	2.4	0	0	2
Dietetic-Kitchen	2.4	24	0	5.8
ECG Laboratory	2.4	0	0	4
EEG Laboratory	2.4	0	0	4
Hemodialysis Unit	2.4	0	0	5.0
Inhalation Therapy	2.4	0	0	4
Laundry	2	30	0	0.5
Library Service	2.4	0	0	0.5
Lobby	1.0	0	0	0.3
Lockers, Lounges, Toilets & Showers	1.5	0	0	0.4
Medical Illustration	2.0	0	0	4
Nuclear Medicine	1.5	0	0	6.0
Nursing Units	1.5	0	1.3	2.0
Office Functions	3.2	0	0	3.0
Pathology--Clinical Lab	3.0	2.3	0	8.0
Pathology--Morgue	3.0	1.0	0	1.5
Pharmacy	3.0	0	0	0.5
PM&R	3.0	0	0	5.2
Pulmonary Function	3.0	0	0	4.5
Radiology	0.5	3.1	2	17
Recovery	1.5	0	0	4
Research Labs	3.0	2.8	0	7.6
Residents' Quarters	1.0	0	0	1.0
Storage	1.0	0	0	0.5
Surgical Service	10.0	0	5	5
Workshops	2.0	0.5	0	5.0
Circulation Areas	1.5	0	0	0.5
Mech Equip. (HVC)	-	10.2	-	-

513.8 MISCELLANEOUS REQUIREMENTS

513.8.1 Vertical Load Requirements

The building system should meet the following vertical load requirements:

1. VA standards generally are in accordance with the National Building Code, with the exception of a projection booth area, which requires a 200 psf loading.

   The nursing areas require a uniform live load of 75 psf.

2. An investigation of high, concentrated loads in non-nursing areas has indicated that areas other than those listed in the NBC may require special consideration. An example list includes:

Area	Total Dead Load
a. Radiology:	
Cobalt 80 Teletherapy unit	13,750#
Topographic table	3,190#
X-ray table	600#
b. Physical Therapy:	
Hubbard Tank	4,130#
Therapy Pool	30,000# or more
c. Central Processing and Distribution:	
Automatic Cart Washer	5,800#
Sterilizer	4,600#
d. Office:	
Electric File	4,900#
e. Kitchen:	
Dishwasher	5,000#
Baking Oven	13,700#
Cooking Oven	11,000#
f. Laundry:	
Flat work ironer	47,500#
g. Diagnostic Area:	
Audiometric Room (9’ x 16’)	12,000#

513.8.2 Attachment Requirements

The following items may be attached to a partition, a ceiling or to the structural slab:

Items	Example Loading
1. Moving radiographic tube hanger	750#
2. Moving laundry bag conveyor	400#
3. Moving patient hoist	300#
4. Lead lined 4’-0”	1,200#
5. Image Intensifier	185#
6. Lead shielding	32 psf
7. X-ray Transformer	185#
8. 10-gal. distilled water carboy	630#
9. Exhaust hood in kitchen	4,000#
10. Surgical gas column	350#
11. Orthopedic hook	300#
12. Surgical light	3,600#
13. X-ray shielding	32 psf max.
14. Grab bars	200#

513.8.3 Floor Slab Depression Requirements

An example list of requirements in excess of 3" includes:

Item(s)	Depression
1. Prefabricated rooms including: audiometric, freezers and refrigerators, R.F. shielded, clean, and environmental control rooms	4" - 8"
2. Recess for cobalt machine.	10"
3. Recess for hydrotherapy tank.	37"
4. Recess for drainage in kitchen and laundry.	6" - 8"
5. Recess for automatic cart washer.	10" - 12"
6. Therapy pool.	66" - 108"
7. X-ray raceway system.	6" - 8"

513.8.4 Other Requirements

The following items in the VA standards or construction details have been identified as potential "misfits" or areas for consideration during the development of the prototype design:

1. Furred space above built in refrigerators required to extend to structural slab above.
2. Floors of built-in freezers and refrigerators required to be flush with adjacent floor in new construction.
3. Concrete slab topping, where used, is required to be 1-1/2".
4. Equipment required to be recessed in partitions:

   Drinking fountains

   Soap holder

   Razor blade receptacle

   Cassette transfer cabinet

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520 DETAILED NEEDS AND REQUIREMENTS: NURSING UNITS

521 INTRODUCTION

The following are detailed needs and requirements for nursing units occurring in VA hospitals. This information is based on extensive interviews with the VA personnel at field stations and in the Central Office, considerable field observation and survey of relevant literature.

It is recommended that detailed needs and requirements be developed for all other areas of the hospitals to ensure a comprehensive understanding of the functioning of each unit by VA's A/E contractors as well as by all components of the VA itself. Such a document if adequately prepared and frequently updated would offer a significant benefit to the VA in obtaining desired performance in their buildings.

522 GENERAL NURSING UNIT

522.1 User Needs

General nursing units, including medical, surgical, orthopedic and neurological units, serve the largest number of patients in the hospital. Each of these units has certain special requirements; however, their basic needs are similar.

522.1.1 Objectives

General nursing units have the common aim of stabilizing the patient's condition to prevent further disability and restoring his physical functions and ability to care for himself.

522.1.2 Operational Relationships

The relationship between general nursing units and other functional units may be defined in part in terms of movement systems. Movement patterns, particularly with respect to material movement vary considerably with different operational patterns, physical facilities and transport systems.

Generally the factors affecting relationships include the following: frequency of movement, urgency of movement (as in a patient's critical life state) and condition of movement (patient on stretcher or linen on a large cart).

Table 520-1 on the following page indicates, in general, the relationships affecting the general nursing unit. Relationships with high frequency urgent need or a controlling condition of movement are indicated. In addition Figure 520-1 depicts the volume of nursing staff traffic between various of the nursing unit.

522.1.3 Characteristics

1. Environment

   The general nursing unit consists of the following environmental zones.

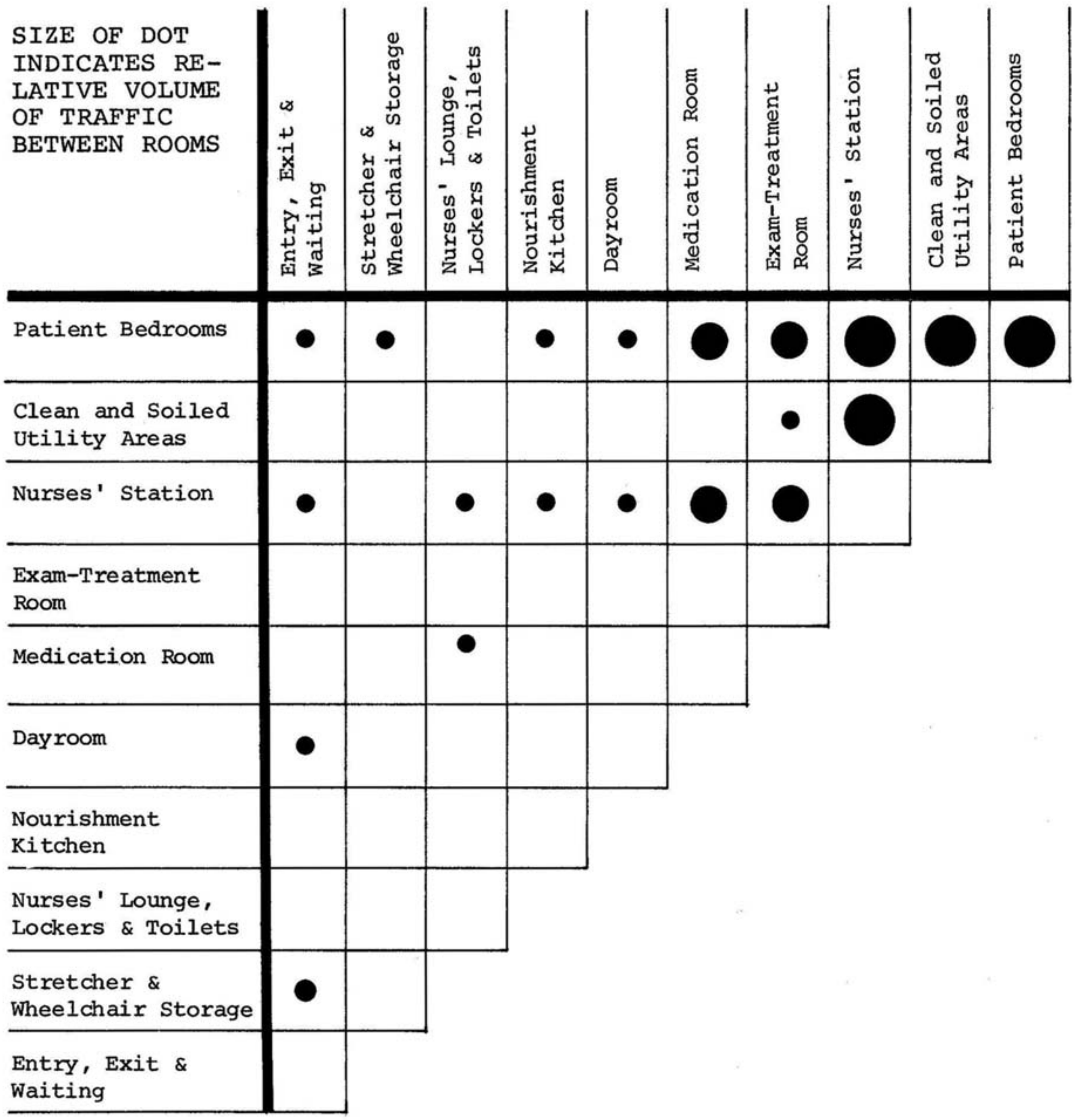
   a. Patient room. This area must accommodate a wide range of medical and social activities including: many diagnostic and treatment procedures, sleeping at any time of the day or night, eating, talking, to visitors, other patients, or the physician, listening to the radio, watching television, etc.

Table 520-1. MOVEMENT FACTORS: GENERAL NURSING UNIT

	Persons: Non-ambulant patient (stretcher)	Ambulant and wheelchair patient	Physician	Nurse	Technician, etc.	Students	Visitors	Material	Food	Drugs	Specimens	Supplies	Records
Cardio/Pulmon.	C	M	M		M	M							
Diag. Radio.	F C	F	M		M	M							
EEG/EMG	U C	M	M		M	M							
EKG	U C	M	M		M	M							
ICU Units	U C		F			F							
Inhal. Ther.		F			M								
Nuclear Med.	C	M											
Occup. Ther.		F			M								
Other D&T	C	M	M		M	M							
Other Nurs.Units	F C	F	F		F	F							F
Outpatient Clinic		F	F			F							
Phys. Ther.	C	F			M								
Rad. Ther.	C	M											
Surgery	C		M			M							
Admin.			M				F						F
Canteen		F	F	F		F	F						
Dietary					F				F C				
Recreation, Etc.		F											
Supply & Process												F C	
Cent.Teach.Facil.			F	F		F							
Laboratory					F						F C U		
Pharmacy					M					F			
Research			M			M							

F - High frequency
U - High urgency
C - Special Condition Factor
M - Some movement

Figure 520-1. GENERAL NURSING UNIT: NURSING STAFF TRAFFIC PATTERNS



This information has been abstracted from John B. Thompson and R.J. Pelletier, “Yale Studies of Hospital Function and Design” (New Haven, Conn.: Yale University, Department of Public Health, 1959)

Patients may bathe and use portable toilet facilities in their rooms. The environment must encourage the patient to maintain a sense of personal dignity while providing optimum conditions for medical diagnosis and treatment.

b. Corridor. Circulation areas on these units are heavily used both by staff and visitors. In addition they are used for distribution of carts and wheeled equipment. Noisy or unnecessary traffic should be minimized. The environment should serve to reduce the sound transmitted to patient rooms and staff work areas. This is particularly important in the evening and night hours. Many conversations of an important or confidential nature occur in corridors. They should not be overheard by patients or staff. Finally, nurses and other personnel spend considerable time in corridors so an interesting and non-institutional character is desirable for this area. Excessive length should be avoided and natural light introduced where possible.

c. Staff support area. The staff support zone must have a variety of environments appropriated to each activity. Activities include clerical work, conferences, informal discussions, and preparation of drugs, dressing, etc., storage and cleaning of utensils and equipment.

2. Organization

The general nursing unit requires a high level of efficiency for routine task plus the ability to observe and treat those patients who are or become seriously ill. Efficiency implies primarily the use of skilled paramedical and medical personnel in an optimum way. For example, nurse/patient contact hours should be increased, while time devoted to walking or clerical work is minimized.

The work load on any nursing unit may vary considerably from day to day depending upon the number of patients assigned to the unit and the required level of nursing care. There is also a variation in the work load throughout the course of a day; the highest level of activity occurring during the daylight hours, diminishing activity during the evening, and the lowest level at night. It may be desirable to allow for adjustment in staffing patterns and in the assignment of beds to a particular nursing unit or nursing station to accommodate these variations in work load.

Many of the patients treated in these units are or have been severely ill and may be in danger of rapid and unpredictable changes in condition. The unit personnel should be able to detect and rapidly respond to these changes.

This requires that supplies, equipment, and staff be available to cope with such emergencies; and it may also require routine monitoring or observation of a wide range of physiological indicators of patient condition. These include the "vital signs", but may also include such general indicators as skin color, nervousness, breathing difficulties, response to medications, tendencies to sleep too much or too little, etc. Adequate awareness of these indicators may require constant or frequent observation of patients by the nursing staff.

Figure 520-2 indicates four alternatives for general nursing unit organization.

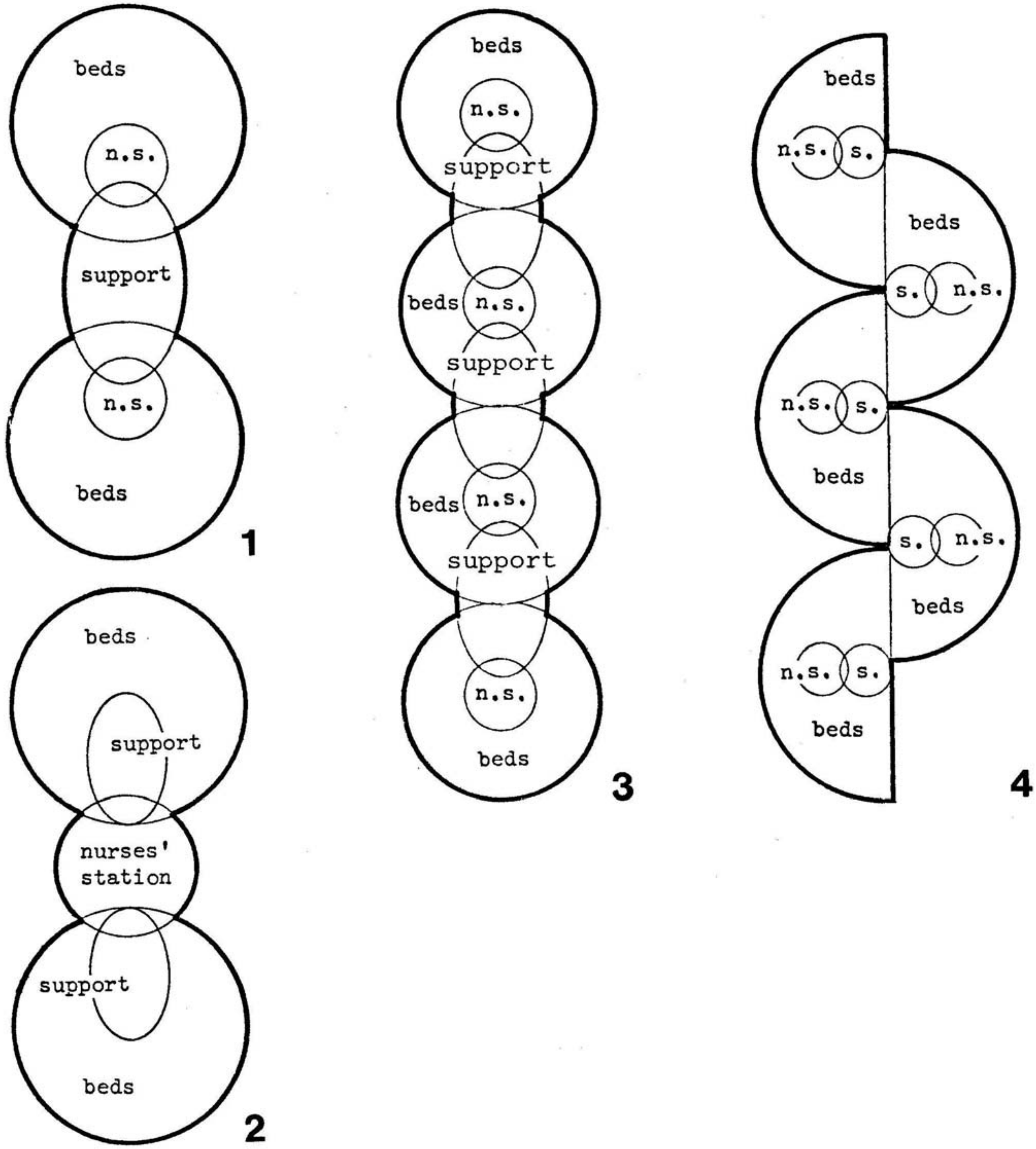
522.1.4 Primary Users

1. Patients

   General nursing units provide accommodation and nursing care to patients with a broad range of conditions from serious illness to minor disability. Patients may be confined to bed, semi -ambulant, i.e. in wheelchairs or on crutches, or ambulant. Their need for nursing assistance varies with the intensity of illness.

   Patients may require sleep or rest at any time of the day or night without disturbance from the activities of other patients, nurses or other staff. They may require physical isolation from other patients for medical or psychological reasons. Their movement within or out of the units may be limited due to requirements for examinations, specimen collection, routine nursing task, physicians' rounds, etc. They should be able to quickly and easily call a nurse if they need care or assistance.

Figure 520-2. GENERAL NURSING UNITS: ORGANIZATION OPTIONS



Nursing assistance may be required for eating, dressing, hygiene, and toileting functions; however, where possible, potential for self help in these activities should be maximized. Patients should be encouraged to use beside commodes or standard toilet facilities, dress and feed themselves, and take care of their personal hygiene requirements. They may also be encouraged to get out of bed and move about the unit.

Patients may require care and assistance in reinforcing and maintaining positive psychological as well as physical condition. They should be able to freely discuss problems with social workers and psychologists well as with unit staff and visitors. They should be able to utilize recreational and diversional facilities, e.g. T.V., radio, games, reading material, and to socialize with other patients to avoid boredom or excessive introspection. However, they should be able to have an appropriate degree of seclusion or privacy. They should be aware of the availability of nursing care and assistance and of their ability to call upon the staff in times of need.

The transportation of certain patients to diagnostic/treatment facilities or the need to transfer a patient from bed to a stretcher for transportation may be harmful to certain patients and should be minimized where possible for these patients. Examples include: a stroke patient who should avoid the jostling of transfer and the bump when entering an elevator, a patient who must abandon the protection of physiological monitoring during transfer or, an orthopedic patient in traction who must be “unstrung” for stretcher transfer.

Some patients on general nursing units may have infectious conditions or be particularly susceptible to infection and require isolation from the rest of the patients on these units.

Most patients currently accommodated on general nursing units are male; however, a small but increasing percentage of females receive care on these units.

Length of patient stay in a V.A. hospital is currently averaging approximately 18 days. Orthopedic and neurological patients may remain in a general nursing unit six weeks or more.

2. Physicians

Specialists assume responsibility for diagnosis and treatment of some of the patients on general nursing units. Their activities involve visiting patients on rounds, conducting examinations, administering treatment, prescribing medications, ordering special diagnostic studies or treatment programs, referring to or making entries in the patient record, and consultation with other specialists, residents, interns and nursing staff. They may also conduct teaching rounds and individual or group instruction of medical students on the unit.

In addition to their activities on these units the physicians may have numerous responsibilities that involve them in other areas of the hospital. For example, they provide consultative services in other areas, work in outpatient clinics, and are involved in hospital staff activities. The surgical specialists spend a great deal of their time in surgery.

Physicians in certain specialties, neurology for example, must supervise diagnostic procedures for both in and out patients. Where such procedures require extensive equipment, contiguous in and out patient facilities may be desirable.

3. Residents and Interns

Residents and interns assume responsibility for the diagnosis and treatment of most patients. Their activities in this respect are similar to those of specialist; however, they are involved with more patients on the unit and spend a greater amount of time on the unit.

They should be able to consult with specialists, other residents and interns, and the nursing staff as needed.

They accompany specialists on routine or teaching rounds, and may supervise and instruct medical students in their activities on the unit. The residents may also be involved in research or study activities while on the unit.

4. Nursing Staff

The nursing staff is charged with providing the broad range of nursing care necessary to serve patients and stabilize and improve their conditions.

Activities on the unit related to nursing are supervised by a head nurse. The head nurse plans and evaluates patient services, schedules and supervises nursing activities, records and reports on nursing care and patient condition, and provides direct care for patients. She should also be aware of the condition of all patients of the unit. She may, therefore, accompany attending physicians, residents, and interns on rounds or make rounds independently or with other members of the nursing staff.

The nursing staff administers various aspects of treatment programs as directed by attending physicians, residents and interns, e.g. preparing and administering medications, applying dressings, giving enemas, etc. and assisting with more complex diagnostic or therapeutic procedures. They observe and measure physiological indicators of the patient's condition. They provide necessary supportive care and assistance to patients and supervise or control patient activities to insure conformance to therapeutic or diagnostic requirements.

In conjunction with these activities the nursing staff will need to make notes or entries on the patients' charts; however, their involvement with general clerical activities should be minimized.

The nursing staff may arrive on the unit in uniform. Purses, overcoats, etc., must be kept secure while they are on duty. Locker facilities are desirable on or close to the unit for the storage of such personal articles or for changing uniforms in certain instances.

The unit staff will take work breaks while on duty. During these breaks they should be able to rest and relax away from normal unit activities. Lounge facilities on or adjacent to the unit will minimize circulation time and permit emergency calls for staff assistance during work breaks.

Toilets for the use of the nursing staff should be available on the unit.

Frequent nursing staff conference are necessary on the unit to transfer information regarding patient condition and treatment schedules from one nursing shift to another and for continuing education of nurses during duty hours.

5. Medical Students

   Medical students will do much of the routine patient diagnostic work, e.g. patient histories, physical examinations, routine laboratory determinations, and may assist physicians, residents, and interns with more complex diagnostic or therapeutic procedures. They will accompany physicians during teaching rounds and may also attend routine rounds with residents and interns. They will participate in group and individual discussions or instruction sessions and may be involved in individual study on the unit.

6. Nursing Students

   Nursing students participate in patient care activities as well as receive instruction on the general nursing unit. They will carry out routine nursing care activities, e.g. administering medication, measuring “vital signs”, collecting samples, etc. and will observe and assist nurses, physicians, residents, and interns with more complex procedures. They may also accompany physicians and nurses on patient rounds.

   Nursing students may receive classroom instruction and participate in group discussions conducted by nursing instructors in conjunction with their work on these units.

7. Ward Clerk

   The ward clerk is responsible for most clerical work, e.g. processing request and order forms, routine charting, preparing schedules, typing memoranda and letters, processing telephone calls, processing admission or disposition records, maintaining personnel records, processing mail, etc. She will also act as the unit receptionist and may run essential errands for physicians or nursing staff.

8. Social Work

   A social worker will be available for consultation with patients and their families. This person should be aware of the functions of the unit and will assume the position of a recognized member of the unit staff. Generally, however, the social worker will not be needed full time on any one unit.

9. Psychology

   A psychologist may administer psychological tests to non-ambulant patients on the unit to determine psychological factors inhibiting the recovery process or a need for vocational rehabilitation.

   Ambulant patients will normally go to central facilities for counseling therapy or vocational assistance.

10. Clinical Laboratory

    Laboratory personnel will come to each unit for collection of specimens.

11. Radiology

    X-ray technicians will come to each unit to make exposures with portable equipment.

12. Maintenance

    See 512.2.

13. Building Management

    See 512.3.

14. Dietary

    Dietary personnel will deliver meals to the patients and collect soiled trays and utensils.

15. Volunteers

The voluntary service provides non-professional nursing and administrative assistance. Volunteers will be involved on all general nursing units.

16. Visitors

Visiting hours on general nursing units are established at each hospital according to local requirements or policies.

Visitors should not disrupt normal operation of the unit. For this reason, their activities should be subject to some degree of control by administrative and nursing personnel. They should be received onto the unit and directed or conducted to the patient's bedside or to visiting spaces. Their access to administrative, nursing and support areas should be restricted. Circulation of visitors through the unit or conversations with patients should not disturb other patients.

Visitors should have access to toilet facilities and drinking fountains while on the unit.

522.1.5 Trends

1. Unionization

There is a trend throughout the country toward unionization of nursing personnel. As unions gain bargaining power their demands will be felt throughout the health care field. This may have a significant effect on the staffing patterns in VA hospitals.

Unions are demanding an increase in the staff/patient ratio. This may bring about an increase in the number of nurses and nursing teams required to cover the general nursing units in VA hospitals, for example, a 40-bed unit now staffed with two teams may require three or four teams in the future. Increased staffing ratios will, in turn, result in a need to reorganize nursing unit facilities to achieve greater efficiency.

2. Patterns of Care

   The ratio of patients that may appropriately be cared for on general nursing units may decrease in the future while the percentage of intensive care patients may increase due to increased ability to preserve life and to conduct complex surgical procedures. The percentage of self care or home care patients may increase as such programs are expanded in the Veterans Administration.

3. Relation to the Community

   The Veterans Administration may play an increasing role in community health care. Therefore, there may be a demand to care for children and increasing numbers of women on general nursing units in VA hospitals.

4. Technology

   The use of physiological monitoring equipment, computers and other sophisticated equipment on nursing units will undoubtedly increase in the future.

522.2 FUNCTIONAL REQUIREMENTS

Patient condition, length of stay, treatment procedures and supportive activities vary appreciably on each of the general nursing unit types: medical, surgical, neurological and orthopedic. In order to achieve flexibility in “floating” patients from one unit to another as bed demand varies and interchangeability of nursing staff with a minimum of disorientation, it is desirable to standardize, to the extent possible, the plan arrangement and space allocations for all unit types.

522.2.1 Functional Relationships

Two general philosophies currently prevail: 1) general nursing units should be separated from intensive care areas in order that I.C.U. ‘s and specialized diagnostic and treatment units may be closely clustered to maximize use of special equipment and technical staff, and 2) general nursing units grouped with intensive care units of the same specialty to allow continuity of patient care. Both options are considered to have merit.

Theoretically, a plan solution could provide both relationships.

1. Medical Service

   It is desirable to establish a horizontal relationship with:

   a. other medical units;

   b. medical intensive care units;

   c. cardiac care units;

   d. diagnostic/ treatment units such as gastroenterology;

   e. outpatient clinics.

2. Surgical Service

   Desirable horizontal relationships include:

   a. other surgical units;

   b. surgical intensive care units;

   c. surgical recovery units and;

   d. outpatient unit.

3. Orthopedic Unit

   Desirable horizontal relationships include:

   a. other surgical units;

   b. surgical recovery unit;

   c. radiographic unit;

   d. cast room and;

   e. outpatient unit.

4. Neurology Unit

   Desirable horizontal relationships include:

a. other neurosurgery units;

b. diagnostic/treatment facilities such as EEG, EMG and a visual field room;

c. outpatient clinics and;

d. physical therapy facilities.

522.2.2 Space Requirements

1. Patient Bedroom

Most diagnosis, treatment and supportive care occurs in the patient bedroom. Facilities required for this may include: oxygen, vacuum, compressed air, electrical power, nurse call systems, electrical isolation systems and physiological monitoring.

Adequate space should be available at the patient beside to accommodate routine diagnostic and treatment equipment and procedures, e.g. I.V. infusions, orthopedic attachments, portable X-ray exposures, etc. This space should also be sufficient to allow for the equipment and personnel required for emergency treatments. Hand washing facilities should be available for the use of staff.

The patient bedrooms must accommodate the wide range of personal and social activities indicated previously. The necessary privacy, space, lighting, and facilities for these activities should be provided.

Single-bedrooms should be available on general nursing units for those patients who require separation from others, e.g. infectious, terminal, disturbed, or offensive patients. In addition, patients who are severely ill benefit from the privacy of an individual room. Therefore, the single-bed rooms should be easily accessible and observable from the nurses' station. Separate toilet and shower facilities are desirable with each of these single-bedrooms; however, such facilities are mandatory only in isolation rooms.

Many of the patients on general nursing units may be adequately accommodated in multi-bedrooms. These rooms should provide some degree of privacy for each of the patients and the total number of patients in each room should generally not exceed four.

One security bedroom may be required on the neurology unit.

It is desirable to provide separate toilet facilities with each patient bedroom to facilitate patient self help and to allow for greater flexibility in room assignment; however, central patient toilets may be acceptable in some cases. Facilities usable by wheelchair patients must be available on each unit. It is desirable, in orthopedic and neurological units, to allow for a high percentage wheelchair use.

2. Patient Bathing Facilities

Central shower and bathing facilities may be provided on general nursing care units; however, isolation spaces and some additional patient rooms for use by female patients should be provided with individual showers. In the future it may be necessary to provide showers with a greater number of patient rooms in order to accommodate an increasing number of female patients. In some instances, bath tubs may be provided in lieu of showers.

Shower facilities adjacent to each patient room will facilitate patient self help and may increase his psychological sense of independence and dignity and thus prepare him for discharge to a home environment.

3. Dayroom

A dayroom for the use of patients and their visitors should be located on or adjacent to each unit. This space should facilitate activities such as watching T.V., reading, playing games, and conversation.

4. Nurses' Station

The nurses' station is located to allow convenient observation and control of unit entrances and exits and of all patient occupied spaces. These may include dayrooms as well as patient bedrooms and circulation spaces. Observation of and proximity to rooms containing seriously ill patients (generally single-bed rooms) is desirable.

Visual and acoustic privacy should be provided for a ward clerk who is normally located within or adjacent to the nurses' station. Space for nurse and physician charting functions, patient records and clerical supplies and communication and monitoring equipment should also be included in the nurses' station. Provision for future additional patient monitoring or communication equipment and a computer terminal is desirable.

5. Examination/Treatment Room

The requirements for this space vary somewhat between medical, surgical, neurological and orthopedic nursing units.

a. Medical and neurological units. In these units the exam/treatment room is primarily used for examinations rather than treatment. It should be equipped with an examination table, a portable examination light, a sink for hand-washing, countertop work space, and facilities for equipment storage and x-ray viewing. Neurology requires sufficient room to allow work space on four sides of a stretcher. The room must be capable of being darkened.

b. Surgical units. The requirements of an exam/treatment room in surgical nursing units are similar to those in medical units except that the room is used more frequently for treatment activities, e.g. dressing changes and suture removal. There may, therefore, be a greater need for supply and equipment storage and for countertop work space.

c. Orthopedic units. The exam/treatment space in orthopedic units should be equipped for application and removal of casts. This requires special sink facilities and additional supply storage. A radiographic room may also be desirable conjunction with the exam/treatment room in orthopedic units.

6. Medication Room

   A space for the storage and preparation of medications should be provided. The nature of this space should be determined by the type of medication supply and distribution system to be used. Space needs vary from a separate room with sink, countertop work space and refrigerated, locked, and open storage space, to a small area in nurses' station for a cart used for delivery and dispensing of medications. In every case, medications should be secure from patients, visitors, and unauthorized personnel.

7. Nourishment Kitchen

   A nourishment kitchen maybe required on the unit for storage and preparation of patient snacks, e.g. coffee, fruit juices, etc.

8. Support Areas

   Support areas should include: clean and soiled utility rooms, clean and soiled linen holding, a housekeeping aids closet, equipment storage, and stretcher and wheelchair storage space.

9. Employees' Lockers

   Employees' lockers and lounge space may be centralized; however, there may be staff morale and utilization benefits in locating these near the nursing units. Currently, decentralized lockers for the nursing staff appear to be particularly desirable; in the future, however, all employee lockers may be so situated.

10. Laboratory

    A small laboratory may be provided on or adjacent to each unit for doing routine determinations. This lab should be equipped with work benches, a sink, natural gas, vacuum, minimal reagent storage, and, in some cases, a fume hood.

11. Offices

    The following offices may be required on or in conjunction with general nursing units:

    a. physicians' offices;

    b. residents' and interns' offices;

    c. nurse supervisor or head nurse's office;

    d. social worker's office and;

    e. nursing instructor's office.

12. Carrels

    Study carrels may be provided for the use of medical and nursing students while they are on the unit.

13. Conference Room

    A conference room should be provided on the unit for small group meeting of 10-12 persons. This room may be used jointly for instructional seminars and, perhaps, patient demonstrations.

14. Corridors

    Corridors are frequently used for patient exercise. Neurology unit corridors should be equipped with handrails. A non-slip material should be used on the floor in all units.

15. Classroom. See 5212.2.1

523 INTENSIVE CARE UNITS

523.1 USER NEEDS

Intensive care units (I.C.U.'s) currently treat between 2% and 10% of all hospitalized patients. Units are organized around a medical specialty, (such as a medical unit or a surgical unit), or on a body systems basis (such as cardiac care or respiratory care). Many user needs for these units are similar to those of the general nursing unit. The following highlights those needs, which are characteristics of I.C.U.'s.

523.1.1 Objectives

The intensive care unit was developed to treat patients who are in a critical life state in an effective and an efficient manner.

523.1.2 Operational

The relationship between an I.C.U. unit and other hospital functional units is determined primarily by a desire to optimize patient care and to efficiently use available resources.

There are a number of major determinants affecting the location of intensive care units.

1. Intensive care units should be located such that personnel from various hospital locations can assemble at a patient's bedside in the shortest possible time. This implies a location adjacent to major vertical and horizontal circulation systems.

2. Units should be located to maximize physical continuity of care. Thus a cardiac unit located next to a medical GM & S cardiac unit would facilitate post-intensive follow-up and insure the availability of the physician in an emergency.

3. Intensive care units are often located to facilitate consultation by various specialists. Many patients in an intensive care unit will have a disability affecting more than one of the basic body systems. Thus consultation between specialists is frequent. If the intensive care unit is adjacent to units served by specialists in other disciplines, both formal consultation and informal interaction are apt to occur more frequently. The interrelation of specialty and intensive care units provides the desired proximity of medical specialists.

4. The distance patients must travel to receive diagnosis or treatment assumes more than normal importance for intensively ill patients. Often patients whose condition may change rapidly are continuously monitored. Transportation of the patient breaks this vital warning system. Patients are weak and may be susceptible to infection. Certain patients require continual rest, freedom from disturbance or emotional upset. These factors all are aggravated by transportation.

5. Intensive care units are often located to provide the most efficient utilization of shared services, equipment and in some cases staff. For example, a cardio-pulmonary laboratory adjacent to several intensive specialty units can easily be used by all. Likewise, a surgical intensive care patient with a cardiac arrest may receive better care if the cardiac unit is directly adjacent.

Tables 520-2, 520-3 and 520-4 indicate in general the movement factors affecting intensive care nursing units.

523.1.3 Characteristics

1. Environment

   The general environmental focus of the unit is to facilitate the treatment of extremely ill patients. Intensive care units usually consist of a general patient care area and staff support facilities. The latter are similar to a general nursing unit.

   To the extent possible the patient care area should resemble a general nursing unit patient room. Patient activity will be subdued; however, some patients will be fully aware of their surroundings and will eat meals, read and receive visitors. Patient apprehension should be reduced where possible.

   A common requirement of all intensive care units is the ability to recognize and respond to rapid and potentially serious changes in patient condition. This requires close, twenty-four hour, observation and care. When a sudden change in a patient’s condition requires emergency action, key members of the hospital staff may be called upon to administer emergency treatment.

Table 520-2. MOVEMENT FACTORS: MEDICAL INTENSIVE CARE UNIT

F - High frequency
U - High urgency
C - Special Condition Factor
M - Some movement

Persons	Non-ambulant patient (stretcher)	Ambulant and wheelchair patient	Physician	Nurse	Technician, etc.	Students	Visitors	Material	Food	Drugs	Specimens	Supplies	Records
Cardio/Pulmon.	C U	C	M		F	M							
Diag. Radio.	C C U	C C	M		M	M							
EEG/EMG	C	C	M		M	M							
EKG			M		M	M							
ICU Units													
Inhal. Ther.					F								
Nuclear Med.	C	C											
Occup. Ther.													
Other D&T	C U	C	M		M	M							
Other Nurs.Units	C	C	F		F	F							F
Outpatient Clinic			F			F							
Phys. Ther.					M								
Rad. Ther.	C	C											
Surgery	C U												
Admin.			M				F						F
Canteen			F	F		F	F						
Dietary					F				F C				
Recreation, Etc.													
Supply & Process												F C	
Cent.Teach.Facil.			F	F		F							
Laboratory					F						F C U		
Pharmacy					M					F			
Research			M			M							

Table 520-3. MOVEMENT FACTORS: SURGICAL INTENSIVE CARE UNIT

	Persons							Material					
	Non-ambulant patient (stretcher)	Ambulant and wheelchair patient	Physician	Nurse	Technician, etc.	Students	Visitors		Food	Drugs	Specimens	Supplies	Records
Cardio/Pulmon.	C U	C	M		F	M							
Diag. Radio.	C U	C	M		M	M							
EEG/EMG	C	C	M		M	M							
EKG			M		M	M							
ICU Units													
Inhal. Ther.					F								
Nuclear Med.	C	C											
Occup. Ther.													
Other D&T	C U	C	M		M	M							
Other Nurs.Units	C	C	F		F	F							F
Outpatient Clinic			F			F							
Phys. Ther.					M								
Rad. Ther.	C	C											
Surgery	C U		F			F							
Admin.			F M				F						F
Canteen			F	F		F	F						
Dietary					F				F C				
Recreation, Etc.													
Supply & Process												F C	
Cent.Teach.Facil.			F	F		F							
Laboratory					F						F C U		
Pharmacy					M					F			
Research			M			M							

F - High frequency
U - High urgency
C - Special Condition Factor
M - Some movement

Table 520-4. MOVEMENT FACTORS: CARDIAC INTENSIVE CARE UNIT

Persons	Non-ambulant patient (stretcher)	Ambulant and wheelchair patient	Physician	Nurse	Technician, etc.	Students	Visitors	Material	Food	Drugs	Specimens	Supplies	Records
Cardio/Pulmon.	C U	C	M		F	M							
Diag. Radio.	C U	C	M		M	M							
EEG/EMG	C	C	M		M	M							
EKG			M		M	M							
ICU Units													
Inhal. Ther.					F								
Nuclear Med.	C	C											
Occup. Ther.													
Other D&T	C U	C	M		M	M							
Other Nurs.Units	C	C	F		F	F							F
Outpatient Clinic			F			F							
Phys. Ther.					M								
Rad. Ther.	C	C											
Surgery	C U		F			F							
Admin.			M				F						F
Canteen			F	F		F	F						
Dietary					F				F C				
Recreation, Etc.													
Supply & Process												F C	
Cent.Teach.Facil.			F	F		F							
Laboratory					F						F C U		
Pharmacy					M					F			
Research			M			M							

F - High frequency
U - High urgency
C - Special Condition Factor
M - Some movement

Instant communication to these staff members, their rapid arrival on the unit, and the immediate availability of necessary supplies and equipment are all vital at such times.

As many as fifteen persons may be involved in these emergency procedures and they may need quick access to all four sides of the bed. Several pieces of equipment are also required adjacent to the bed in these circumstances.

2. Organization

Many environmental and operational characteristics of these different units may be similar, but there are significant reasons to provide separate facilities for each. For example, the nursing skills required to observe and care for critically ill surgical, medical, and cardiac patients differ and separate staffing may be necessary. In addition to separate staffing requirements, each of these units may need to relate to other areas in the hospital such that a combination of intensive care facilities is precluded.

The prime organizational factor is constant patient observation by the nursing staff. This implies a limited number of beds grouped around a central work station.

A secondary, but important, factor is rapid access to equipment and supplies. Supplies are used in relatively large quantities and access is frequent. Activities requiring preparation on the unit should occur in a manner which will allow nurses to maintain observation of patients whenever possible.

Generally the level of activity on I.C.U.'s is constant throughout the day with only a slight reduction during the night hours. An ability for the staff to leave the pressures of the unit for short periods of time, while remaining on call, is highly desirable.

523.1.4 Primary Users

1. Patients

Patients will be brought to the surgical intensive care unit from the surgical recovery room, the operating theater, the emergency room, or from general nursing units. Medical or cardiac patients, on the other hand, may be brought to intensive care units from the emergency room, admitting areas, or from general nursing units.

Many intensive care patients are in a critical life state when brought to the unit; however, some patients may be admitted to receive this level of care to prevent the development of critical conditions. Patients will be kept on the unit until their conditions are stabilized such that they may be safely cared for in a less intensive nursing environment. The duration of stay, therefore, may vary from a matter of hours to weeks.

Some intensive care or cardiac care patients may be unconscious or heavily sedated. Many patients however, will be conscious or semi-conscious. These patients may be uncomfortable or in pain, confused, and frightened or apprehensive about their condition. The activity in the unit, the essentially strange environment, possibly compounded by dependence on monitoring and life support equipment, the awareness of other critically ill patients, and the loss of ability to care for themselves may increase this fear or confusion. In some cases, patients have developed moderate to severe neuroses during their stay on intensive care of cardiac care units as result of such factors.

Steps may be taken to avoid these adverse psychological effects. Patient exposure to potentially disturbing aspects of these units may be minimized, e.g. they may be visually and acoustically isolated from other critically ill patients and from activities such as emergency treatment or removal of deceased patients. Unfamiliar life support and physiological monitoring equipment required at the patient's bedside may be located, when possible, out of the patient's normal field of vision. The patient's awareness of his environment may be reinforced by making his personal possessions visible and easily accessible and by providing windows so that he can observe the time of day or night.

In addition to positive psychological effects, acoustic isolation of individual patients in intensive and cardiac care units would provide areas for confidential and often emotional conversations with physicians, clergy, nursing staff, social workers, or visitors.

Some patients in intensive care and cardiac care units are fed intravenously; however, many will be served meals and between-meal snacks at the bedside.

Many patients are attached to physiological monitoring leads, intravenous fluid tubes, respirators, wound and airway suction, and other devices. Any movement of a patient which would require these monitoring or life support devices to be disconnected may be dangerous; therefore, activities such as bathing, toileting, receiving visitors, etc, may be carried on in the bed or the immediate bed area. In some cases bedside facilities may be available for such activities, e.g. bedside commodes and bathing facilities. Patients may be encouraged to use such out-of-bed facilities if their condition permits. Diagnostic or treatment procedures which require relocation of patients and removal from monitoring and life support devices should be minimized.

Some patients in intensive care units may have infectious conditions. These patients should be physically isolated from other patients. Facilities for handwashing and storage for clean and soiled gowns and masks should be available at the point of access to and/or within isolation spaces. Relative air pressures should insure minimal movement of air from the isolated area to other patient or staff areas.

Other patients may require isolation because of extreme susceptibility to infection, e.g. burn patients. The isolation facilities and precautions required for these patients are similar to those described above, with the exception that air flow patterns should be reversed.

2. Physicians

While one specialist may assume general responsibility for providing emergency coverage and consultative service on an intensive or cardiac care unit, programs for the care of individual patients are generally established by their attending physicians. These attending physicians may visit their patients frequently and are called in times of emergency.

The specialists responsible for an intensive or cardiac care unit should be readily available to the unit while the hospital. Facilities for eating, sleeping, and a relaxing as well as office and conference space on or near the unit may be required for this physician.

Attending physicians may likewise need to stay on or near the unit during periods of emergency or potential emergency and may also need facilities for sleeping, eating and relaxing.

Because of the potential for a rapid change in patient condition, the results of diagnostic procedures should be quickly available to physicians. For example a maximum of two to four hours may be allowable for routine clinical laboratory test results; however, test results may be required within minutes during emergencies.

Physicians may require privacy in the unit for discussions with patients and relatives and conferences with the nursing staff, students and colleagues.

3. Residents and Interns

Residents carry out the same general activities as specialists in intensive care or cardiac care units. Some are assigned to units and require office space and access to conference facilities and, possibly, facilities for sleeping, eating, and relaxing while on duty. Others attending patients in the unit may require similar facilities for eating, sleeping, or relaxation.

Residents carry out the same general activities as specialists. Interns may assume patient care responsibilities under the supervision of residents or specialist. Facilities should be available for the use of residents and interns for charting, diagnostic study, discussion, etc. Residents may be assigned office space on some units. Access to conference space plus facilities for eating, sleeping and relaxation may be desired.

4. Nursing Staff

Nurses on an intensive or cardiac care unit are highly skilled in their knowledge of nursing procedures and their ability to manipulate the complex equipment required. They work under considerable pressure in an environment where disappointment is frequently encountered.

Nurses must maintain almost constant visual surveillance of each patient in the unit and of monitor read-out screens. The nurses' station provides a base of operations for these activities; however, the focus of nursing activity is at the patient's bedside. Optimum observation of patients should be obtained from the nurses' station. Ideally, however, all patients should be visible from any point in the unit.

Nurses should not be required to leave the unit while they are responsible for the care of patients. Therefore, all necessary supplies, medication and equipment should be available on the unit or readily obtainable without leaving the unit. Disposal of human wastes, dressings, food, paper, etc., and return of soiled linen and supplies should also be possible without suspension of nursing care responsibilities.

The staff should be able to take brief work breaks in an environment that will provide relief from the tensions of the unit and yet is immediately adjacent to it.

5. Medical Students

   Exposure to intensive and cardiac care patients is an important part of the instruction of medical students; however, their education should not disrupt the activities of the unit. Maximum use of closed circuit television and other devices may facilitate instruction without interfering with patient care in these units.

6. Nursing Students

   Small groups of nursing students may assist with patient care and receive instruction on these units.

7. Social Work

   See 522.1.4, 8.

8. Psychology

   A psychologist may visit the unit to counsel with patients and relatives. Privacy is important for these sessions.

9. Clinical Laboratory

   Laboratory personnel may come to these units for the collection of samples to be processed in the central clinical laboratory. In some cases, laboratory personnel may work part-time or full-time in laboratories on the units.

10. Radiology

    Personnel may come to these units to make exposures with portable equipment. If the work load is great enough and facilities are provided, they may be assigned to these units on a part-time or full-time basis.

11. Maintenance

    See 512.2.

12. Building Management

    See 512.3.

13. Dietary

    See 522.1.4, 14.

14. Visitors

    It may be desirable to allow relatives of patients in intensive or cardiac care units to visit them frequently at any time of the day or night. Such visits should not conflict with other activities on the unit, and therefore, they may be unpredictably suspended at times. A waiting area adjacent to the unit should be available for the use of visitors before or between allowed visits. Visitors should be able to travel from this area to the patient's bedside without disturbing or observing other patients.

    Facilities for private conversations between relatives and attending physicians or social workers should also be available.

523.1.5 Trends

1. Patterns of Care

   Intensive care units may become increasingly specialized in the future. For example, medical intensive care units may be divided into separate specialties such as neurological, gastroenterological, respiratory, and cardio-pulmonary intensive care.

   Surgical specialty units may also be developed, e.g. orthopedic, neurosurgical, and cardiovascular intensive care units. These units may be sufficiently interrelated so that the formation of an "intensive hospital within-a-hospital" may result.

   The percentage of the total beds in the hospital devoted to intensive care will probably increase in the future.

   It is possible that the treatment of critically ill patients may become a recognized medical sub-specialty.

2. Technology

   Physiological monitoring equipment will become smaller and more sophisticated in the future. This equipment may allow for more comprehensive monitoring and greater patient mobility, and facilitate nursing care by minimizing the size and/or number of obstructions at the patient bedside.

   The requirements for sophisticated supporting services, e.g. computers, will undoubtedly increase.

523.2 FUNCTIONAL REQUIREMENTS

523.2.1 Functional Relationships

Figure 520-3 and Figure 520-4 illustrate the two basic intensive care relationship options: 1) primarily to other intensive care units and diagnostic support or, 2) primarily to post intensive beds for each service.

Figure 520-3. INTENSIVE CARE UNIT: OPERATIONAL RELATIONSHIP OPTION 1

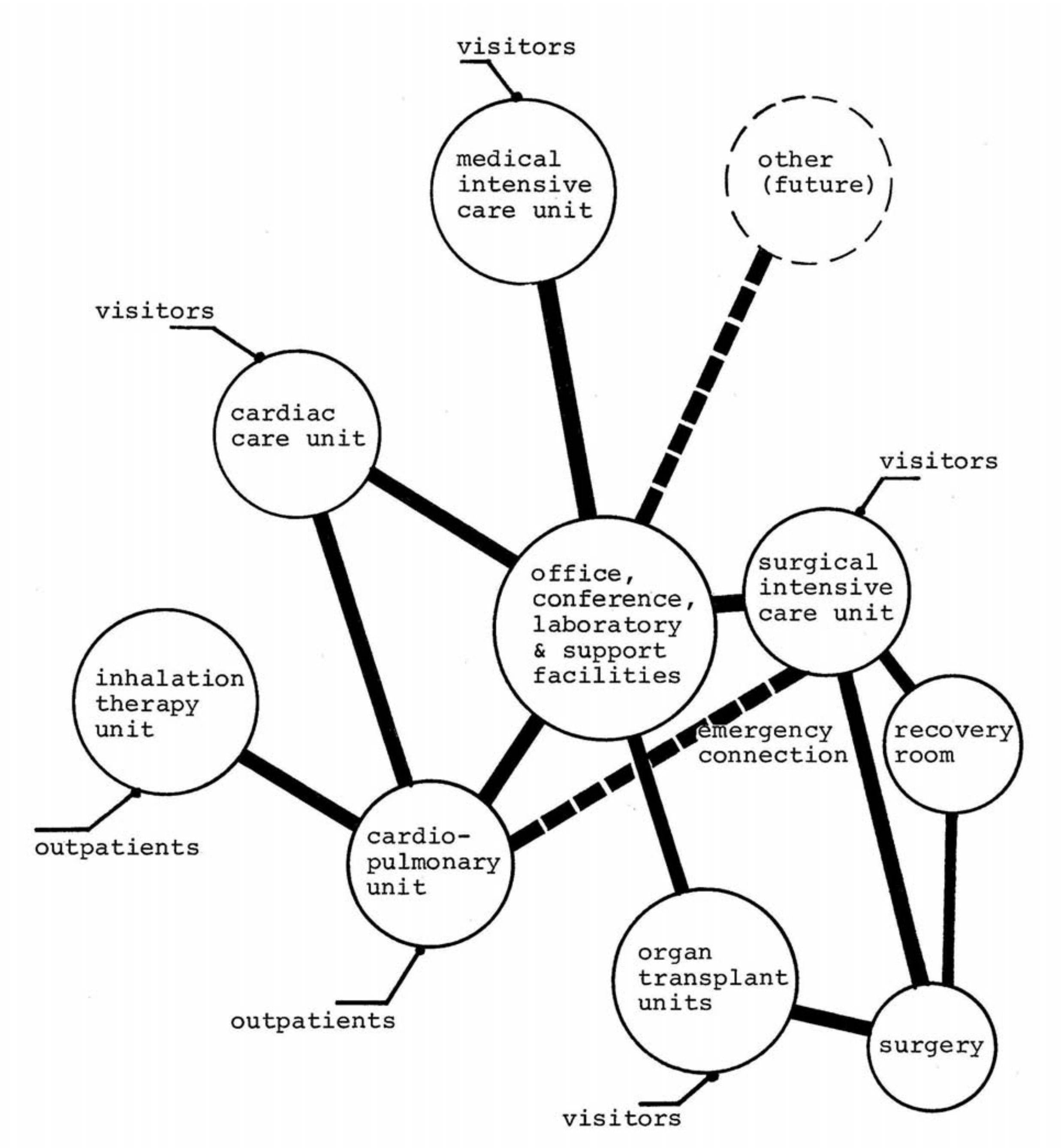
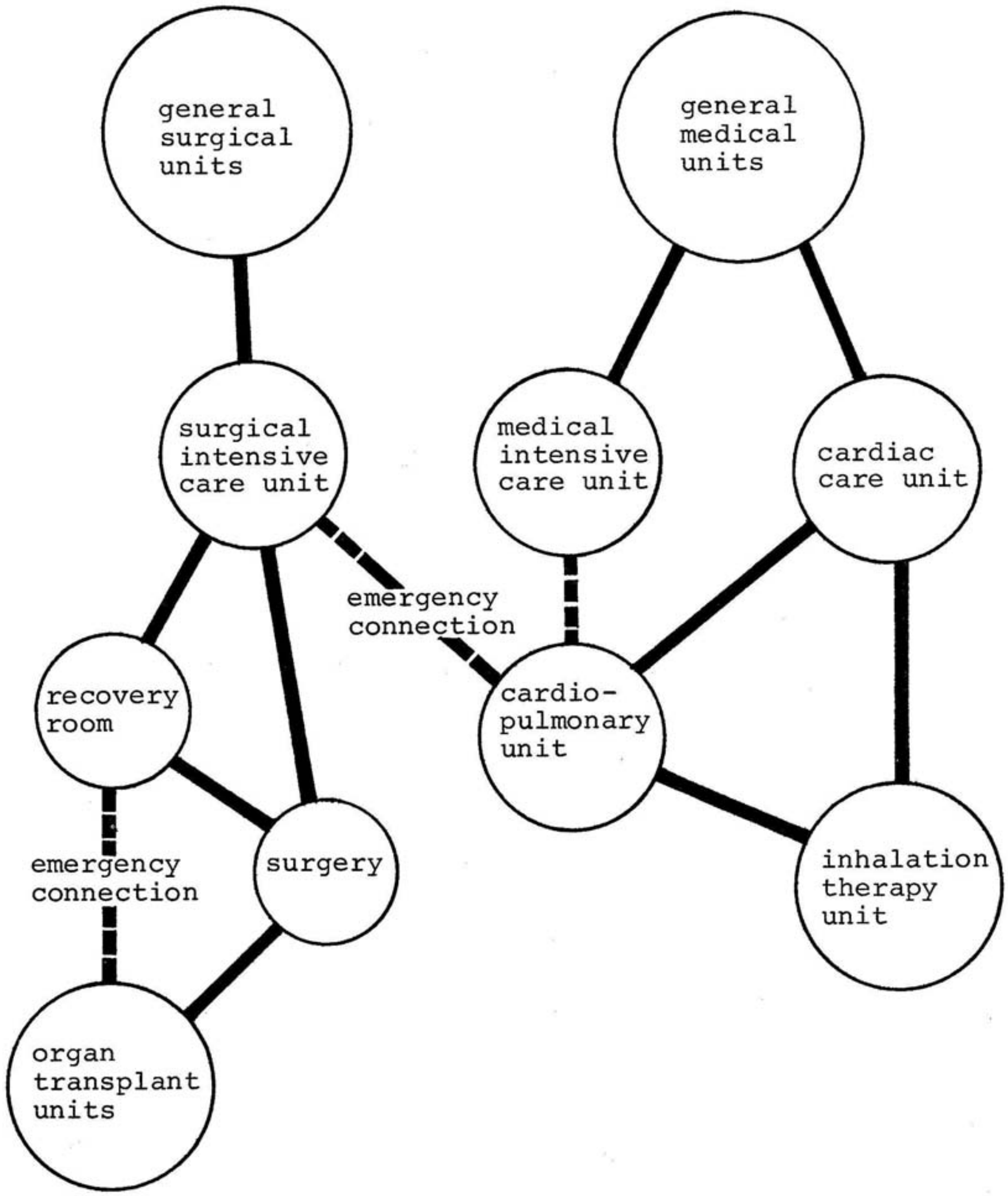


Figure 520-4. INTENSIVE CARE UNIT: OPERATIONAL RELATIONSHIP OPTION 2



523.2.2 Space Requirements

1. General

   The intensive care unit should provide optimum working conditions for physicians and nurses and a reassuring atmosphere for the patient. This implies a quiet area where conversations or other sounds will not disturb patients or be overheard by them. Lighting levels should be such that nurses can observe patient respiration rates and skin color 24 hours per day, while allowing patients to sleep when they desire.

   Temperature levels should be controllable within a normal range. Windows in the unit not only serve to orient patients but also provide relief from the intensive environment for the staff.

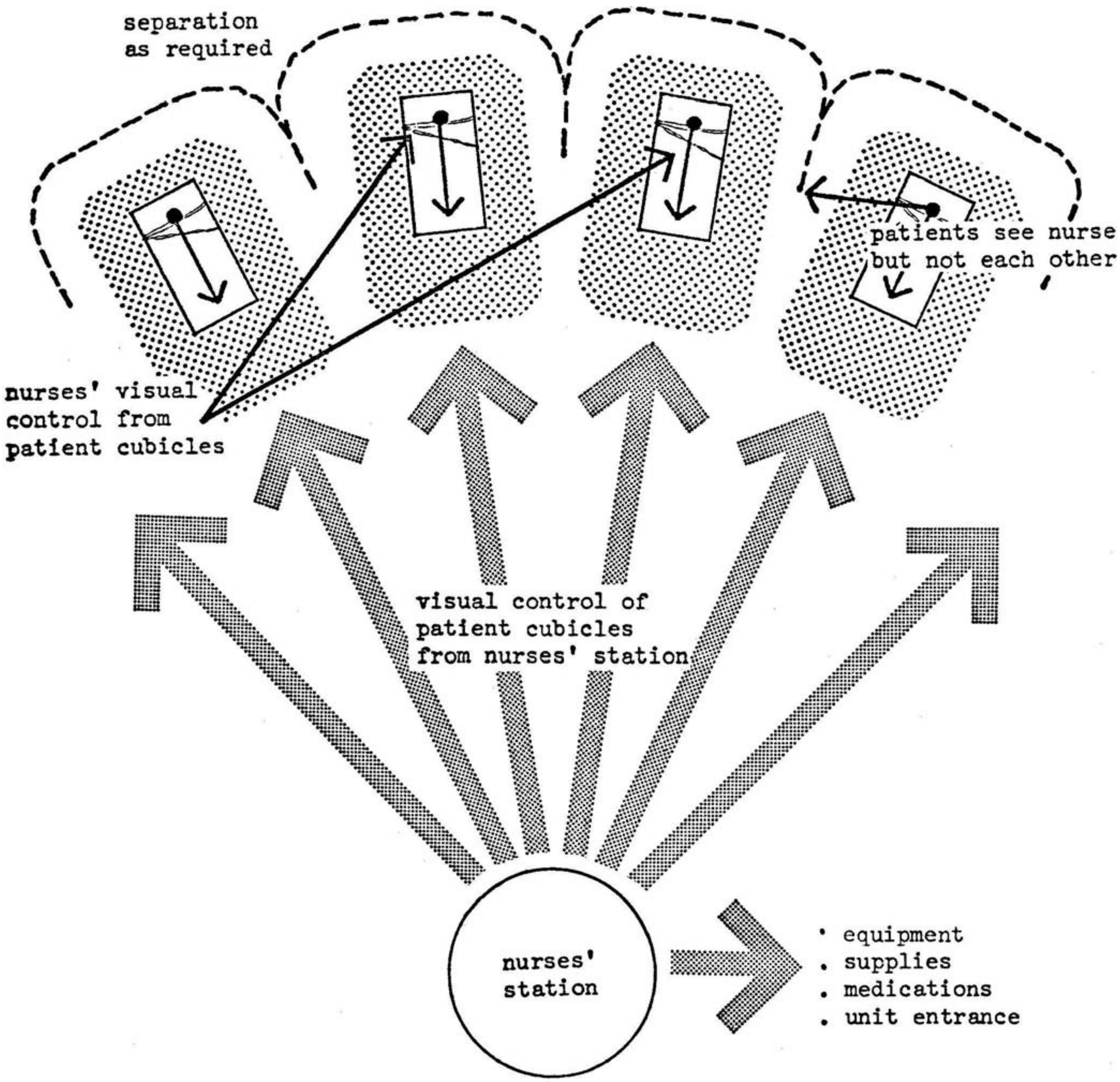
2. Patient Room

   Each patient bed area in intensive and cardiac care units should be supplied with necessary services for emergency as well as routine care. These may include multiple oxygen and vacuum outlets, compressed air outlet, electrical power, and connection to central monitoring terminals. The space around each patient bed should accommodate necessary personnel and equipment for emergency procedures. Each patient bed should be visible from the nurses' station to allow for the requisite level of observation (see Figure 520-5). Provision should be made at the patient's bedside for the storage of some personal possessions and individually assigned utensils and equipment for patient care.

   As mentioned previously, some intensive care patients may require physical isolation from other patients in the unit due to infectious conditions. Isolation spaces should provide the requisite degree of separation, but should also allow for necessary observation from nursing areas. Facilities for gowning and handwashing should be provided at the entry to these spaces. Services provided in isolation areas should be the same as those in other bed areas of the unit.

   Cardiac care patients should be protected as much as possible from disturbing sights or sounds on the unit. For this reason, each patient should be provided with some degree of visual and acoustical isolation from other patients in the unit.

Figure 520-5. INTENSIVE CARE UNIT: VISUAL CONTROL DIAGRAM



It may also be desirable to provide for acoustical as well as visual isolation of patients in medical and surgical intensive care units; however, the provision of such isolation should not limit the ability of staff to observe patients or administer appropriate levels of routine or emergency care. (See Figures 520-6 and 520-7).

3. Nurse's Station

   The nurses' station should be located to permit direct visual observation of all patients at all times. Monitor terminals at the nurses' station should be located for easy visibility while not obstructing the nurses' view of the patients. Space and facilities should be provided for a clerk and for nurse and physician charting functions. Adequate storage should be available in the nurses' station for patient's records and clerical supplies. It should be possible for staff to converse without disturbing patients. Lighting levels at the nurses' station should be adequate for performance of staff duties; however, this lighting should be controlled to eliminate glare or unnecessary distraction to the patients. Facilities for storage and preparation of medications may also be included as part of the nurses' station.

4. Toilet Rooms

   Some patients in intensive or cardiac care units may be able to use standard toilet facilities. One patient toilet room should be adequate for the use of these patients.

5. Equipment Storage

   Storage space should be provided for equipment used in the unit, e.g., portable toilet, in-bed scale, Stryker frame, external cardiac compressor, etc.

6. Staff Facilities

   Facilities may be required for on call staff to relax, sleep, and bathe within the immediate area of intensive care or cardiac care units. A minimum facility for such use would be one room with a bath which might serve two or more units.

Figure 520-6. INTENSIVE CARE UNIT: PATIENT ENVIRONMENT DIAGRAM

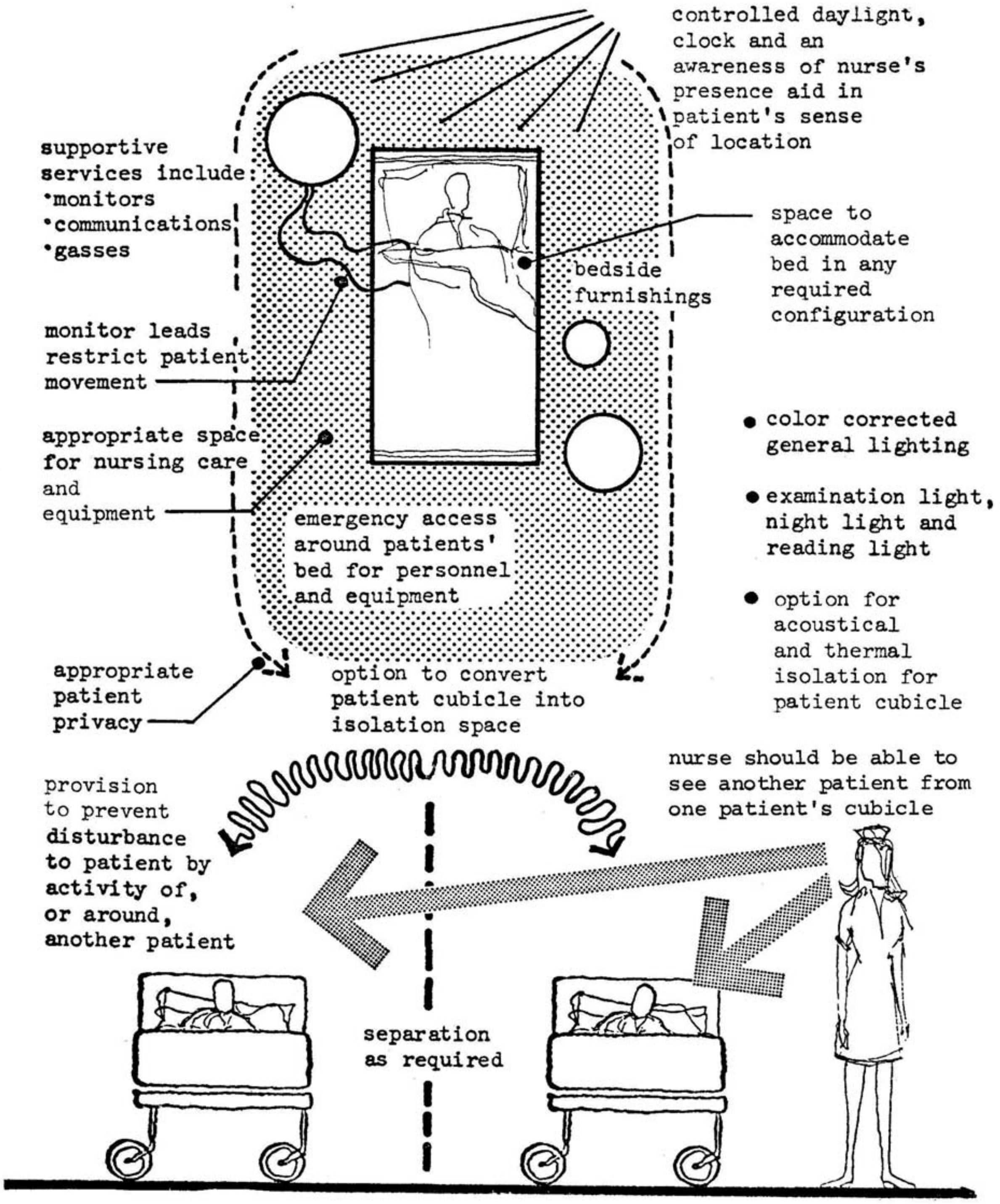
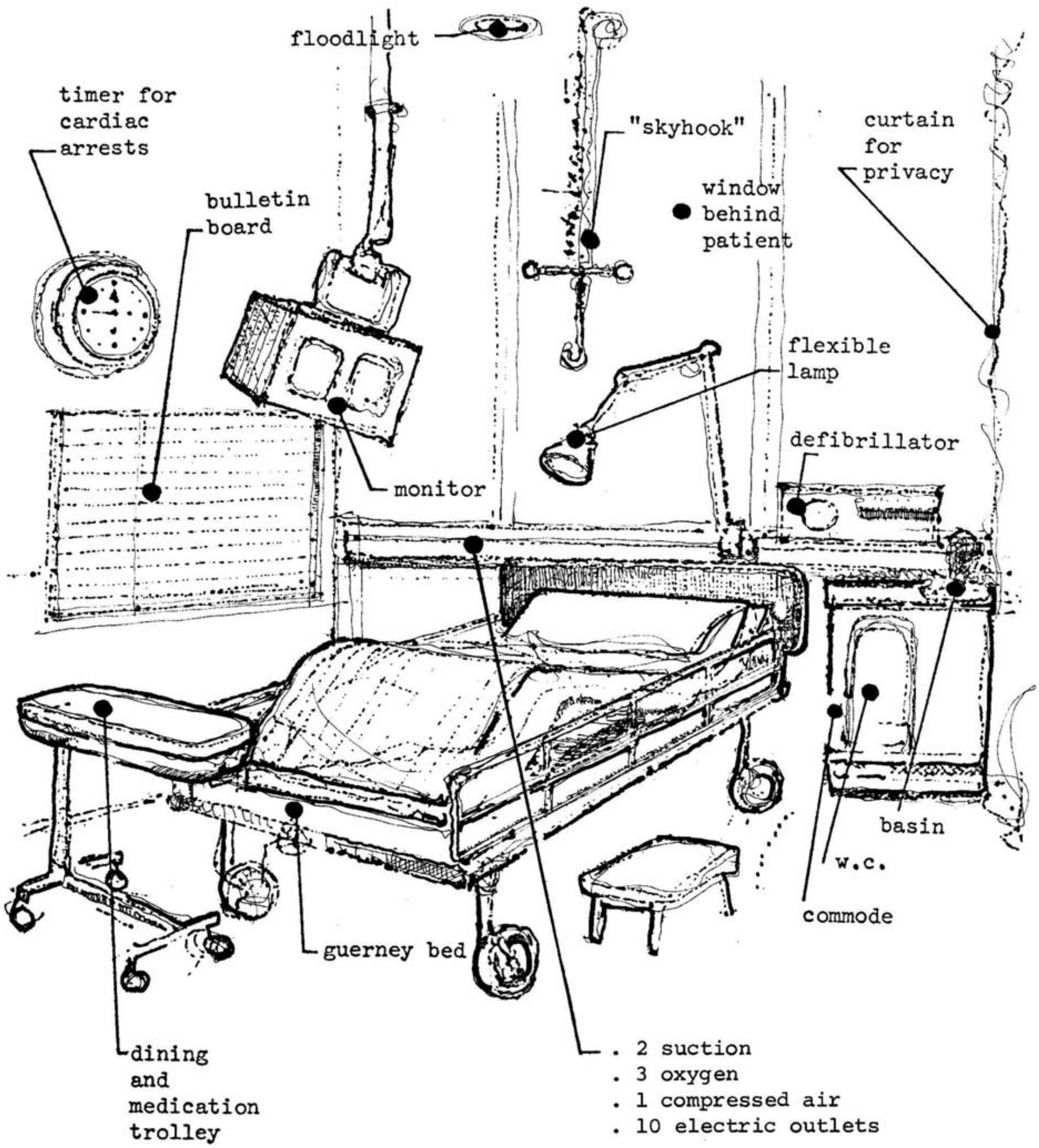


Figure 520-7. CARDIAC CARE UNIT: PATIENT ROOM EXAMPLE UNIVERSITY OF CALIFORNIA MEDICAL CENTER



It may be desirable to provide separate facilities for each of the units, and, in some cases, multiple facilities may be needed for the additional use of nursing staff and attending physicians.

Lounge facilities for the use of on-duty staff may also be desirable. Such facilities could be used by staff from more than one unit.

7. Waiting Room

   A separate waiting room should be provided for visitors to intensive and cardiac care units.

8. Consultation and Interview Room

   A room for during professional consultation or interviews with patients' families should be available to the intensive and cardiac care units.

9. Laboratory

   A small laboratory space should be provided for conducting blood gas, blood volume, and other determinations during time when central clinical laboratories may be closed. This laboratory may be shared with other intensive care units if the relationship between units permits.

524 SELF CARE UNIT

524.1 USER NEEDS

A self-care unit will serve ambulant general medical and surgical patients. It will provide accommodations for a substantial number of patients (perhaps 20% of the total GM & S patients) who require intermittent contact with hospital diagnostic or treatment services and who are able to function with a minimum of nursing support.

524.1.1 Objectives

The self care unit has been developed for use by certain types of patients as an alternative to acute GM & S bed assignment in order to effect economies in facility construction and paramedical staffing while providing an acceptable level of medical care.

524.1.2 Operational Relationships

Patients will be generally ambulant or in wheel chairs. They will use various medical support facilities including out-patient clinics, diagnostics and therapeutic radiology, clinical laboratory, physical medicine, pulmonary function, inhalation therapy and nuclear medicine. In addition, the canteen and recreational facilities will receive frequent use.

Movement to diagnostic or treatment facilities will be non-urgent and of an intermittent nature. Drugs, supplies, food, etc., will be delivered in a manner similar to other nursing units.

Nursing service will, in many instances, be provided to the unit on an “on call” basis similar to home nursing programs.

524.1.3 Characteristics

The general environment and organization will be similar to a hotel. Space and furnishing should facilitate day ambulant patient use as well as sleeping.

524.1.4 Primary Users

1. Patients

   All patients on the unit will feel relatively well and function as in a home environment. They will be admitted to the unit from the community or from a general nursing unit for the purpose of undergoing diagnostic studies or therapy which cannot feasibly be provided on an outpatient basis, or for instruction in the management of a chronic illness, e.g. diabetes. In addition, individual hospitals may elect to use self care units for pre-operative patients.

   Pre-operative patients will be visited by the surgeon and the anesthesiologist. Other patients will not ordinarily see physicians on the unit.

   The patient may be anxious about his condition. He may frequently seek information about test results and test schedules. Patients will be individually responsible for keeping appointments and for remaining on the premises. The patient will likely seek social or recreational activities with other patients on the unit to occupy time not devoted to scheduled activity.

   Patients will receive individual instruction on the unit from nursing personnel, dietitians, physiotherapists or other members of the staff. On occasion, however, this instruction will occur off the unit. Automated teaching devices may be employed for supplemental instruction. Group instruction may be given to patients assembled on the unit or in the outpatient clinic.

   All patients will be dressed in street clothes during the day. With the exception of those on special diets, patients will be expected to eat their meals in the hospital canteen. Meals served on the unit will not be eaten in patient rooms.

2. Physicians

   Normally a physician will not be required on the unit; however, one should be immediately available if needed for emergency treatment.

3. Residents, Interns and Students

   It is not anticipated that teaching programs will be conducted on the unit.

4. Nursing Staff

   Staff will be required on the unit for minimal supervision, treatment and patient instruction. Convalescing patients may require a minimum of assistance with certain therapeutic procedures and changing dressings. Pre-operative patients will require surgical preparation procedures including pre-anesthesia medication, washing and shaving.

5. Maintenance

   See 512.2.

6. Building Management

   See 521.3.

7. Visitors

   Visitors are anticipated on the unit throughout the daytime and evening hours. Patients will converse with visitors in their individual rooms or in general social areas.

524.1.5 Trends

The use of self care units is somewhat experimental and adequate operating cost data has not been developed. It is probable, therefore, that initially; a small percentage of beds will be devoted to self care.

Ultimately, 20-30% of the total patients could possibly be housed in such units. It is conceivable that self care units could serve as “float” beds for specialized or general nursing units in which case the facilities would be constructed for this dual function.

524.2 FUNCTIONAL REQUIREMENTS

524.2.1 Functional Relationships

No critical relationships established. Convenient access to diagnostic and treatment functions is desirable.

524.2.2 Space Requirements

1. Patient Room

   Bedrooms may be single or multiple. They should be hotel-like in character with the bed placed against the wall. Preferably the bed should convert into a sitting position for day use. Additional chairs should be provided for visitors. The room should be attractive and suitable for daytime activities such as writing letters, reading or watching television. Medical gases, a nurse call system, or other medical support equipment are not required.

2. Nurses' Work Space

   A nurses' station similar to a GM & S unit may not be required. An office equipped with a desk, two chairs and a filing cabinet for nursing personnel may be sufficient in lieu of a GM & S type facility. This space would be used for counseling, charting and general record keeping.

   Patients may leave the unit to receive medications. In this case, a medication room would not be required. Likewise, the provision of utility space would depend on policy regarding patient treatment on the unit. If treatment were performed in the outpatient unit, utility rooms would not be required.

3. Day Room

   Currently, criteria for day rooms are identical with those of GM & S unit. Utilization experience may indicate that some additional space is desirable due to the higher proportion of ambulant patients. This room should be sub-divisible into a group instruction area seating approximately twelve persons with remaining space devoted to normal day room activities. Natural light is desirable for the day room area.

4. Nourishment Area

   A small room in which patients may prepare coffee and snacks or obtain ice cubes would be desirable.

525 PSYCHIATRIC UNIT

525.1 USER NEEDS

In most recent years psychiatric units have been included in most new Veterans Administration hospitals. It appears that this pattern will continue although the percentage of hospitalized psychiatric patients apparently is declining at this time.

525.1.1 Objectives

The psychiatric unit is an integral part of a comprehensive system of mental health care. This system also includes day care programs, outpatient treatment and consultation for patients in other units of the hospital. The psychiatric unit is mainly employed for the treatment of veterans for the acute phase of an emotional disorder.

Emphasis, generally, is on brief rather than long-term therapy for patients with relatively favorable prognosis. Patients with resistive disorders who fail to respond to treatment are transferred to other specialized V.A. hospitals.

525.1.2 Operational Relationships

The relationship between this unit and other functional units is much less exacting than between most other units in the hospital. However, a strong relationship with other psychiatric programs such as day care or outpatient can be prime importance for particular psychiatric programs.

An active occupational therapy program is important in patient rehabilitation. This therapy may occur on the unit or, if not feasible, in closely related facility. Occupational therapy should be available to patients on a 16 hour per day, 7 day per week basis.

The use of medical and other supportive supplies on the psychiatric unit is minimal. Drugs, linen and nourishment comprise the bulk of required supplies.

A relation to the out-of-doors, preferably at ground level, provides a substantial benefit for patient treatment as will as easing the burden on the staff in their attempt to provide a range of environmental exposure.

Table 520-5 indicates the major psychiatric unit operational relationships.

525.1.3 Characteristics

1. Environment

   The aim of psychodiagnosis and psychotherapy is to build and restore the patient's ability to cope with his normal life situations. To this end, the psychiatric unit represents, in essence, a microcosm of the real world with the essential difference that the demands made on the patient can be controlled and necessary medical intervention applied. Ideally, the psychiatric unit should provide a variety of behavioral setting where patients can be exposed to human interactions and discussions on a variety of levels appropriate to their condition and progress. Control, on the one hand, and relative freedom of choice and self-responsibility on the other, are the two factors which have to be reconciled, both environmentally and administratively, in order to generate the atmosphere of trust and security that is a useful complement to the patient care programs.

   An inherent conflict exists in the desire, on the one hand, to maintain facility appearance and security and, the desire to encourage patient independence and self trust on the other. Current philosophy resolves this conflict in favor of patient self trust. Generally, facilities are constructed and furnished in a manner, which maximize the image of and reliance on patient responsibility.

   With regard to noise control, it is necessary for confused patients to be able to distinguish between signals and noise. Therapeutic sessions between professional staff and patients should be without sound transfer to other areas, and without sound disturbance from other areas.

2. Organization

   The treatment philosophy with regard to the integration of day and outpatient programs with unit activities will affect the organization and allocation of physical facilities.

Table 520-5. MOVEMENT FACTORS: PSYCHIATRIC UNIT

	Persons							Material					
	Non-ambulant patient (stretcher)	Ambulant and wheelchair patient	Physician	Nurse	Technician, etc.	Students	Visitors		Food	Drugs	Specimens	Supplies	Records
Cardio/Pulmon.													
Diag. Radio.													
EEG/EMG			M			M							
EKG													
ICU Units													
Inhal. Ther.													
Nuclear Med.													
Occup. Ther.		F	M			M							
Other D&T													
Other Nurs.Units			M			M							
Outpatient Clinic			F			F							
Phys. Ther.													
Rad. Ther.													
Surgery													
Admin.			M			M	F						M
Canteen		M	F	F		F	F						
Dietary									F C				
Recreation, Etc.		F											
Supply & Process												M C	
Cent.Teach.Facil.			M	M		F							
Laboratory											M C		
Pharmacy										F			
Research													

F - High frequency
U - High urgency
C - Special Condition Factor
M - Some movement

Social spaces are important as a setting for diagnosis and therapy. Generally these become the focus of the unit's activity.

Staff work areas adjacent to social areas provide an opportunity for unobtrusive observation, informal social interaction, or direct intervention where appropriate.

Current treatment patterns are such that any member of the psychiatric team may be involved with a particular treatment.

525.1.4 Primary Users

1. Patients

   The diagnostic make-up of a typical psychiatric unit will include patients with psychotic, neurotic and character disorders.

   Regardless of the diagnosis, patients may be sad, apprehensive, resentful, apathetic or blasé. Their feelings about themselves typically include a sense of failure, anxiety, uncertainly, anger, frustration, loneliness or depression.

   Admission procedures include routine physical, laboratory and X-ray examinations as well as a careful patient history and a range of psychodiagnostic tests.

   Patients' needs vary from time to time according to treatment and progress. Sometimes patients need seclusion and privacy, while at other times they need to be able to join with individuals or larger groups. There is a general tendency to withdraw socially, which needs to be sympathetically discouraged.

   The majority of patients are physically fit, out of bed and active, and capable of caring for themselves and performing a variety of task under nominal supervision. Their activities include many things which are routinely done in the home or place of work. They feed themselves, and take care of hygiene and toilet requirements.

The range of activities at any time may be diverse with a number of patients engaged in individual or group sessions and the remainder pursuing individualized treatment schedules. Some patients may watch T.V., play cards, chat, or receive visitors, while others may take an occasional nap, go for a walk, exercise, or engage in hobbies and work, either individually or in groups. Group recreational and occupational activities are generally attended by a member of staff who supervises and encourages the patients in their pursuits.

Patients characteristically participate in the maintenance of the ward, wash and iron their own clothes and prepare snacks. Most patients have relative freedom of the hospital and may be permitted off the hospital grounds, accompanied or unaccompanied. On occasion, groups of patients may be taken on an excursion.

The majority of patients need not maintain continual direct visual contact with a nurse but an awareness of a nurses' presence generates reassurance. A few patients, particularly at the beginning of treatment, while able to engage in simple, occupational pursuits, may need to remain continually close to a nurse during their waking hours. Other patients, although free to circulate within the unit, may require continual twenty-four hour observation until treatment becomes effective.

On infrequent occasions, non-ambulant patients may be admitted to the psychiatric unit. These patients require a complete range of diagnostic, therapeutic and supportive care normally accorded GM & S acute patients.

Female patients represent only a small percentage of the total patient load.

While the use of drugs is effective in controlling disturbed patients, there is still need for patients in extreme states to be isolated and protected in order to prevent their becoming a danger to themselves and others.

In general, drugs, medications, treatment equipment, diagnostic and other treatment facilities must be adequately secured from patients.

2. Psychiatrist

   The psychiatrist functions as director, coordinator and counselor of other members of the psychiatric team. The psychiatrist, in consultation with the team, determines the diagnostics program for specific patients, evaluates the results of tests, prescribes the treatment, supervises the administration of treatment, programs and checks and analyzes patients' progress. In addition he will interview patients and patients' relative and conduct individual and group psychotherapy sessions. He may also conduct teaching rounds and conferences on the unit and in certain instances initiate and conduct psychiatric research.

   The psychiatrist may be actively involved in the outpatient or day care clinics, particularly, in the follow-up of patients who have been previously treated. In addition, he may provide consultation for patients on other units in the hospital.

3. Psychologist

   The psychologist in the psychiatric unit is responsible for the administration and evaluation of psychological test of all types. The psychologist is also continually involved in the treatment of patients, and is specifically responsible for vocational counseling and rehabilitation.

   The psychologist is actively involved in the teaching of staff, interns, medical students, and psychology trainees. He may also participate in or conduct research projects.

4. Residents and Interns

   Residents in psychiatry may be directly involved in psychodiagnostic and psychotherapeutic procedures. Most arranging and managing of examinations and tests and treating patients will be done by the residents. They have major responsibility for patient care when the psychiatrist is not available i.e., nights and weekends. Residents may wish to study or have an opportunity to relax "on call".

   Interns have patient responsibility which is similar to the resident in some cases. They may assist the psychiatrist and/or resident on their rounds, assist in diagnosis and treatment procedures and patient charting. They may need to study during their assignment to the unit.

5. Psychiatric Nurses

The nursing staff of a typical unit may consist of a head nurse, R.N.s, L.P.N.s and nursing assistants.

The head nurse is responsible for all nursing care on the unit and cooperates with the psychiatrist in developing nursing techniques that will most effectively carry out the therapeutic program. Her activities, in addition to the supervision of nursing care, will include scheduling and supervision of the functions of the nursing staff.

The nursing staff participates in all phases of the patients' treatment and, accordingly, plays a key role in creating a therapeutic environment. They attend to both the physical and emotional needs of the patient and serve as a useful information source on patient behavior for the psychiatrist and other members of the team. The nursing staff assists in the administering of the various somatic therapies and is responsible for the maintenance and security of patient records.

In addition to their clinical duties, the nursing staff may act as recorders, observers and participants in research, and as teachers to the auxiliary nursing staff and nursing students.

Nursing care constitutes most of the daily personal contact between patients and staff and, through this, the nursing staff, in their general behavior, serves as a model for influencing patient behavior. Patients should be free to approach the nursing staff, on inclination, to discuss, ask questions or ask assistance. The nursing staff, on the other hand, should have a means to avoid over-exposure by being able to retreat from patient attention occasionally.

The role of the nursing staff is essentially therapeutic and administrative, not custodial. However, the nurse should be able to observe and control any patient who may be under sedation or undergoing special treatment and to observe patient group activity areas.

The nursing staff may wear uniforms or everyday clothes according to preference. It is desirable that overcoats and other personal articles be kept secure while they are on duty.

6. Medical Students

   A maximum of eight medical students will accompany the psychiatrist, resident or intern on patient rounds. They conduct patient interviews of a confidential nature, observe therapy sessions and participate in seminars or formal instruction on the unit. They may also need to study and perform simple laboratory test while assigned to the unit.

7. Nursing Students

   Nursing students also participate in patient care activities. They administer medications, are active in some therapeutic procedures, and may assist on patient rounds. They may receive classroom instruction or participate in seminars on the unit. The number of nursing students on the unit varies.

8. Psychology Trainees

   Psychology trainees are normally Ph.D. candidates. They function in a manner similar to the psychologist and under his direction, and there are usually several on a 30-bed unit.

9. Ward Clerk

   The ward clerk is responsible for the bulk of the administrative paper work relating to the admission, care, and discharge of patients, the preparation of all dispositions, the processing of physicians' orders for medication and treatment, the updating of patient charts and records, and the distribution of mail. In contrast to GM & S units, which have a greater turnover of patients, the psychiatric ward clerk can cope with a larger patient load.

10. Social Worker

    The role of the social worker in the psychiatric team is to appraise the social background of patients and to help establish attainable goals for patient treatment.

The social worker also provides a service to patients and their families, and, is responsible to seek improvement, where appropriate, of the social situation to which the patient will return.

The social worker may participate in training programs of the hospital and may undertake or participate in research projects.

11. Laboratory Personnel

    Laboratory Personnel will collect specimens not collected by the unit staff.

12. Researchers

    Psychiatric research is concerned with the normal and abnormal ranges of mental health. It may be carried out by professionals with patient care responsibilities or those almost exclusively involved in research. Areas of research include behavioral studies, psycho-pharmaceutical studies, psychobiological studies and studies of treatment program effectiveness.

    Methods involve clinical observation and clinical and laboratory testing. Many measurement procedures are routine and may be done in a central clinical laboratory; however, lab work may, in a few special instances, be done on the unit.

    Audio-visual monitoring systems linked to patients' rooms may be used for observation of physiological and behavioral symptoms. Centralized computer systems may be used to process statistical data.

13. Maintenance

    See 512.2

14. Building Management

    See 512.3

15. Dietary Personnel

    Dietary personnel will be responsible for the delivery of patients' meals either on individual trays or in bulk and for the collection and return of the soiled food receptacles to dishwashing and disposing area.

16. Visitors

Relatives and friends of the patients are an essential part of the therapeutic program. They are encouraged to visit and to take part occasionally in the patients' activities. Visitors may at times conflict with certain diagnostic and therapeutic routines, so control of visitor traffic may be desirable. The staff should be able to maintain observation of certain patients during visits. Visitation may require safeguards to protect patient well-being.

Visitors arriving for staff interviews should be able to wait in comfort outside the general area of patient activity.

525.1.5 Trends

Knowledge of the etiology of mental disease is rapidly increasing and new diagnostic and treatment programs are continually evolving.

The recent decrease in inpatients, and in length of inpatient stay is expected to continue. A corresponding increase in outpatient load is anticipated.

The separation between impatient and outpatient programs is becoming blurred. Currently, the day care program is being integrated with outpatient programs. Eventually inpatient and outpatient programs may be combined to minimize staff duplication and preserve continuity of care.

Outpatient care may, increasingly, extend to family members or whole families.

An additional trend is the decentralization of patient care as a result of the availability of psychiatric services close to a patient's home. Parallel with this, there may be increased centralization of specialized psychiatric treatment programs on a regional level.

525.2 FUNCTIONAL REQUIREMENTS

The size of the unit is a function of patient care programs and staffing patterns. Currently, units of not less than 20 beds nor greater than 30 beds to be suitable.

525.2.1 FUNCTIONAL RELATIONSHIPS

The psychiatric unit should have direct access to the outdoors and be convenient to physical, occupational and recreational facilities. In addition, immediate proximity to the psychiatric outpatient department may be desirable.

Access to the unit for visitors should be simple and direct.

Orientation within the unit should be as obvious as possible. There should be no unusual configuration, patterns, areas of glare, or excessive length of corridor to cause loss of orientation. Similarly, the treatment of floors, walls and ceilings should respond to the need to de-emphasize or reinforce awareness of the environment as may be desirable. Patients should be helped to familiarize themselves rapidly with the general layout of the unit and the hospital.

Sources of noise, such as kitchens and workshops, should be kept away from sleeping quarters and other areas where quiet is required.

Some control of patient movement into and out of the psychiatric unit is generally required. In some cases visual control of points of access and egress is sufficient; however, it should be possible to lock each psychiatric unit. (See Figure 520-8).

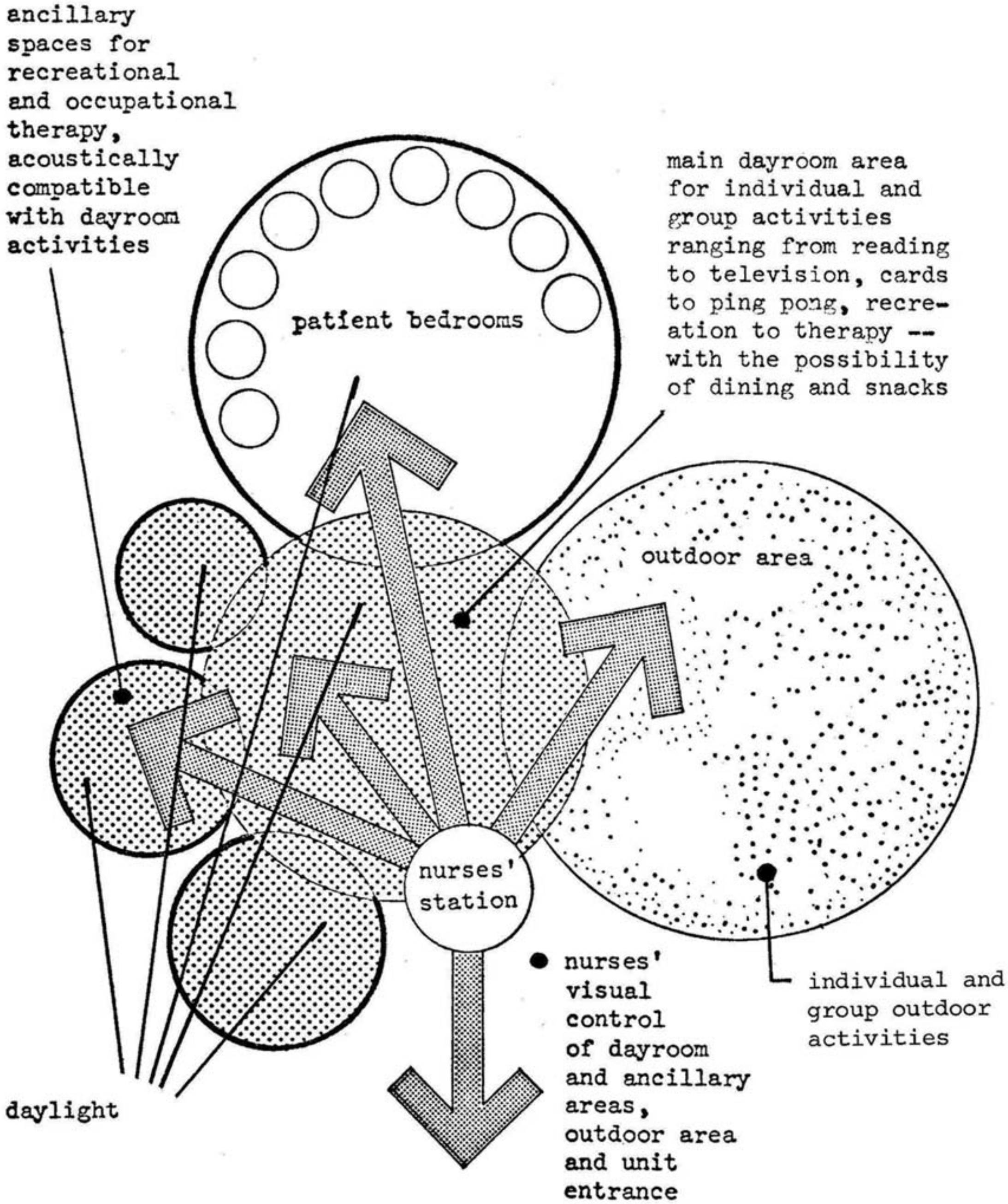
525.2.2 Space Requirements

1. Patient Room

   Patient groupings are significant in terms of patient care interrelationships. Two-bed rooms may, in some cases, stimulate strong patient reactions. Three-bed rooms may tend to lead to ambiguous situations where the drawing together of two patients makes the third feel rejected. Many patients fare best in four-bed units.

   Multiple bedrooms, preferably, should be so arranged that there is a degree of privacy for each patient. Each individual’s space should be appropriately defined and conducive to personal activities such as reading, writing, conversation, entertaining visitors, and sleeping.

Figure 520-8. PSYCHIATRIC UNIT: PRIMARY RELATIONSHIPS



Each personal space should contain a daybed, a chair, individual locked wardrobes for clothes and other possessions, together with facilities for the placement of belongings such as radios, books, and pictures, etc. Where doors are provided, they should open into the patients' room with emergency provision for opening by the staff if necessary.

Single rooms may be needed to help anxious patients achieve an increase sense of security. They may also be needed for patients who work outside the unit and need to return to a private space to offset the effect of stressful social encounters during the day. Single rooms should also be provided to accommodate the small number of female patients.

Currently, patients who require general nursing care are normally transferred to the appropriate medical unit. In the future, it may be desirable for non-ambulant patients to be treated in the unit, in which case, oxygen and suction may be required in the patients' rooms.

The degree of patient compatibility with regard to the physical environment within the unit is established not only by the shape and organization of the spaces but also by the lighting, color, acoustics, ventilation and heating. With regard to patient areas, local lighting should be under the patients' control and be bright or dim as required. Subdued night lighting near the floor level is necessary for nocturnal traffic without interfering with sleep.

2. Security Room

Some patients may require temporary seclusion during extremely distressed states. At least one security room should be provided for such use in each psychiatric unit. This room should be similar to a normal 1-bed room; however, the finishes, equipment and furnishings should be chosen to minimize the risk of self-injury during confinement.

3. Patient Shower and Toilet Facilities

   Patients should have convenient access to toilets and showers and/or baths. The desire to maintain and promote patient dignity and self-reliance may justify the allocation of toilets and showers to each patient room. One centrally located bathroom should have the capability to contain a free standing tub which, in addition to being used to bathe infirm patients, may be used for physical therapy.

4. Dayrooms

   Day spaces should be compatible with the formation of various groups of different sizes and different social, recreational and therapeutic activities, ranging from reading to T.V., from cards to ping pong, etc. In planning dayrooms, it must be assumed that all patients in the unit are likely to be out of bed and may all be occupying the dayrooms simultaneously. The multi-use of space is desirable but not at the expense of any essential individual function within that space.

5. Exterior Area

   Several recreational activities can usefully take place outdoors, such as shuffleboard, ping-pong, etc. A congenial outdoor area with direct and easy access from the unit is desirable.

6. Dining Room

   Mealtimes provide a useful opportunity to encourage a patient to associate with groups. A central dining area, on the unit, should be provided for this purpose.

7. Nourishment Kitchen

   A nourishment kitchen should be located adjacent to the dining area and should be easily accessible to the patients to prepare coffee, snacks and occasional meals.

8. Group Therapy Room

   Currently, there is inadequate space for group therapy functions in many units. It may be desirable, to provide a designated group/therapy room that is appropriately equipped, functionally and environmentally for that function. A student observation area adjacent to this space may also be desirable.

9. Occupational Therapy Room

   Similarly, it may desirable to provide a small occupational therapy room, either on the unit or shared between adjacent units, to enable patients who may wish engage in therapy on an informal unscheduled basis to do so without leaving the unit.

10. Patient Utility Room

    A patient utility room for washing, ironing and mending clothes may be desirable and could be shared between units. Equipment would include a washing machine, a drying machine, an ironing board, and perhaps, a sewing machine.

11. Nurses' Station

    The nurses' station should be located to allow for easy observation and control of entrances and exits and of patient activity areas. Space and facilities with reasonable visual and acoustical privacy should be provided for the ward clerk's activity. Privacy for conversations between staff members is usually desirable. Patient records contain personal and confidential information and should be appropriately secured.

12. Examination/Treatment Room

    An examination/treatment room with facilities similar to that provided in the general medical unit is sufficient for shock therapy and other procedures. This room may also be used for history-taking and interviews. A small desk and chairs may be provided for this purpose. Examinations and treatment require natural light to facilitate the detection of illness. Lighting and lighting controls should respond to particular program needs: For example, perception testing might require total darkness, T.V. playback of patient videotapes might require semi-darkness, and group or individual therapy might require normal light.

13. Offices

Offices for psychiatrists, psychologists, residents, head nurse and social workers and certain categories of trainees may be required in conjunction with the unit. Some flexibility in the trainee office assignment may be required to meet the variable student teaching commitments. The use of offices to accommodate two or more students is not desirable and may conflict with teaching and patient care activities in that students may participate in intimate conversations with patients.

14. Conference/Consultation Room

A conference/consultation room should be provided on the unit for consultant and medical student use and for small group meetings of 10-12 persons. This room may be used jointly for instructional seminars and, perhaps, therapy programs.

15. Support Areas

Support areas should include clean and soiled utility rooms, clean and soiled linen holding, a housekeeping aides' closet, recreational equipment storage, and stretcher and wheelchair storage space.

16. Psychological Testing Units

Psychological testing is administered to most psychiatric patients and many other patients in Veterans Administration hospitals. Space for group administration of various tests should be provided within the nursing tower and, preferably, convenient to psychiatric units. The test may involve small groups of four to ten patients, a psychologist or psychology technician and, perhaps, a student.

17. Nursing Student Carrels

Study space in the form of carrels should be provided in conjunction with each psychiatric unit for use by nursing students.

18. Nursing Instructor's Office

    Instruction of nursing students is the responsibility of a nursing instructor, independent from the unit staff. This instructor should be provided with office space on or adjacent to the unit.

19. Classroom

    See 5212.2.1

526 NURSING HOME CARE UNIT

526.1 USER NEEDS

These units function in a manner similar to a general medical and surgical unit with the exception that a high percentage of patients are ambulant, the level of sustaining medical care is less and the length of stay is greater.

526.1.1 Objectives

Nursing home care facilities in V.A. hospitals treat patients, who require a substantial level of nursing support, will probably be hospitalized for six months or more and whose activities will be confined primarily to the nursing unit.

The major mission of the nursing home care unit is to restore maximum physical and psychological patient functions.

526.1.2 Operational Relationships

The nursing home care units related to other hospital functions in a non-exacting way; that is, there are no relationships which require specific contiguity to a particular supply and distribution system or other nursing units. Patients leaving the unit for treatment or recreation will be ambulant and able to proceed without escort. Supplies are of non-critical nature and can be distributed through normal hospital procedures. Patient care programs would benefit, however, from a close proximity to outdoor recreational areas.

526.1.3 Characteristics

1. Environment

   The general environment of the unit should be cheerful and open with natural light in social spaces and corridors, if possible. Walking surfaces should provide secure footing. Glare or other disorienting features should be avoided.

2. Organization

   Out of bed and group activity and group interaction will be emphasized on the unit. Social spaces therefore should provide the focus for unit organization. Unobtrusive observation of social spaces and corridors by nursing personnel is desirable.

526.1.4 Primary Users

1. Patients

   Most patients will be elderly. Many will require the assistance of crutches, wheelchair or walker. Dizziness or loss of balance may occur in certain patients. Others may have irregular eating or sleeping habits. Disorientation and temperamental dispositions are common on the unit. Patients may leave the hospital for short periods to visit family or friends.

   The restoration of patient functions involves to a large extent, outpatient activities. Patients are encouraged to minimize the time spent in the bedroom during non-sleeping hours. Treatment on the unit includes physiotherapy, occupational therapy, manual areas therapy, vocational rehabilitation, group counseling, general exercise and training in the activities of daily living. Most therapy programs are conducted with groups of patients: however, treatment is also provided for patients confined to bed. In many cases, patients are encouraged to leave the unit for treatment in general hospital facilities. Therapy programs on the unit may involve a considerable amount of equipment such as looms, typewriters, sewing machines or minor carpentry equipment.

   Patient social activities assume great importance in maintaining psychological a physical capability. Activities on the unit may range from quiet reading or conversation to watching television or movies, dancing or playing games such as ping-pong or pool. In many instances, these activities will occur simultaneously. Eating food, both regularly scheduled meals and informal snacks is usually a favorite patient activity. The social interaction that takes place during meals is an important contributor to the patient care process.

   Certain patients may benefit from the training in the activities of daily living during meals as well.

2. Physicians

   Physicians will visit the unit periodically to examine patients. However, a permanent staff member may not be assigned to the unit.

3. Residents and Interns

   It is not anticipated that teaching will occur on these units unless a special center for gerontology is established when specific medical specialties in this field develop.

4. Nursing Staff

   Skilled nursing is required to maintain an active rehabilitation program. Nurses will assist in treating chronic medical conditions, helping patients maintain a high level of daily activities and in most therapy programs.

5. Nursing Students

   Student nurses will receive a portion of their training on the nursing home care unit. A maximum of eight students may participate at one time.

6. Maintenance

   See 512.2

7. Building Management

   See 512.3

8. Dietary

   See 525;1;4, 14

9. Visitors

   Visitors to the unit will be common. They will be entertained in patient rooms or in group social spaces.

526.1.5 Trends

The future of nursing home care units in the "nursing tower" is unclear. Currently, most units are being constructed as detached facilities.

As the standard of living increases and medical knowledge expands, the total number of elderly persons will increase, thus expanding need. It is not necessarily true, however, that the required number of V.A. nursing home care beds will expand in proportion.

As knowledge concerning the diseases of old age develops, the nursing home care unit program may expand and the unit itself become a center for intensive diagnosis and treatment. In this event, the relationship with other hospital units may become an important determinant in the location of nursing home care units within the hospital.

526.2 FUNCTIONAL REQUIREMENTS

526.2.1 Functional Requirements

No critical relationships exist. Convenient access to physical and occupational therapy is desirable. Outdoor recreation space adjacent to the unit would contribute to therapy programs.

526.2.2 Space Requirements

1. Patient Rooms

   Bedrooms should respond to patients' physical and psychological requirements. Furnishing, colors and textures should resemble residential environments. Personal effects such as pictures, flowers, and cards should be encouraged.

   In multi-bedrooms, patients must be able to read, write or conduct other quiet activities without disturbing other patients. The capability of converting the bedroom into a sitting room would conceivably be utilized by many patients.

   Where possible, toilet and bathing facilities should be designed to promote dignity and independence. Private compartments for personal effects in shared bathrooms are desirable.

All furnishings and equipment, including storage units, switches, lavatory fixtures and operable windows must be usable by wheelchair patients. This requires ample space for wheelchair-bed transfer and night storage of wheelchairs.

Due to the increased length of patient stay, additional horizontal and vertical storage space would be desirable. Space will be needed for clothing (patients will be dressed) personal effects, books, writing paper, suitcases, extra blankets, prosthetic devices and soiled clothing and linen. A ventilated space is desirable for the latter.

Bedroom services may include piped oxygen, television, and lighting for reading, examination and social activities. An audio-visual nurse call system is desirable.

2. Dayroom

   Emphasis will be placed on out-of-room activity. Social spaces should encourage participation by providing a pleasant environment plus maximum flexibility to accommodate varied activities. A capability to allocate sub-spaces for different types of activities is desirable. Lighting, surface finishes, and acoustical qualities must be consistent with theses activities.

3. Nurses' Work Spaces

   Work spaces will be similar to those of GM & S unit. Nurses should be able to observe corridors and group spaces. It may be desirable to provide an office or small conference room adjacent to the nurse's station for patient, visitor and staff interviews, for team conferences and for use as a private study work area.

4. Supporting Facilities

   Similar to those on a GM & S unit.

5. Teaching Facilities

   Similar to those on GM & S unit with the exception of facilities for residents, interns and medical students.

527 CLINICAL STUDIES UNIT

527.1 USER NEEDS

A clinical studies unit is a diagnostic functional unit operating under the administrative responsibility of the hospital medical service.

527.1.1 Objective

Intensive studies are carried on here dealing with the psychological and chemical changes in metabolic processed brought about by disease. These studies generally involve the following:

1. Precise control and measurement of the factors which may affect metabolism, e.g., food intake, fluid intake, environmental temperature, humidity, drugs and medications, etc.

2. Measurement and analysis of metabolic “products”, e.g., feces, urine, blood, perspiration, respiration, etc.

3. Measurement of physiologic indicators of metabolic activity, e.g., temperature, blood pressure, weight, rate of circulation, etc.

527.1.2 Operational Relationships

In general the relationship patterns established for the GM & S unit are applicable to the clinical studies unit.

Joint use of laboratory and teaching space can be facilitated by locating the unit adjacent to gastroenterology and hemodialysis unit. Cross consultation between medical specialties in clinical studies unit and gastroenterology is desirable to maintain.

527.1.3 Characteristics

1. Environment

   The environment should be generally similar to a GM & S unit.

2. Organization

In order to conduct these studies with the requisite degree of precision, it is necessary to keep the patients in a separate unit where control over significant variables can be maintained and where supervision is available to insure that patient activities will not invalidate test results.

The study programs carried on in the metabolic unit may require that the patients significantly alter their usual patterns of activity. They may eat or drink only what is given to them; they have to collect all waste products, i.e., feces and urine, rather than disposing of them by flushing the toilet and they have to be available at specific times for various tests, measurements, and collection of samples. Since these requirements may conflict with long established habits, the patients may have to be thoroughly instructed in these requirements, and wherever possible, safeguards should be instituted to insure appropriate action.

The quantity and content of all patient meals may have to be carefully controlled, measured, and recorded. To assure this, these meals are prepared on the unit by specially trained deictic personnel.

Many of the sample analysis and measurement procedures are essentially routine and may be done in a central clinical laboratory; however, some test may be done in a laboratory on the unit.

Various levels of psychological monitoring may be required for any patient in the unit.

527.1.4 Primary Users

1. Patients

The majority of patients in the clinical studies units are ambulant and mostly capable of caring for themselves. They can feed themselves, use toilet facilities, and take care of their general hygiene and toilets requirements, without nursing assistance. They are capable of utilizing out-of-bed entertainment and recreation facilities, e.g., lounge, and card playing facilities, etc. They are also capable of taking their meals out of bed. If there is no conflict with the test being conducted, these patients may be encouraged to utilize their ambulant or self-care abilities as much as possible.

In addition to ambulant patients, there may be non-ambulant, acute patients on a clinical studies unit. These patients require the complete range of diagnostic, therapeutic and supportive care normally accorded acute patients.

It is likely that many of the patients on the clinical studies unit will not understand the nature of the tests being conducted or the importance of precise control and measurement. Others may lack sufficient motivation to assure complete cooperation.

For these reasons, the patients may require considerable instruction and supervision.

Many patients may also be apprehensive about the results of the test, their chance for recovery, and their future activities, etc. and will need to discuss these concerns with interested and qualified personnel.

2. Physicians

The clinical studies unit is generally under the direction of an internist.

The physician or physicians responsible for the clinical studies unit will, with the help of residents, determine and evaluate study programs for specific patients, check on the progress of various studies being conducted, and analyzed the study results. They may also conduct teaching rounds and conferences on the unit for interns and medical students.

In addition to theses activities, the physicians may also be available for consultation on other cases in the hospital and may assume direct responsibility for the care of certain patients on general medical units. They may also work in the outpatient clinics.

Depending on their interests, physicians or residents may be involved in doing some laboratory analysis in the unit.

Patients from other sub-specialty units may come to the unit on a consultative basis or to visit their patients who have been assigned to the unit.

3. Residents and Interns

   Residents in internal medicine may be directly involved in carrying out study programs and analyzing the results. Much of the routine work involved in arranging and managing studies and providing necessary medical care to the patients will be done by these residents.

   Interns are not normally assigned to the clinical studies unit as a normal part of their rotation through the hospital. They may, however, come to the unit during rounds to receive instruction.

4. Nursing Staff

   The nursing staff is responsible for providing the nursing care required by each of the patients; and has the additional responsibility of carrying out programs of observation, measurement, and sample collection. Records must be maintained by the nursing staff detailing precise results of various observations and tests as well as information concerning routine care and patient condition.

   The nursing staff assumes a significant responsibility for the education and supervision of patients. This requires close contact between patients and nurses. Patients should be free to approach the nursing staff to ask questions or seek assistance. The nursing staff, on the other hand, should be able to observe and control patient activities to the extent required by the studies being conducted. The nursing staff should have a thorough understanding of the nature and requirements of the studies being conducted. This may require frequent meetings of the unit staff, discussion of cases with physicians, and observation and assistance of physicians on rounds. Ideally, the clinical studies unit should have a separate, specially trained nursing staff assigned to it.

5. Medical Students

   A significant number of medical students can be expected to accompany doctors on unit rounds.

6. Nursing Students

   Nursing students will also visit the clinical studies unit.

7. Social Work

   A social worker should be available for consultation with patients and their families. This social worker should be aware of the functions of the unit and should assume the position of a recognized member of the unit staff. In most cases, the social worker will not be present on the unit full time.

8. Maintenance Management

   See 512.2

9. Building Management

   See 512.3

10. Dietary

    There will be at least one dietitian who will work full-time on the clinical studies unit. This dietitian will prepare menus for the individual patients, which satisfy the requirements of the tests being conducted. She will also supervise the preparation of meals and measure and record the types and quantities of food consumed by the patients. In the course of these activities, the dietitian may have frequent meetings with physicians and patients and will work closely with the nursing staff.

11. Visitors

    Patients in the clinical studies unit will be free to have visitors provided there is no conflict with the studies being carried on. Care has to be taken to insure that the visitors do not give the patients food or drink which would invalidate the study results.

527.1.5 Trends

1. Teaching

   Currently V.A. hospitals do not provide a comprehensive patient base for adequate training in endocrinology and metabolism. Residents, interns, and medical students do not have an opportunity for contact with a large range of metabolic or endocrine problems due to the small number of women and children patients in V.A. hospitals.

   Future developments may increase the number of such patients in V.A. hospitals, with corresponding effect on clinical studies unit.

2. Medical Care

   As physicians become more familiar with the functions and capabilities of clinical studies units and as knowledge of the relation between metabolic processes and disease is expanded the demand for beds in these units may well increase. In addition, this may result in an increased need for supporting facilities or services, e.g. radiographic and fluoroscopic facilities, constant temperature rooms, or radioisotope lab facilities.

3. Technology

   It is likely that the use of physiological monitoring equipment, including telemetry, will increase in the future. The use of radioisotope in the study of various conditions may also increase.

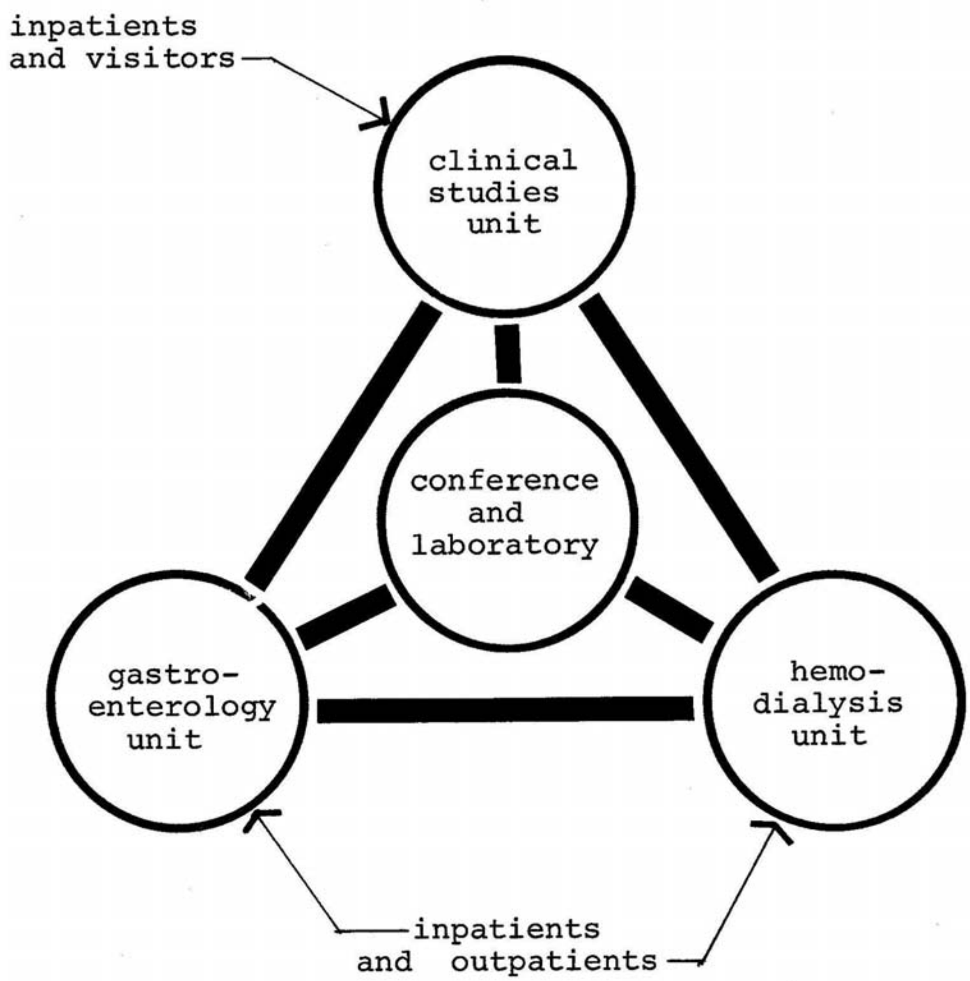
   Computerized monitoring, analysis and record keeping equipment will undoubtedly increase as more sophisticated systems and equipment are developed.

527.2 FUNCTIONAL REQUIREMENTS

527.2.1 Functional Relationships

Figure 520-9 illustrates an optimum relationship between the clinical studies unit and hemodialysis and gastroenterology units.

Figure 520-9. CLINICAL STUDIES UNIT: OPERATIONAL RELATIONSHIPS



527.2.2 SPACE REQUIREMENTS

1. Patients Rooms

   Three basic types of patient rooms may be included in the clinical studies units.

   a. Single–bed rooms to be used for the most strictly controlled studies, i.e. ”balance studies”.

   b. Multi-bed rooms for patients on less demanding study programs.

   c. Single-bed, constant temperature rooms for temperature and perspiration studies. Such rooms are not included in current facilities, but may be a desirable future option.

   Each patient room should be provided with a separate specimen collection toilet to allow for control and to minimize potential errors in specimen collection. A lavatory should be provided in conjunction with this toilet and should be located to encourage handwashing after use of the toilet.

   Connection should be provided at each patient bed station for individual physiological monitoring equipment.

   The size, furnishings, and basic services, e.g., oxygen, vacuum, compressed air, and power for these rooms should be comparable to general nursing unit patient rooms.

2. Patient Shower and Bathing Facilities

   Centralized patient shower and bathing facilities may be provided; however, a separate shower is desirable in conjunction with each patient room to allow greater flexibility in the study of female patients, contagious patients, etc., on the unit.

   All of these facilities should be usable by wheelchair patients.

3. Nurses' Station

   Space and facilities should be provided in the nursing station for a ward clerk and for nurse charting functions. The station should include adequate storage space for patient records and clerical supplies.

   Space should also be allowed to accommodate terminals for patient monitoring equipment and for a possible future computer terminal.

   The nurses' station should be located to allow for easy observation and control of unit entrances and exits and of patient-occupied spaces. These include patient rooms as will as lounge, recreation, dining and circulation spaces.

4. Utility Rooms

   Clean and soiled utility rooms, space for storage of clean and soiled linen, a janitor's closet, and stretcher and wheelchair storage space should be provided.

5. Exam-Treatment Room

   An exam-treatment room, similar to that provided in general nursing units, should be included.

6. Laboratory

   A laboratory should be provided in conjunction with the clinical studies unit. This lab should be equipped with work benches and sinks as required and should have power, water, vacuum, and natural gas service. A fume hood should be provided for handling stool samples. Adequate sample storage includes a freezer and refrigerator as well as shelf space. A small, e.g., 4 channel, autoanalyzer may be included in this laboratory if the number and complexity of tests warrants.

7. Kitchen

   The kitchen in a clinical studies unit may be equipped with "domestic" facilities, e.g., a range, freezer, refrigerator and sink. The kitchen, however, requires more work and storage space (including refrigerated frozen storage) than a normal domestic kitchen.

8. Dayroom

   A dayroom should be provided for patient recreation and relaxation.

   Since most of the patients are ambulant and capable of taking their meals out-of-bed, the dayroom may be utilized for group dining.

9. Offices

   a. Nurse supervisor's or head nurse's office

   b. Dietitians' offices

   c. Physicians' offices

   d. Social worker's office

10. Meeting Room

    A room capable of accommodating groups of from 8 to 10 persons should be included on the unit for use during unit staff meetings, instruction of nursing or medical students, etc.

11. Conference Room

    A large conference room, to accommodate groups of 15 to 25 persons, should be accessible from the unit. This space may be located to facilitate joint use by several units on one floor or adjacent floors.

528 GASTROENTEROLOGY UNIT

528.1 USER NEEDS

The extent of the services offered by the gastroenterology unit will be determined by the V.A. Central Office in conjunction with the staff of the individual facility.

Two basic service patterns are currently being followed.

1. The gastroenterology unit may provide diagnostic and consultative service only. Gastroenterology patients would be assigned to general medical wards.

2. The gastroenterology unit may include diagnostic facilities and a closely related ward for the care of gastroenterology patients.

The following discussion is limited to the first service pattern, that is, the gastroenterology unit as a diagnostic and consultative service. The requirements for gastroenterology patient care areas are essentially the same as those for general medical wards and need not be duplicated. The major distinguishing requirement for a gastroenterology ward is a need for close proximity to gastroenterology diagnostic facilities. These facilities are identical for both types of unit and are discussed in the following narrative.

528.1.1 Objectives

The gastroenterology section in V.A. hospitals provides diagnosis and treatment for diseases of the esophagus, stomach, intestine, and related organs, e.g., liver, gall bladder. The most common gastroenterological diseases encountered are ulcers and colitis.

The diagnostic procedures on the gastroenterology unit fall into four general categories.

1. Sample collection and analysis, e.g., secretary studies, biliary studies, stool analysis, and blood determinations.

2. Direct examination of patients, e.g., endoscopy, sigmoidoscopy, gastroscopy.

3. Fluoroscopic and radiographic examinations of the gastrointestinal system.

4. Measurements of physiologic variables, e.g., pressure differentials (manometry).

528.1.2 Operational Relationships

As indicated previously, a significant number of conditions studied in the clinical studies unit may involve the gastrointestinal system and fall within the field of interest of gastroenterology. For this reason, a close relation between the two units may be desirable. Such a relationship would facilitate interaction between the sub-specialties involved and would allow for joint use of diagnostic, laboratory, teaching and conference facilities.

The relationship to other functional units is generally non-critical. Priority should, however, be given to medical intensive and acute nursing units.

The procedures and equipment involved in the examination and diagnosis of inpatients and outpatients are the same. If appropriate access, waiting, and dressing facilities are provided, one gastroenterology unit may be able to conduct both inpatient and outpatient procedures.

It may be argued that sample analysis and fluoroscopic and radiographic examinations need not be done on the unit, but should be done in the central clinical lab and in radiology. The inclusion of these facilities in teaching hospitals not only allow for rapid diagnosis of emergency cases, but also serve as useful tools for comprehensive training of residents, interns and students. Exclusion from the unit will generate a need for frequent patient and staff travel from the unit to radiology and laboratory.

528.1.3 Characteristics

1. Environment

   The environment should be generally similar to a GM & S unit.

2. Organization

   Organizational factors include an ability for nursing personnel to observe patients continuously while they are on the unit.

528.1.4 Primary Users

1. Patients

   Most of the inpatients examined in the gastroenterology unit will be ambulant, but a few may be brought to the unit from other nursing floors in wheelchairs or on stretchers. Outpatients examined on the unit will generally be ambulant.

   All of the patients will be conscious and capable of following instructions; however, they may be confused or apprehensive and may require constant supervision while on the unit.

   For some procedures, e.g., secretory studies, the patients will be kept on the unit for a period of hours. During this time they may be able to engage in passive diversional activities such as reading or listening to the radio.

2. Physicians

   The gastroenterologist will engage in various diagnostic, consultative, administrative, teaching, and, perhaps, research activities on the unit. These can include, but may not be limited to, the following:

   a. direct examination of patients, e.g., endoscopy, sigmoidoscopy, and gastroscopy;

   b. fluoroscopic examinations;

   c. study of test results and dictation of diagnoses;

   d. consultation with patients;

   e. consultation with physicians from other specialty or sub-specialty areas of the hospital;

   f. performing special laboratory determinations;

   g. supervising and instructing technicians;

   h. consulting with and supervising gastroenterology residents;

i. instructing and demonstrating procedures for interns and medical students;

j. individual study and;

k. research studies.

In addition to these activities, gastroenterologists have responsibilities that involve them in other areas of the hospital. They will assume direct responsibility for the care of some patients on general medical units; consult with physicians in other areas of hospital; work in outpatient clinics; and will be involved in medical staff activities.

3. Residents and Interns

The activities of residents on the gastroenterology unit parallel those of the gastroenterologists. The residents will also be involved in individual study and possibly research. They should be able to carry on these activities without significant interruption of their clinical duties.

In addition to activities on the unit residents will be involved with consultative and patient care activities in other parts of the hospital. They may assume direct responsibility for care of patients in general medical units and may frequently assist the gastroenterologists in the care of their patients. They may also provide consultation to physicians and residents from their sub-specialty areas of medicine.

Assignment to the gastroenterology unit is not a normal part of an internship rotation program; however, interns will be introduced to the functions of the unit during their rotation through the medical service. They may come to the unit singly or in groups for consultation, observation, or for clinical presentations.

4. Nursing Staff

The gastroenterology unit is primarily a diagnostic rather than a patient care unit. For this reason, there will generally be a minimum need for nursing personnel assigned to the unit.

5. Medical Students

   Medical students may receive individual or group instruction on the unit. Provision should be made to accommodate groups of from eight to ten students during this instruction. It may also be desirable to allow groups of four or five medical students to study on the unit.

6. Technical Staff

   The technical staff assigned to the gastroenterology unit are trained to carry out certain measurement, sample collection, and analytical procedures. They will prepare patients for examination and may assist the physicians in medical procedures. In addition, they may observe and control patients on the unit, clean and maintain equipment, order, receive, and store supplies, and record test results. They may also be involved in processing x-rays. The number of technicians required will be determined by the patient load.

   Training for gastroenterology technicians is not currently provided in school. These technicians must, therefore, be trained through work and instruction on the unit. Facilities should be provided on the unit for meetings, discussions, individual instruction, and study as a part of a continuing technician training program.

7. Clerical Staff

   A secretary may be assigned to each gastroenterologist to transcribe diagnoses, handle correspondence, make appointments, etc. In addition, there should be at least one secretary-clerk to handle the general clerical work required for the operation of the unit. In large units or units with significant outpatient responsibilities, this secretary-clerk may also act as a receptionist.

8. Other Ancillary Personnel

   A radiology technician may be assigned to the unit to operate the radiography-fluoroscopy machine and process films. Depending on the patient load, hospital policy, schedule of operation, etc., this technician may be assigned on a full time, part time, or on-call basis.

9. Maintenance

   See 512.2

10. Building Management

    See 512.3

528.1.5 Trends

Increasingly complex and demanding laboratory procedures for gastrointestinal studies will probably be developed in the future; however, the basic methods of extracting samples and examining and treating patients should not change significantly. Future changes to the gastroenterology unit, therefore, may involve basic changes in facilities or services required.

528.2 FUNCTIONAL REQUIREMENTS

528.2.1 Functional Relationships

Figure 520-9 illustrates the optimum organization of clinical studies, hemodialysis and gastroenterology units. Figure 520-10 indicates a future possible relationship to gastroenterology nursing units.

528.2.2 Space Requirements

1. Gastric Studies Room

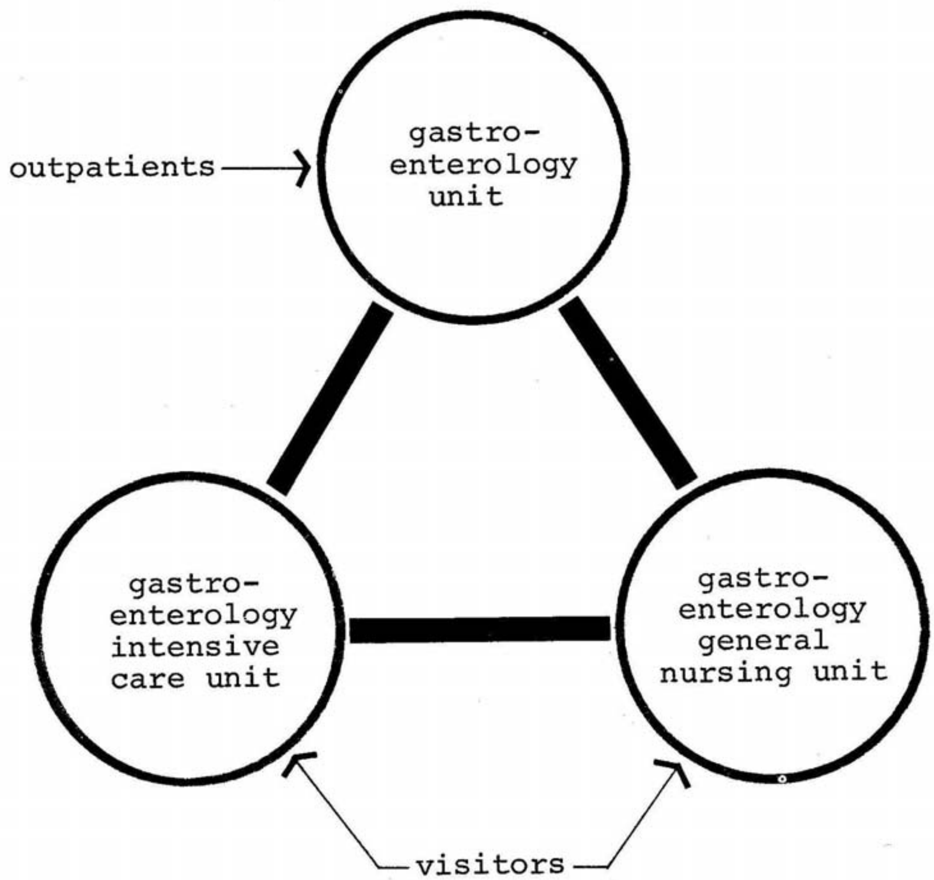
   This room should have space and facilities for the collection of gastric samples from several patients at one time. Required are seating for patients, sample extraction and collection apparatus with connection to vacuum outlets, countertop with space, a sink for handwashing, and storage for necessary supplies and equipment.

   It is necessary for a technician to observe and assist the patients at all times during collection of samples. Allowance should be made for the technician to remain in the room.

2. Manometry Room

   This space may be comparatively small. It must accommodate a cot for the patient to lie on, the manometry equipment, and space for a technician. Manometric studies may not be conducted in all gastroenterology units; therefore, inclusion of space depends on program.

Figure 520-10. GASTROENTEROLOGY UNIT: OPERATIONAL RELATIONSHIPS WITH RELATED NURSING UNITS



3. Examination Room

   All examination rooms on the unit should be equipped for endoscopy, sigmoidoscopy, and gastroscopy. They should include appropriate lighting, examination table, storage for necessary supplies and equipment, countertop work space, handwashing sink, and vacuum outlets. X-ray view boxes, and a small desk or writing surface for the use of the physician should also be included.

4. Radiography-fluoroscopy Room

   Provide a standard radiographic-fluoroscopy faculty with direct access to a patient toilet.

5. Dark Room

   If the frequency of use is sufficient, automatic developing equipment may be provided in this room; however, facilities for manual development should also be included.

6. Laboratory

   A laboratory equipped with work benches, a fume hood, sinks, storage space for reagents, equipment, and supplies, and refrigerated and frozen sample storage is desirable on the gastroenterology unit. As was mentioned previously, this may be shared with the clinical studies unit if proximity permits.

7. Utility Room

   This space is used for cleaning and storage of equipment and supplies. It should be equipped with a sink, countertop work surface, and storage space.

8. Offices

   a. Gastroenterologists' office

   b. Residents' office

   c. Technician's office

9. Conference Room

   A large conference room, to accommodate groups of up to 25 persons, should be accessible from the unit. This space may be located to facilitate joint use by several units on one floor or adjacent floors.

10. Medical Student Study Space

   This may be one room with several study cubicles or carrels and may be shared with other units on the same or adjacent floors.

11. Outpatient Facilities

   If a significant number of outpatients are to be examined on the unit, reception, waiting and dressing spaces should be provided.

529 HEMODIALYSIS UNIT

529.1 USER NEEDS

The hemodialysis unit is a treatment unit under the administrative responsibility of the hospital medical service.

529.1.1 Objectives

This unit provides space and facilities for the treatment of both inpatients and outpatients who have renal insufficiency.

The basic treatment on the unit involves bypassing the patient's kidney by channeling the patient's blood supply through special dialysis equipment which removes the toxins normally removed by the kidneys. These toxins are diffused through special membranes in the dialyzer and absorbed by a dialysate solution, which is then discarded. The processed blood is then returned to the patient's system.

529.1.2 Operational Relationships

Potential joint use of the unit by inpatients and outpatients indicates a need to locate the unit so outpatients and their relatives will not disrupt other inpatient unit activities.

Many patients with renal failure will be severely ill. In units treating this type of patient, adjacency with other intensive care units is desirable. Sharing of equipment, specialty medical consultation and emergency assistance can be encouraged by this proximity.

The interaction between the hemodialysis unit and clinical studies and gastroenterology units has been discussed.

529.1.3 Characteristics

1. Environment

   The unit environment should incorporate the characteristics of an intensive care unit with those of an ambulant patient social area. Certain patients in the unit will be critically ill while, in units with a home training program, other patients will be talking, watching television or engaging in other recreational activities during treatment. Two separate environmental areas or two separate units may be desirable where both patient types are treated. See 528.1.4.1, Patients.

2. Organization

   There are two systems of supplying dialysate solution to the individual patient dialyzers:

   a. The single patient system in which the dialysate supply unit and the dialyzer are both located at the patient bedside. The supply unit prepares and controls the fluid for the individual dialyzer.

   b. The multiple patient system consists of a central dialysate preparation unit, which supplies prepared solution to several bedside control stations and dialyzers.

   Space and facilities should be provided for both systems in the hemodialysis unit. Most treatments will utilize the central dialysate supply unit; however, some patients may require special dialysate solutions which could be prepared and supplied from individual bedside units. The inclusion of both systems also allows for emergency coverage at times when the central unit may be out of operation.

   Before treatment, the patient and equipment must be prepared and following treatment, the dialyzer must be disconnected, the patients cannula reapplied, and the reassembled prior to its next use.

   Due to unpredictable complications or delays the scheduling of treatments will remain somewhat flexible. Normally, the unit will be operated on a twenty-four hour, seven-day a week basis in order to accommodate these delays.

   During treatments, the patient's well-being depends on the proper functioning of the equipment. Any breakdown or malfunction may be harmful or dangerous to the patient. For this reason the staff should be constantly aware of equipment function and of the patient's condition. This may be accomplished through monitors built into the equipment and by physiological monitoring of the patient, but provision should also be made for constant visual observation by the nursing staff.

In addition to treatment facilities, allowance may be made for training of patients and their families in the use and care of home dialysis equipment.

529.1.4 Primary Users

1. Patients

   The patients treated in the hemodialysis unit fall into three general categories:

   a. Patients with chronic, irreversible renal insufficiency. These patients will require hemodialysis treatment approximately twice a week for the rest of their lives. They currently have to come to the hospital for treatment; however, many may be candidates for home dialysis programs if these are instituted.

      These patients are generally ambulant, conscious, and comparatively well. Some patients remain in bed during treatment; however, this is not required for all. Many may be more comfortable during dialysis if they can sit in suitable “lounge” chairs. While receiving treatment the patients may read, watch television, converse, write, sleep, or engage in any number of activities, which do not require movement out of bed or away from the dialyzer and control equipment. It may be desirable to treat most of these patients in one space to allow patient socializing and simplify nurse observation.

      Staph infections of implanted shunts are fairly common among these patients. Precautions should be taken to avoid the spread of such infections.

      Many patients will be apprehensive about their general health, family responsibilities, work, etc., and may need to discuss concerns of this nature privately with interested and qualified personnel.

   b. Chronic patients with temporary renal insufficiency due to disease or trauma. These patients may require hemodialysis for a period of days or weeks until their kidneys are sufficiently recovered to function effectively without assistance.

They will be admitted to the hospital and will be brought to the unit periodically from general nursing units. While on the unit, they require the level of nursing care normally accorded general medical or surgical patients.

c. Patients awaiting kidney transplants. These patients will be similar to chronic patients, but may be undergoing immunosuppressive therapy prior to surgery. They may, therefore, require fairly strict isolation during treatments. Physical isolation and normal hand washing and gowning techniques should be sufficient.

2. Physicians

The hemodialysis unit will be directed by physicians experienced in renal pathophysiology. These physicians direct the activities of the nursing and its technical staff as well as performing necessary examinations and treatments, e.g., implanting cannulas, removing clots from shunts, kidney biopsies, etc. While on the unit they may consult with other physicians and residents and they will be involved with individual and group instruction of interns and medical students.

In addition to these activities, these physicians have responsibilities that involve them in other areas of the hospital. They may assume direct responsibility for the care of some patients in general nursing units, consult with physicians in other areas of the hospital, work in outpatient clinics, or be involved in hospital staff activities.

3. Residents and Interns

The activities of residents parallel those of physicians on the hemodialysis unit. They assume many of the same responsibilities for patient examinations and special treatment procedures; however, their work is subject to evaluation and direction by the physicians.

Interns will also be assigned to the unit in certain instances.

4. Nursing Staff

   The hemodialysis unit will have a separate, full-time nursing staff assigned to it. They will assume responsibility for supervision and nursing care of the patients while they are on the unit and should be able to observe all patients and respond quickly to patient requests or emergencies.

5. Medical Students

   Medical students may receive individual or group instruction in the unit. The usual group size will be from eight to ten persons; however, groups of up to 20 may be involved in some sessions, e.g., clinical presentations. Facilities for these larger conferences may be shared with other units on the same or adjacent floors.

6. Technical Staff

   The technical staff will be responsible for the operation of the dialysis equipment. They will prepare the equipment for each treatment, check its operation during treatments, disconnect and remove equipment after treatments, dismantle, clean and reassemble dialyzers, and maintain all equipment in proper working order. They will also prepare the various dialysate solutions.

7. Clerical Staff

   A secretary may be available to each physician and in addition a secretary-clerk may be assigned to handle general clerical work.

8. Maintenance

   See 512.2

9. Building Management

   See 512.3

10. Dietary

   The manner and frequency of patient food delivery will be similar to a general medical and surgical unit. Outpatients treated in the unit will require regular meals or, in some cases, special diets.

529.1.5 Trends

The V.A. may well assume an increasing role in community care. This would undoubtedly bring about an increased demand for hemodialysis facilities in V.A. hospitals.

As more efficient, compact, and economic dialysis equipment is developed there may be an increased dependence on home dialysis. Facilities for training in home dialysis would therefore be indispensable in the hemodialysis unit. On the other hand, long range studies of dependency on dialysis equipment and procedures may tend to place higher value on transplantation, if immunosuppression problems can be managed, and if adequate donor supplies are available.

529.2 FUNCTIONAL REQUIREMENTS

529.2.1 Functional Relationships

Figure 520-9 previously illustrated the optimum organization of hemodialysis, clinical studies and gastroenterology units. In addition, close proximity to medical intensive care units would be desirable.

529.2.2 Space Requirements

1. Patient Room

   Two types of patient rooms may be included on the hemodialysis unit:

   a. Single bed rooms to be used for patients who are critically ill or isolated.

   b. A multiple bed room for other patients.

   Services at each patient bed station should include oxygen, vacuum, compressed air, power and dialysate disposal. Terminals should be provided at all beds for physiological monitoring equipment.

2. Patient Shower and Toilet Facilities

   A separate toilet and lavatory should be provided for each single bed room in addition to a shared toilet and lavatory for each multiple bed room. The need for bathing will occur but not for all patients. One shower is considered adequate for most units.

3. Patients' Dressing Area

   A patient's dressing room containing individual cubicles with chairs and lockers should be provided on the basis of one per bed plus two.

4. Nurses' Station

   This area, located for visual surveillance of the bed areas, will accommodate nurses and, at times, physicians or others. Space and facilities should be provided for nurse charting functions with adequate storage area space for patients' records and supplies. Space should also be allowed to accommodate terminals for patient monitoring equipment and future computer terminal.

5. Equipment Service Area

   The equipment service area will be divided into three sub areas:

   a. the soiled area for receiving, disassembling and cleaning,

   b. a clean area for sterilizing and reassembling,

   c. an area for storing prepared dialysate supply units and analyzers.

6. Dialysate Preparation Area

   The dialysate preparation area should contain the necessary concentrate, dilution tanks, and auxiliary equipment such as pumps, valves, heater, monitor and panel control devices.

7. Examination/Treatment Room

   An examination/treatment room similar to that provided in general nursing units should be provided

8. Biochemistry Laboratory

   The biochemical laboratory should contain facilities for biochemical, hematologic and/ or bacteriologic processing and/or analysis of specimens. This laboratory may be shared with other specialty units such as the clinical studies unit.

9. Kitchen

   A small kitchen for the preparation of snacks and the instruction of patients on special diets should be provided.

10. Offices

    Provide offices for physicians, secretaries, residents and a social worker's office (which may be shared with other units).

11. Storage Area

    Adequate storage should be provided for stand-by equipment and replacement parts.

12. Utility Rooms

    Clean and soiled utility rooms, clean and soiled linen storage, a housekeeping aide's closet, and stretcher and wheelchair storage should be provided.

13. Waiting Room

    A waiting room for patients and patients' families containing easy chairs, an occasional table, and book and magazine racks should be available near the unit.

14. Home Dialysis Training Area

    Space and facilities should be provided for training of patients and their families in the use and care of home dialysis facilities. These facilities are not currently provided but it is indicated that they will be required in the future.

5210 ORGAN TRANSPLANT UNIT

5210.1 USER NEEDS

The organ transplant unit is a newly developed treatment unit operating under the administrative responsibility of the hospital surgical service.

5210.1.1 Objectives

As organ transplant nursing unit serves post- and pre- surgical transplant recipients. Its functions include restoring or maintaining body function sufficiently for the recipient and the donor, post operative recovery care and counseling with the recipient and the relatives. Recipient patients often remain on the unit during their entire stay in the hospital. Donors are not normally cared for on the unit.

5210.1.2 Operational Relationships

Concepts concerning the facilities and organization of organ transplant units are still evolving, as are the technical skills necessary to successfully perform these procedures. Frequent introduction of new techniques, drugs and equipment can be anticipated. Radical reorganization of the unit both internally and as it relates to other hospital facilities is conceivable.

Developing patterns of transplant patient care indicate that individual units may be established for each organ, i.e., heart, kidney and in the future, liver, lung and others, where sufficient patient demand exists. Each unit should be relatively independent with separate equipment, supplies, diagnostic and treatment facilities and staff.

A transplant unit must provide a suitable environment for the entire range of patient illness intensity. In this respect the determinants of a relationship between this unit and other nursing units will be one of efficient utilization of staff, equipment and facilities. Continuity of care may be a factor if patients are to be transported to GM & S units. There is a question as to the value of a close relationship to surgery. Currently certain units have been constructed contiguous to surgery, but need for close relationship is infrequent. It is probable that most future transplant units will be located in close proximity to other intensive and specialty care units.

Table 520-6 indicates the major organ transplant unit operational relationships.

5210.1.3 Characteristics

1. Environment

   The desired environment for the unit will be similar to a GM & S or intensive care unit depending upon the degree of isolation desired and the severity of patient illness in a particular section of the unit. Many pre- and post-operative patients will require intensive nursing. Some patients need only a routine level of observation and care.

2. Organization

   Optimum organization for transplant units has not yet been determined. Several theoretical models currently prevail.

   Patterns of organization depend on the unit size. One model for a larger unit is illustrated in Figure 520-11. This provides separation of pre- and post-operative patients with shared support facilities.

5210.1.4 Primary Users

1. Patient

   Prior to entering the unit the patient and his family may have ambivalent feelings about the prospects for survival or well-being offered by transplantation. The patient's hopes will rise and fall during the course of his treatment, thus creating severe emotional strain. This strain may be further increased by having to ask a donor, perhaps a close relative, to give a vital organ. These tensions often lead to irrational behavior from the patient and his family. Frequent counseling and instruction concerning the procedures and risks of a transplant are required to alleviate this stress. Relatives are included in many discussion sessions. They must understand and accept the implications of transplantation, e.g., life long medication and possible rejection.

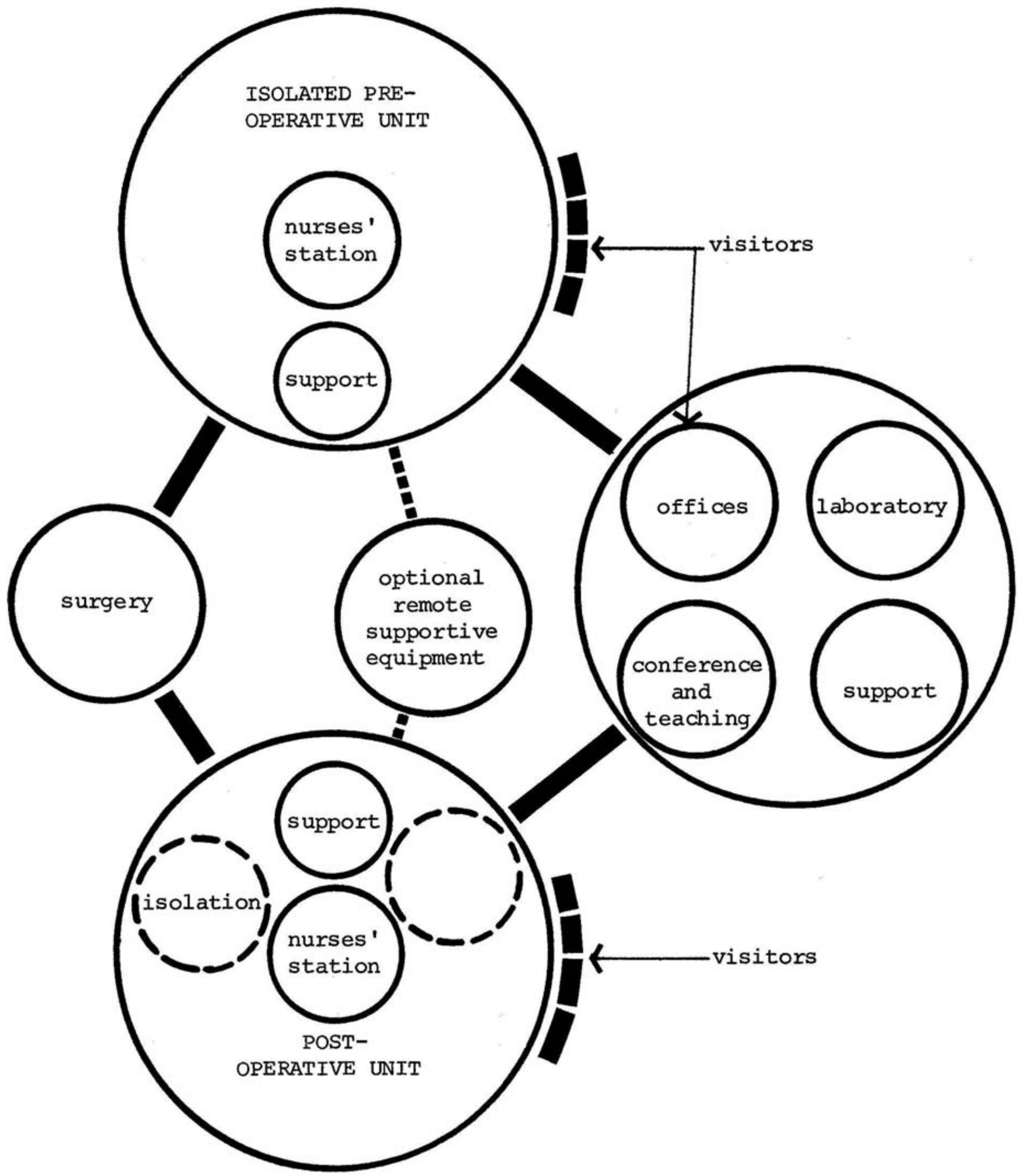
Table 520-6. MOVEMENT FACTORS: ORGAN TRANSPLANT UNIT

	Non-ambulant patient (stretcher)	Ambulant and wheelchair patient	Physician	Nurse	Technician, etc.	Students	Visitors	Material	Food	Drugs	Specimens	Supplies	Records
Cardio/Pulmon.	C U	C	M		F	M							
Diag. Radio.	C U	C	M		M	M							
EEG/EMG	C	C	M		M	M							
EKG			M		M	M							
ICU Units													
Inhal. Ther.					F								
Nuclear Med.	C	C											
Occup. Ther.													
Other D&T	C U	C	M		M	M							
Other Nurs.Units	C	C	F		F	F							F
Outpatient Clinic			F			F							
Phys. Ther.					M								
Rad. Ther.	C	C											
Surgery	C U		F			F							
Admin.			M				F						F
Canteen			F	F		F	F						
Dietary					F				F C				
Recreation, Etc.													
Supply & Process												F C	
Cent.Teach.Facil.			F	F		F							
Laboratory					F						F C		
Pharmacy					M					F			
Research			M			M							

F - High frequency
U - High urgency
C - Special Condition Factor
M - Some movement

Persons: Non-ambulant patient (stretcher), Ambulant and wheelchair patient, Physician, Nurse, Technician, etc., Students, Visitors
Material: Food, Drugs, Specimens, Supplies, Records

Figure 520-11. ORGAN TRANSPLANT UNIT: OPERATIONAL RELATIONSHIPS



A patient entering the unit may be gravely ill and require a considerable period of intensive treatment prior to transplant surgery. Usually immunosuppressive drugs are started 7 to 10 days prior to surgery. During this period the patient is more susceptible to infection and may require protective isolation. Body fluids and other body functions will be measured frequently. Hemodialysis is often required for kidney transplant patients. Computers and other instrumentation will be increasingly used in care of such patients.

After surgery the patient will, in most cases, bypass the recovery room and be transported directly to the nursing unit. The patient room should be relatively pathogen free and isolated from all non-essential traffic. Protective isolation using techniques similar to those in surgery may be required for the first 48 to 72 hours. The surgeon may require the use of laminar air flow room for certain patients. If isolation is desired food and supplies may be wrapped and delivered in sterile utensils.

Intensive nursing is required for the first 48 to 72 hours. Unless complications develop, patients may be transferred to a multi-bed unit after this period. Within three days the patient may begin to walk; however, physiological functions continue to be carefully measured. Dialysis of renal patients may also be continued.

The risk of post-operative infection is high. Patients may develop convulsions, septic shock, psychosis, diabetes, myocardial infarction, pneumonia or other conditions, which require long periods of hospitalization.

The average length of hospital stay may be 30 days. During the later stages of hospitalization, the patient may be ambulant and on occasion leave the hospital for short periods of time.

2. Physicians

Surgeons normally assume responsibility for patient care on an organ transplant unit; however, a diverse number of medical specialties are involved in sustaining a patient both pre-and post-operatively. Consulting physicians require access to the patient, patient chart, nursing personnel and other physicians. Group discussions involving students, residents and other technical persons are common.

Diagnostic and treatment procedures are performed on the unit where possible. Group discussions involving students, residents and other technical persons are common. Diagnostic and treatment procedures are performed on the unit where possible. Results of laboratory tests should be available within four hours. Access to clinical laboratory facilities should therefore be available for them on a 24-hour basis.

3. Nursing Staff

Continuous patient observation and intensive care will be required for extended periods of time. Psychological pressures are considerable; the rejection of a transplanted organ may have a severe impact on staff morale. The environment should be such that the "intensity" of the unit is diminished. In addition, the staff should have an area for relaxation away from the direct pressures of patient care. Space for change of shift conferences, consultation with physicians and for inservice or student training programs should also be available.

Nurses' work areas should generally be acoustically isolated to avoid patient disturbance and to provide privacy for confidential conversations.

4. Trainees

Teaching programs will be similar to those of other intensive care units. Closed circuit television should be used where possible to minimize unnecessary traffic on the unit.

5. Supporting Staff

Staff activities will be similar to those of other intensive care units.

6. Visitors

Visitors are an important consideration on a transplant unit. They maintain patient morale and, in the case of relatives, will provide an important component of the required lifelong care.

The patient should be able to see and communicate with visitors at all times during his stay on the unit. Closed circuit television or preferably, direct observation through a glass partition, coupled with an audio system, will be required during periods of isolation. At other times direct contact is desirable; however, visitors should not disturb other patients on the unit.

5210.1.5 Trends

1. Medical Care

   It is probable that the total number of patients in organ transplant units will increase and also that the number of specialized units may increase. Transplantation of a wide variety of organs may be possible in the future.

   Advance in the science of immunology on the other hand, may eventually eliminate the need for isolation facilities or even specialized units.

2. Technology

   The use of equipment for a variety of purposes will undoubtedly increase. The prime design parameter is adaptability: the ability to change components with a minimum of disruption or to totally dismantle and reorganize a unit in an economical manner.

5210.2 FUNCTIONAL REQUIREMENTS

5210.2.1 Functional Relationships

Ideally, each specialty transplant unit would relate to:

1. intensive care beds of the same medical specialty;
2. acute beds of the same medical specialty,
3. other organ transplant units;
4. the hemodialysis unit (renal transplant only) and;
5. surgery

5210.2.2 Space Requirements

1. Patient Rooms

   Patient rooms may consist of isolation rooms and multi-beds rooms. Isolation rooms will be similar to those currently provided for septic cases. A gown, mask and sterile glove techniques may be used. The room and furnishings will be washed down with an antiseptic solution prior to occupancy and frequent cultures will be taken to insure the adequacy of isolation techniques and of mechanical HVC system. Air pressure will be carefully regulated to maintain a positive pressure in the patient room; however, air locks are not required. Dialysis and other machinery should be centralized if possible. Hand washing, lavatory and toilet facilities should be provided within the isolation space.

   Multi-bed rooms should house four patients each. They will be similar to GM & S bed rooms with the exception of leads from the centralized monitoring and supportive equipment to the patient bed. Meals will be served on trays at the patient's bed. Visitors will be allowed to enter the area.

2. Nurses' Work Space

   The nurses' ability to observe patients in all bed areas of the unit should be maximized. This will reassure the patient as well as allow constant observation by staff personnel.

   Three distinct nursing centers may be established, depending on the size of the unit; for pre- operative patients, for isolation and for post-isolation patients. Continuity of care is important for staff morale as well as patient care; therefore, individual nursing centers should relate to one another and allow a free interchange of nurses.

   Other staff facilities such as storage, utility, medications, etc., will be similar to other intensive and intermediate units.

3. Dayroom

   A dayroom for post isolation patients is desirable.

4. Office and Conference Space

   Multi-discipline conferences will be frequent as will teach seminars and lectures. Adequate space available to the unit should be providing for this. Closed circuit television to this area from every patient room should be available. X-ray view boxes, dictation equipment and a small library are also desirable in this area.

   Offices for all full time staff should be adjacent to the unit. Additional space is required for psychological testing of donor and recipient, family counseling, etc.

5211 CARIDIO-PULMONARY UNIT

5211.1 USER NEEDS

The cardio-pulmonary unit is a relatively new diagnostic unit operating under the administrative responsibility of the hospital medical service.

5211.1.1 Objectives

The cardio-pulmonary unit provides the space, facilities and staff required to carry out diagnostic studies of the heart and/or lungs.

A broad range of diagnostic studies may be conducted in a cardio-pulmonary unit, for example:

1. Heart:

    a. Measurement and recording of the electrical currents generated by the heart muscle as it works, e.g., electro-cardiography

    b. Graphic representation and analysis of the sounds produced by the action of the heart, i.e., phonocardiography

    c. Measurement of blood pressure and blood pressure differentials

    d. Fluoroscopic and radiographic visualization of the heart

2. Lungs:

    a. Measurement of lung volume

    b. Measurement of ventilatory function of the lungs

    c. Measurement of the gas exchange function of the lungs

    d. Fluoroscopic and radiographic visualization of the lungs

5211.1.2 Operational Relationships

The cardio-pulmonary unit requires a large investment in equipment and a highly skilled staff. It is probable, therefore that, in most facilities, one will serve both inpatient and outpatients.

Inpatients coming to the unit will generally be ambulant or in wheelchairs. In certain instances, however, critically ill patients will be brought from intensive care units. In addition, certain types of organ transplantation patients will require diagnostic procedures in the unit. Proximity to medical and cardiac care units and organ transplant units would minimize the risk in transferring patients.

Cardio-pulmonary technicians are trained to deal with emergencies that may arise on the unit. These technicians may be assigned to the cardiac emergency team, which will respond to emergencies anywhere in the hospital. Intensive care and cardiac care units are the most likely areas for such emergencies. Close proximity to these units would facilitate emergency care by these technicians.

Medical specialists and certain technical staff consult during surgical procedures. A close relationship between the unit and surgery would maximize staff utilization consultation.

Outpatients should be able to come to the unit with a minimum of inconvenience and without disrupting the activities on other nursing units.

There are significant similarities between the training of cardio-pulmonary technicians and inhalation therapists. Much of the equipment used in cardio-pulmonary and inhalation therapy units has similar operational and maintenance requirements. A close relationship between these two units might facilitate cross utilization of these trained personnel. Such a relationship might also enable a joint use of some equipment.

5211.1.3 Characteristics

1. Environment

   The environment should provide an aseptic and efficient space in which to conduct technical procedures. Patient stay is relatively short but their level of apprehension will, at times, be high.

2. Organization

   There are strong clinical reasons for combining facilities for the study of these two organs. A primary disease in either the heart or the lungs will generally lead to a secondary involvement of the other. A thorough diagnosis, therefore involves studies of both the heart and lungs.

   Staffing advantages can also be realized through combined facilities. The technical training required for diagnostic procedures of the heart and lungs is similar in many respects. Combined facilities allow for utilization of trained personnel in both areas of study.

   In part, the same equipment is used for studies of the heart and lungs. A combined cardio-pulmonary unit, therefore, eliminates the need for duplication of such equipment.

   Physiological monitoring may be required during many of the tests.

5211.1.4 Primary Users

1. Patients

   As previously stated, both inpatients and outpatients may be examined in the cardiopulmonary unit. Routine heart and lung studies are not particularly hazardous and may be done on an outpatient basis. Studies such as cardiac catheterization and pulmonary angiography, however, require hospitalization due to the fairly high risk of complications during and after these procedures.

   Most patients currently examined in V.A. cardio-pulmonary units are inpatients admitted in an acute or semi-acute condition and who are undergoing diagnostic studies to ascertain the extent of disability. Such patients will undoubtedly make up a significant portion of the patient load in cardio- pulmonary units in the future; however, the proportion of outpatients examined should increase with growing emphasis on early diagnosis and preventive care.

   Patients coming to the cardio-pulmonary unit may be weak and may tire easily. Provision should therefore be made for patients to be seated while awaiting testing or between multiple tests.

Some patients will have to change clothing prior to examinations. Provision should be made for dressing and secure holding of patient possessions and clothing during examinations.

Patient apprehension may be reduced by encouraging socializing while waiting and by providing reading material. Apprehension may also be minimized if waiting patients cannot see or hear examinations or tests being conducted on other patients.

Many patients examined in the cardio-pulmonary unit have heart conditions. It is possible that some of them may be in danger of cardiac arrest while in the unit.

2. Physicians

Patients may be referred to the cardio-pulmonary unit by many specialist on the hospital staff; however, cardiologist are most directly involved in the operation of the unit. Physicians need not be involved in many routine procedures; however, they conduct complex procedures, e.g., cardiac catheterization or pulmonary angiography.

It is desirable that physicians be readily available to the unit during normal hours of operation both for consultation with residents, interns, and technical staff and to respond quickly to emergencies.

Additional physician activities include patient interviews and examinations, consultation with other physicians, instruction of medical students in groups or individually, group meetings of professional staff or unit personnel, evaluation of test results, dictation and individual study.

3. Residents and Interns

The activities of the residents on the cardio-pulmonary unit parallel those of physicians with the exception that residents will be more routinely involved with unit operations.

The cardio-pulmonary unit is not a normal assignment in an intern's rotation through the services of a hospital. Interns may, however, come to the unit for consultation, group discussion or demonstrations. They may also assist physicians and residents in diagnostic or treatment procedures.

4. Nursing Staff

Some procedures, conducted on the cardio-pulmonary unit, require nursing assistance, e.g., cardiac catheterization and pulmonary angiography. In addition, many of the patients examined on the unit require nursing care and observation. A full time nursing personnel should be assigned to the unit.

5. Technical Staff

The technical staff administers routine studies in the unit. They set up testing equipment, prepare patients, instruct, observe, and assist patients during testing, record results, observe and adjust equipment during testing, disconnect equipment after testing, clean and maintain equipment as needed, and do routine laboratory tests, e.g., blood gas analysis. The technical staff also assists the physician during complex procedures. Academic training for cardio-pulmonary technicians is not currently provided, therefore there are usually trained in V.A. cardio-pulmonary units. Training will be through direct involvement with procedures and by seminars, discussions, and demonstrations. These sessions will generally involve a small number of technicians. They may utilize training aids such as x-rays, movies, slides, color T.V., computers, etc.

The technical staff will be supervised by a head technician. This technician will coordinate technical staff activities, work schedules, and instruct the technical staff as necessary.

6. Medical Students

Medical students may come to the unit for individual or group instruction or demonstration and, may assist with some of the unit's procedures. Their involvement with the unit will, however, be on a short term basis and they may go elsewhere in the hospital for individual study.

7. Support Staff

   Clerical personnel may be assigned to the unit to maintain unit records, transcribe diagnosis, and provide general secretarial services to physicians and residents.

   If a significant number of outpatients are to be examined on the unit, these clerical personnel may also act as receptionists.

8. Radiology

   X-ray technicians will come to the unit from radiology to assist with cardiac catheterization and pulmonary angiography procedures.

9. Maintenance

   See 512.2

10. Building Management

   See 512.3

5211.1.5 Trends

1. Medical Care

   The incidence of diseases of the heart and lungs has been increasing in the recent past and there is no indication that this increase will not continue in the future. The patients load in cardio-pulmonary units should, therefore, continue to increase.

   As noted earlier, the proportion of outpatients on the unit may increase, with growing emphasis on preventive care.

   A greater patient load may also bring about a demand for special cardio-pulmonary patient care units, specifically, cardio-pulmonary intensive care units and cardio-pulmonary general nursing care units. If developed, these units would ideally be located close to the cardio-pulmonary unit.

2. Technology

   Continued development of physiological monitoring equipment may have significant effects on the cardio-pulmonary unit. More versatile telemetric equipment should simplify testing procedures by eliminating the need for direct attachment between patients and equipment. This would be particularly helpful in procedures such as cardiac catheterization where the amount of monitoring equipment in the room and monitoring leads attached to the patient severely restrict patient and staff mobility during procedures.

   Increased use of computers in relation to patient monitoring and diagnosis is likely on the cardio-pulmonary unit.

   More complex laboratory procedures for heart and lung diagnosis and increased use of radioisotopes are probable in the future. This would imply a closer interaction between cardio-pulmonary units and central clinical laboratory and radioisotopes facilities.

5211.2 FUNCTIONAL REQUIREMENTS

5211.2.1 Functional Relationships

Ideally, the cardio-pulmonary unit would relate to:

1. medical intensive care unit;
2. cardiac intensive care unit;
3. inhalation therapy unit;
4. organ transplant unit;
5. surgery;
6. pulmonary intensive care units and;
7. pulmonary intermediate care units.

5211.2.2 Space Requirements

1. Cardiac Catheterization Laboratory

   This space is used for radiographic and fluoroscopic studies of the heart and lungs. These studies involve the insertion of a catheter into the patients' heart or lungs through the circulatory system, extraction of blood samples and injection of contrast media. Elaborate radiographic and fluoroscopic equipment may be required for these studies, e.g., biplane fluoroscopy and radiography, cinefluoroscopy, image intensifiers, rapid cassette changers, etc. In addition, a thorough range of physiological monitoring equipment is needed to keep track of the patient's condition during procedures and warn of impending emergencies. Equipment to deal with possible emergencies must also be available, e.g., a defibrillator and resuscitator. Exercise equipment and equipment to measure ventilatory function, volume or gas exchange function of the lungs may also be required. The necessary equipment and instruments required for the insertion of catheters, extraction of samples, and injection of contrast media must also be at hand during procedures.

   In addition to the above equipment, there may be as many as 13 or 14 persons present in the cardiac catheterization laboratory during complex procedures.

   The insertion of the catheter is considered a minor surgical procedure, therefore, aseptic precautions usual for minor surgery should be observed.

   Vacuum, oxygen, compressed air, and, optionally, nitrous oxide may be used in the cardiac catheterization laboratory.

   The following spaces may be considered ancillary to the cardiac catheterization laboratory.

   a. Utility room. For cleaning and storage of equipment and supplies needed in the cardiac catheterization lab. This space may also be equipped for flash sterilization of equipment during procedures, depending on overall hospital supply policy. Countertop work space, a sink, and shelving for storage are required.

b. Scrub space. Facilities should be provided for the physician and assistants to scrub before procedures.

c. Shower and gowning facilities. Facilities for the cardiac catheterization team to shower and gown should be provided.

d. Dark room. A dark room should be provided. It would be desirable to install automatic developing equipment to minimize film processing time; however, manual developing equipment may be adequate for a minimal facility.

e. Control room. A control room or both is required for remote operation of the radiographic and fluoroscopic equipment.

f. Monitoring and recording room. To minimize the number of personnel and quantity of equipment in the procedure room, it may be desirable to provide a separate space for the monitoring terminals and recording equipment. If provided, this space would require direct connection to monitor leads in the procedure room. Convenient access and direct observation should be provided between this space and the procedure room.

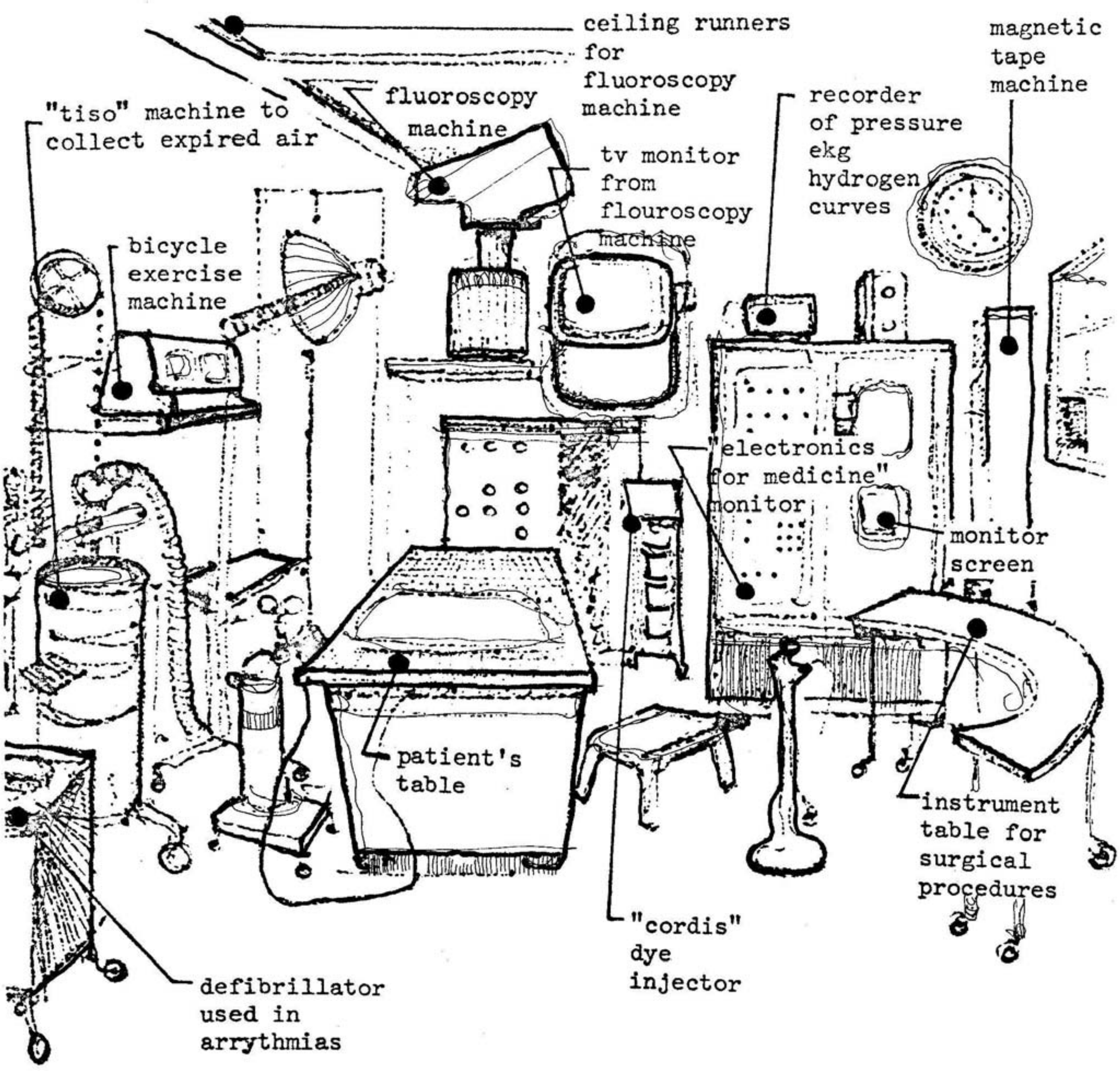
2. Laboratory

A small laboratory should be provided in the cardio-pulmonary unit for blood-gas analyses and routine biochemistry procedures. This lab requires countertop work space, equipment storage, space for special equipment, e.g., blood gas analyzers, vacuum outlets, and a sink with normal service. The lab is used during cardiac catheterization and pulmonary angiography procedures and for analyzing samples collected during pulmonary function determinations. Accuracy in some cardio-pulmonary lab determinations, e.g., blood gas analysis, requires a minimal time lapse between collection and analysis, therefore, this lab should be easily accessible from collection spaces.

3. Utility Room

A utility room may be provided for the cleaning and storage of equipment and supplies, e.g., mouthpieces, tubes, etc. used in pulmonary function and other studies.

Figure 520-12. CARDIAC CATHETERIZATION UNIT: San Francisco General Hospital



The provision of such a room will depend on hospital and unit supply collection, processing, and distribution procedures. The room should be equipped with countertop work surface, storage shelving, and one or more sinks with normal service.

If the relation to the inhalation therapy unit permits, this room may be a joint use facility for both units.

4. Equipment Storage

   Much of the equipment used in cardio-pulmonary units is portable or likely to be available in portable models in the near future. This equipment should be easily moved from storage to the examination and testing spaces. Additional back up equipment or equipment to be used on patient care units for those patients who cannot be brought to the cardio-pulmonary unit may also be stored here.

5. Pulmonary Function Laboratory

   Routine patient examinations and tests are performed in this laboratory to evaluate the functions of the lungs, e.g., measurement of lung volume, gas exchange function, and ventilatory function. Each patient will be tested individually and will be under the direct supervision and observation of a technician.

   If the cardio-pulmonary unit is a combined inpatient and outpatient facility, this lab may have a fairly high outpatient load and should be provided with easy access to outpatient reception and waiting areas on the unit. Convenient access to equipment storage and utility space is also required.

   Oxygen, vacuum, carbon dioxide, and carbon monoxide may be utilized in the various tests conducted in the pulmonary function lab.

   Several patients may be undergoing tests simultaneously in this space. It would be desirable to provide for acoustic and visual separation of these patients. Such separation should not, however, interfere with staff observation during testing or with emergency procedure.

6. Electrocardiographic Laboratory

   This laboratory provides facilities for studies of the function of the heart through external measurement and graphic recording of the electrical impulses generated by the heart as it works, e.g., electrocardiography and vectocardiography. Studies involving measurement and graphic recording of the sounds produced by the working heart also may be conducted in this lab, e.g., phonocardiography.

   These studies may be conducted while the patient is at rest and during or after specifically defined and measured exercise periods. Therefore, in addition to the electrocardiography or phonocardiographic equipment, space and facilities are required for exercise equipment and for the patient to sit or lie down during tests.

   The E.C.G. lab, like the pulmonary function lab, may have a significant outpatient load and should be provided with access to outpatient reception and waiting areas on the unit.

   Several patients may undergo tests simultaneously in the E.C.G. lab. Acoustic and visual separation between theses patients would be desirable but is secondary in importance to adequate staff observation and emergency treatment procedures.

   In some cases it may be desirable to provide electrocardiographic and pulmonary function facilities in one laboratory. This would allow for monitoring of heart function during pulmonary procedures without duplication of E.C.G. facilities. It would allow for joint use of such equipment as treadmill or bicycle exercise machines.

7. Offices

   a. Physicians' Offices. Offices for physicians directly involved with the cardio-pulmonary unit may be required. These offices should allow for a normal range of office activities, including examining x-rays. It is desirable to provide outside exposure for these offices.

   b. Residents Offices. Offices similar to those for physicians may be required for residents on the unit. Due to variability in the number of residents on the unit at any one time, some flexibility may be necessary in the assignment of these offices, e.g., certain offices will accommodate two residents.

c. Head Technician's/Nurse's Office. An office may be required for the use of the head technician and the full-time nurse.

d. Clerical Office. If clerical personnel are assigned to the unit a clerical office should be provided. This office should be closely related to the physicians' and residents' offices, but may also require some proximity to reception and waiting areas.

8. Technician Station

The technicians will require some facility for writing, storing paper and forms, etc. In small cardio-pulmonary labs this may be included in the testing space: however, in larger facilities a separate space may be desirable.

9. Meeting Room

A small meeting room to accommodate ten to twelve persons should be provided on or adjacent to the unit for teaching, consultation, unit staff meetings, etc.

10. Conference Room

A conference room to accommodate groups of up to 30 persons should be reasonably accessible from the unit. This may be shared with other units on the same floor or adjacent floors.

11. Patient Waiting

An area to accommodate waiting patients should be provided on the unit. If the outpatient load is small, a fairly precise schedule of patient examinations may be followed. Inpatients can be brought to the unit at specific times for their examinations; therefore, the need for waiting space is minimized. If, on the other hand, there is a large outpatient load, scheduling is much more flexible and the need for waiting space is greater.

12. Patient Dressing

If outpatients come to the unit, there will be a need for patients to change clothing prior to testing. Specific facilities may be required for this. These should provide adequate privacy and some provision should be made to protect patient clothing and valuables during testing.

5212 TEACHING

5212.1 USER NEEDS

A large proportion of the new V.A. hospitals will be affiliated with university medical schools throughout the country. Educational space requirements may vary considerably according to the program of the individual hospital and affiliated medical school; however, facilities within the following categories will certainly be included:

1. facilities located on a unit and used basically by personnel assigned to that unit;

2. facilities located in close proximity to two or more units and used primarily by personnel from these units, and;

3. central facilities, not associated with specific patient care or diagnostic units, for general use in educational programs.

   The scope of this study is limited to nursing area potions of the hospital; therefore, facilities in the first two of these categories are the prime consideration.

5212.1.1 Primary Users

The following is a list of trainees, classified by hospital activity, who may require educational facilities in nursing areas on or adjacent to nursing units.

1. Medical Service

   a. Resident intern - 2 to 4

   b. Dialysis technician - 15

   c. Pulmonary function technician - 15

   d. Medical student - 6

2. Nursing Service

   a. Basic nursing student - 6

   b. Graduate nurse - 1

   c. Intern/resident nurse - 1

   d. Practical nurse - 4

   e. Nursing assistant - 6

3. Psychiatry

   a. Resident/intern - 2

   b. Medical student - 1

4. Psychology

   a. Psychology student (M.S. or Ph.D.) - 1

5. Social Work Service

   a. Social work student - 1

   b. Social work assistant - 1

6. Surgical Service

   a. Resident/intern - 2 to 4

   b. Medical student - 6

5212.2 FUNCTIONAL REQUIREMENTS

Activities of the various trainees may include individual study, individual or group instruction and discussion, observation and/or participation in patient care and diagnostic activities, laboratory work, and/or trainee research. The facilities required for each trainee category depend on the nature of their involvement with these activities. All trainees will be involved in group instruction or discussion and classroom facilities should be provided in conjunction with those units to which trainees may be assigned. The following trainees require additional facilities as noted.

5212.2.1 Space Requirements

1. Residents and Interns. Residents and interns assume a major responsibility for patient care in all of the units under consideration. They should be also provided with offices on the unit and should also have access to laboratory facilities on or adjacent to the unit.

2. Medical Students. Medical students are also involved in patient care and should have access to private facilities for patient examinations and confidential discussions. Spaces such as exam/treatment rooms or consultation rooms should be available to these students for such use. In most cases, offices for medical students are not required and individual study carrels on or adjacent to the unit should be adequate. One exception to this is the psychiatric unit. The medical student on the psychiatric unit may require private office/interview space in which case carrels may not be sufficient. Medical students should also have access to laboratory facilities on or adjacent to units on which they are working.

3. Psychology Students. Each psychology student should be provided with a private office.

4. Nursing Students. Nursing students are trained by nursing instructors not assigned to the unit nursing staff. Office facilities should be provided for these instructors on or adjacent to the units in which they are teaching. The students themselves should have access to study carrels on or adjacent to the unit.

5. Graduate Nurses. Graduate nurses should be provided with study carrels on or adjacent to the units to which they are assigned.

6. Intern/Resident Nurses. Office facilities should be provided for intern/resident nurses.

7. Social Work students and Assistants. Office space should be provided in which social work students and assistants may conduct confidential interviews with patients and their families.

8. Technician Trainees. Technical trainees should have access to study carrels in close proximity to their work areas.

In addition to the spaces mentioned above, some allowance may be required in other areas of the nursing unit to facilitate teaching functions.

9. Patient Room. The patient room becomes an educational facility during ward rounds. There should be sufficient space to allow students and staff to gather around the patient's bed without excessive rearrangement of furniture.

10. Examination/Treatment Room. The examination/treatment room may also serve as a demonstration room where groups of students may observe and assist in patient care and diagnostic activities. As in the patient room, there should be sufficient space to allow a number of students to observe proceeding clearly and in reasonable comfort.

11. Consultation Room. A consultation room may frequently serve as a small classroom or seminar room. Additional consultation facilities, beyond current criteria, may be desirable to facilitate such activities.

5213 RESIDENTS' QUARTERS

5213.1 USERS NEEDS

5213.1.1 Objectives

Residents are "on-call" periodically during their term of service. The on-call period generally does not last more than one night consecutively; however, during this time, the resident is completely responsible for the care of patients in his specialty. Residents' quarters provide an in-hospital base during the on-call period.

5213.1.2 Operational Relationships

The relationship of the residents' quarters to other functional units is not critical. It is desirable, however, to minimize the resident's travel time to nursing units in his specialty.

There are two basic options for providing resident facilities: centralized and decentralized. Centralized facilities group private and communal spaces for all residents in a location quickly accessible, yet separate from the activities of the nursing units. Decentralized facilities puts private spaces close to a particular nursing unit, and provides a group lounge in a separate location.

5213.1.3 Characteristics

1. Environment

   Activities will include reading, quiet and noisy games, sleeping, eating (snacks), conversation, watching television and bathing. Appropriate environments should be provided for these activities

2. Organization

   The organization of the unit will vary depending on whether a centralized or decentralized facility is provided. In either case, the type of unit found in a typical V.A. hospital will generally resemble a hotel in organization.

5213.1.4 Primary Users

V.A. residents may either be male or female. Recently there has been an increase in female residents.

Residents may be called to care for patients at any time. They will often have to sleep at irregular hours during the day or night.

Discussions between residents when relaxing in the unit provide an important element in the learning process. These discussions should therefore be encouraged.

5213.1.5 Trends

The status of residents has greatly increased in the last few years. It is probable that this trend will continue. Salaries and the facilities provided for residents may more closely equal that of staff physicians in the future.

5213.2 FUNCTIONAL REQUIREMENTS

5213.2.1 Functional Relationships

All functional relationships are non-critical in nature. Proximity to nursing units desirable.

5213.2.2 Space Requirements

Options for centralized or decentralized facilities are outlined.

1. Centralized Facilities

    a. Bedroom. A small studio bedroom with a clothes closet and adjacent private bath will be sufficient. Double rooms and gang sanitary facilities are not normally feasible because of the increasing frequency of female residents

    b. Lounge. An area should be provided to allow for T.V. watching, card playing, informal conversation, reading and the like.

    c. Nourishment kitchen. All residents will eat their meals in the hospital dining facilities, but a small kitchen and adjoining eating area for snacks would be desirable.

d. Storage. Separate storage space for linen, general supplies and housekeeping supplies is required.

2. Decentralized Facilities

a. Bedroom. Individual bedrooms and bathing facilities may be provided on each nursing floor.

b. Lounge and nourishment kitchen. These spaces may be provided in centralized location separate from the nursing floors similar to the centralized facilities listed above.

5214 BIOMEDICAL ENGINEERING

Biomedical engineering is a new and rapidly expanding service in V.A. hospitals. It is concerned mainly with the design, development and construction of a wide range of special instruments, including such devices as cardiac pacemakers, artificial kidneys, and medical lasers, and ultrasonic transducers for application in the field of clinical medicine.

The manufacture of such instruments, which may require elaborate equipment, is not compatible with the bed-related patient care functions and, although the nursing units may use much of the instrumentation developed, it is recommended that biomedical engineering be regarded as a central support facility and located outside the general nursing tower.

530 Cost Base

531 GENERAL

531.1 Background

The data in this section have been collected and analyzed during three different phases of the Systems Integration program, each phase having a somewhat different scope.

531.1.1 In the first phase, four hospitals were analyzed for total construction cost and for the individual costs of four of the six subsystems finally included within the scope of the Prototype Design. The hospitals studied were three VA field stations - Atlanta, Washington and Martinez - and one community hospital in Watsonville, California. The relevant subsystems were structure, ceiling, partitions and heating-ventilation-cooling. For the resulting data, see the Phase 1 Research Study Report, Volume 2, Section I.C.

531.1.2 In the second phase, two more VA hospitals - Miami and Memphis - were added, but only the bed care areas of these buildings were analyzed. This data is presented in the Phase 2 Research Study Report, Volume 3, Section 350.

531.1.3 In the third phase, two more subsystems were added - plumbing and electrical subsystems. The analysis was also somewhat more detailed than in the previous phases. It included a breakdown by functional area classification for all subsystems in the support areas of the hospital, except structure, which is broken down by roof, tower floor and base floor. However, only Memphis and Miami were included in this final study. Therefore, the detailed cost breakdowns in this section are for those two hospitals only. A summary of total subsystem costs is given for all six hospitals.

531.2 SIMILARITIES AND DIFFERENCES

All of the hospitals studied have certain similarities. Each consists of tower nursing floors superimposed upon larger floors, which contain the clinical, administrative, and service facilities. The structural concept for each of the buildings is regular bays of concrete or steel framing. Services are principally vertical but vary considerably in the degree of mechanization involved. All are within the southern part of the United States and not subject to very low temperatures.

Only three of the hospitals could be characterized as high rise - those at Miami, Memphis and Atlanta. Of these, the Atlanta hospital has a steel structural frame; the others are concrete. The Washington VA hospital, the Watsonville community hospital and the Martinez VA hospital are four- to five-story concrete frame buildings, all of flat slab (plate) construction.

531.3 COST PARAMETERS

All costs stated in the Cost Base are given in dollars per outside gross square foot (OGSF) of either total building area or functional area, as appropriate. They are based on typical costs prevailing in the San Francisco area at a time when the national ENR Building Cost Index was 960. They include overhead and profit for both general contractors and subcontractors, and thus represent the proportionate part of the general contract paid by the VA for each item.

531.4 BASIC CONSTRUCTION COST

The average total contract for the six hospitals analyzed was $48.60 per OGSF. This figure is used in the Cost and Time Analysis (Section 750), to represent the typical cost of VA hospitals using conventional design and construction.

531.5 SUBSYSTEM COSTS

The six integrated subsystem together, in every instance, represent about 50% of the total construction cost of the buildings. The distribution of costs within them varies considerably with the design approach incorporated. The relative costs of the subsystems for each building are shown on Table 530-1. The scope of each subsystem represented by the data is given in the corresponding subsystem description in Section 300 of the Design Manual.

Table 530-1. SUMMARY OF SUBSYSTEM INSTALLED COSTS

Dollars per outside gross square foot of total building area ($/OGSF) adjusted to an ENR Building Cost Index of 960.

HOSPITAL	STRUC	CEIL	PART	HVC	PLUMB	ELEC	SUB-TOTAL	OTHER	CONTR TOTAL
Atlanta VAH	8.10	1.44	5.95	7.25	(2.15)	(2.11)	27.00	22.50	49.50
Washington VAH	7.58	1.71	6.35	8.24	(2.15)	(2.11)	28.14	23.08	51.22
Martinez VAH	5.86	1.56	6.28	7.61	(2.15)	(2.11)	25.57	22.35	47.92
Watsonville CH	7.33	1.26	5.73	8.62	(2.15)	(2.11)	27.20	24.49	51.69
Miami VAH	6.58	1.47	5.69	4.92	2.20	2.13	22.99	24.35	47.34
Memphis VAH	6.38	1.11	5.26	5.49	2.09	2.08	22.41	21.54	43.95
Average	6.97	1.42	5.88	7.02	2.15	2.11	25.55	23.05	48.60
Percent of total	14.3	2.9	12.1	14.4	4.4	4.3	53	47	100

Note: Plumbing and electrical costs were estimated for Miami and Memphis only. Figures in parentheses are the averages from these two hospitals applied to the other four to provide comparable integrated subsystem totals.

532 DESCRIPTION OF HOSPITALS STUDIED

532.1 STUCTURE

532.1.1 General

There is no use of pre-cast, pre-stressed or post-tensioned construction in the hospitals, although there is a limited use of pre-cast tees for large spans (chapel and auditorium) at Miami and a considerable use of pre-cast and non-structural exterior wall panels at both Miami and Memphis. The highest cost concrete frames occur in the two California hospitals because of the seismic force resisting elements, in spite of the fact that they are rather low buildings.

Establishing a cost for shear walls posed a special problem because it is impossible to tell, from an examination of working drawings, which concrete walls in a particular building were considered by the structural engineer to be acting as shear resisting elements in his calculations. Estimating therefore proceeded on the following assumptions: the structural concrete of any exterior wall which could transfer shear was counted 100% as structure. Any interior concrete walls, which enclosed the same type of spaces as are to be enclosed by the shear walls of the Prototype Design, e.g., stairwells and mechanical rooms, were counted 100% as structure. Interior concrete walls enclosing other types of spaces were assigned 50% to structure and 50% to partitions.

532.1.2 Miami, Florida, VA Hospital

This hospital consists of twelve floors plus basement and pipe basement and a two-story penthouse. The nine nursing floors are in a tower with characteristic bays of 16’10” x 24’10”. Floor heights are 11’8” floor-to-floor. Pan joists span the short dimension of each bay, supported by flat beams of equal depth (12” plus 2-1/2” slab). The structural floor is 1-1/2” below the finished floor, the difference allowing for recessed tile, filled with light-weight concrete. This has the smallest structural bay of any of the hospitals studied and is one of the most economical in structure. The concrete topping, although adding weight and cost to the structure, undoubtedly reduced the cost of labor and formwork required for the many floor recesses.

532.1.3 Memphis, Tennessee, VA Hospital

The Memphis field station is a thirteen-story building, with pipe basement and two-story penthouse. There are ten tower floors, which contain conventional wards, and one special floor for a spinal cord injury clinic. Floor heights are 11'11" floor-to-floor. Bays are 21'8" x 21'8". The structure is basically a waffle (two-way joist) system with typically 10" deep joists and 3" slab. There is no topping slab as at Miami so that recesses are formed by dropping joists and slabs as necessary. The factors which appear to make this system somewhat more costly than the Miami system are the large amount of form surface and the complications of changing floor elevations. Further, the bay sizes are slightly larger.

A two-story group of psychiatric wards in the base of the building is of similar construction to the tower, and the structure of the one-story intensive care unit on the roof above the second floor supports only its own roof and suspended ceiling.

532.1.4 Atlanta, Georgia, VA Hospitals

The Atlanta field station consists of nine floors of wards in a tower above a base composed of two basements and two general floors, with a mechanical floor separating the tower and base. The basic structure is a frame of rolled steel shapes supporting metal decking with concrete infill. Roof framing is similar to the floor framing. Fireproofing of the horizontal steel members is of the sprayed variety; columns and peripheral beams are fireproofed with poured concrete. Structural bay sizes are regular throughout the building and vary from 20' x 24' to 24' x 32'.

This is the only steel frame building in the group investigated. Its relatively high framing costs appears to result from the required fireproofing, particularly the formed concrete around all columns and edge beams (other members are sprayed) and its large bays, the largest in the group in the group of hospitals studied.

532.1.5 Watsonville, California, Community Hospital

The Watsonville hospital, along with all of the remaining examples, utilizes a flat concrete slab (plate). The bays are relatively large for this type of construction; thickness of the slab is 10". This condition, plus the extensive use of bearing shear walls instead of columns, has resulted in a large quantity of concrete per floor with correspondingly high unit cost.

The building was designed with four floors of wards plus mechanical penthouse above a larger one-story base; however, two of the ward floors were not constructed in the first increment.

532.1.6 Washington, D.C., VA Hospital

The field station at Washington, D.C., although very large in area, contains only four stories and a large basement. It is of reinforced concrete flat slab construction with 10" slabs forming the second, third and fourth floors and 12"slabs for the first floor and basement. The pattern of structural bays is fairly regular and in the range of 20' to 24' column spacing.

532.1.7 Martinez, California, VA Hospital

The Martinez field station is of reinforced concrete flat slab construction (9-1/2" slab throughout) with a base composed of a first floor and basement with three ward floors above. The exterior walls are mainly of poured concrete with brick veneer finish. The structural system is very similar to that of Washington, D.C, but has thinner slabs. Bay sizes are in a general pattern of approximately 20' x 24' throughout the building.

532.2 CEILINGS

532.2.1 All of the hospitals have suspended ceilings, generally some form of grid system with acoustic tile. The Miami hospital utilizes a plaster suspended ceiling adjacent to its corridors as a plenum for return and exhaust air; this double ceiling makes Miami's system one of the more expensive, but serves to reduce the cost of ductwork. Martinez and Washington contain a relatively large amount of metal pan acoustic tile. The Watsonville hospital is the only one to utilize gypsum board ceilings in areas where metal lath and plaster are typical of VA hospitals.

532.2.2 The Memphis hospital contained a large amount of metal pan acoustic tile in its original design, but a Central Office deductive change order in 1965 ($40,568) substituted fissured mineral fiber tile, a difference approximating $.25 per gross square foot on the ward floors. It should be noted that at hospitals where splined tile has been installed the system has been criticized by the maintenance personnel because of the difficulty of access to pipes and mechanical equipment above the ceiling. Generally, splines simply are not replaced where non- recurring maintenance has occurred. Also criticized was the use of lay-in ceilings on psychiatric wards and in bedroom closets.

532.2.3 There was no apparent integration of ceiling and lighting components in any of the hospitals except the normal placing of fixtures within the pattern of a ceiling grid. Ceiling fixtures are in practically all cases surface-mounted.

532.3 Partitions

532.3.1 General

There is very little on variety in the types of partitions. Typically, metal studs with lath and plaster separate rooms, corridors and lobbies, and masonry usually encloses shafts, duct space and stairwells. Finishes are similar, varying from regular weight wall vinyl in corridors of one hospital to heavy wall vinyl in corridors of another.

The Watsonville hospital, an exception, has painted gypsum board in many locations where vinyl-finished plaster is used in the other hospitals. No movable or demountable partitions are used on the ward floors in any of the six-hospitals studied, with the exception of a small amount at Martinez.

532.3.2 Miami, Florida, VA Hospital

The partitions at Miami are typically masonry and metal stud with lath and plaster, finished either in standard or heavy vinyl wall fabric. The bathrooms are finished in ceramic tile and a small amount of cement enamel surfacing occurs in housekeeping aide closets.

Large quantities of masonry partitions and ceramic tile were used at Miami. Masonry was used many times in places where metal studs usually occurred in other hospitals, like plumbing chases and small vertical shafts. Large quantities of ceramic tile are used in the kitchens, toilets, laundry areas, and baths. Door costs are lower than most because this hospital’s nursing floors have mostly five-bed rooms, which need less doors per floor.

532.3.3 Memphis, Tennessee, VA Hospital

Memphis, like Miami, has a large quantity of masonry partitions, which is not uncommon for the East. Metal stud with lath and plaster is used throughout. Vinyl wall surfacing is common in all areas of this hospital: heavy wall fabric in public areas like corridors and lobbies, and regular wall fabric in bedrooms, dayrooms, etc. The vinyl wall fabric cost is slightly higher here because smaller rooms are more numerous.

532.3.4 Atlanta, Georgia, VA Hospital

The interior partitions at Atlanta are metal lath and plaster on steel studs and masonry. Atlanta’s finishes are similar to the other hospitals, using ceramic tile in baths and related areas, cement enamels surfacing in housekeeping aide closets, etc. The significant difference is that the standard vinyl wall covering is used in both public areas and patient areas. There are more four-foot doors at Atlanta than at the other hospitals. This is because the bedroom sizes are smaller, more one- and two-bed rooms, which call for more doors for a given number of beds.

532.3.5 Watsonville, California, Community Hospital

The Watsonville partitions are unlike the other hospital partitions. They consist mostly of gypsum drywall facing on metal studs. Structural concrete walls are not included in the partition cost base. Finishes are either paint or vinyl wall fabric, mostly painted drywall.

532.3.6 Washington, D.C., VA Hospital

The Washington field station also has basic types of partition: masonry and metal stud. The metal stud partitions are covered with metal lath and plaster and then a vinyl wall fabric. The finishes are similar to those in Memphis, in that a standard weight vinyl is used in bedrooms and dayrooms and heavy vinyl in public areas. Cement enamel surfacing and paint are used in small service rooms throughout each floor.

532.3.7 Martinez, California, VA Hospital

The Martinez partitions are not unlike the partitions in Washington. They consist mostly of metal lath and plaster on steel studs and some masonry. Finishes again consist of standard and heavy vinyl wall covering, ceramic tile, cement enamel surfacing and paint.

532.4 HEATING-VENTILATION-COOLING

532.4.1 General

All of the projects have repeated nursing floors. Memphis, in addition to the tower wards, has two two-story wings of psychiatric wards and an isolated circular intensive care unit, which are on separate systems from the tower wards.

All of the nursing areas except for those at Watsonville utilize induction units in the bedrooms and ducted systems for interior areas. In the Miami VA hospital the induction units are in a ceiling plenum space adjoining the interior corridor; in all of the others they are below the windows. This accounts for the relatively small amount of ductwork and distribution cost in Miami, resulting in the least costly system of all of the hospitals studied. The Watsonville Community Hospital has a system ducted from rooftop fans down the outside walls of the bathrooms and then through reheat coils above the bathroom ceilings to each bedroom. No air is returned. This system results in extensive ductwork and air handing units and produces the highest unit cost.

532.4.2 Miami, Florida, VA Hospital

The Miami nursing areas contain a preponderance of five-bed rooms and are cooled and ventilated by a very simple and compact system of induction units in suspended ceilings adjoining bedroom corridors. Heat has never been required since the hospital was occupied in February 1968 but is available through the two-pipe induction system. Interior spaces are served by ducts from mixing boxes. Exhaust air from bedrooms is circulated through the hung ceiling plenum into the plumbing riser shaft at each bathroom to a fan on the roof. The system requires a very small amount of ductwork and air-handling equipment, but does call for more plaster ceiling than the others. If a need arises for large rooms to be partitioned into smaller rooms, it is unlikely that the system can be adapted.

High-pressure, dual-duct systems with terminal mixing boxes are used typically in all medical areas except for deep therapy and central sterile which are served by low-pressure, single-zone system. The surgical suite is provided with individual room reheat and humidification from a low-pressure, single-zone system. There is another low-pressure, single-zone system for the auditorium and cafeteria, and a similar arrangement with tempered air for the laundry and kitchen.

Air-handling units are either factory assembled or built up on site depending on size and type of system. General areas, P.M. & R., radiology, deep therapy, the cafeteria and the auditorium are supplied with 28 to 58% outside air. All other areas except those with induction units receive 100% outside air.

Scheduled maintenance of induction units takes 20 minutes per unit, quarterly, for the cleaning of filters, coils and grills. In the renal area this occurs weekly.

532.4.3 Memphis, Tennessee, VA Hospital

All areas served by single-duct systems from factory assembled air-handling units. Exhaust is typically 100%, except for the auditorium, and nursing areas, general areas and some medical areas, which have wall or ceiling induction units. Only medical areas have high-pressure systems. The surgical suite and intensive care unit have individual room reheat and humidification. Service areas such as the laundry, shops, kitchen and pool are heated and ventilated, but not cooled.

In the Memphis field station nursing wards, under-window induction units supply the peripheral bedrooms, and interior areas are supplied by ceiling induction units. All units receive warm air, and adjust temperature with chilled water coils.

The two-story psychiatric wards are served by a similar system, with an exceptionally complicated installation for the corridors, which increases the unit cost of the HVC in this area, particularly in the quantity of piping.

The 24-bed intensive care unit does not utilize induction units. It is supplied by a fully ducted system with complex controls. The circular shape of this ward appears to permit economic centralized distribution.

An interesting aspect of the distribution to the tower floors is the vertical stacks, approximately 11'0" x 7'9", at each of the four corners of the tower. The northeast and southwest stacks contain supply ducts and the others contain the exhaust systems. Access to these shafts is very difficult.

Extensive adjustment has been reported in the Memphis system to achieve adequate balance. Operating expenses for the first year appeared excessive, but apparently subsequent adjustments have corrected this situation.

532.4.4 Atlanta, Georgia, VA Hospital

The HVC system for the Atlanta wards is typical for recent VA hospitals. It consists of induction units in peripheral bedrooms and a simple ducted system for interior spaces. Almost all of the individual elements of the system are low or medium in cost, except for the terminals, which are relatively high in cost because of the nature of their integration with the other building components. Recirculation occurs only through the induction units.

532.4.5 Watsonville, California, Community Hospital

The Watsonville hospital has been utilized to illustrate a project which does not conform to VA standards but indicates trends in community hospitals, which might affect future VA planning. It is smaller than most VA hospitals, with a projected capacity of 202 beds. This factor to some degree produces a higher cost but it is not considered to be a major influence.

The Watsonville hospital utilizes 100% fresh air, tempered and controlled by reheat elements at each room. The air-distribution system, as previously explained is related to the patient bathrooms at the exterior walls.

This is the most costly system studied. However, the largest element of cost is in the ductwork which requires little or no maintenance, whereas the cost of terminals is very low, and it is the terminals of induction systems that produce the highest maintenance cost.

532.4.6 Washington, D.C., VA Hospital

Probably because of the height restrictions in Washington, D.C., the planning of this hospital results in very large floors which must contain many activities other than, those directly connected with the treatment of inpatients. A typical floor consists of four T-shaped ward areas stemming from a central core, which contains social and clinical areas not necessarily related exclusively to inpatient care.

532.4.7 Martinez, California, VA Hospital

The Martinez field station is the oldest of the projects reviewed and was planned and constructed before the current policies for air-conditioning were developed. It is a conglomeration of cooled and non-cooled areas on each floor and also has clinical and outpatient facilities located on the ward floors. A typical floor contains 160 beds in peripheral rooms, some of which were permitted to have cooling as well as heating, others of which were not. The original design provided for future cooling of all areas by adding to the central chilling plant. Since its original occupancy, only limited areas have been authorized for cooling, not enough at any one time to take advantage of the provision for the new, larger chiller. The original design attempted to accommodate the interim period between partial and complete air-conditioning by providing a fresh-air duct in addition to the heating and cooling ducts. The induction unit terminals, however, were initially provided with controls, which would accommodate future chilled water in all cases. The result is that the overall system, only partially cooled, is among the more costly installations.

532.5 PLUMBING DISTRIBUTION

The plumbing distribution subsystems in both the Memphis and Miami hospitals have the following characteristics, with exceptions noted:

1. Central drinking chilled water, vacuum, nitrous oxide and oxygen with extensive distribution systems.

2. Soiled and waste, vertical drains down to basement and horizontal collection mains by gravity to sewer. The deep therapy area at Miami is pumped.

3. Central domestic hot water with extensive distribution system.

4. Separate waste handling system for trash chutes and scraps from kitchen, with grinding stations, extractors slurry pumps, pulp containers, etc. Miami has a grease interceptor basin for the kitchen.

5. Laundry served from separate domestic hot water generators and compressed air system. Additional equipment including heat reclaimer, retention pit, etc.

6. Central compressed air for laboratories and medical areas with extensive distribution system.

7. Fire protection, combination wet and dry standpipe system with sprinklers in basement, storage areas and others as required. Equipment includes fire pump, cushion tank and air compressor, and necessary appurtenances.

8. Swimming pool at Memphis served from its own heating system and including filters, hychlorinators, surge tank, pump, etc.

533 COMPONENT COSTS

533.1 STRUCTURE

Table 530-2 lists the costs of the major structural components at Miami and Memphis. Neither of them use shear walls. Cost differences between the tower and base floors below the tower are due to larger columns. Reduced load capacity requirements account for the lower cost of roof construction.

Table 530-2. STRUCTURAL COST BREAKDOWN

Dollars per square foot of framed area (except as indicated) adjusted to ENR Building Cost Index of 960.

	STRUC. CONC.	CONC. TOPPING & FINISH	REBAR	TOTAL
Miami VAH				
Nursing tower floor framing	$3.07	$0.62	$1.75	$5.44
Lower floor typical framing	3.07	0.62	1.75	5.44
Lower floor below tower	3.85	0.62	2.09	6.56
Roof framing	2.94	0.31	1.68	4.93

Aggregate: 5.50 per sq. ft. of structural frame
6.58 per outside gross square foot

	STRUC. CONC.	CONC. TOPPING & FINISH	REBAR	TOTAL
Memphis VAH				
Nursing tower floor framing	$4.21	$0.21	$1.27	$5.69
Lower floor typical framing	3.80	0.21	1.16	5.17
Lower floor below tower	4.45	0.21	1.33	5.99
Roof framing	3.36		0.97	4.33

Aggregate: 5.26 per sq. ft. of structural frame
6.38 per outside gross square foot

533.2 CEILINGS

Table 530-3 lists the costs of the major types of ceiling. The ceiling costs in the support areas of the two hospitals averages somewhat less per gross square feet of floor area than in the bed-care areas because there are large areas of shop, storage and boiler room uses, which have merely paint on the structure. Miami utilized a significant amount of cement enamel in moist areas.

Table 530-3. CEILING COST BREAKDOWN

Dollars per outside gross square foot adjusted to an ENR Building Cost Index of 960. (All ceilings are suspended except “exposed construction, painted “ and “sprayed plaster”.)

	SA	SP	CE	SP	MF	EP	Total	$/s.f. CEILING
Miami VAH								
Bed-care areas	1.05	.52	.02		.08	.01	1.68	1.78
Support areas	.73	.39	.13			.01	1.26	1.34
Entire hospital							1.47	1.56
Memphis VAH								
Bed-care areas	1.06	.12	.01			.01	1.20	1.27
Support areas	.82	.18	.01	.01		.04	1.06	1.13
Entire hospital							1.11	1.18

SA Suspended acoustic tile
SP Suspended plaster painted
CE Suspended plaster, cement enamel or vinyl
SP Sprayed plaster, on concrete structure
MF Membrane faced acoustic tile
EP Exposed structure painted

533.3 PARTITIONS

Table 530-4 lists the costs of the major partition components. Tables 530-4a, 4b and 4c break down each of these components into specific types. The types of partitions in the hospital support areas generally do not vary from those in bed-care areas. Miami utilizes a larger proportionate amount of masonry wall as against metal-stud partitions. In the support areas of the building, both hospitals have a small amount of special shielding partitions, but the overall partition cost is less because of large areas with minimum finishes, such as shops, boiler rooms and storage space.

Table 530-4. PARTITIONS COST BREAKDOWN

Dollars per outside gross square foot (except as indicated) adjusted to an ENR Building Cost Index of 960.

	Basic Matr.	Finish	Doors & Misc.	Total	$/sq. ft. of PART.
Miami VAH					
Bed-care areas	2.45	2.30	1.20	5.95	5.16
Support Areas	2.74	1.76	1.01	5.51	4.95
Entire Hospital	2.60	1.99	1.10	5.69	5.04
Memphis VAH					
Bed-care areas	2.61	2.13	1.40	6.14	4.79
Support Areas	2.07	1.52	1.26	4.85	4.55
Entire Hospital	2.24	1.71	1.31	5.26	4.62

TABLE 530-4a. PARTITION COST BREAKDOWN, BASIC MATERIALS

Dollars per outside gross square foot adjusted to an ENR Building Cost Index of 960.

	SP	MC	CC	TOTAL
Miami VAH				
Bed-care areas	1.34	1.11		2.45
Support areas	.67	1.62	.45	2.74
Memphis VAH				
Bed-care areas	1.65	.96		2.61
Support areas	1.36	.60	.11	2.07

SP Steel Studs and Plaster
MC Masonry Core
CC Concrete Core

Table 530-4b. PARTITION COST BREAKDOWN, FINISHES

Dollars per outside gross square foot adjusted to an ENR Building Cost Index of 960.

	SV	HV	CT	CE	P	ST	PF	TOTAL
Miami VAH								
Bed Care Areas	.72	.50	1.03	.04	.01			2.30
Support Areas	.43	.35	.34	.16	.06	.18	.24	1.76
Memphis VAH								
Bed-care Areas	1.02	.46	54	.10	.01			2.13
Support Areas	.50	.44	.28	.22	.08			1.52

SV Standard Weight Vinyl Wall Covering
HV Heavy Duty Vinyl Wall Covering
CT Ceramic Tile
P Paint
ST Structural Facing Tile
PB Plaster on Block

Table 530-4c. PARTITION COST BREAKDOWN, DOORS AND MISCELLANEOUS

Dollars per outside gross square foot adjusted to an ENR Building Cost Index of 960.

	HD	OD	B	TOTAL
Miami VAH				
Bed-care areas	.48(360)	.72(837)		1.20
Support areas	.04(46)	.81(1103)	.16	1.01
Memphis VAH				
Bed-care areas	.51(370)	.89(960)		1.40
Support areas	.29(104)	.79(1654)	.18	1.26

HD Four-foot hospital doors, including frame, finish and hardware
OD Other doors
B Rubber, vinyl and ceramic base
(00) Number of doors

533.4 HEATING-VENTILATING-COOLING

Table 530-5 lists the costs of the major mechanical components, except central plant equipment. The various departments housed in the lower floors include several areas of highly specialized services and in some instances very long runs of piping and ductwork.

Table 530-5. MECHANICAL COST BREAKDOWN

Dollars per outside gross square foot adjusted to an ENR Building Cost Index of 960.

	MECH.* EQUIP.	DUCTS	PIPES	TERM-INALS	CON-TROLS	TOTAL
Miami VAH						
Bed-care areas	.70	1.67	.52	1.08	.39	4.36
Support areas	1.24	3.19	.28	.46	.32	5.49
Entire hospital						4.92
Memphis VAH						
Bed-care areas	.46	1.67	1.40	1.08	.60	5.21
Psychiatric	2.06	2.11	1.73	1.13	.74	7.77
Support areas	1.30	1.96	.74	.64	.48	5.12
Entire hospital						5.49

* “Mechanical equipment” includes equipment installed in mechanical rooms or floors which receive steam, hot water and chilled water supplied from a central boiler and chiller plant. Ducts and heating-cooling piping to the functional areas beyond this point are averaged under the “ducts” and “pipes” columns.

533.5 PLUMBING DISTRIBUTION

Table 530-6 lists the costs of the major plumbing distribution components. Plumbing fixtures are not within the scope of the distribution subsystem, but a cost figure is included for them to allow comparison with more typical estimates.

Table 530-6. PLUMBING COST BREAKDOWN

Dollars per outside gross square foot adjusted to an ENR Building Cost Index of 960.

	EQUIP.	PIPING	MED. GAS.	FIRE PROT.	TOTAL	FIXT.
Miami VAH	.04	1.49	.38	.29	2.20	.60
Memphis VAH	.04	1.37	.50	.18	2.09	.83
Average					2.15	.74

533.6 ELECTRICAL POWER DISTRIBUTION

Table 530-7 lists the costs of the major electrical power distribution components.

Table 530-7. ELECTRICAL COST BREAKDOWN

Dollars per outside gross square foot adjusted to an ENR Building Cost Index of 960.

	EQUIP.	FEEDER DISTRIB.	BRANCH DISTRIB.	TOTAL
Miami VAH	.41	.18	1.54	2.13
Memphis VAH	.38	.19	1.51	2.08
Average				2.11

534 FUNCTIONAL AREA COSTS

534.1 FUNCTIONAL AREA CLASSIFICATION

For purposes of analyzing subsystem cost distribution among the various functional areas in the “base” portion of the hospital, eighteen categories have been established for the field stations at Miami and Memphis.

1. Nursing units (Memphis only)
2. Surgical suite
3. Recovery
4. Radiology
5. Deep therapy
6. Clinical laboratories
7. Research laboratories
8. Animal research
9. Physical medicine and rehabilitation
10. Auditorium
11. General areas (offices, on-call rooms, clinics, social workers, chapel, libraries, recreation, dental, out-patient department, admitting, lockers pharmacy, morgue and medical illustration.)
12. Dietetic services
13. Cafeteria
14. Central sterile
15. Laundry
16. Warehouse, storage and housekeeping
17. Shops
18. Pool (Memphis only)

A category referred to as 0 (zero) covers mechanical rooms, stairways, elevators, etc. The structural subsystem is prorated as a fixed cost over all functional areas.

534.2 SUMMARY TABLES

Tables 530-8 and 530-9 summarize subsystem costs for the major functional areas in the support areas of the Miami and Memphis field stations. Figures 530-1 and 530-2 chart the same information plus indicating the relative size of the areas to which the various costs apply.

534.3 CEILINGS

534.3.1 Figures 530-3 and 530-4 illustrate the proportion of ceiling costs distributed among functional areas at Miami and Memphis. Variations in the unit costs are mostly attributed to type of finish material.

534.3.2 The two hospitals differ to a significant degree only in the shops and laundry, warehouse, storage, and housekeeping areas. At Miami such spaces are generally finished with plaster or suspended acoustic materials, while at Memphis similar spaces are finished with relatively inexpensive paint or spray applied plaster finishes over the exposed structure. Three times as much space at Memphis is so simply and inexpensively finished.

534.3.3 The majority of the ceiling finishes at both Memphis and Miami were found to have similar unit costs when compared directly by functional area. However, the Miami costs tend toward a uniform 10 to 15% higher level than those at Memphis. One reason for this tendency lies in the fact that a higher proportion of cement enamel and suspended plaster ceiling finishes were employed throughout the Miami support areas. There is 2 to 3 times as much suspended plaster and 2 to 10 times as much cement enamel to be found at Miami than at Memphis. There are also substantial quantities of membrane faced acoustical tile at Miami not found at Memphis. The double ceilings which are utilized as plenums in the Miami corridors are further reflected in the higher unit costs.

534.3.4 Even though unit costs for ceiling finishes in similar functional areas may vary as much as 75% between Miami and Memphis, the overall average unit costs differ by no more than 16%.

Table 530-8. FUNCTIONAL AREA COST IN SUPPORT AREAS OF MIAMI VA HOSPITAL

Dollars per outside gross square foot adjusted to an ENR Building Cost Index of 960. Integrated subsystem totals include $6.58 for structure.

TYPE	CEILS.	PART.	HVC	PLUMB.	ELEC.	TOTAL
0	0.12	5.02	-	-	-	10.13
1	(There are no nursing units in the base.)					
2	1.45	5.50	10.06	3.49	4.03	31.11
3	1.34	6.06	6.81	3.52	4.06	28.37
4	1.35	6.33	3.52	2.51	3.03	23.32
5	1.10	19.56	5.65	1.23	2.41	36.53
6	1.58	4.82	7.28	3.53	2.30	26.09
7	1.19	6.19	9.47	3.45	2.32	29.20
8	1.38	6.38	10.48	4.79	2.39	32.00
9	1.68	5.92	4.95	1.79	1.96	22.88
10	1.35	5.18	5.52	1.66	1.70	21.99
11	1.35	6.05	4.37	1.89	2.20	22.44
12	1.17	3.97	7.76	1.82	3.53	24.83
13	1.28	3.56	7.54	1.80	1.92	22.68
14	1.47	5.47	3.94	2.20	2.50	22.16
15	1.27	3.09	9.69	6.91	2.24	29.78
16	1.43	3.88	3.14	1.10	2.20	18.33
17	0.76	4.81	3.89	1.87	2.06	19.97
18	(Miami does not have an indoor pool.)					

Figure 530-1. FUNCTIONAL AREA COSTS IN THE SUPPORT AREAS OF THE MIAMI VA HOSPITAL

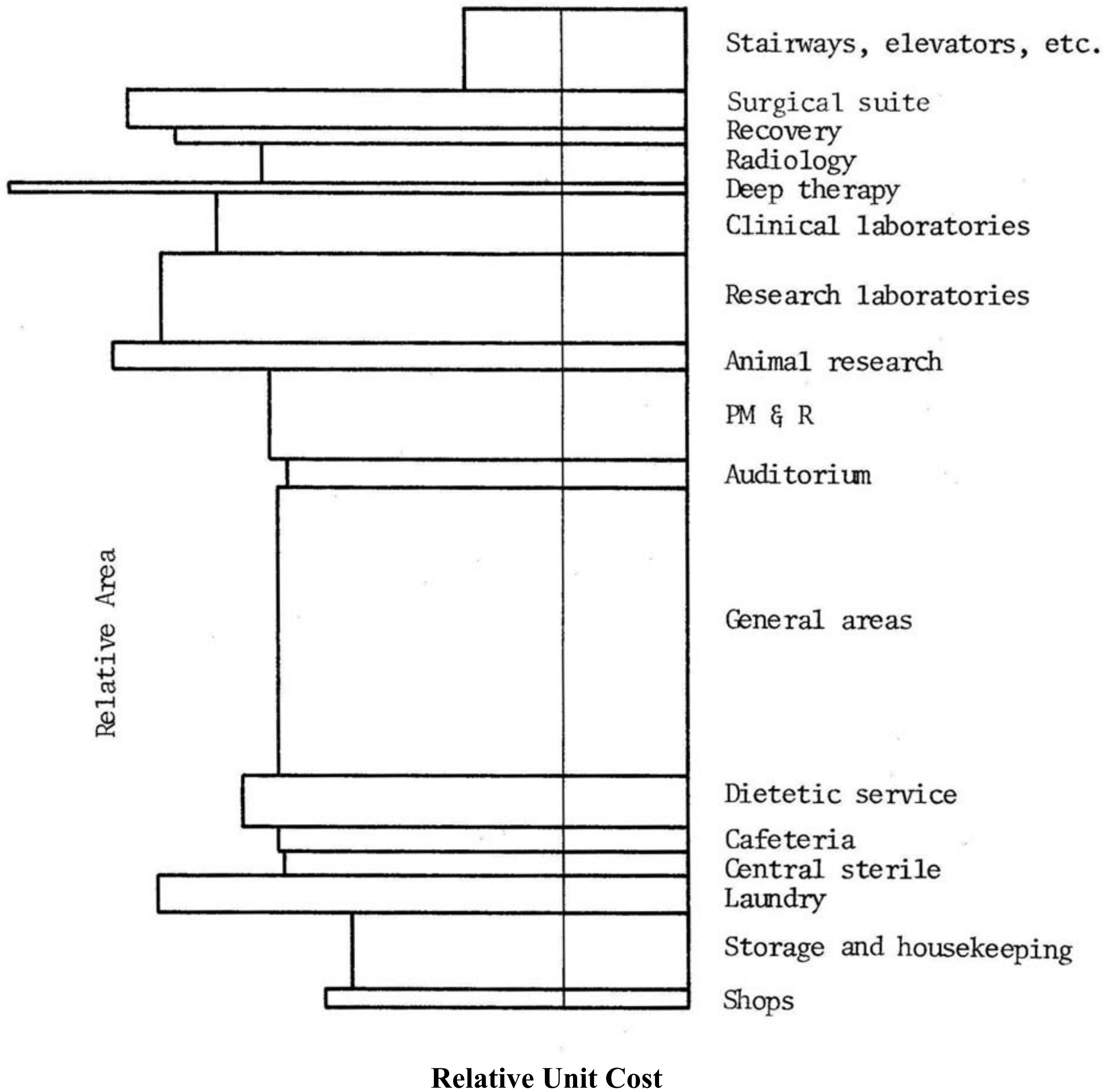
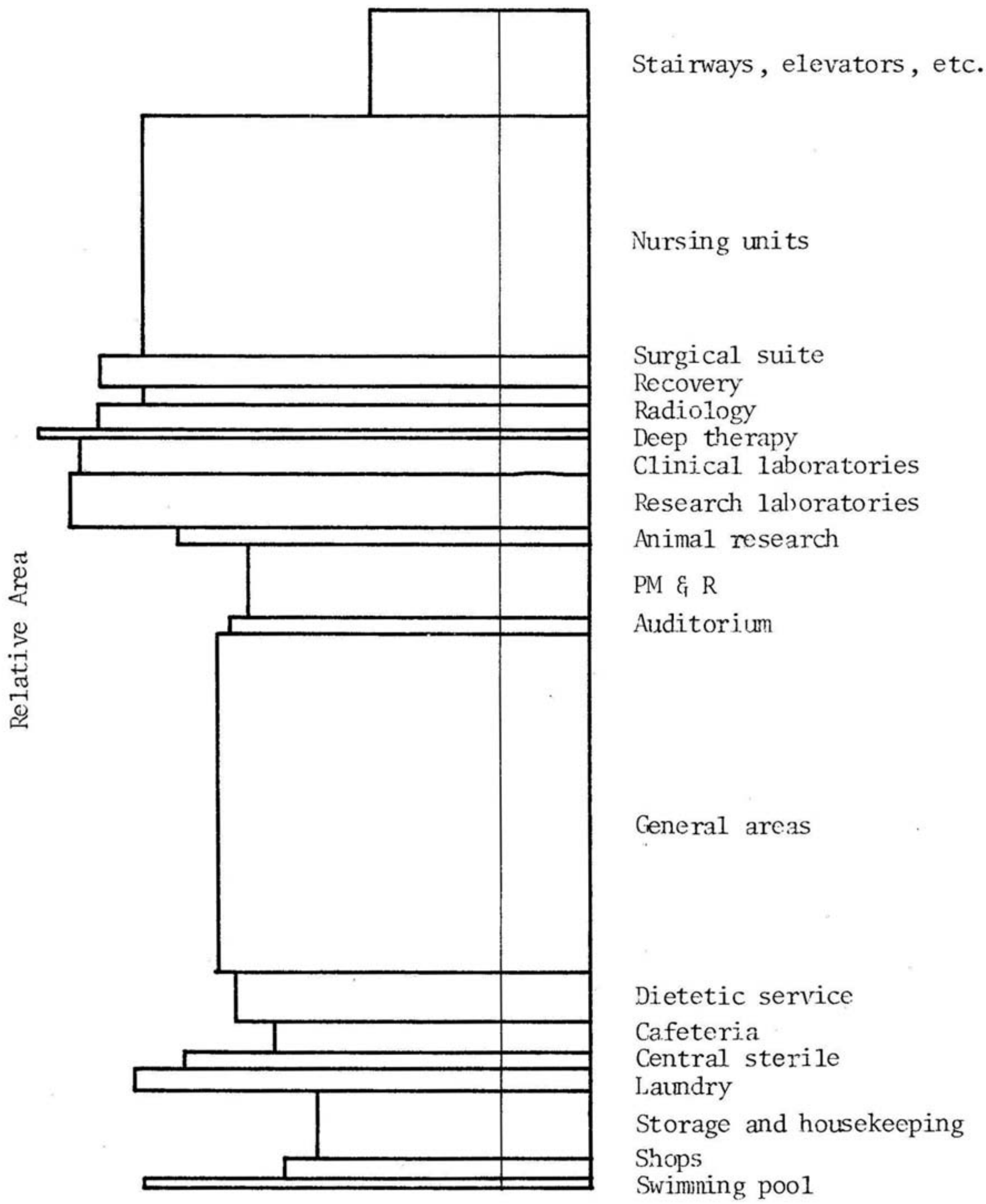


Table 530-9. FUNCTIONAL AREA COSTS IN SUPPORT AREAS OF THE MEMPHIS VA HOSPITAL

Dollars per outside gross square foot adjusted to an ENR Building Cost Index of 960. Integrated subsystem totals include $6.38 for structure.

TYPE	CEIL.	PART.	HVC	PLUMB.	ELEC.	TOTAL
0	0.27	5.79	-	-	-	12.44
1	1.26	6.58	7.76	2.22	2.24	26.44
2	1.30	5.65	7.18	4.27	4.32	29.10
3	1.26	5.20	6.38	3.63	3.68	26.53
4	1.27	7.79	6.22	3.20	4.15	29.01
5	1.30	16.18	4.93	1.10	1.89	31.78
6	1.31	5.80	10.92	3.16	2.68	30.25
7	1.13	6.27	10.41	4.17	2.48	30.84
8	1.18	6.36	5.74	2.46	2.07	24.19
9	1.19	4.18	4.62	1.64	2.03	20.04
10	1.35	5.43	5.03	1.37	1.36	20.92
11	1.23	5.54	4.89	1.67	2.18	23.64
12	1.25	2.80	5.08	2.13	3.47	21.11
13	1.13	3.03	4.70	2.01	1.46	18.71
14	1.32	4.25	8.00	1.23	2.90	24.08
15	0.32	2.28	7.95	8.45	2.12	27.50
16	0.36	2.12	3.73	1.80	1.83	16.22
17	0.23	4.05	3.44	2.37	1.69	18.16
18	1.29	2.43	8.95	5.93	1.85	26.83

Figure 530-2. FUNCTIONAL AREA COSTS IN THE SUPPORT AREAS OF THE MEMPHIS VA HOSPITAL



Relative Unit Cost

Figure 530-3. CEILING FUNCTIONAL AREA COSTS FOR MIAMI

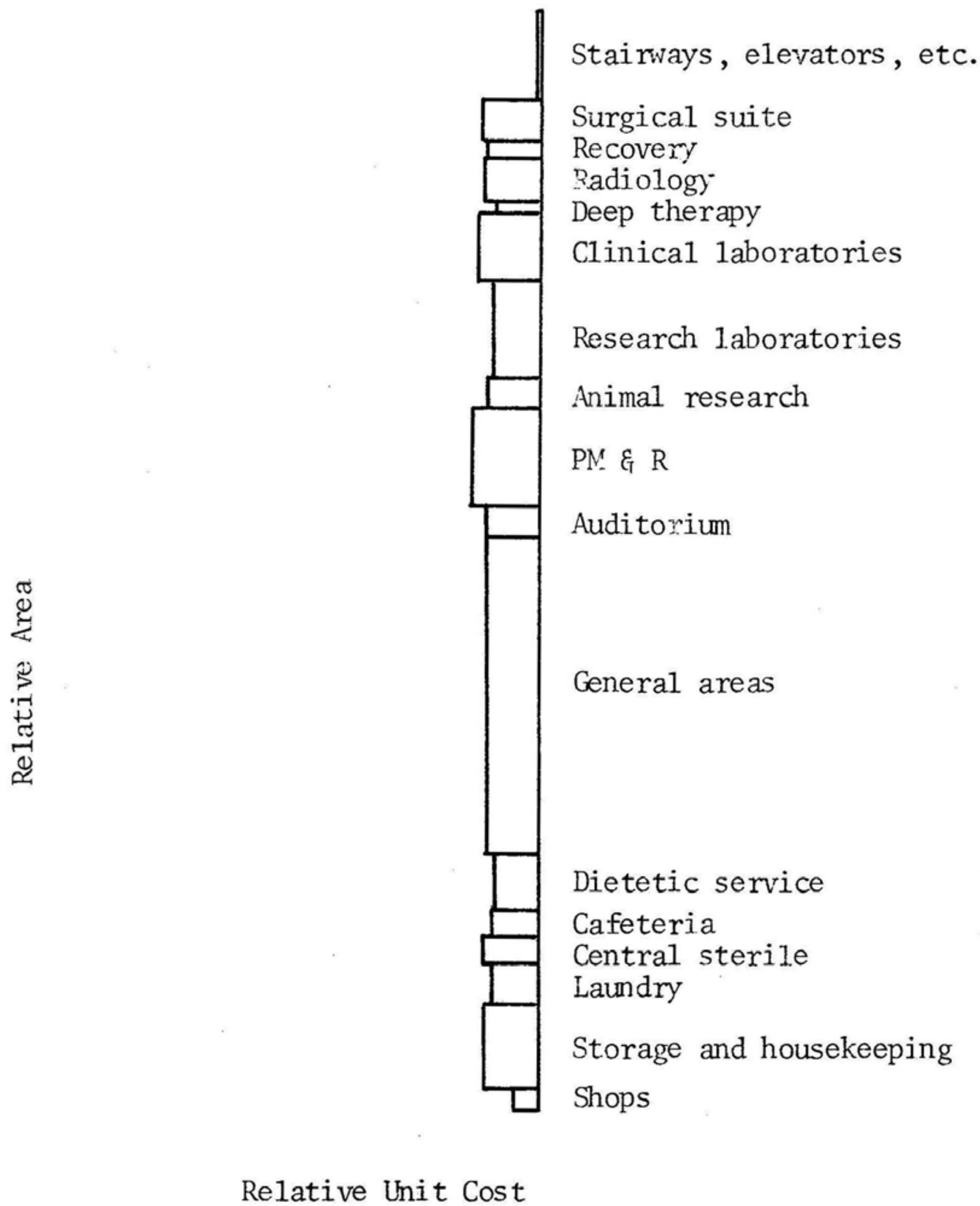


Figure 530-4. CEILING FUNCTIONAL AREA COSTS FOR MEMPHIS

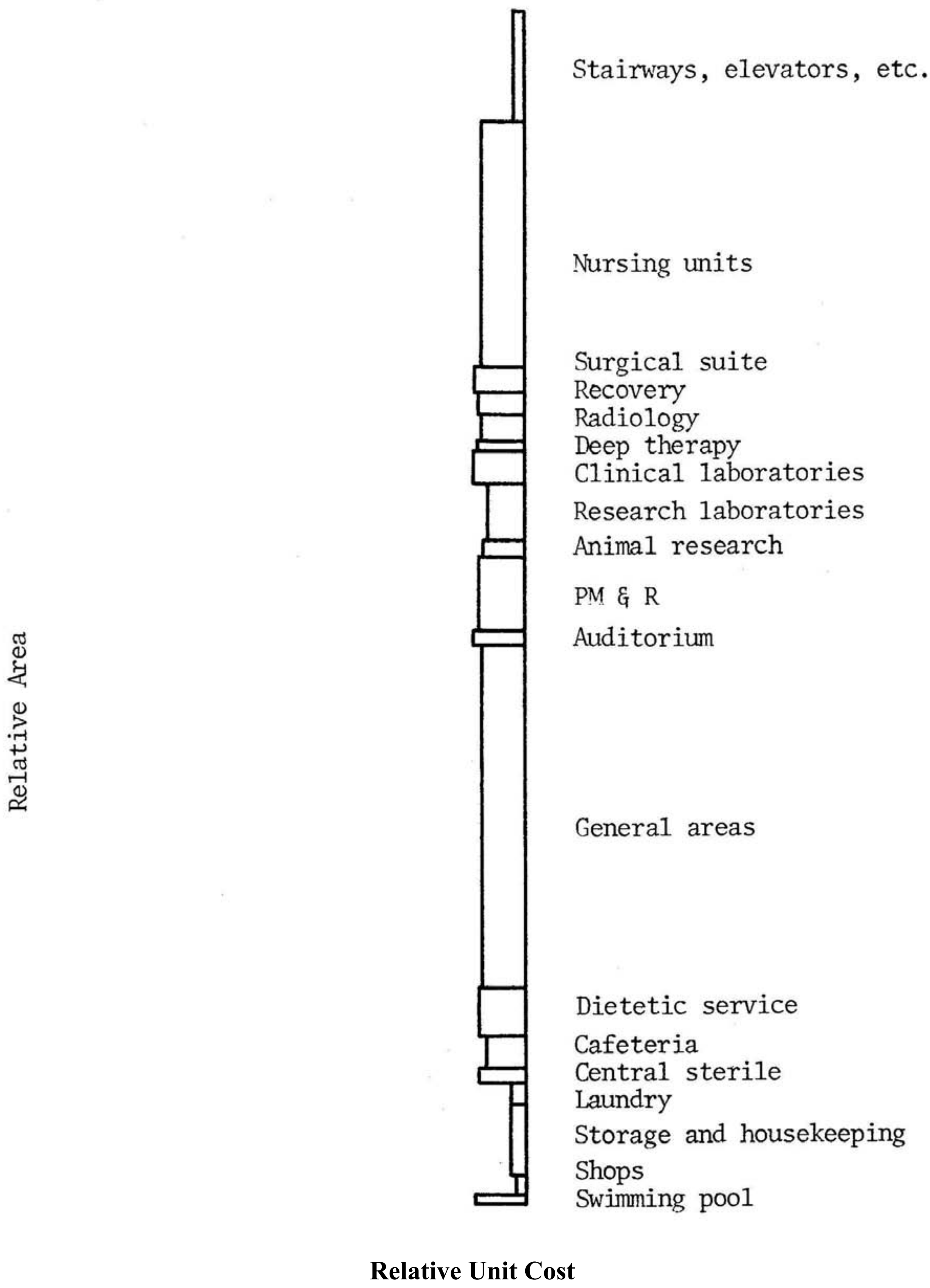


Figure 530-5. PARTITION FUNCTIONAL AREA COSTS FOR MIAMI

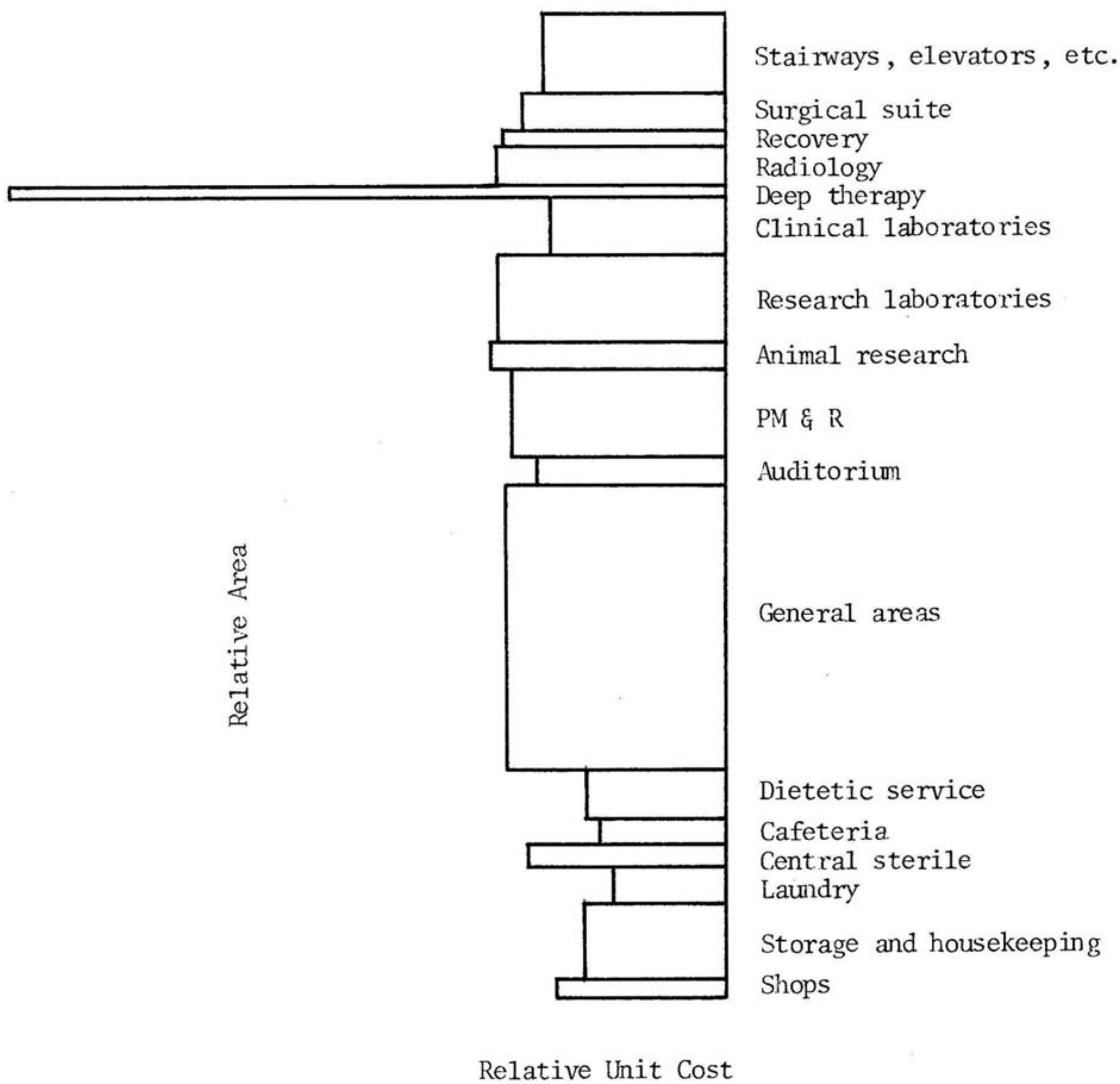
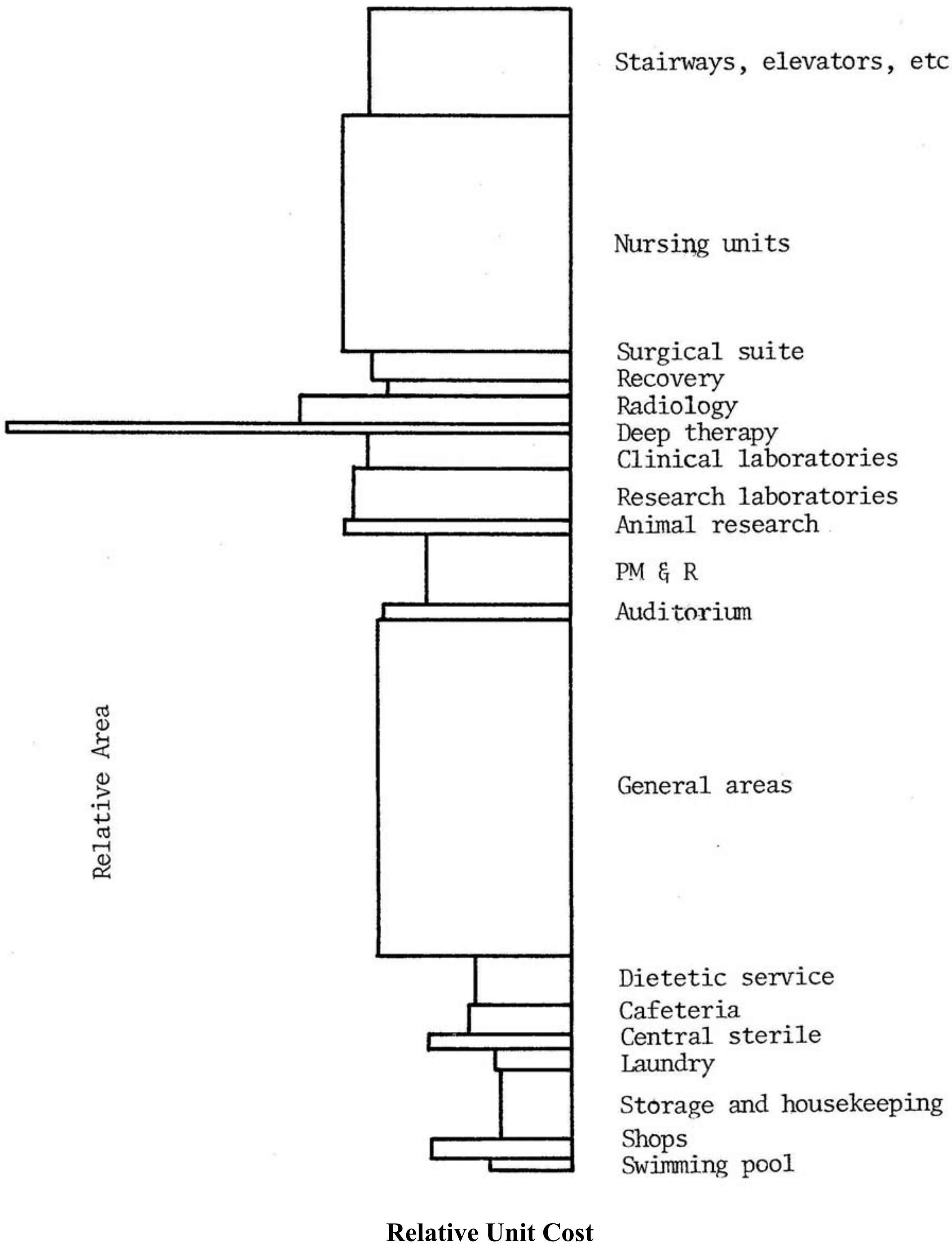


Figure 530-6. PARTITION FUNCTIONAL AREA COSTS FOR MEMPHIS



534.4 PARTITIONS

534.4.1 Figures 530-5 and 530-6 illustrate the proportion of partition costs distributed among functional areas at Miami and Memphis. The principal determinant of the cost per unit of floor area is simply density, i.e., quantity within each functional area. The type of partition and quality of finish are relatively minor factors by comparison, with a few notable exceptions as in radiology and deep therapy. The following discussion of both quantity and quality attempts to explain some of the notable differences.

534.4.2 Partition costs within the areas occupied by laundry, warehouse and storage areas are the very lowest, because there are very few partitions and the finishes consist generally of paint on structural surfaces or partitions.

534.4.3 The partition costs of the mechanical rooms and shops are moderately higher due to the fact that these areas are generally subdivided into smaller spaces, resulting in greater quantities per given area, though the finishes are no better than in the warehouse and storage areas. Equally moderate are the partition costs found in the dietetic, cafeteria, and central sterile areas. In these areas the finishes are more durable, but the density of partitions is low. The costs of prefabricated cold storage boxes are not included in these computations.

534.4.4 Next in order of cost fall the laboratories, general offices and miscellaneous, surgery and recovery areas. The general offices and miscellaneous areas all have moderate requirements for durability of finishes, but are generally subdivided into many small spaces requiring a high density of partitions. The laboratories, surgeries and recovery units have a lower density of partitions with more expensive finishes, resulting in average partition costs approximating those of the general offices and miscellaneous service areas.

534.4.5 The nursing units contained within the base structure at Memphis have average partition costs somewhat higher than those of the laboratories and surgical suites, primarily due to the relatively high partition density coupled with a requirement for equally durable finishes.

534.4.6 The most expensive functional areas within the base structure, in terms of partition costs, are deep therapy and radiology. In radiology at Memphis, the partition cost by unit area is 50% greater than the overall average, primarily due to the high cost of radiation shielding, lead-lined concrete-block partitions surrounding the x-ray apparatus.

534.4.7 In the deep radiation therapy department, the high density concrete radiation shielding walls surrounding the cobalt generator are from 12” to 36” in thickness. The high cost of this shielding when applied to the relatively small floor area occupied by the department, results in unit costs for partitions of 3 times the overall average.

534.4.8 The unit costs for partitions in the Memphis and Miami support areas do not differ to any significant degree. The differences which do exist can generally be attributed to differing densities. The functional spaces in the Miami facility tend to be smaller and more numerous than the comparable spaces in Memphis. While a direct unit cost comparison for partitions by functional area may reveal variations of up to 45%, the overall average unit costs between the two hospitals are within 2%.

534.5 HEATING-VENTILATING-COOLING

534.5.1 Figures 530-7 and 530-8 illustrate the proportion of HVC costs distributed among functional areas at Miami and Memphis. The following discussions of specific high cost features attempts to explain some of the notable differences.

534.5.2 In the surgical suites, a separate emergency HVC system doubled the average unit cost at Miami, and similarly a special mechanical equipment requirement at Memphis increased the unit cost there by an additional $1.87.

534.5.3 A large storage area within the radiology department, which is not fully served, lowered the unit cost at Miami, and conversely, the remoteness of the department at Memphis required extraordinarily long duct runs, raising the unit cost there.

534.5.4 Exhaust systems required by laboratory fume hoods or kitchen exhaust hoods raise the HVC unit costs in both hospitals in those functional areas by as much as $4.40 per square foot.

534.5.5 The unit cost for central sterile at Miami is low due to its close proximity to the mechanical equipment. The same functional area has a high unit cost at Memphis due to the inclusion of $2.72 per square foot for special items of mechanical equipment and appurtenances.

Figure 530-7. HVC FUNCTIONAL AREA COST FOR MIAMI

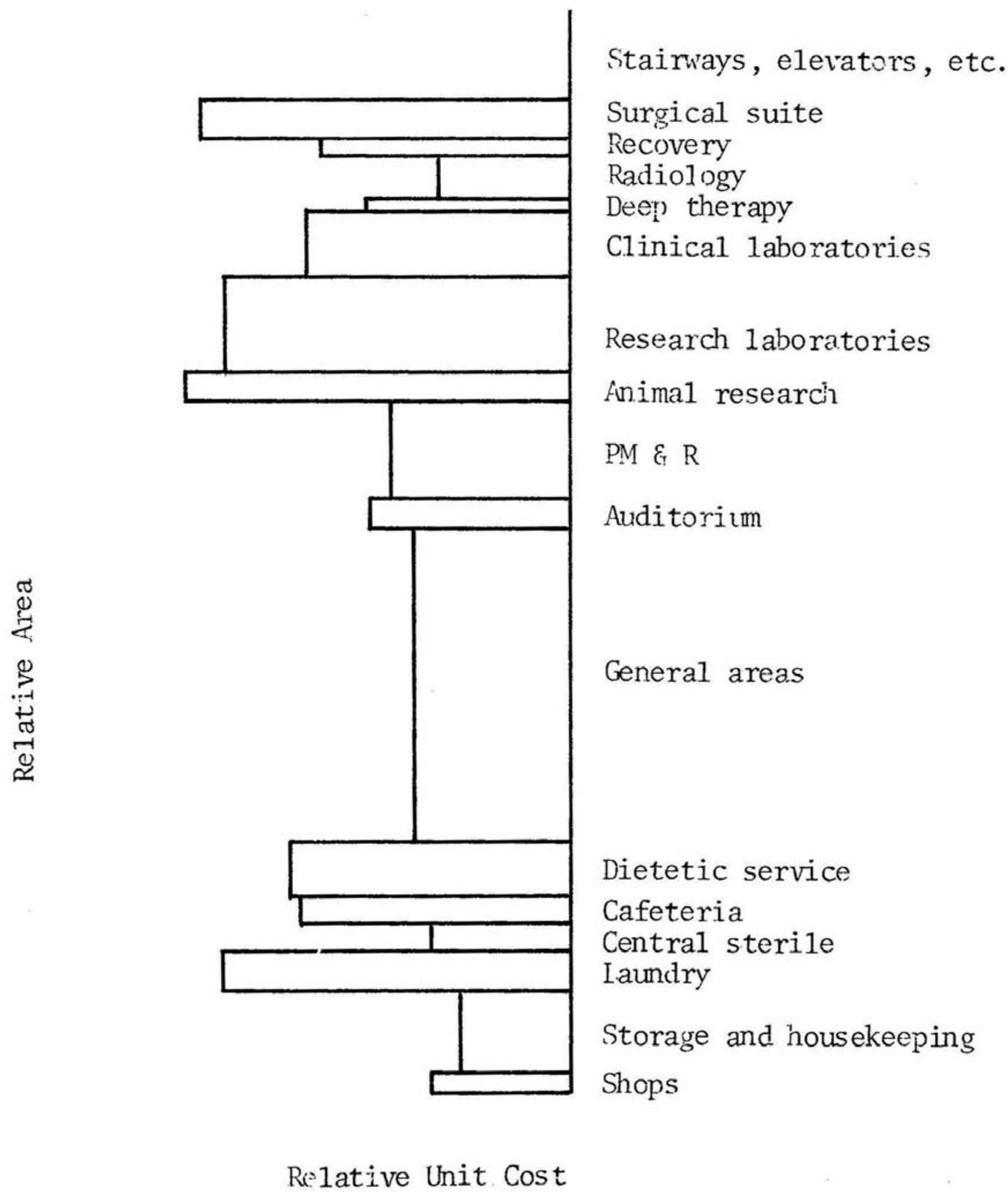
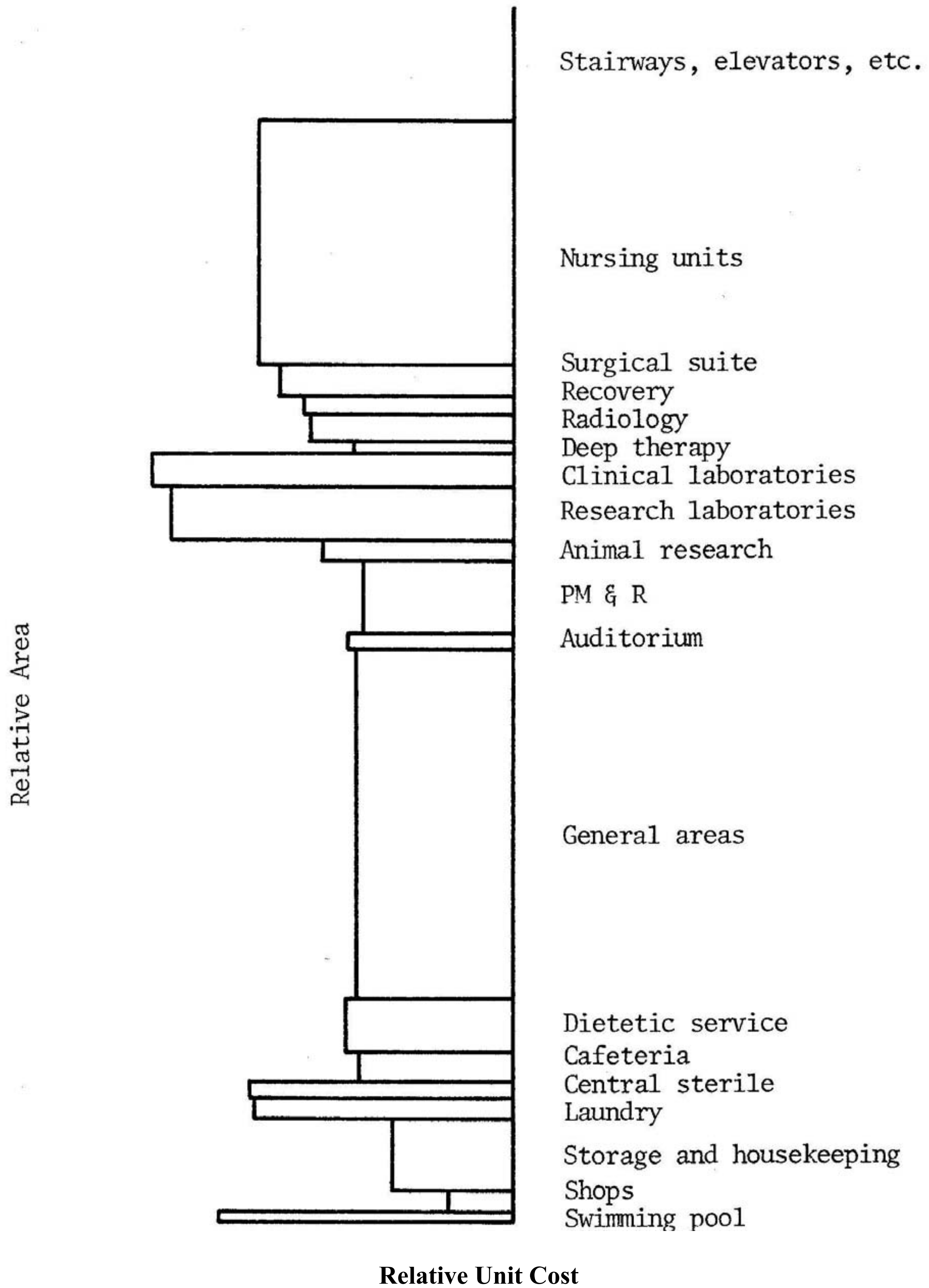


Figure 530-8. HVC FUNCTIONAL AREA COSTS FOR MEMPHIS



534.5.6 Excessive quantities of rectangular high pressure distribution duct caused the average unit cost to double within the animal research laboratories at Miami.

534.5.7 Exhaust hoods included in the dietetic and cafeteria areas at Miami helped to increase the unit costs in those areas by 50 per cent.

534.5.8 The heavy duty industrial requirements imposed on the system by the laundries include special exhaust systems and additional quantities of steam piping, all of which combines to increase the unit costs there by about 60 per cent over the average.

534.5.9 The system requirements imposed by the swimming pool area fond only at Memphis are increased by large capacity steam piping and excessive distribution ductwork due to its remoteness from the fan room.

534.6 PLUMBING DISTRIBUTION

534.6.1 Figures 530-9 and 530-10 illustrate the proportion of plumbing distribution costs among functional areas at Miami and Memphis. Variations in the unit cost between these areas is generally attributable to special requirements in one or more of the four basic plumbing components: equipment, piping, medical gas distribution and fire protection.

534.6.2 The only functional areas that are significantly affected by abnormal equipment costs are the laundries at both hospitals and the swimming pool at Memphis. In each case the costs included for equipment represents approximately one quarter of the total costs.

534.6.3 Piping costs are a major factor in the deep therapy department, dietetic service, central service and laundry facilities. In each case they comprise 60 percent or more of the total. Those areas in which the piping costs represent approximately one half of the total are the nursing units, radiology, laboratories, miscellaneous service areas, and the cafeteria. Those areas in which the piping costs amount to approximately one third of the total include the surgical suites, recovery, physical medicine, and the warehouse and storage areas.

534.6.4 The medical gas piping, which is concentrated in the nursing, recovery, and intensive care units as well as the surgical suites, radiology department, and laboratories, is a high cost factor for those functional areas. These same areas are similarly affected by the costs of special equipment, and special rough plumbing for equipment.

534.6.5 The cost of fire protection throughout both facilities represents a small proportion of the total costs with the exception of cafeterias, warehouse and storage areas, and the shops, all of which are required to have automatic sprinkler systems. The animal research laboratory at Memphis also has a high proportionate cost for this item.

534.6.6 The highest indicated unit costs for plumbing at both Miami and Memphis are found in the laundries. This is due to the special equipment and equipment connections, and the need for large capacity, independent subsystem elements. For example, the laundry facilities include separate hot water generator, compressed air units, heat reclaimers, and water softening apparatus.

Figure 530-9. PLUMBING DISTRIBUTION FUNCTIONAL AREAS COSTS FOR MIAMI

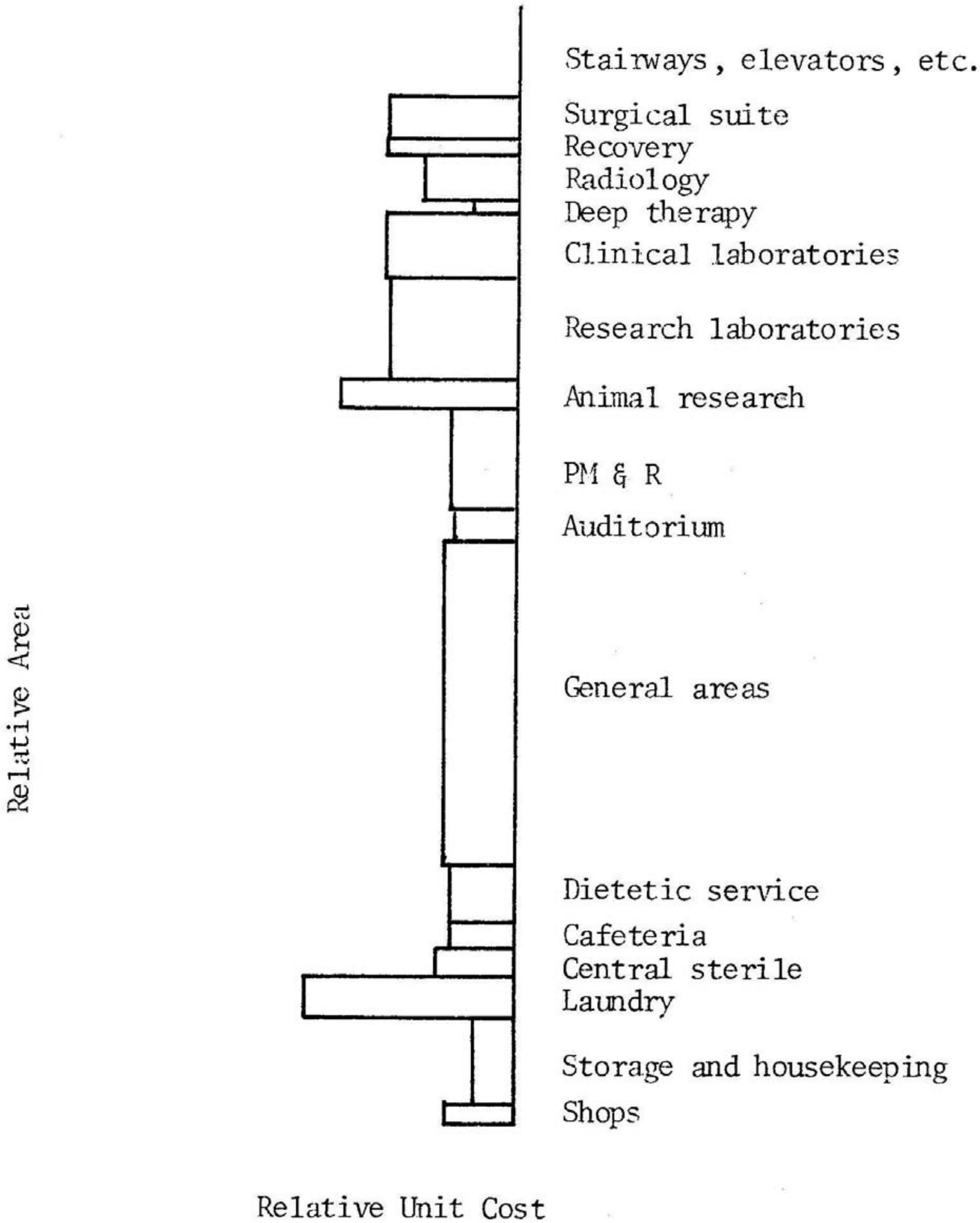
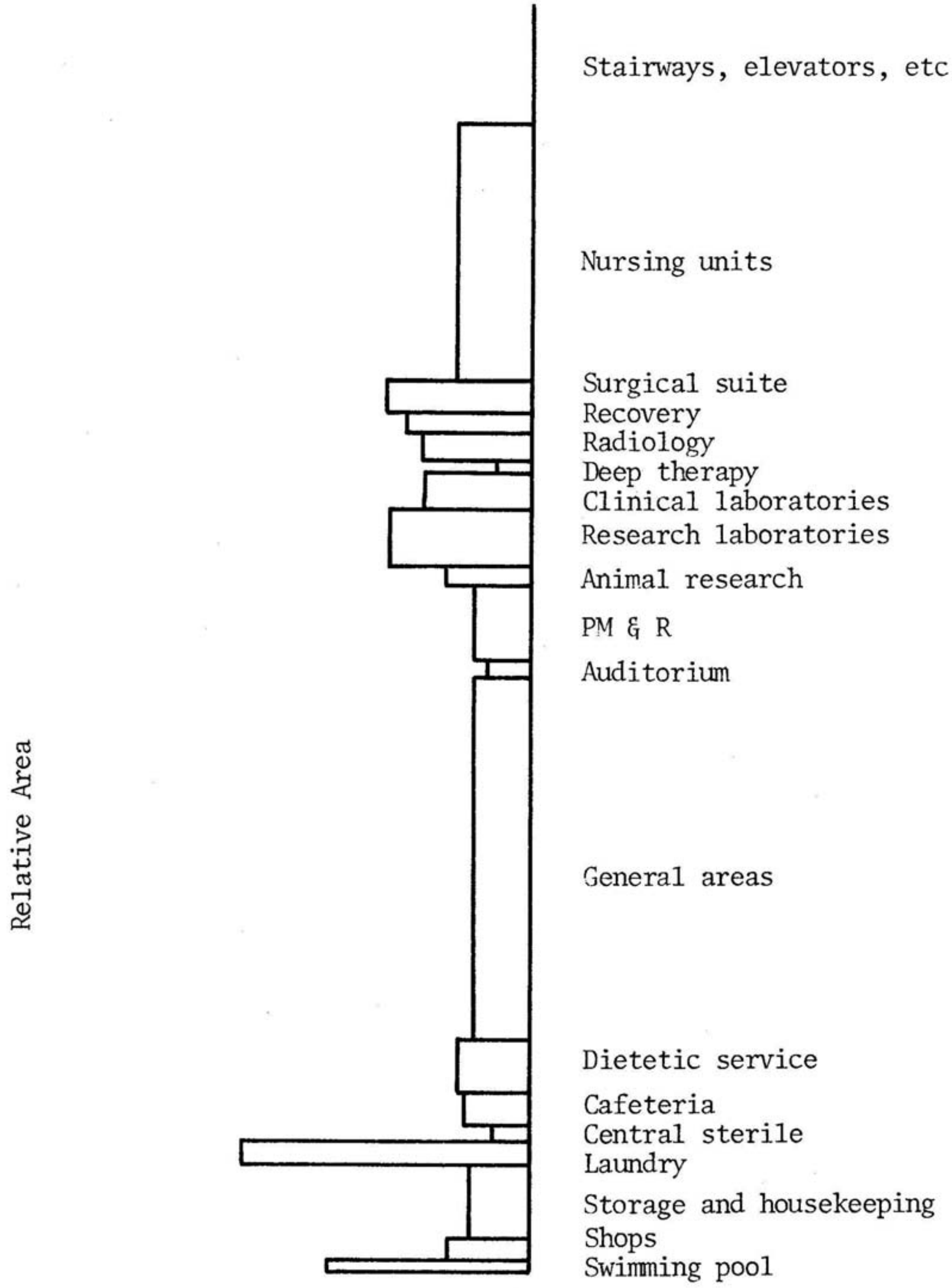


Figure 530-10. PLUMBING DISTRIBUTION FUNCTIONAL AREA COSTS FOR MEMPHIS



Relative Unit Cost

The next highest unit costs are found in the swimming pool at Memphis. This also due to the inclusion of special elements such as independent hot water generators, filtration apparatus, automatic chlorinators, pumps and local circulation piping.

534.6.7 Those functional areas in which unit costs fall in the middle range are characterized by heavy proportion of costs in piping and medical gas distribution. Examples of such moderate plumbing costs areas would include the nursing units, radiology, the laboratories, and the physical medicine and rehabilitation department.

534.6.8 The areas with the lowest unit costs are those that have little or no medical gas piping and no abnormal fire protection requirements. Theses low cost areas include deep therapy, the auditorium; dietetic and cafeteria areas, and the central service area. The warehouse, storage, and shop areas also tend toward the low end of the scale in spite of their relatively high fire protection requirements.

534.6.9 Variations between the Miami and Memphis hospitals as high as 50 percent in the case of the animal research departments, where special fire protection was required at Miami. The overall unit costs, however, fall within six percent.

534.7 ELECTRICAL POWER DISTRIBUTION

534.7.1 Figures 530-11 and 530-12 illustrate the proportion of electrical distribution costs among functional areas at Miami and Memphis. Those areas that are relatively small in size or in which the requirement for numbers of outlets or power consumption is large, have the highest cost unit costs. The functional areas with the highest costs include the surgical suites, recovery units, and the radiology areas. Other areas with proportionately high costs are laboratories, dietetic service areas, central service, and the deep therapy units. Other causes of higher unit costs found within certain functional areas are isolated, ungrounded systems and explosion proof devices in the surgical suites, and unusual branch circuit wiring in the recovery units.

534.7.2 Elaborate power or lighting systems such as those found in surgery, recovery, nursing, radiology, deep therapy, laundry, and central sterile have a high proportion of their total cost in equipment. The lowest proportionate costs for equipment are found in the areas occupied by the laboratories, physical medicine, dietetic spaces and cafeteria.

534.7.3 The functional areas which reveal the largest proportion of the total costs devoted to branch circuit distribution are logically those spaces which require large numbers of outlets such as laboratories, nursing areas, surgical suites, radiology, physical medicine, dietetic service and cafeteria, central service, laundry, shops, warehouse, and the pool area at Memphis. In each of these functional areas the cost for branch circuit distribution comprises more than one half the total cost.

534.7.4 The area in which the costs for feeder distribution are a major portion of the total cost are recovery, radiology, and deep therapy areas, the miscellaneous service areas, and the laundries. These proportionally high feeder costs reflect either unusually long runs due to remoteness of the functional area, or large capacity conductors demanded by extraordinary power requirements. The two functional areas with the highest feeder distribution costs include deep therapy and the laundries, both of which have high power consumption requirements.

534.7.5 The overall units costs for electrical distribution subsystems at Miami and Memphis are very close, differing by only five percent. Unit costs by functional area, however, vary by as much as 27 percent.

Figure 530-11. ELECTRICAL POWER DISTRIBUTION FUNCTIONAL AREA COSTS FOR MIAMI

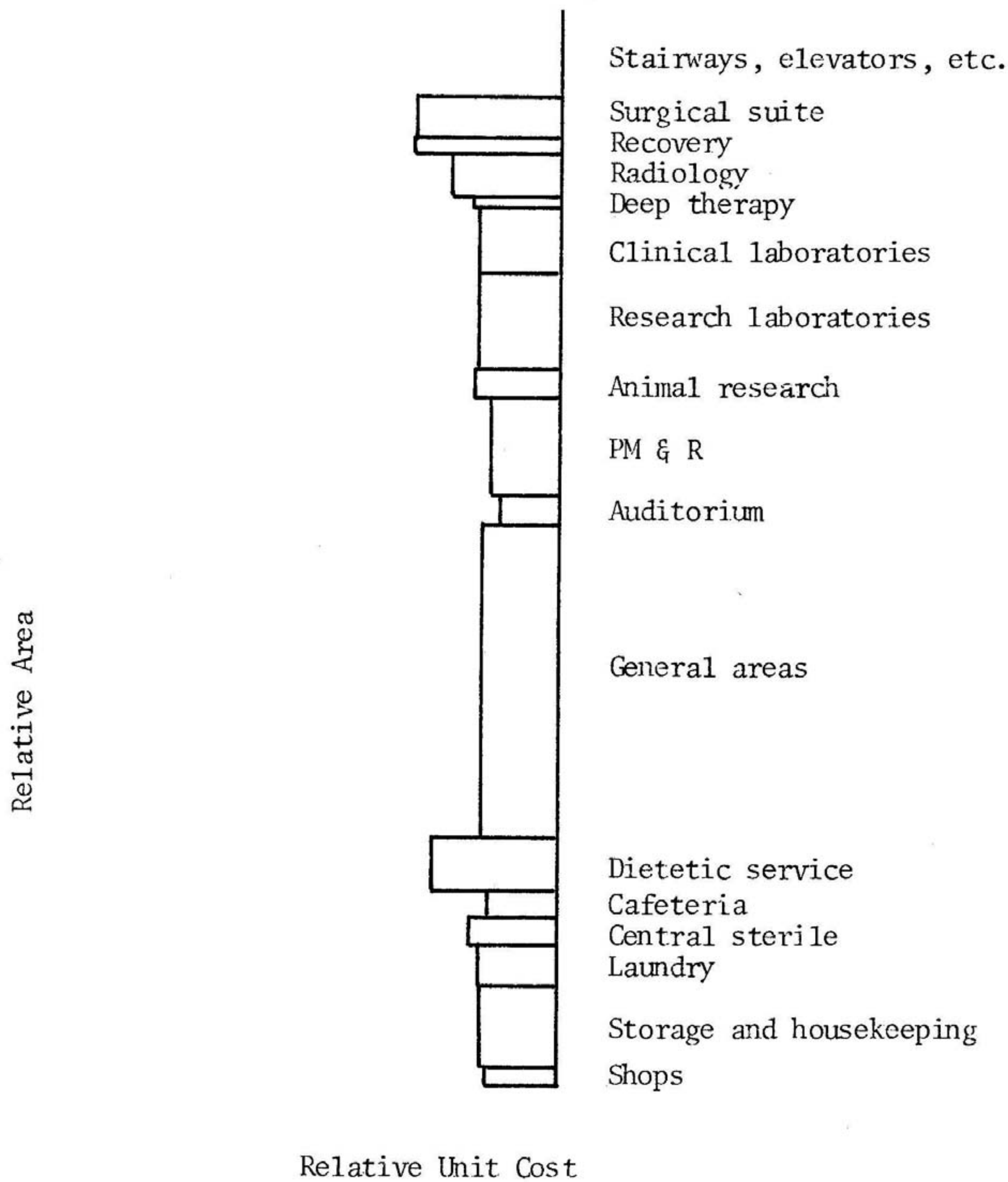
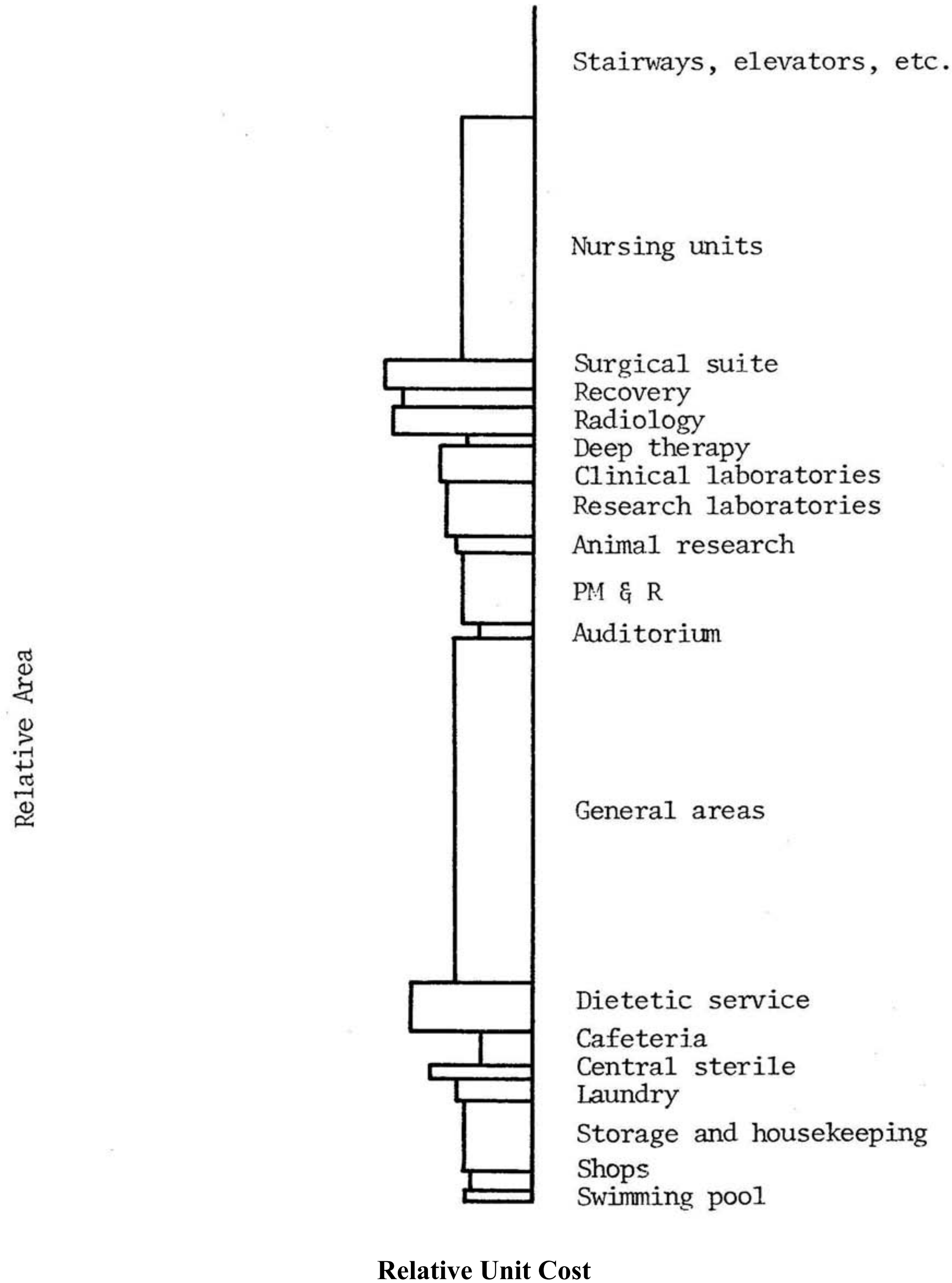


Figure 530-12. ELECTRICAL POWER DISTRIBUTION FUNCTIONAL AREA COSTS FOR MEMPHIS



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540 Building Trade Unions

541 INTRODUCTION

The attitude of building trade unions toward increasing industrialization in the building industry does not form a clear and stable picture. In practice, attitudes differ from trade to trade, local union to local union, and union member to union member. These attitudes may or may not be in concert with union policy at the national level, the attitudes of the National Labor Relations Board, or the courts. Additionally, these many shades of opinion are constantly changing in response to such factors as the availability of jobs in a given area, pressures from public opinion, and the relative strength of the local union.

Because of this varied and changing picture, any attempt to pin down union attitudes over the country as a whole would be impractical and in any case quickly outdated. This discussion, therefore, will concentrate on trends in union attitudes, the factors which influence these attitudes, and ways of determining attitudes at a particular time and place.

In general, the problem of industrialization for the construction trades is parallel to the problem of automation in other industries, and in general the same kinds of responses by labor can be observed in both cases. Resistance to change and fear of the unknown are typical human characteristics. A propaganda cartoon of 1830 shows all the dire consequences to be expected from the introduction of steam power in factories, and even went so far as to recommend that mothers bear no more children since steam power would take away any possibility of jobs for them. (1)

As a background, we will begin with discussions of the concept of industrialization and the general attitudes of labor unions. We will then discuss the position of unions relative to prefabrication in terms of the strategies open to them, their legal position, policies of the national union leadership, recent agreements, and future trends.

542 INDUSTRIALIZATION

542.1 DEGREE OF PREFRABICATION

542.1.1 The construction industry has always been industrialized to some degree. Even in the most conventionally built building today, nearly every item used in construction comes from a factory. The issue at this point is the accelerating rate at which factory-built components are becoming larger and/or more complicated, thereby reducing work required at the site.

542.1.2 Industrialization can range from the making of bricks in a factory, which are assembled at the site, to building whole buildings in a factory and merely hooking them to plumbing and power. This off-site work can be done by manufacturers or subcontractors in their own factories, by general contractor in his shop, or by setting up a "site factory" adjacent to the building. The work can be performed by the union or non-union factory workers of the supplier, members of building trade unions working in a factory, or the contractor's own men next door to the job site. With so great a range of degrees of prefabrication, sites where it can take place, and union status of participants, it is easy to see how confusion and seemingly arbitrary decisions can arise on the part of all concerned.

542.1.3 The trend toward increased industrialization seems to center on a single set of premises: that work can be done more accurately, more efficiently, and more productively in factory. The factory provides an enclosed, weather-protected environment, with better working conditions, the opportunity to use heavy fixed equipment, and the opportunity for better inspection and control procedures. (2) These advantages, plus the ability to use less highly skilled labor which is presumably less costly, and the elimination of the seasonal nature of construction, make factory production a tempting alternative in many cases. On the other hand, there are several inherent problems in factory fabrication which may often outweigh the advantages. Among these are the costs of setting up the production line, costs of transporting the prefabricated components to the job site, and costs of storing the assemblies until they are needed. Thus, it is not a foregone conclusion that large prefabricated components are better or more economical than site-assembled components. Each case must be weighed by the A/E or construction contractor on its own merits.

542.2 PREFABRICATION AND THE BUILDING SYSTEM PROTOTYPE DESIGN

The issue of whether or not buildings should be more industrialized than they presently are is particularly significant for the VA systems integrations project because the use of standardize "rules" allows a higher degree of prefabrication than usual. For example, in conventional design and construction, trunk ductwork may vary from floor to floor to meet different conditions, whereas corresponding ductwork in a hospital built using the Prototype Design may be identical for all service modules. In the conventional case, prefabrication would probably not be suggested because each area would be different; in the case of the systems building, similar sets of ductwork could be assembled off-site and "plugged in" at the site.

The trend has been toward increased industrialization of building components in response to the increased cost of on-site labor. However, the degree of prefabrication, the location of the prefabricating facility, the status of the participants, and the usefulness of "industrialization" depends on the conditions surrounding each case.

The Prototype Design has been developed to allow whatever degree of prefabrication seems to be indicated by the given conditions, rather than to depend on union acceptance of a particular degree for its success.

543 BASIC CONCERNS

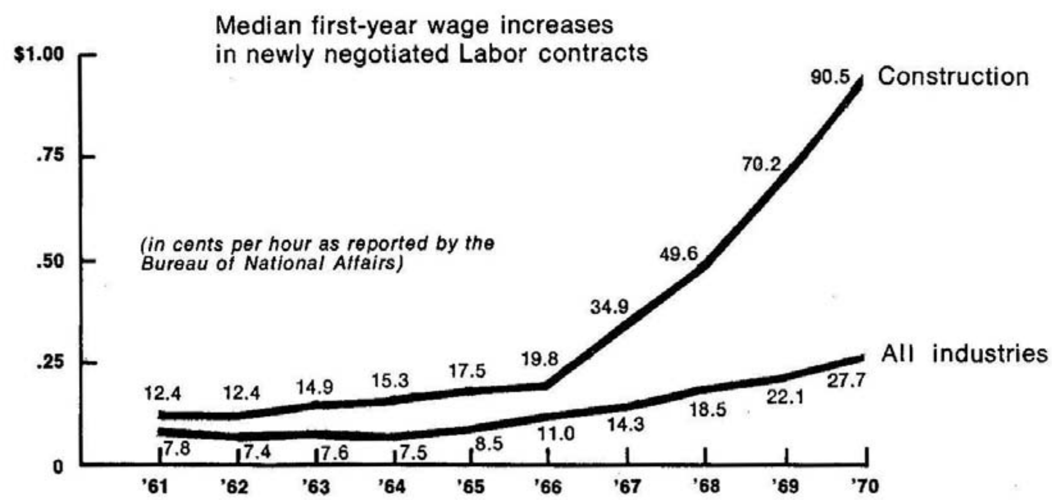
543.1 MEMBERSHIP

The building trade unions in the U.S. are made up of eighteen trades, organized into 10,000 locals, and comprise about three million members. (3) “Total union membership as a percentage of all construction workers in contract construction increased from 68.3% in 1956 to 75.0% in 1966. This is in contrast to the general trend of unionism in the rest of the economy where union strength has actually declined in relative terms . . . .

“In general, it would seem that, judging by wage rate and fringe benefits, the degree of unionization is highly correlated to the size of construction projects. In other words, union strength declines as the type of construction becomes lighter from heavy construction (highest degree of unionization) to . . . . home building (relatively low).” (4)

543.2 WAGES

543.2 .1 Since 1966, wages in construction trades have skyrocketed as compared to wages in other industries as shown by the following chart: (5)



543.2.2 Fortune Magazine states that unskilled workers are getting raises of over $2,000 per year, and that by 1972 a substantial percentage of skilled construction workers will be making around $20,000 per year. (6) While it is a matter of record that many skilled workers make from $8 to $10 per hour, a study of compensation in the building industry by the Bureau of Labor Statistics states:

"Though wages are high, annual earnings are generally low for construction workers. This paradoxical situation has been assumed to exist because work is seasonal, hazardous, and subject to an extensive amount of time lost because of bad weather and industrial strife; also, workers lose time looking for work between short-term jobs."

543.2.3 The study shows that the difference in employment between the most active month and the least active month is more than 600,000 jobs. In addition, more than one-fourth of the industry's total work force earns a majority of its income in another industry and only about half of those who earn all or most of their wages in construction, work during all four quarters of the year. (7)

543.2.4 During 1971, the alarm over the pace of wage increases in the construction industry has caused the President to suspend the Davis-Bacon Act, requiring payment of local prevailing wages (which in practice means union wages) on Federally financed projects, from February 23 to March 29. When the provisions of Davis-Bacon were reinstated, the formation of the Construction Industry Stabilization Committee was announced. This Committee reviews and approves or disapproves proposed wage settlements in the construction industry. While early efforts of this Committee were ineffective (painters in Little Rock, Arkansas were granted a 36% increase spread over three years), later efforts have held settlements to about 7% per year. (8)

543.2.5 One reason for the ability of labor unions to command such large increases is their ability to control the availability of labor through their apprentice training and hiring hall practices. In fact, the shortage of labor is the second greatest factor (after weather) causing job delays. (9)

543.3 JOB SECURITY

543.3.1 Perhaps as great a goal for the unions as high wages is full employment and increased job security. This goal has two spin-offs which influence union attitudes toward industrialization -- worries about their skills becoming obsolete, and worries those other trades will take over their work.

543.3.2 The fears about security on the part of the unions find expression in different ways. Perhaps the most important is the emphasis that the unions now put on contract provisions dealing with job security. Increasingly, unions are negotiating contracts providing substantial payments for past service in the form of separation pay to employees whose jobs are eliminated. Greater emphasis is being placed on improvements in private pension plans that permit earlier retirement, with increased pension benefits over and above payments provided by the Federal Social Security Act. These plans increasingly provide that the benefits accumulated over a number of years of service will not be lost if the employee leaves the company prior to the age of retirement. (11)

543.3.3 While all union members want job security, there is some confusion about how best to achieve it. In many cases, increased automation has led to an increase in jobs. In addition, many union members believe, and this is echoed in their national policies, that the technological advance will continue and they must move with it.

543.3.4 "American labor reacts positively and with vigor to an industrial society and encourages major technological advances. It realizes that it is only through technology devoted to the purposes of man that the production of goods can reach levels high enough for man to live with decency. While recognizing theses goals of industrialism, labor's acceptance of technology drives -- though sincere and hopeful -- remains tentative and confused." (12)

543.3.5 The picture of union desire for security as related to technological change seems to boil down to this: unions realize that change will continue to take place, and want to be on the bandwagon, but individual union members are afraid that they will be the one replaced by a machine. This view is supported by a study of local unions by Leonard Sayles and George Strauss:

". . . automation is a creeping phenomenon and one about which it is difficult to formulate a clear union policy or to arouse clear membership support. Normally it affects only a few workers at a time. The strong and understandable desire of individual workers to hold on to what they have encourages a certain amount of selfishness and makes unity behind job protection measures difficult to achieve. One steward explained: The members are divided on the basis of seniority.

The high seniority men are sitting pretty and don't pay much attention to the fact that men with lesser seniority are being laid off. They seem to say 'it is not happening to me' and they close their eyes to what is happening." (13)

543.3.6 The second element of the job security goal of unions, fear that others will take over some of their work, is expressed in the jurisdictional dispute. This occurs when there is a disagreement about which trade is responsible for a portion of the work, such as whether carpenters or plasterer should install drywall. In the event that jurisdictional disputes cannot be settled by the parties involved, they may be presented to the National Joint Board for the Settlement of Jurisdictional Disputes. (14) The introduction of industrialized building technology tends to increase the number of these disputes.

544 ATTITUDES TOWARD PREFABRICATION

As can be imagined from the foregoing discussions of industrialization and labor union goals in general, the attitudes of unions toward industrialization in the building trades are quite varied.

544.1 UNION STRATEGIES

"Unions faced with technological change may adopt one of three strategies: (1) the policy of obstruction; (2) the policy of competition; (3) the policy of control. The strategy adopted will not necessarily be a national one. A local with many unemployed members may attempt a policy of competition or obstruction, while a local which enjoys a tight labor market may actually welcome changes which raise the marginal product of its members. Haber and Levinson found evidence of all three strategies: bricklayers, for example, concerned with the rise in the use of brick substitutes, approved the use of a new, larger-sized brick (policy of competition). Lathers and plasterers use both direct and indirect methods of competition in their effort to prevent the use of drywall, which completely substitutes for the services of their crafts. While working to reduce the desirability of drywall through building codes and publicity campaigns, the unions have accepted and encouraged the use of the plaster gun. Carpenters have generally followed a policy of control and have not objected to the use of small power tools provided they are operated by union members. A case of obstruction may be found in the painters' restrictions on the use of the spray gun, although they have only rarely resorted to outright prohibition. " (15)

544.2 LEGAL INFLUENCES

544.2.1 The legal influence on union reaction to prefabrication is somewhat confusing. In most industries, "hot cargo" agreements, those which force and employer not to do business with a particular outside firm, such as might be used to keep a contractor from using prefabricated items, constitute an illegal secondary boycott.

544.2.2 "Prior to the amendment of the NLRA by the Labor-Management Reporting and Disclosure Act of 1959, the statutory secondary-boycott prohibitions applied only 'forcing or requiring' one person to stop doing business with another person. Hence, an employer might, if he chose, voluntarily agree with a union not to deal with certain persons, although a union could not lawfully attempt to enforce such an agreement by strike action. Now, Section 8(e),

added to the NLRA by the 1959 amendments, forbids the mere execution of such 'hot cargo' agreements and makes it an unfair labor practice for an employer and a union to enter into such an agreement." (16)

544.2.3 However: "A proviso to Section (e) exempts from that section's provisions agreements between unions and employers in the construction industry relating to the contracting or subcontracting of work to be done at the site of the construction, alteration, painting, or repair of a building, structure, or other work. The exemption does not extend to 'hot cargo' agreements concerning supplies or other products or materials produced or manufactured elsewhere and delivered to construction sites.

544.2.4 "Reversing an earlier policy, the NLRB now holds that picketing or other coercion to obtain a hot cargo pact in the construction industry is lawful. Some Federal courts support this policy, but most courts disagree. Also reconsidering an earlier decision, the Board holds that picketing to "reaffirm" a hot cargo contract prohibiting subcontracting to nonunion firms is lawful; however, picketing to enforce the contract against specific nonunion firms would be unlawful, the Board said. A Federal appeals court ruled that a subcontracting clause is primary, and lawful, if it affects the labor relations of a general contractor and protects his employees only; if it aims to regulate working conditions of a subcontractor's employees or sanctions a boycott against a subcontractor, then the construction industry's hot cargo exemption would not permit enforcement of the clause through picketing." (17)

544.2.5 This would seem to suggest that unions could legally force contractors to deal only with union-approved subcontractors for all work on the building site itself, but could not boycott products manufactured elsewhere. The way such a law works in practice, however, can be seen in the following reviews of two recent court decisions. Both of these cases revolve around the NLRB's right-of-control test.

544.2.6 Under this test, if the owner, architect or engineer specifies the product, then the contractor has no control over its use. In the absence of such control, union refusal to handle the product cannot be a primary dispute between the union and the contractor over preservation of on-site jobs and must, instead, be an illegal product or secondary boycott.

544.2.7 "Boycotts of prefabricated building parts are commonly provided for in collective bargaining agreements in the construction industry as a mean of work preservation, and they are not unlawful. But are they statutorily protected also in situations where the reassembled parts are specifically required by the job contract? A Federal court of appeals has said they are.

544.2.8 "A contractor, whose agreement with a plumbers' union provided that installation of all pipe two inches and under would be done by employees on the job site, won a bid for a construction job specifying that certain heating and cooling equipment be preassembled in the factory. Such equipment involved the use of pipes described in the union agreement.

544.2.9 "The union ordered the workers not to handle the equipment, and the work did not progress. The contractor claimed that the provisions of his job contract placed the situation beyond his control and that the union was actually in dispute with the party – a hospital – for which the job was being done, since that party alone could change the specifications.

544.10 "In adjudicating the case, the NLRB upheld the contractor by applying its 'right to control' (more precisely, power to control) test for determining of secondary boycott activities." (18)

544.2.11 However, this was not how the court of appeals viewed the situation. In short and simple language, the court in effect said that the contractor had no business signing a job contract which called for prefabricated parts when he knew that his union contract barred the use of such parts.

544.2.12 The court expressed dissatisfaction with the NLRB's "right to control" test and said, "We believe that (the) test must be abandoned", citing similar conclusions of commentators and all the other Federal appellate courts. (19)

544.2.13 A later court decision on another hospital project had a similar result: "The U.S. Court of Appeals for the District of Columbia has, for the second time, told the National Labor Relations Board (NLRB) to abandon the right-of-control test it uses in determining whether union refusal to handle prefabricated products is legitimate work preservation or illegal secondary boycott activity.

544.2.14 The case stemmed from carpenter's refusal to install premachined doors on a Decatur, Illinois hospital project. The doors were specified by the architect. The contractor, having no control over their use, was a neutral in the dispute, and the union's objective was to force the contractor to quit doing business with the hospital and the hospital to quit doing business with the door manufacturer, the NLRB ruled." (20)

544.2.15 Again the court disagreed:

It "called the test narrow, mechanical, mistaken and artificial. 'The legal effect of the board's test is to allow an employer to bind his own hands and thereby immunize himself from union pressure occasioned by his employees' loss of work. In one act, the employer helps to create a labor conflict and simultaneously washes his hands of it. The result goes far beyond the purposes of prohibiting secondary union activity: to limit the arena of economic conflict, to protect uninvolved, truly neutral parties from becoming involved in labor disputes not their own." (21)

544.2.16 The NLRB has indicated in a subsequent decision, however, that it will continue to use the right-of-control test except in those cases where the courts specifically order it not to do so.

544.3 NATIONAL UNION POLICY

544.3.1 Union policy toward prefabrication, expressed at the national level, is quite positive. Almost without exception, national union leaders express cooperation with attempts to industrialize. Some trades see increasing prefabrication as being clearly in their interest. Hunter P. Wharton, President of the International Union of Operating Engineers, is, enthusiastic: ". . . speaking for the Operating Engineers Union, the expanded work opportunities for hoisting engineers in the assembly of modules and large prefabricated sections [is an area of promise]." (22)

544.3.2 Similar attitudes are expressed by William Sidell, Vice President of the United Brotherhood of Carpenters and Joiners of America:

"The Brotherhood of Carpenters stands ready to meet our responsibility to our industry and to the society in which we live. It is on this basis that shortly after World War II we took what I believe was a realistic position when we determined that industrial approaches were inevitable for the construction industry, particularly in the housing field. So we decided not to fight their advancement, but rather to get involved and make our contribution to this industry." (23)

544.4 RECENT AGREEMENTS

544.4.1 In spite of the confusion of the law and the wide range of views taken by local unions, the picture is not necessarily unfavorable to prefabrication. In a sense, we have been talking about the unusual cases; in the majority of cases, unions are accepting more and more prefabrication and moving to insure that they are included. Some examples of current agreements which pave the way for increasing prefabrication are the following:

1. The Laborer's International Union of North America now claims contracts with 80% of the systems building firms in the U.S. engaged in factory-built housing production. (24)

2. "Tri-trades" agreements between Electrical Workers, Carpenters and Plumbers, and several housing system producers, that extend craft union benefits to factory workers and provide for interchangeability of work among the three crafts, lessening the likelihood of jurisdictional disputes. (25)

3. A labor agreement paying plumbers the same rate for in-factory work as for on-site construction in the making of prefabricated "plumbing walls." While per hour labor costs are the same, the chief savings come from uniform design, factory assembly, less chance for pilferage on site, and greater predictability of cost for the contractor. (26)

544.4.2 On the other hand, after signing an agreement with the United Association of Plumbers and Pipefitters, providing that if prefabricated plumbing walls manufactured by U.A. members they would be accepted on the job site, one manufacturer found that problems still arose with local unions.

One local would agree to install prefabricated plumbing walls only if they were manufactured within the jurisdiction of the local union. In this case, the local union did not want their jobs taken away by plumbers elsewhere, union or not.

544.4.3 This case seems to summarize the present situation. National unions and many union members are willing to go along with prefabrication; however, problems can easily crop up in dealing with local unions.

544.5 FUTURE TRENDS

A glimpse into the future may be provided by certain Construction Industry Collective Bargaining Commission recommendations, which former Secretary of Labor George Schultz planned to push for implementation. The new commission has called for an end to rank-and-file ratification of contracts by union workers, recommending instead that national unions and contractor associations be empowered to approve action of their local subordinate. Wage rates will be adjusted to local variations, however. Variation of work rules and wage rates by locality, and the need for local ratification of union agreements, have been a constraint to the prefabrication of components for national or international markets.

545 DETERMINING LOCAL UNION REACTION TO PROPOSED PREFABRICATION

As we have shown, there is no single national attitude on the part of the unions strong enough to guarantee acceptability or non-acceptability of a proposed case of prefabrication at the local level. How then does one determine the acceptability of a certain sort of prefabrication in a given area at a given time?

Several sources of information about local conditions are available. If the item in question is already on the market, the manufacturer may be able to provide valuable information if he has had experience in this area. It is clearly to the manufacturer's benefit if he can get his product accepted and he may be willing to do most of the work. One should be careful, however, because the manufacturer's experience in one part of the country does not necessarily mean conditions will be similar elsewhere.

A survey of local contractors may yield information about precedents in the area, and the local office of the Association of General Contractors may be helpful.

Naturally, one would thoroughly check local codes and, if possible, existing labor contracts for the various trades. If there is any uncertainty at this point, one should go to the Building Construction Trades Council, with an introduction from one of the unions involved. The Construction Trades Council will help determine which trades are involved and what their attitudes may be. It is important to deal with the crafts involved before a decision is made, and one should develop as strong a case as possible, for example, insuring that there will be a project built.

546 CONCLUSIONS

1. Despite the variations in local attitudes and the lack of agreement in the courts toward unions' right to control the degree of prefabrication on construction projects, the total picture seems to be encouraging. National union policies indicate that the leadership understands that prefabrication will almost inevitably increase, and that unions must find ways to work within this trend. It is clear to these national officials and many union members that they can at best only temporarily hold back industrialization by policies of obstruction.

2. At present, however, a great deal of power rests with the local unions, who are primarily concerned with their own job security rather than national trends. This is likely to be a continuing, though diminishing problem, and one, which may crop up at any place or time. Thus, while the trend is favorable, it should not be taken for granted that it applies in any specific case.

3. It seems likely that building trade unions will attempt to extend their jurisdiction into factories making prefabricated components. Union labels will identify work done in factories by union employees, making it acceptable to job site craftsmen.

4. Because of year-round employment and controlled working conditions, factory wages for workers will run about 80% of that of on-site construction wages, except where agreements require the same benefits for craftsmen either on or off the site. Factory workers will generally be less skilled, so unless other production efficiencies are inherent in the factory fabrication, lower wage rates will not in themselves significantly reduce costs.

5. Bargaining will increasingly be done at a larger scale, with large manufactures instead of small contractors, and national union groups instead of local entities.

6. Establishment of intertrade work rules for labor, so that one tradesman can overlap into the area of another, appears to be acceptable for factory fabrication labor agreements.

7. Elimination of the need for local ratification of labor agreements would open the way for national agreements on the use of prefabricated components in national and interregional markets by establishing one consistent set of work rules through the nation.

8. Based on recent evidence, the building trade unions are beginning to show more willingness to see factory fabrication as the way of the future, and are moving to insure that their members are included.

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21. Ibid, p.44.

22. HUD Challenge, March 1971, p.7.

23. Ibid, p.8.

24. Engineering News Record, June 17, 1971, p.3.

25. HUD Challenge, March 1971, p.7.

26. Engineering News Record, June 24, 1971, p.13.

550 Laws and Regulations

551 CODES

551.1 The Building System Prototype Design has been developed in complete compliance with the NFPA National Fire Codes, The Uniform Building Code, the National Building Code, and the National Plumbing Code. It is the intent of the design Manual that all detailed system and building designs developed from the Prototype Design maintain this compliance unless specifically determined otherwise by appropriate authority.

551.2 Codes differ from each other many items, and are all subject to variable interpretation and modification. From the point of view of the building system, which must have nationwide applicability over a reasonable period of time, the spirit is more important than the letter. Regardless of how a particular regulation may be interpreted, the overall objective is a safe, functional building that provides an environment appropriate to its programmed activities. No point in the description of the Prototype Design should be construed as a release from this general responsibility.

551.3 A chief difficulty in the application of codes to the design of buildings in general, and systems building in particular, is that they tend to be reactive rather than anticipatory. That is, they may scrupulously regulate traditional modes of construction, but they can become confusing or misleading, or simply fail to provide guidance, when new modes are introduced.

551.4 This problem has become quite apparent in regard to the increasing use of “adaptable” building components and “interstitial” space. The issue is not that these relatively new concepts violate the codes in some way, but simply that the codes do not refer to them at all. Under these circumstances, a safe building cannot be produced solely on the basis of a “correct” interpretation. The A/E and the authorities having jurisdiction must take the systems approach to an overall fire safety “strategy” for each individual project in accordance with its unique characteristics of program, site, building configuration, etc.

551.5 When this approach is taken, the Prototype Design provides the opportunity for certain innovations. The organization of the building into mechanically independent service modules which coincide with fire sections and which concentrate all vertical shafts in special bays at the perimeter, suggest a more positive use of the HVC system during a fire than is possible with more conventional arrangements. For example, it may not be necessary to shut down return air throughout the building, but only in the area of escape. Adjacent areas of refuge might be automatically pressurized to prevent spread of smoke, while the exhaust rate within the affected module is boosted. These special modes are not required by the Prototype Design, they are merely provided as alternatives when a particular strategy is being developed.

552 FEDERAL PROCUREMENT REGULATIONS

The following sections have been selected and reviewed because they are applicable to the system.

552.1 Use of Federal Specifications; Para 1-1.305.5 requires the use of Federal, or Interim Federal Specifications when available for material, equipment or service specified in Federal construction. Para 1-1.350-3 stipulates the conditions for deviating from these specifications. Federal Specifications have been reviewed and no deviations are apparent.

552.2 Use of Federal Standards: Para 1-1.306-1 requires the use of Federal Standards by all executive agencies. Remarks above concerning Federal Specifications also apply here.

552.3 Formal Advertising: Para 1-18.102.1 permits exceptions to the requirements for formal advertising in the case of experimental construction. It is not now anticipated that any exception would be necessary for the proposed demonstration hospital.

552.4 Construction Specifications: Para 1-18.107 states that the technical provisions of construction specifications will be appropriate for competitive bidding, and will be sufficient for completion of construction without additional specifications. This may be in conflict with certain forms of construction management, and/or with some types of product development program.

552.5 Type of Contracts: Paras 1-18.111, 1-18.201, 1-18.306, 1-18.307 and 8-18.111 discuss the use of firm fixed-price and cost-reimbursement type contracts. The latter type, combinations of the two types, and negotiated contracts of either type are permitted only under special conditions. This could present some constraint to the use of a construction manager.

553 VA MANUAL M-7

553.1 Manual M-7, titled “Planning Criteria for Medical Facilities”, is prepared by the Veterans Administration, Department of Medicine and Surgery. It is the general space criteria for all VA hospital planning and is in conformance with Bureau of the Budget policy (Circular A-57)

553.2 Manual M-7 represents a complication of extensive investigation and the collected judgment of many persons within the VA. It is periodically re-evaluated and revised to respond to changing medical technology and data gathered from various VA field stations.

553.3 It is the intent of the Prototype Design to conform to the criteria expressed in Manual M-7 as well as those changes currently under study. It is essential, however, that the building system allow a range of options, which will accommodate future changes in planning criteria. Therefore, current VA planning criteria, such as M-7, represent only one option within the system. (See Section 634 for recommendations concerning a review of M-7.)

554 VA CONSTRUCTION STANDARDS

554.1 SUBSYSTEM CHECKLIST

The following checklist indicates which VA Construction Standards are applicable to each subsystem.

554.1.1 Structure

Tolerances	4-1
Prestressed concrete	4-2
Anchors for masonry	6-3
Steel frame design	12-1
Floor slab surfaces	CD-15
Details regarding handicapped	CD-28
Standards and codes	CD-30
Roof structures	CD-38
Fire protection	FPS-12, FPS-16

554.1.2 Ceiling

Cubicle curtain tracks	15-1
Medical gas outlets	311-1
Supply conveyor enclosures	860-1
Standards and codes	CD-30
Ceiling heights	CD-34
Flame spread and smoke development	FPS-6
Exits and exitways	FPS-9
Fire sections and partitions	FPS-11
Fire protection	FPS -12, FPS-16

554.1.3 Partitions

Corner protective guards	14-2
Metal door bucks	24-1
Vinyl wall coverings	35-1
Ceramic tile	42-1
Automatic door control	54A-1
Medical gas outlets	311-1
Electric receptacles	801-3
Supply conveyor enclosures	860-1
Dwarf partitions	CD-14
Doors	CD-21
Razor blade receptacles	CD-25
Details regarding handicapped	CD-28
Standards and codes	CD-30

Electrostatic shielding	CD-33
Ceiling heights	CD-34
Fire apparatus cabinets	FPS-3
Flame spread and smoke development	FPS-6
Exits and exitways	FPS-10
Fire doors	FPS-10
Fire partitions	FPS-11
Fire protection	FPS-12, FPS-16
Laundry chutes	FPS-14
Trash chutes	FPS-18

554.1.4 Heating-Ventilating-Cooling

Refrigeration equipment	651-1
Condensate return piping	683-1
Location of ducts	CD-3
Standards and codes	CD-30
Pipe labels	CD-32
Roof-mounted equipment	CD-38
Fire protection	FPS-12, FPS-17

554.1.5 Plumbing Distribution

Plumbing standards	301-1, 301-2, 301-3, 301-5, 301-6, 301-7
Downspouts	CD-2
Location of piping	CD-3
Details regarding handicapped	CD-28
Standards and codes	CD-30
Pipe labels	CD-32
Automatic sprinkler protection	FPS-5, FPS-9
Standpipes	FPS-7
Fire protection	FPS-12

554.1.6 Electrical Power Distribution

Electrical system	800-1
Location of conduits	CD-3
Details regarding handicapped	CD-28
Standards and codes	CD-30
Fire protection	FPS-12
Essential hospital electrical service	FPS-15

554.1.7 Non-System Items

Thermal insulation of exterior wall	31-1
Roof isolation	31-2
Ceramic title	42-1
Pneumatic tube systems	307-1
Water softening	406-1
Dietetic equipment	502-1, 502-2
Refrigeration equipment for HVC	651-1
Central plant	700-1, 700-2
Alarm system	801-7
Remote dictating system	806-1
Antenna system	813-1
Entertainment system	814-1
Elevators	850-1
Dumbwaiters	850-2
Laundry equipment, women's psychiatric ward	CD-12
Window curtains	CD-24
Details regarding handicapped	CD-28
Roof decks	CD-29,
Standards and codes	CD-30, FPS-12
Curtain walls	CD-31
Electrostatic shielding	CD-33
Windows	CD-35
Roof structures	CD-38
Dietetic equipment exhaust	FPS-4
Cooling towers	FPS-13
Laundry chutes	FPS-14
Fire protection	FPS-12, FPS-16
Trash chutes	FPS-18
Fire alarm systems	FPS-19

554.2 DISCREPANCIES

554.2.1 Construction Standard 4-2 implies that prestressed concrete construction should not be used in seismic areas. If applied within the system rules for the Prototype Design, there is no engineering reason why prestressing should be used anywhere in the country. Prestressed concrete may in fact be expected to usually provide the most economical detailed design solution.

554.2.2 CD-15 implies that concrete floors slabs must either be monolithic or have a toping slab of 1-1/2 inches. The Prototype Design calls for a three-inch topping slab to simplify and expedite original construction and particularly to facilitate adaptability in relocation of items requiring depressions.

554.2.3 24-1 requires certain door bucks to extend through the ceiling to the slab above. The Prototype Design specifies that no such frames may penetrate the ceiling, i.e., they must receive all necessary structural support from the ceiling itself. This is done to simplify door installation and relocation, and to minimize obstruction in the service zone.

554.2.4 CD-25 requires used razor blade receptacles to be recessed within partitions. The Prototypes Design calls for all such items to be surface mounted, in this case integrated into a lavatory console. The purpose is to protect the acoustic properties of partitions and to facilitate relocation of service elements.

554.2.5 CD-34 permits ceiling heights under nine feet in certain areas. The Prototype Design specifies a uniform ceiling height throughout, and nine feet is recommended in bed-care areas. The same Construction Standard also requires a minimum height of ten feet in laboratories, presumably for fume hood clearance. If an entire floor, or a large area such as a fire section, were to be assigned mainly as laboratory space, a uniform height of ten feet could be established by increasing floor-to-floor height by one foot. For small laboratories, however, conformity to the nine-foot height should be workable.

554.2.6 FPS-3 requires that fire apparatus cabinets in patient areas be recessed into partitions. Although this can be done within the Prototype Design, it is discouraged except where really necessary, for the reasons started in 554.2.4 above.

554.2.7 FPS-11 requires all corridor partitions to be full height and fitted to the floor slab above. The Prototype Design calls for these partitions to stop the ceiling. None of the building codes used by the VA (NFPA Life Safety Code, NBC and UBC) require the extension of corridor partitions beyond the ceiling. FPS-11 itself allows one-hour smoke barriers to stop at the ceiling provided the ceiling is rated at one hour and is “impermeable” to smoke and fumes. The assumption made for the Prototype Design is that if the ceiling provides one-hour separation, then corridors are adequately protected by one-hour partitions that stop at the ceiling.

In any case, the detailed characteristics of the ceiling and partitions must be developed as part of an overall fire safety “strategy” as discussed in Section 551.4 above.

555 VA MASTER CONSTRUCTION SPECIFICATIONS

555.1 SUBSYSTEM CHECKLIST

The following checklist indicates which VA Master Construction Specifications are applicable to each subsystem.

555.1.1 Structure

Concrete	4
Roofing slabs, precast concrete	7
Caulking and sealant	8
Steel decking	11
Structural steel	12
Sprayed-on fireproofing	12A
Painting	56
X-ray construction	64

555.1.2 Ceiling

Concrete	4
Roofing slabs, precast concrete	7
Caulking and sealants	8
Steel decking	11
Structural steel	12
Gypsum roof decks	13
Miscellaneous metal work	14
Miscellaneous building specialties	15
Lathing and plastering	28
Drywall construction	33
Acoustical treatment	34
Painting	56
Electromagnetic shielding	58
X-ray construction	64

555.1.3 Partitions

Caulking and sealants	8
Miscellaneous metal work	14
Miscellaneous building specialties	15
Hollow steel doors and frames	24, 24A
Various partitions	27A, 27B
Lathing and plastering	28
Carpentry and millwork	30
Dry wall construction	33

Acoustical treatment	34
Wall coverings	35
Glazed wall surfacing	35A
Ceramic tile	42
Builders' hardware	54
Automatic door operators	54A
Painting	56
Electromagnetic shielding	58
X-ray construction	64

555.1.4 Heating-Ventilating-Cooling

Miscellaneous building specialties	15
Painting	56
Air conditioning	600
Air-handling units	601
Unitary air-conditioning equipment	604
Exhaust systems	622
Air ducts and devices	681
Piping systems (HVC)	683
Automatic control systems	688
Thermal insulation (HVC)	692
Vibration bases and equipment	695
Testing and balancing	699

555.1.5 Plumbing Distribution

Painting	56
Hydro-pneumatics	300
Interior plumbing	301
Plumbing fixtures	302
Oxygen system	311
Nitrous oxide system	312
Central suction system	313
Compressed air system	317
Fire protection system	321

555.1.6 Electrical Power Distribution

Painting	56
Basic electrical requirements	800
Electrical circuits	801
Electrical power and control equipment	802
Lighting systems, indoor	803
Electrical power system, auxiliary	804
Electrical power systems, isolated	805

555.2 DISCREPANCIES

555.2.1 Section 33, Drywall Construction, refers to partitions extending above suspended ceilings contrary to system rules.

555.2.2 Section 33 also describes suspended ceilings which would not meet the subsystem performance requirements. Since there are a number of different ways that a ceiling could be detailed within the limits set by the Prototype Design, appropriate specifications cannot be written until the specific design has been developed for an actual building project.

555.2.3 There are currently no Master Specifications for prestressed or precast structural concrete, and these are both generic design options within the Prototype Design.

555.2.4 The use of phased bidding and/or construction management may require special bid forms, etc. The following documents could be affected:

Bid Form	BF
Invitation for Bids	IFB
Instructions to Bidders	IBF
General Provisions	GPF
General Requirements (over $10,000)	GR
General Conditions	G
Samples and Shop drawings	S

No changes are necessary to the above documents if the system is used without bidding change or construction management.

556 VA STANDARD DETAILS

556.1 SUBSYSTEM CHECKLIST

The following checklist indicates which VA Standard Details are applicable to each subsystem.

556.1.1 Structure

Floor slab depressions	1B
Stair details	10a to 10F
Showers	13, 13A
Lead lining in X-ray rooms	24
Lead sleeve for vertical pipes passing through lead lined floor	24J
Elevators	29 to 29G
Expansion joint cover plates	30
Seal strip details	31
Ceiling support for X-ray tube stand	36
Letter box and mail chute	38
Therapeutic pool details	47

556.1.2 Ceilings

Schedules of interior finishes	2
Operating and EEG room details, shielding	23, 23A
Lead lining in X-ray rooms	24

556.1.3 Partitions

Schedule of interior finishes	2
Base, wainscot and wall finish details	3
Ceramic tile trim shapes	3A
Partition coursing details, exposed concrete masonry units	3B
Partition framing details, metal stud and plaster	3C
Corner guard details, interior	5
Door schedule	7
Doors to patients' bedrooms	7A
Door details	7B
Frames for interior doors	8
Frames for manually operated sliding doors	8A
Frames for automatic sliding doors	8B
Observation windows	11

Toilet stalls, urinal screens and dressing booths	12
Showers	13, 13A
Grab bars	14 to 14B
Razor blade receptacle	16
Ceramic tile panels	17
Corridor wall railing	19
Seats in shower stalls and dressing booths	20, 20A
Chalkboards and bulletin boards	21
Operating rooms and EEG room details, shielding	23 to 23B
Lead lining in X-ray rooms, etc.	24 to 24G
Cassette transfer cabinet	24H
Bed wall outlets	26 to 26H
Elevators	29 to 29G
Post office details	46
Vanity	53
Shelving	60 to 60H
Pass window details	62
Racks	64B, 64C
Cabinets	70 to 70N
Kitchen cabinets	71 to 71E
Counters	72, 72A
Thru-wall counter	72K

556.1.4 Heating-Ventilating-Cooling

Louver details	9
Operating and EEG room details, shielding	23A
Cabinets, nurse server	70

556.1.5 Plumbing Distribution

Plumbing fixtures	4 to 4C
Toilet stalls, urinal screens and dressing booths	12
Showers	13, 13A
Mirror and lavatory elevations	15
Oral surgery room or dental treatment alcove	22
Dental X-ray room or dental X-ray and examination room	22A
Operating and EEG room details, shielding	23, 23B
Lead sleeve for vertical pipes passing thru lead lined floor	24J
Bed wall outlets	26 to 26H
Benches	52

Vanity	53
Cabinets	70B, 70C
Kitchen cabinets	71 to 71E
Counters	72B
Kitchen table with sink	73B
Soiled dish table	73C
Kitchen sink	73D
Sinks, free standing	73E

556.1.6 Electrical Power Distribution

Bed wall outlets	26 to 26H
Benches	52
Vanity	53
Cabinets	70B, 70C
Kitchen cabinets	71 to 71E
Counter	72B

556.2 DISCREPANCIES

556.2.1 Detail 1B indicates requirements for slab depressions up to four inches in depth in ward areas whereas the system rules call for no depressions in the structural slab and provide a tree-inch topping which is sufficient for shower stalls, etc., given appropriate modification of curb details. If in a particular case deeper depressions are really indispensable, either a thicker topping slab may be used or the structural slab may in fact be dropped. In either case structural cost is increased, and with the latter solution adaptability is reduced.

556.2.2 Details 8 and 8B show door frames penetrating the ceiling. See 554.2.3 above.

556.2.3 Detail 15 indicates lavatory plumbing enclosed in partitions. The Prototype Design calls for services to be contained in surface mounted containers. See 544.2.4 above.

556.2.4 Details 26A to H show bed wall outlets flush mounted. Comment on Detail 15 above applies.

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PROJECT REPORT

VOLUME 3

Volume Three, the Project Report, is the consultants account to the Veterans Administration of the systems integration program. It provides a summary, conclusions, recommendations, and various appendices such as the design rationale, example designs, special procedures and the cost and time analysis.

600 NARRATIVE

610 SUMMARY

620 CONCLUSIONS

630 RECOMMENDATIONS

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610 Summary

611 THE PROBLEM

611.1 COST VS. PERFORMANCE

Over the years there has been a steady increase in the construction cost of hospitals, and recently there has been a rapid escalation of these costs. Because of the long period from inception to occupancy of a field station, typically seven to eight years, the Veterans Administration is not only denied the use of the building as rapidly as desired, but the capital cost is increased by this escalation. At the same time, rapidly advancing medical technology calls for facilities that can respond efficiently to changing needs. A larger proportion of the VA's capital budget is allocated to alteration and renovation of existing hospitals than to the construction of new hospitals. Traditional modes of construction are not providing adequate adaptability, nor, in fact, are they fully meeting current user needs in terms of general performance.

611.2 CONVENTIONAL DESIGN AND CONSTRUCTION

Traditional procedure has tended to underemphasize many of the interrelationships between components and subsystems which significantly affect the overall cost, performance and adaptability of buildings. This tendency has produced inefficiencies at several levels:

1. Manufacturers develop specialized products without reference to specific ways in which they will be combined with the products of other manufacturers. The A/E must therefore in effect design a different building "system" each time he deals with a new building under new circumstances. Normal design schedules and budgets do not permit serious systems analysis, so the result is usually a composite of performance compromises, unintentional experiments, and vast numbers of special condition details.

2. Building and plan configurations tend to be overdesigned, as if they were to remain unaltered in any way for fifty years. The organization of building services (mechanical, electrical, etc.) on the other hand, is usually underdesigned, on the apparent assumption that as concealed elements, their configuration is of no consequence.

Each subcontractor is more or less free to use his own judgment in finding the shortest route between two points, and much of the detailed coordination between subcontractors is worked out in the field on an ad hoc basis. The result is a building which is awkward and costly in routine maintenance and repair, let alone in growth and change.

3. The lack of pre-coordination between manufactured products, and the lack of discipline in the layout of service subsystems, are serious deterrents to the development of prefabricated assemblies. Manufactures are unwilling to commit themselves to mass production of large complex units as long as interface conditions within buildings are essentially unpredictable from their point of view.

4. The conventional design approach has emphasized highly optimized opening configurations and the measure of planning efficiency in terms of gross-to-net-area ratios and the like. Thus, it has encouraged a design process in which many detailed architectural decisions are made prior to serious consideration of structural and service distribution requirements. The result has been very complex structures and service networks tailor-made for the opening configuration but severely restrictive to alteration.

5. Buildings are often evaluated during construction and occupation, but evaluation procedures are usually not specifically structured for maximum return of useful information, either to the original designer or to A/E's working on current similar building projects. Thus many design deficiencies are repeated, even though they may have been identified. Without specific feedback procedures for introducing improvements in design and construction, innovation is painfully slow, depending largely on the limited personal experience of individual designers.

6. Conventional design procedures are highly linear, requiring a complete program before design can begin, and a complete preliminary design before working drawings can begin. Furthermore, architectural design is developed to a considerable level of detail before engineering design is started. The people responsible for each phase do most of their work independently, rather than as a team. This type of process is time-consuming and makes coordination difficult.

Interrelated decisions which should be made on the basis of trade-offs are often made in different phases, so that the later decisions are unduly constrained by the earlier ones.

612 THE SYSTEMS APPROACH

The clear need for a more rational approach to the design, construction and alteration of buildings has led to widespread interest in the concept of systems.

612.1 TERMINOLOGY

612.1.1 THE SYSTEMS APPROACH is a strategy of problem definition and solution which emphasizes the interaction between problem elements and between the immediate problem and its larger context, and which specifically avoids traditional methods of independent or ad hoc treatment of the various elements.

612.1.2 BUILDING SYSTEMS INTEGRATION is the simultaneous development of a group of coordinated components, traditionally treated independently, to improve their combined performance through controlled interaction. Direct physical integration is not necessarily implied.

612.1.3 A BUILDING SYSTEM is a particular method of design and construction involving a specific group of coordinated components.

612.1.4 A PROTOTYPE DESIGN is a basic system design establishing the performance and dimensional limits within which alternative detailed designs may be produced to accommodate specific conditions at various times and places. It is not a standardized scheme for identical repetition; it is a generalized decision process, of which various specific designs are the products.

612.2 THE BUILDING AS A SYSTEM

There is nothing new about the notion that a building is a collection of systems: a structural system, a mechanical system, an electrical system, and so on. What has evolved more recently, however, is the conceptualization of the whole building as a system, and further, the total process of building production and utilization as a system demanding a much higher degree of internal coordination than has been achieved so far. This internal coordination, or integration, begins with an analysis of the building into its components and a study of how well each meets its intended function under real conditions. Of particular interest is how the characteristics of each component directly or indirectly affect the performance of the others and of the total building.

The object of the analysis is to identify those design features which are responsible for the most serious negative effects.

612.3 PERFORMANCE DESIGN

Before recommendations for corrective measure can be formulated, the various design determinants of the building type and components in question must be identified and interpreted. They include user needs, applicable standards and regulations, available technology, geographical and environmental factors, labor union practices and target costs. Building components are grouped under various categories, or subsystems, and formal statements of how each subsystem is expected to respond to these determinants are drafted to serve as the basis for system design; these are the "performance requirements". In a prototype design, they are retained as an integral part of the system description as criteria for detailed design.

612.4 THE BUILDING SYSTEM AS A SET OF RULES

The first step toward increased efficiency is the establishment of rational standards for design and construction which can serve as a common basis for coordinated decisions among administrators, A/E's, contractors and users. A prototype design is, first and foremost, a set of such rules. Not until all parties understand and agree to comply with the rules can the development of specific designs proceed effectively.

612.5 UNCOUPLING PRECEDES INTEGRATION

The principles of systems integration do not dictate immediate achievement of a high degree of physical integration of building products and components. Prefabricated assemblies as an efficient construction technique must evolve from the interpretation, application and refinement of a particular set of system rules by many people over a series of similar building projects. In fact, in the analytical phase in which the prototype design itself is under development, the major subsystems must be "uncoupled", that is, clearly separated out within the building to establish radically simplified interface conditions. This technique allows designers, manufacturers and contractors to deal with manageable increments of the total problem on their own terms. It is also very useful in the detailed design of highly adaptable building subsystems.

612.6 COST/PERFORMANCE TRADE-OFF

A cost-effective design is one which either provides the highest level of performance for a given target cost or provides a given level of performance at the lowest cost. (There is rarely a "cheapest-best" alternative available.) But the usual cost-benefit analysis concerns itself simply with a comparison of several subsystem or component alternatives, whereas actual conditions within a building are the combined effect of various sets of components which cut across subsystem classification.

The acoustic environment, for example, depends on a high degree of design coordination between partitions, ceilings, mechanical equipment, surface materials and service distribution terminals. The theoretical sound transmission class of a partition is meaningless if the ceiling provides a flanking path, or if electrical outlets puncture the surface, or if sound passes readily along ductwork.

Systems analysis and integration include the identification of these performance-related component sets and the characteristics which must be balanced to achieve any given criterion. Cost-benefit analysis can then be more realistically applied to trade-off problems directly in terms of negotiable levels of performance.

612.7 CONVERGENCE AND FEEDBACK

612.7.1 The process of systems integration must be viewed as continuous, rather than as terminating at a certain point with a perfected set of components. New building products are constantly being developed and marketed by industry. New building techniques are periodically introduced by engineers or contractors. New performance requirements evolve as the activities within buildings change. And the evaluation of components in use invariably reveals unanticipated bugs which should be eliminated from future protection. This process involves five broad classes of activity:

1. Determination of performance requirements,

2. evaluation of available building products and techniques,

3. design of systems and components,

4. analysis of cost and scheduling implications, and

5. evaluation of buildings utilizing the integrated systems and components.

612.7.2 Several characteristics of the relationships between these activities must be pointed out as clarification of the manner in which the various tasks in this program were executed:

1. There is no clear boundary between these activities in actual practice. Their overlap is considerable, so the placement of certain tasks under one activity or another is fairly arbitrary. All of them may be considered as part of a general design process.

2. Although at first glance these activities appear to follow logically one from the other in the order listed, they are in fact not independent. Each cannot be carried beyond a certain point without information that must be obtained by starting one or more of the others. “Chicken-or-egg” questions arise constantly, and tasks often must proceed on the basis of assumptions about what will be learned from other work not yet completed.

3. Each of the first four activities must be repeated several times, at different levels of specificity, before a demonstration building can be designed and the fifth activity commenced. Field evaluation then becomes a primary source of feedback information for continuous development of the system. In other words, the process is cyclical, each cycle producing more design detail, more accurate cost projections, more effective performance, etc.

4. No amount of recycling of the first four activities can conclusively prove that the proposed prototype design will in fact achieve the stated objectives. Only the construction of one or more buildings will allow the fifth activity to be implemented and the feedback loop to be closed.

5. At least three parties must engage in these activities at various times and degrees: the consultant in executing this study, the VA in establishing a data base for continuous development and programming specific projects, and the A/E in designing the building. The scope of assigned tasks must be carefully adjusted so that each party can provide maximum benefit and minimum constraint to the others.

6. A fourth party could become involved in the process, specifically in the design activity, depending on the strategy chosen for implementation. This fourth party is the building product manufacturer. If a sufficient market can be aggregated and guaranteed, manufacturers can be induced to bid on the basis of performance specifications, contributing innovative product design particularly suited to the owner's special requirements.

   However, not only are such guarantees impractical within the constraints of current federal funding policies and procurement regulations, but new product development adds a significant amount of time and effort to the design activity which must be well under way before construction can begin. An alternate strategy, exemplified by this project, is to develop a building system prototype design directly, through more or less conventional A/E consultant procedures, utilizing products already available. Manufacturers can then be expected to respond later through their normal R & D programs when it becomes evident that the VA will continue to construct hospitals within the established context of the systems integration program.

613 SCOPE

The scope of this project has been limited to the first four activities described above (Section 612.7). The design and construction of a demonstration hospital is presently under consideration by the Veterans Administration to allow commencement of the fifth activity and thus provide a field test of the principles of systems integration.

The project was also limited in the following ways:

1. Only six building subsystems were under direct study: structure, ceiling, partitions, heating-ventilating-cooling, plumbing distribution and electrical power distribution,

2. only building products already in production are utilized in the design,

3. it has been assumed that the building system will be used exclusively for new construction,

4. the design had to conform to all federal procurement regulations, laws, and budget policies, and all VA construction standards and planning criteria, except as specifically authorized by the VA, and

5. the system had to be capable of effective application anywhere in the United States.

614 OBJECTIVES

The primary objectives of the VA systems integration program have been cost control, improved performance, adaptability, time reduction and the provision of a basis for long-range development of a hospital building system. The vehicle for working toward these objectives has been the Building System Prototype Design, referred to more briefly as the Prototype Design.

614.1 COST CONTROL

614.1.1 First Cost

Besides the manufacturer's delivered price for a building subsystem or component, the selection of that item has three other predictable interacting effects on the first cost of a building: the cost of its installation, the cost of products which must be used in conjunction with it, and its influence on the critical path of the construction schedule. Normally, the first of these is taken into account by conventional estimating procedures. But the other two are frequently overlooked, the second because there is usually not enough time allotted for design to allow effective cost-benefit analysis of significant alternatives; the third because selection often must be made before a construction schedule can be developed in sufficient detail to measure sensitivity. A special case of the latter difficulty is the cost effect of a product on change orders in which the product may become involved.

The development of the Prototype Design has been directed at the establishment of controlled interface conditions, permitting the widest possible latitude in the selection of components without adverse effect on adjacent components, and allowing postponement of certain critical selections until their impact on scheduling can be assessed. The purpose of this approach is not necessarily first cost reduction per se, but rather to improve control over cost and thus allow more realistic budgeting.

614.1.2 Life Cost

The total cost of housekeeping, maintenance and alterations of a hospital building over a forty-year period can be expected to be at least five times the contract cost of the original construction.

Also, these activities interfere to various degrees with medical and administrative activities; that is, they affect the total efficiency of the hospital. Furthermore, the more difficult it is to alter an existing configuration, the less likely that useful alteration will be undertaken, thus forcing staff to work under increasingly inefficient conditions. These considerations are primary design determinants, placing high priority on simplicity, adaptability and access.

614.2 IMPROVED PERFORMANCE

As noted above (Section 612.6), many aspects of a building's performance are not determined by the characteristics of any one component, but rather by the combined effect of certain sets of components. The development of the Prototype Design has proceeded from an analysis of these relationships, not so much to raise existing performance standards as to establish basic standards of coordination and thus assure that, whatever standards are applied by the VA, desired performance levels can be realistically achieved and maintained under field conditions. The A/E must preserve and exploit this precoordination in his detailed design if user needs are to be effectively satisfied.

614.3 ADAPTABILITY

614.3.1 Prevention of Obsolescence

By far the most critical aspect of building performance to be improved through systems integration is adaptability. Adaptability is critical not only because of the cost considerations mentioned above, but also because of the very rapid rate at which technical and administrative obsolescence can overtake any design configuration, no matter how carefully planned. Mission and program requirements are changing so rapidly, in fact, that hospitals are frequently referred to as obsolete the day they open their doors.

614.3.2 Options for Opening Configuration

One purpose of system adaptability is to allow the widest possible range of design configurations so that the particular demands of each site and program can be met on their own terms, without unnecessary additional constraints due to system limitations. The Prototype Design, in particular the planning discipline, has been developed to provide this versatility.

614.3.3 Efficient Alteration

The other purpose of system adaptability is to allow for rapid and economic execution of desired changes, both during and after original construction, with minimum down time for the elements being changed, and minimum interference with activities outside the area of change. It requires, however, that the detailed designs for each building be carefully considered to ensure full utilization of the Prototype Design concepts.

614.4 TIME REDUCTION

The problems of cost escalation, obsolescence and inefficiency of space utilization are all aggravated by the lengthy periods now taken for programming, planning, design, construction and alteration. A primary function of the Prototype Design is to simplify the decision-making process and thereby allow significant time reductions in at least some of these areas.

614.5 LONG-RANGE DEVELOPMENT

As mentioned in the problem statement (Section 611.2), conventional design and construction procedures are not well suited to the accumulation and application of experience. Efficient implementation of a long-range systems integration program will require the establishment of a data base and an evaluation and feedback mechanism so that each successive construction project can contribute a maximum of useful information. The intent of the Prototype Design is to propose a rational discipline which can serve as a vehicle for this type of systematic development.

615 TASKS

Since 1967 a joint venture of Building Systems Development and Stone, Marraccini and Patterson has been working with the Research Staff of the Veterans Administration's Office of Construction to apply the principles of systems integration to the problems and objectives described above.

615.1 The project has proceeded as a phased program with each phase under separate contract. Phase 1 was a feasibility study and was published by the Veterans Administration in October 1968 under the title "Integration of Mechanical, Electrical, Structural and Architectural Systems in VA Hospital Facilities".

615.2 Phase 2 involved the initial development of a prototype design for a building system, specifically for that portion of the hospital containing bedrooms and bed-related functions. Four building subsystems were selected as the primary subjects of this effort: structure, heating-ventilating-cooling, partitions and ceiling. The final report was published in February, 1971 and is titled "Application of the Principles of Systems Integration to the Design of the 'Nursing Tower' Portion of a VA Hospital".

615.3 This report is the product of Phase 3, during which the building system Prototype Design has been extended in applicability (to the total hospital) and scope (the plumbing distribution and electrical power distribution subsystems). A projected fourth phase would involve the design and construction of a hospital to demonstrate and evaluate the proposed system.

The procedure for Phase 3 was similar to that of Phase 2. Although not strictly linear, the following basic tasks were involved:

1. Identify configuration and activity requirements for the various functional areas and spaces within the total hospital, with particular emphasis on those requirements which may conflict with the "nursing tower" system proposed in Phase 2. (Sections 510 and 520.)

2. Modify Phase 2 building subsystem performance requirements as may be required by extension of functional space analysis into the total hospital. Develop performance requirements for plumbing distribution and electrical power distribution.

(In the early stages of the system development process, performance requirements for the building subsystems were derived from the user needs, functional requirements, VA regulations, etc. They have subsequently been revised to reflect the design decisions generated by that process and are now to be considered design criteria for specific construction projects. As such, they are literally components of the building subsystems, and have therefore been editorially integrated into the subsystem descriptions in Section 300.)

3. Expand the cost base developed in Phase 2 to include the total hospital and the two additional building subsystems. (Section 530.)

4. Review the space modules and other planning concepts developed in Phase 2 for the “nursing tower” and investigate their applicability to the rest of the hospital. Develop new planning modules as may be required to provide a coordinated group for a total hospital building system. (Section 200.)

5. Develop a set of hospital design configurations utilizing the proposed planning modules, which could be further developed into detailed building designs. (Section 250.)

6. Revise and expand the Prototype Design proposed in Phase 2 as required to include the six designated subsystems in a coordinated set of building components for the total hospital. Continue evaluation of building products presently on the market in terms of the subsystem performance requirements. (Section 300.)

7. Establish target costs for each subsystem, and compare long-term costs of conventional design and construction with anticipated long-term costs of buildings utilizing the Prototype Design. Similarly, compare conventional and system scheduling. (Section 750.)

8. Develop a schematic hospital design illustrating application of the Building System Prototype Design, and discuss its cost, scheduling and performance characteristics. (Section 730.)

9. Update investigation of labor union restrictions presented in Phase 2. (Section 540.)

10. Review applicable documents, report apparent conflicts with the Prototype Design and recommend changes as appropriate. (Section 550.)

616 THE BUILDING SYSTEM PROTOTYPE DESIGN

The results of executing the tasks outlined above are presented in Volume One, Design Manual; Volume Two, Data Base; and the appendices in Volume Three, Project Report. The basic characteristics of the Prototype Design are discussed in Section 110, and are only summarized here.

616.1 During preliminary planning, schematic building designs are generated as assemblies or relatively large-scale planning modules, rather that as arrangements of individual rooms. The modules establish overall dimensions of the building as well as primary structural and service distribution patterns. Detailed architectural plans are developed within this fixed framework, concurrently with, rather than prior to, detailed structural, mechanical and electrical designs.

616.2 The basic "building block" for generating schematic designs is the service module. Service modules are one-story units of building volume which can vary in area but are considered optimum at about 10,000 square feet. Each module has its own mechanical and electrical rooms on the functional floor, each is served by a single independent service distribution network, and each is completely contained, alone or with another module, within a single fire section.

616.3 Main horizontal service distribution within the service modules occurs in the "interstitial" space – a horizontally accessible service zone above the ceiling. The ceiling is suspended below a shallow girder-and-beam structure rather than from a truss, and is designed as a continuous platform to allow workmen to move freely over its entire surface. Recommended minimum clearance under the beams is five feet, thus providing full headroom between beams.

616.4 The service zone is highly organized into reserved subzones for various services. The purposes of this "precoordination" are to provide clear access and passage for all trades, to minimize crossovers and other conflicts, to assure reasonable space for future extensions and additions, and to permit positive location of all components. All services except gravity drains downfeed into the functional zone below.

616.5 All partitions except two-hour fire partitions stop at the ceiling-platform and thus do not interrupt the service zone.

To the greatest practical extent, service drops are surface-mounted and enclosed in furred-out partition components or proprietary containers.

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620 Conclusions

621 BENEFITS

621.1 COST CONTROL

621.1.1 First Cost

The Prototype Design developed in this study does not consist of a list of building products. Rather it provides a framework of coordinated basic subsystem designs within which the VA and the A/E can derive the optimum specific design for each program, time and place. process of trade-offs. The predetermination of interface conditions in advance of any specific building project and its detailed design problems saves the A/E time usually spent doing this for each job. This allows him more time for product selection and cost-benefit analysis.

An example of simplification through a controlled interface is the particular relation between the ceiling-platform and the structure selected for the Prototype Design. By limiting the structure to medium spans, a beam and suspended-ceiling scheme became practical for the establishment of a horizontally accessible service zone. In typical long-span, deep-truss, interstitial-space schemes, the ceiling is placed at or near the bottom chords, forcing a compromise between efficient truss depth and sufficient service space. But beams and girders can be proportioned to produce a relatively shallow structure, allowing most of the services to pass below them. Thus the depths of the structure and the service zone can be independently optimized.

The organization of component design by general building subsystems which cut across various trades provides a basis for structuring cost estimates so that they can be directly related to the performance level of a functionally related set of components, thus allowing rational cost-performance trade-offs. The organization of hospital design on the basis of service modules provides the capability of establishing a construction budget in terms of per module estimates, as well as the usual per-square-foot and per-bed figures, thus allowing budgeting adjustments in fairly large units.

The intent is to avoid the more traditional devices for cost-cutting which involve reduction in quantity or quality of more or less randomly selected products, or across-the-board tightening of space standards, without particular regard for the impact these decisions may have on the hospital as a system. Experience has shown that these devices are in fact often very wasteful in terms of the final cost-effectiveness of the project. The allocation of budgetary surpluses, and response to program changes, are likewise frequently inefficient in the context of traditional design and cost control procedures.

The principle impact of the Prototype Design on cost is intended to be in the areas of maintenance and alterations, rather than first cost. Nevertheless, the very characteristics which have been developed to reduce life costs – simplicity, adaptability and accessibility – are bound to have a beneficial effect on construction cost also, for example, by improving the feasibility of field changes. The simplicity and standardization of subsystem design also makes estimating itself a much simpler and more efficient process, less subject to accidental omissions and similar errors.

In a project constrained to use only currently available non-proprietary products, but directed to improve performance, some increase in first cost over present methods is implicit. There are prospects of compensating for this effect quite directly through significant reductions in design and construction time made possible by the deliberate detailing of the system for that purpose. But how much of a savings is realized depends on how far the VA is willing to go in the way of altering customary decision-making procedures, how well A/E's and building contractors understand the scheduling benefits of the system, and on what theoretical basis time savings are translated into cost savings.

621.1.2 Life Cost

A major part of the design effort has been on the organization of service distribution, the provision of convenient access for maintenance, repair and replacement, and the control of interface conditions for ease of alteration. The theory is that this discipline will pay off in the long run. However, an attempt to reliably predict actual cost savings in these areas is not feasible. There are too many variables involved, and not enough field experience with the particular kind of solution proposed. Nor is there any reasonable way to estimate what it is currently costing the VA to not have properly accessible and adaptable spaces in terms of physical plant utilization.

However, a discussion of the probable order of magnitude of the anticipated savings, and their implications for total owning cost, is presented in Section 752.

Actual long-term costs will depend to a considerable extent on geographical and other project-specific factors. For example, HVC operating costs will vary with climate, exterior wall design, building orientation, local utility rates, etc. Nevertheless, certain characteristics will have a beneficial effect regardless of local differences. The mechanical simplicity of a single-type HVC system, for instance, will require less elaborate training and supervision of maintenance personnel.

621.2 IMPROVED PERFORMANCE

621.2.1 The Shell

By utilizing only one-half to two-thirds the number of columns typical in conventional design and construction, the Prototype Design presents less structural obstruction in functional spaces. Also, the provision of a service zone accessible directly through service bays, rather than through functional spaces, will eliminate much of the usual cross-traffic of engineering personnel with patients and medical staff. This in turn makes scheduling of engineering personnel time less critical.

The use of a ceiling-platform as a barrier between service and functional zones provides required fire protection and acoustic separation without the necessity of constructing partitions from slab to slab. Surface mounting of services also enhances these characteristics by eliminating the many holes in partitions produced by the conventional practice of routing services internally.

621.2.2 Services

The decentralization of the HVC system into mechanically independent service modules with an approximate correspondence to departmental areas simplifies the problem of local variation in environmental requirements, and allows the service to each module to be modified, or even shut down, without affecting other areas of the hospital. For example, some areas of the hospital may be provided with 100% exhaust while others use varying amounts of return air, and each area can be individually adjusted one way or the other.

Organizing plumbing and electrical networks on the same basis further establishes the independence of the service modules.

621.3 ADAPTABILITY

621.3.1 Options for Opening Configuration

Rather than develop the Prototype Design around a single space or service module, a range of modules has been generated from a basic dimensional discipline, thus allowing the A/E a wide latitude in selecting spatial and assembly characteristics appropriate to a particular program and site. The possible combinations of these characteristics are so extensive as to provide a virtually infinite number of unique design configurations, including most conventional hospital forms.

Furthermore, the range of possible modules is open. That is, as VA policy in regard to, say, ward size or room size changes over time, new modules can be readily developed from the basic dimensional discipline. In fact, the discipline itself can be adjusted if necessary, without disturbing the overall organization of the system.

621.3.2 Efficient Alteration

Perhaps the single most significant advantage of the Prototype Design over conventional design and construction is in its capability for efficient alteration. This capability applies for all types of alteration from the simple addition of an electrical outlet to the complete renovation of a section of the hospital for the installation of a new specialty unit. It therefore has beneficial effects on both operating and capital budgets.

Adaptability has been achieved primarily through the “uncoupling” of the building components. Partitions and door frames do not penetrate the ceiling and so may be removed or relocated with minimum effect on the ceiling and the services above it. Services are distributed through highly accessible reserved zones and surface-mounted on partitions and so may be extended or relocated without breaking out sections of the ceiling or partitions.

Service distribution networks are separated into independent modules and thus minimize disruption caused by major shutdowns.

Adaptability has also been enhanced by the use of planning components of simple geometry with predetermined capabilities for a variety of internal functional arrangements. For example, the establishment of fire section boundaries prior to development of detailed departmental layouts may introduce some inconvenience in planning the opening configuration, but it provides a much simpler context for future alterations. This means a reduced probability that fire partitions would ever have to be relocated.

Alterations during design and construction, due to changes in program, budget or scheduling, are also simplified, and may be accomplished on a more rational basis than has been possible within conventional procedures.

621.4 TIME REDUCTION

621.4.1 Design Time

The planning components, particularly the space and service modules, have been specifically developed to expedite the schematic design process. These modules may be selected prior to availability of highly detailed program information. In fact, preliminary programs can be developed directly in terms of the modules themselves. Alternative design configurations can be quickly generated and evaluated by rearranging the comparatively large scale modules into various assemblies, rather than recombining vast numbers of individual rooms, as is normally the case in conventional design. Since these modules include specific structural and service distribution patterns, an early start on engineering design is also possible.

It must be emphasized in this regard that although the Prototype Design provides a high degree of precoordination, it in no sense is preengineered. The basic concepts are all sound in terms of good engineering practice, but their successful implementation will still require the full range of A/E services. In particular, the early involvement of structural, mechanical, electrical and acoustical engineers is recommended to obtain full benefit from the system.

621.4.2 Construction Time

The classification of building components as either permanent or adaptable has a critical effect on construction scheduling because the permanent parts are built first. A typical sequence is suggested in Section 463. The keys to construction time saving with the Prototype Design are the separation of rough and finish trades by means of the ceiling-platform and the provision of reserved zones for each service. A continuous platform has been judged to be much more useful for these purposes than a catwalk system. The termination of partitions at the platform is expected to allow more rapid installation.

621.4.3 Accelerated Scheduling

The time savings described above are provided by the Prototype Design within the context of federal funding constraints. However, much more significant savings are possible by the utilization of accelerated scheduling techniques such as "fast-track". The basic strategy in these techniques is to overlap some of the major activities which in conventional practice are performed linearly. The various tasks within each activity are so arranged that the decisions necessary for commencement of the next activity can be made at the earliest possible time.

This requires a willingness on the part of all concerned parties to commit themselves early in the process to certain key decisions. However, if the schedule is properly designed, many detailed decisions can be made considerably later than normally required. That is, time available for each major activity except construction can actually be increased while significantly reducing the total production time.

The Prototype Design, for reasons mentioned in Sections 621.4.1 and 621.4.2 above, is particularly well suited for accelerated scheduling. This technique is discussed more fully in Section 761.

621.5 LONG-RANGE DEVELOPMENT

Optimum solutions to the basic cost/performance problems of VA hospitals, or any other building type for that matter, cannot be found in the context of the current fragmented and trade-oriented production process. Unfortunately, the necessary changes leading to fully industrialized building will require major commitments and considerable time, and are well outside the modest scope of the Prototype Design.

What has been established, however, is the basic framework for a rational development process which can immediately test some promising innovative concepts, and which can eventually lead to highly cost-effective building systems. The intent of this framework is to provide the VA with improved capability for effective utilization of whatever building products and design and construction methods are available at the time, while progressing incrementally toward a more complete hospital building system. It is also intended to serve as a common frame of reference for all departments and services within the VA which are concerned in any way with the programming, design, construction, operation and evaluation of hospitals.

622 COSTS

For purposes of comparison with projected costs of hospitals utilizing the Building System Prototype Design, a number of existing VA hospitals of conventional design and construction were analyzed to establish a cost base. (Section 530.) To assist in estimating probable costs of systems hospitals, an example building schematic design was developed from an actual VA master plan. (Section 730.) The cost estimate for the example design is presented and analyzed in Section 751.1, and target costs for the integrated subsystems are suggested and discussed in Section 751.2. The following table summarizes the subsystem cost estimates in dollars per outside gross square foot.

Subsystem	Cost Base Range	Cost Base Average	Target Range	Example Design
Structure	5.86 - 8.10	6.97	8.60 - 11.30	9.63
Ceiling	1.11 - 1.71	1.42	2.10 - 3.85	2.38
Partitions	5.26 - 6.35	5.88	3.30 - 5.90	3.63
HVC	4.92 - 8.62	7.02	4.00 - 6.50	4.75
Plumbing	2.09 - 2.20	2.15	2.00 - 3.00	2.14
Electrical	2.08 - 2.13	2.11	2.00 - 2.50	2.31
Totals		25.55		24.84

The "shell" subsystems have also been assigned target costs in units more meaningful to each.

Subsystem	Target Range	Subsystem Unit
Structure	$8.00 - 10.45	per square foot of framing
Ceiling	$2.50 - 4.55	per square foot of ceiling
Partitions	$31.75 - 56.00	per lineal foot of partition

The scope covered by these costs is outlined at the end of the description of each subsystem in Section 300 in the Design Manual.

623 LIMITATIONS AND CONSTRAINTS

623.1 CONSTRUCTION TYPES

There are certain types of construction for which the Prototype Design is not well suited. These include buildings of non-rectangular geometry, high-rise buildings over 160 feet, low-rise buildings less than two or three stories, and additions to existing buildings with floor-to-floor heights less than seventeen feet.

There are also certain functional space types which are considered “drop-outs” due to special structural or servicing requirements. They include kitchens, laundries, cobalt rooms, boiler rooms, and the like. Many of these areas can be incorporated within a systems building, but they may require significant modifications of one or more of the building subsystems by the A/E, at their location within the structure.

623.2 PLANNING AND DESIGN

Even though the planning components have been carefully studied to assure their internal capabilities, and even though a reasonable range of size and proportion is available for selection, nevertheless once the design configuration has been established the A/E is obliged to work within the boundaries of the service modules and fire sections, and this is a type of discipline not normally encountered in new construction. It is anticipated, however, that after the A/E has become familiar with the properties of the entire system, he will in fact find new design freedoms to compensate for this restriction. For example, these same planning components provide him with design tools which can greatly facilitate the generation and evaluation of significant configuration alternatives, for which he normally would simply not have the time.

The system rule concerning a uniform ceiling-platform height throughout each floor does not readily permit the variation in room height sometimes felt to be architecturally desirable. Three types of modification are available, however. Since it is actually the platform height which is critical as far as system performance is concerned, a suspended ceiling below it may be used to vary room height, if the partitions are attached to the platform rather than the ceiling. Or in special area such as auditoriums, an intermediate floor may be omitted to allow a full two-story space. On the ground floor, floor levels may vary in areas not used by non-ambulatory patients.

To provide the required lateral bracing, shear walls must extend continuously downward through the building to the foundations. Allowable openings are seriously restricted. Exterior shear walls limit fenestration, and internal shear walls inhibit planning. The system rules and suggested design configurations are intended to minimize this effect, but it cannot be altogether eliminated. The cluster of shear walls around stacked service bays can be particularly troublesome since they tend to form an enclosing row of towers at the building perimeter. In large horizontal design configurations, they can also introduce significant internal obstructions to the planning of efficient circulation patterns and departmental layouts. However, since the location, size and proportion of the service bays are only partially predetermined by the Prototype Design, these parameters can be adjusted within certain limits by the A/E to optimize any particular configuration.

623.3 REDUNDANCY

In the interests of design and construction simplicity and long-range adaptability, over-design of certain building components and spaces is recommended. These include floor load-bearing capacity, size of trunk ducts and other service mains, size of mechanical and electrical rooms and service chases, and depth of the service zone above the ceiling. Other system characteristics imply larger than normal amounts of materials or space. For example, the rigorous organization of service runs prohibits typical point-to-point routing, and increased floor-to-floor height produces taller columns and elevator shafts, more exterior wall, etc. Also, the use of a limited range of space and service modules adjustable only in rather sizeable increments of area implies deviations from maximum room sizes and gross-to-net-area ratios set by current practice or regulations.

This redundancy is considered entirely justified by anticipated benefits, but nevertheless must be taken into account when the Prototype Design is compared with conventional design and construction, particularly in terms of first cost. An analysis of these cost effects is presented in Section 751.3.

623.4 MAINTENANCE AND HOUSEKEEPING

Although the basic design of the building components has been specifically directed at the alleviation of various maintenance and housekeeping problems, a perfect solution has not yet been achieved. Three conditions in particular should be noted. First, the decentralization of air-handling equipment will require engineering personnel to travel throughout the hospital to execute some of their routine maintenance tasks. Second, the location of certain components in the service zone accessible only horizontally via space with restricted headroom may in some instances be less convenient to these personnel than direct access from below or access to the equipment if it were located in the functional zone. Third, surface mounting of services may not be as simple for housekeeping purposes as is the case with services concealed within partitions.

623.5 NEED FOR CARRY-THROUGH

The application of the principles of systems integration to the particular problems of VA hospital construction has so far produced a hypothesis and some suggestions on how it might be tested. However, no amount of theoretical argument or cost-benefit analysis can prove in advance that innovative design ideas, when implemented under field conditions, will in fact meet the stated objectives in a completely satisfactory manner. The principles must be continually applied through detailed design and construction, the entire process carefully monitored, and the results fully evaluated before the proposed system can claim specific improvements over conventional methods. Furthermore, efficient implementation of a long-range systems integration program will require the establishment of a data base and an evaluation and feedback mechanism so that each successive construction project can contribute a maximum of useful information. (See Section 111.2.2 for a diagram of this process.)

Some components of the data base have already been developed to a certain point for purposes of the systems integration study. (Volume Two.) It is recommended that the VA develop these components further and generate additional components. (See Section 632.) Particularly lacking in the present data base is operating and alteration cost information on existing hospitals suitable for cost-benefit evaluation of proposed designs. (Section 631.2.2.)

623.6 HAZARDS OF INNOVATION

One of the principle difficulties with the implementation of any new process is its integration into the existing framework of conventional practice. For example, in specifying that most partitions stop at the ceiling, the Prototype Design is in conflict with building codes and regulations which specifically require corridor and smoke-stop partitions to run from slab to slab. Many other requirements are presumably based on the assumption that this latter condition will be met. Thus in proposing what seems to be one simple deviation from conventional construction, an entire fire safety strategy becomes ambiguous in its application, forcing fire safety authorities to evaluate not only the specific change, but what amounts to a whole new strategy. (See Section 551.)

A similar difficulty arises from the fact that participants in the implementation of a new design and construction process must to some extent modify their customary work and thought patterns. This adjustment confronts not only administrators, as suggested above, but also A/E and construction contractors. The ultimate success or failure of an innovation depends largely on the understanding and attitudes applied to the experiment by these key people. For example, if construction contractors do not examine the ceiling-platform concept with sufficient care to convince themselves that it permits real time savings through more efficient trade phasing, their bids are not likely to reflect this theoretical advantage, at least not on the first “demonstration” hospital.

The A/E in particular has the responsibility not only of developing detailed designs for the integrated subsystems which reflect the intent of the Prototype Design, but also of developing the non-integrated subsystems in a complementary manner. The resident engineer in turn must exercise particular care in the supervision of construction to ensure compliance with the system rules, such as the rights-of-way in the service zone above the ceiling.

630 Recommendations

631 FURTHER DEVELOPMENT OF THE PROTOTYPE DESIGN

The Prototype Design is intended to provide the basic framework for the eventual development of a complete hospital building system. As such, it should be continually expanded and refined.

631.1 CONSTRUCT A DEMONSTRATION HOSPITAL

A Veterans Administration hospital project currently in progress should be selected as the vehicle for demonstration construction and evaluation (implementation of Step 5 in Section 612.7.1). The demonstration building should be new construction of a complete hospital to avoid constraints imposed by an existing building. This should occur in conjunction with the evaluation program described in Section 631.2 below. The A/E contractor selected for such a project must be one who is sympathetic with the systems approach in general, and the Prototype Design in particular, and who can be expected to fully exploit the functional, economic and architectural potentials of the system.

631.2 DEVELOP AN EVALUATION PROGRAM

To receive full benefit from a demonstration construction project, it will be necessary to carefully monitor the entire production process from inception through occupancy, and systematically evaluate the Prototype Design in the spirit of testing a hypothesis (See Sections 111.2 and 765.)

631.2.1 Design and Construction

As soon as a specific project is selected as the demonstration for system design and construction, development of a formal monitoring and evaluation program should be initiated. If possible, an approximately concurrent project, to proceed by conventional design and construction, should be designated the “control” project. Both demonstration and control projects should be monitored by the same program.

631.2.2 Operations and Alterations

Besides periodic inspections during the building life span to evaluate long-term performance, continuous monitoring through special cost accounting procedures should be initiated to provide a cost base specifically related to each subsystem.

For example, utilities supplied to each mechanical subsystem should be separately metered. Not only should the scope, cost and attendant problems of each alteration be carefully noted, but requests for alterations that are denied or postponed must also be recorded.

631.2.3 Operating Manuals

The staff operating the demonstration hospital, and each succeeding systems hospital, should be provided with all necessary information, perhaps in the form of “operating manuals”, to insure full utilization of the system characteristics. They should be instructed in system capabilities, particularly for various kinds of alteration. However, care must be taken to avoid alterations which would degrade original performance or impair future adaptability.

Operating manuals should be prepared for each project by the O/C and the A/E during design and construction of the building.

631.3 CONSTRUCT A MOCK-UP FOR PHYSICAL TESTING

An essential feature of a building system is the continuing development, testing and refinement of system components. The system described in this report provides the framework for an initial demonstration hospital, but more significantly, it is also a framework for a continuing program of system development and refinement. Access to physical testing facilities would provide valuable assistance for this program, as well as for testing and refinement of detailed design solutions.

Optimum testing facilities would consist of a full-scale mock-up of a systems building segment constructed with actual components. It is recommended that the Veterans Administration explore the feasibility of building a mock-up and implementing a systems test program.

Testing programs might include the investigation of:

1. Installation methods for specific components.

2. Performance of components including finishes, joints, sound transmission, etc.

3. Accessibility for maintenance and alterations.

4. Adaptability implications including cost, time, noise, dust, etc.

The opportunity to study new component designs prior to an actual field installation would allow verification of performance and refinement of details. It would also identify potential installation problems.

In addition to physical testing, a mock-up would be of informational value. Building users, potential bidders, VACO staff architects and others could familiarize themselves with the building system by touring a mock-up facility.

631.4 EXPAND SCOPE TO MORE SUBSYSTEMS

Research studies should be undertaken to incorporate more building subsystems into the Prototype Design.

Suggested priority is:

1. Materials handling and transportation.

2. Communication systems.

3. Exterior wall.

4. Casework, furniture and lighting.

5. Roofing, flooring, and other finishes.

631.5 MODIFY SYSTEM FOR SPECIAL BUILDING TYPES

The Veterans Administration currently builds relatively independent facilities for research, nursing-home care and psychiatric care. It may be beneficial to investigate the feasibility of adapting the building system to these specialized uses.

631.6 EXTEND CAPABILITY TO NEEDS OF OTHER USES

The Feasibility Study (Phase 1) indicated that a relatively large guaranteed market was necessary for an industrial response to performance requirements. Without a guarantee, it may be possible to achieve the desired response, provided a large potential market is available.

It is suggested that the Veterans Administration explore means of increasing the potential market for systems components. This might be accomplished through adaptation of the system to the medical needs of other governmental agencies or other health system organizations.

632 FURTHER DEVELOPMENT OF THE DATA BASE

As a further development of the material presented in Volume Two, the Office of Construction should establish and maintain a design and construction data base for use by the VA, A/E's, manufacturers, construction contractors, and agencies other than the VA, applicable to conventional as well as systems projects. The basic components of the data base could be:

632.1 USER NEEDS

The user need study should be extended to all hospital functional units. Once obtained and verified, this information should be made available to those responsible for building design decisions.

In addition, a continuing program of evaluation and updating of the user need statements should be implemented.

632.2 CODES AND STANDARDS

All pertinent VA documents, including existing codes and standards adopted by the VA, should be incorporated into the data base. Each should be modified in form and content as necessary to relate them very directly to all other data base components with minimum overlap and conflict.

632.3 PERFORMANCE REQUIREMENTS

632.3.1 The development of a comprehensive data base of criteria derived from a study of the dimensional and environmental requirements of activities would provide the Veterans Administration with the following benefits:

1. Optimum and minimum performance standards which may be varied as activity patterns change.

2. A means of obtaining approval of space performance by governmental agencies and "users" prior to individual facility design.

3. A body of information for use by architects in making design trade-offs.

4. A clear relationship between activity requirements and building performance would be established. Space criteria could be used to review subsystem performance requirements.

A similar program has been initiated by the Ministry of Health in England with apparent benefit.

632.3.2 Subsystem Performance Requirements

The design criteria for the integrated subsystem (Section 300) provide the format and initial content for a current statement of VA building subsystem performance requirements. These should be periodically expanded and refined to eventually describe a complete hospital building system in performance terms. VA Construction Standards should be converted to this format, translated into performance requirements and incorporated into the data base. (See Section 632.2 above.) Construction Standard CD-31 for curtain walls is already in the appropriate language.

632.4 SPACE MODULE CATALOG

The planning module and configuration concepts contained in this report form the framework for a continuing program of plan development and evaluation. It is proposed that the VA undertake the development of a catalog of space module capabilities to provide a data base for the initial selection of space modules and for service module organization.

This Report identifies a limited range of plan capabilities for eleven space modules plus a number of configuration options for each. It is suggested that these space modules be tested with additional arrangements for various functional units. Further study will allow dimensional "tuning" of the modules and may lead to the development of additional modules and/or the discarding of some of the eleven. New modules, for example, would be required if the VA were to adopt a 30-bed G.M. & S. unit as a standard.

Evaluation is an essential element of the program outlined. The space module catalog must represent current VA thinking. A continuous process of field evaluation of functional layouts, feedback and modification must be maintained.

Every space module constructed should be monitored as to its ability to meet current needs and to provide the desired adaptability.

The assembly of a space module catalog and its continual evaluation would provide the VA with a measure of reliability. That is, the selection and construction of permanent building elements prior to detailed programming and design can be based on the experience represented by the catalog.

632.5 BUILDING TECHNOLOGY AND SYSTEMS INFORMATION

The data base should include a reference file of building products and construction methods. Manufacturers should be asked to provide reliable product information in a form allowing direct cost-performance comparisons. A/E's should be required to submit product evaluation information on standard forms developed by the VA. Products installed in hospitals should be evaluated periodically to verify performance.

632.5.1 Systems Information

In addition to data developed within the VA, it is suggested that other building system projects be closely monitored. Systems information on these might include: products, performance bidding, building organization, construction management, accelerated scheduling, etc. An active program of investigation could entail:

1. Establishing a comprehensive systems library including information from medical and non-medical projects throughout the world.

2. Seminars with persons who are directly involved with systems development programs.

3. Field investigation and evaluation of project performance. In some cases, detailed monitoring of adaptability, cost or other factors over a period of years may be warranted.

4. Initiating joint study programs involving VA research personnel and staff members from systems-oriented private firms. VA staff might work in consultants' offices or individuals from consultant firms could join the VACO staff for specific research programs.

633 FURTHER RESEARCH

633.1 DEVELOP COMPUTER PROGRAMS

As the data base develops into a functioning clearinghouse for all VA construction information and procedures, the feasibility of handling some of the material by computer should be studied. Rapid and reliable processing and retrieval of up-to-date information is indispensable to an efficient design and construction process.

Computer programs could also be developed to assist the O/C and the A/E in some of the more complex design procedures, particularly in cost-performance trade-offs.

633.2 ENCOURAGE MANUFACTURERS TO DEVELOP NEW PRODUCTS

A variety of product development programs are described in Section 764. They should be periodically explored for feasibility as experience is gained with the Prototype Design. Meanwhile, the subsystem design criteria should be used to encourage manufacturers to develop new products with improved cost and/or performance characteristics. As long as the VA cannot guarantee specific markets to these manufacturers, it must at least assure them that the Prototype Design has been officially adopted as the basis of an ongoing system development program within the context of the overall construction program (See Sections 111. 2.2 and 614.5).

633.3 STUDY FEASIBILITY OF PHASED BIDDING AND CONSTRUCTION MANAGEMENT

Various means of accelerating the design and construction process are discussed in Section 761. Phased bidding is seen as the most promising of these approaches. Construction management, as described in Section 762, offers a technique for handling the special problems of phased bidding. These methods have a potential for reducing project time and improving cost control far exceeding what can be achieved simply by application of integrated subsystems within current scheduling and management procedures. They should therefore be made the subject of detailed feasibility studies to determine how they may be adopted by the VA for all construction, systems and conventional.

633.4 STUDY RELATIVE MERITS OF HORIZONTAL VS. VERTICAL HOSPITAL CONFIGURATIONS

Currently adequate cost/benefit information related to configuration is not available. It is suggested that there is sufficient benefit potential for the Veterans Administration to warrant such a study.

Operational costs are closely interrelated with hospital configuration. Factors such as the selection of transportation systems, building height and the relationship of functional units are coupled with decisions regarding type of distribution systems, administrative policy, employee wage rates and socio-medical factors such as acceptable patient waiting times. A system of trade-offs involving these factors is suggested.

633.5 DEVELOP NEW WORKING DRAWING TECHNIQUES

Section 440 in the Design Manual stresses the importance of contract documents in the successful application of the Prototype Design. Some ways in which working drawings could be organized to take advantage of system characteristics are also mentioned.

There has been a recent proliferation of new techniques for working drawing production including photography, multi-color printing, and the use of computers. The unique characteristics of the Prototype Design may make it particularly well suited for the exploitation of some or all these techniques.

With the rapidly increasing complexity of modern hospitals, working drawings have become correspondingly complex and voluminous. The cost of producing, checking, reviewing, changing, printing and transmitting these documents has become a major expense in the design process. Increasingly large contingency factors are being included in construction contractors' bids because of the extreme difficulty in arriving at accurate estimates on the basis of such complicated, and often confusing, documents.

The VA should study the general problem of effective and efficient communication through contract documents in the light of these developments, in terms of both organization of symbolism and notation and the use of advanced production techniques, particularly as appropriate to the Prototype Design.

634 REVIEW OF PLANNING CRITERIA

634.1 The Joint Venture has been asked to identify areas where changes in VA criteria such as Manual M-7 would provide the Veterans Administration with better design and construction methods or space utilization. A comprehensive study of space utilization was not within the scope of this study; however, considerable effort was expended in an attempt to identify constraints to desired building performance or other project objectives.

It is not intended to recommend specific changes, but rather to suggest a basis for possible further investigation. The objectives of cost control and equitable distribution of funds to each project which are implied in Manual M-7 must be maintained. Within the context of this study, the additional objectives of reduced design and construction time, minimum obsolescence at the time of first occupancy, and efficient use of space throughout a building's life span should also be considered.

634.2 There is a close relationship between room size, operational policies and building organization. Currently, maximum square foot requirements for individual spaces are precisely defined. Maximum areas are in many cases effectively minimum; that is, spaces cannot be reduced much below the maximum indicated and still function.

It may be desirable to allow the building designer more freedom to vary room sizes to accommodate different patterns of operation, or to achieve a plan which is consistent with overall building organization and future adaptability. For example, it is conceivable that an increase in a specified room size may allow multi-use of space, thus eliminating other required spaces; or, increased space for single-bed rooms may allow the building perimeter to run straight through rather than notching in, thus providing for future adaptability at minimal cost. (See Section 751.3.3 for a discussion of the cost effect.)

It may be possible to allocate space with, say, a 15% increase allowance above a reasonable minimum. All spaces would not require this increase, thus the overall average increase could be restricted to, say, five percent. Further investigation would, of course, be needed to determine a workable range for the desired result.

634.3 It is generally true that if adaptability is to be provided, certain concessions to future use must be made. Decentralized mechanical systems may require more area. Circulation systems may be organized to accommodate future uses and thus will not be tailored to a specific solution. Factors such as these will tend to decrease the net-to-gross ratio; however, they may not increase first cost and should reduce life cost substantially.

634.4 The system discipline will also result in increased total area. Space module and structural disciplines must be respected. Area requirements may indicate that 4-1/2 space modules are required or that 15-1/2 structural bays are necessary on a particular floor. A method of allowing increases in area to even module or span increments must be provided within the space allocation system.

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700 APPENDICES

710 Design Rationale, Planning Module

711 CHOICE OF MODULE SCALE

711.1 THREE OPTIONS IDENTIFIED

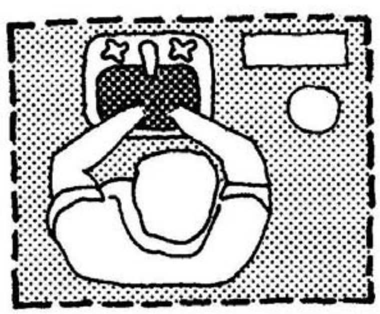
711.1.1 Planning modules are increments of a total system of organization, in this case, the hospital. A module may be derived from:

1. the space required to perform a certain activity;
2. the range of activities which may be coupled together in one space (a room), or,
3. a grouping of rooms which are interrelated by functional need (functional unit).

These are illustrated in Figure 710-1.

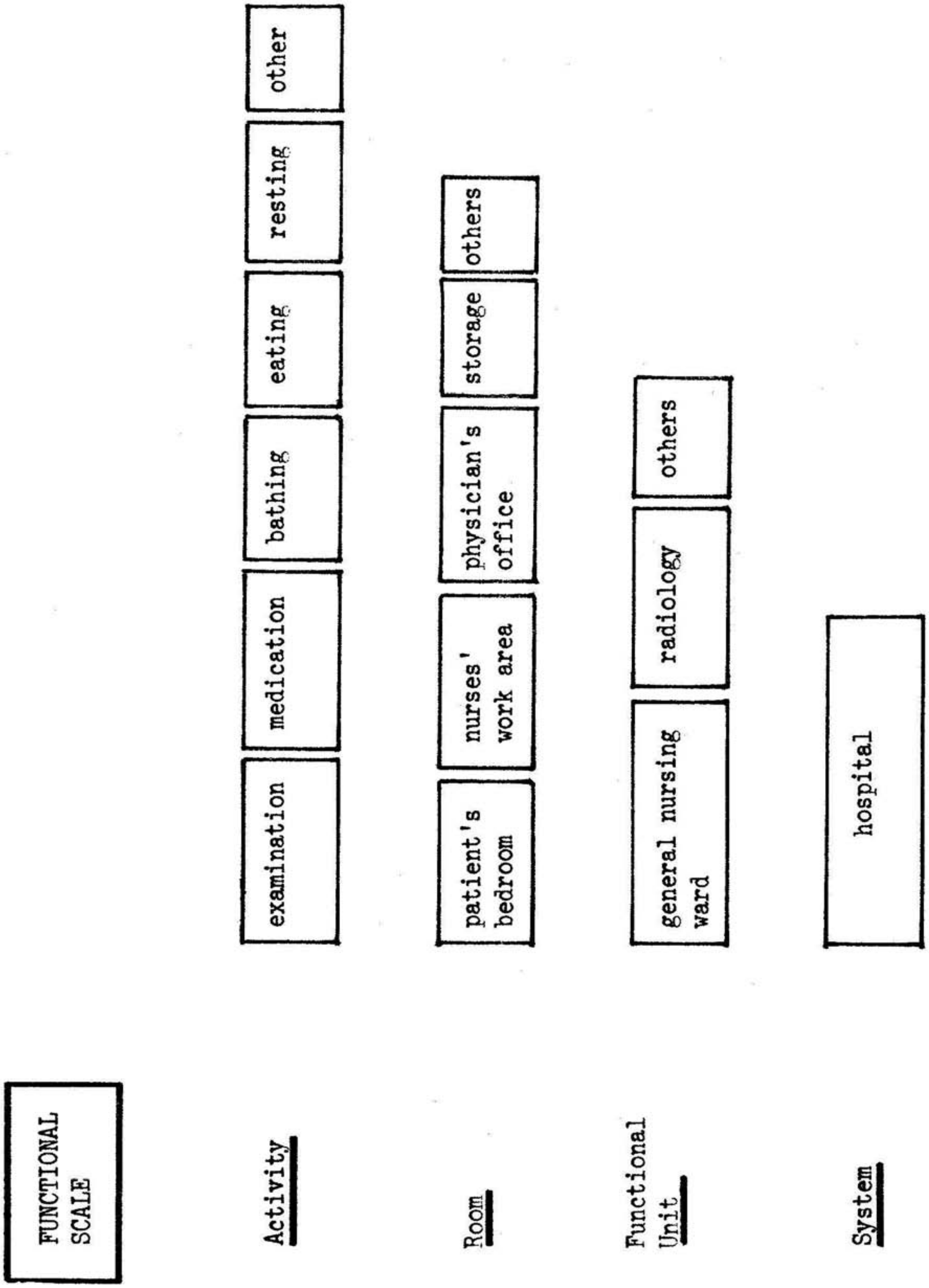
711.2 CHARACTERISTICS OF THREE POSSIBLE MODULE SCALES

711.2.1 Activity Module

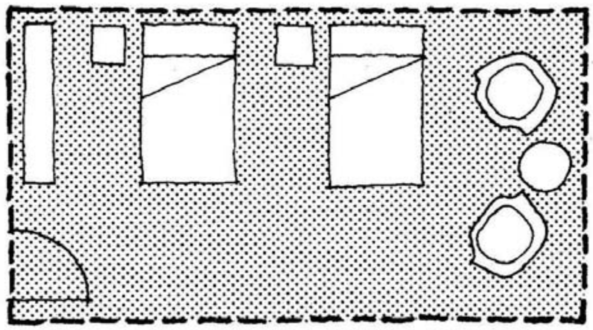


1. The activity module is a fundamental element in planning, an irreducible minimum, although not independent of other functions.
2. An activity, for example hand washing, will influence the system by generating a need for space, plumbing, partition finishes, partition attachments, lighting, temperature control, etc.

Figure 710-1. FUNCTIONAL NETWORK EXAMPLE



711.2.2 Room Module



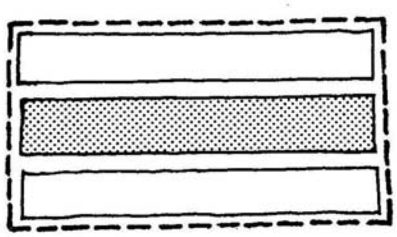
1. A room is the most commonly used “building block” in the current planning process.

2. A room must integrate and generalize the needs of all activities contained within it. In addition it generates needs relating to sound transmission, perimeter exposure, fire safety, organization, etc.

3. The range of adaptability necessary for hospitals cannot be approached at a room scale. However, adaptability within rooms is necessary to permit increase or change in functional capacity.

4. It is difficult to relate structural or mechanical organization to an individual room in a systematic way. A room is not sufficient to generate service sub-systems.

711.2.3 Functional Unit Module



1. This module allows the generalization of environmental and planning characteristics at a scale compatible with mechanical and structural considerations.

2. This module can be manipulated to achieve various configurations while functional and environmental capability remain constant.

711.2.4 Each module scale option: activity, room or functional unit, generates a level of need which must be satisfied by the building system. The functional unit scale has been selected as the major “building block” for the system. Only at this scale can one deal with problems of service distribution, structure, fire safety, and configuration.

712 THE SPACE MODULE

712.1 DERIVATION

712.1.1 When viewed in the context of the total hospital, the bed care portion is somewhat unique:

1. The bed care portion consists of generally repetitive elements (nursing units).

2. It has particular requirements for aspect (outlook) and perimeter to area ratios.

3. Nursing units are often consistent in size and arrangement from one hospital to the next.

The above features led to the development of space modules with pretested functional content which can be configured and, if desired, constructed prior to the actual plan layout of each module.

712.1.2 Within the capabilities of the building system, it is obviously preferable to maximize the range of plan options available to the VA, provided that the objectives of functional content, cost and adaptability can be achieved. While it may be possible to develop one optimum plan solution for a specific medical program, the uncertainty of medical programs and change in facility requirements makes the ability to achieve a large number of plan solutions necessary.

712.1.3 From an analysis of current nursing unit plan types, it was apparent that almost every imaginable variation of geometrical form has been used at one time or another. It is interesting to note, however, that the vast majority of solutions fall into a limited number of geometrical patterns and have reasonably consistent dimensional characteristics. Almost all solutions examined are variations of the core (“race track”), double-loaded corridor or cluster organizations which have been used as independent towers or attached to a larger element. A representative sample of plan solutions is shown on the following pages.

712.1.4 **Organization**

In examining the inherent characteristics of nursing unit plans, it was apparent that certain functional requirements tend to establish sets of constraints and variables.

1. The patient room must be on the perimeter of the unit, adjacent either to the exterior of the building or an interior court.

2. Patient rooms must be adjacent to a corridor or circulation space.

3. The location and amount of support facilities directly associated with patient beds is variable.

4. The greatest need for large, unobstructed area is in various types of intensive care units.

5. The general nursing unit (acute unit) comprises the majority of hospital areas devoted to patient bed-related care. Thus, it usually becomes the determinant of “nursing tower” configuration.

6. Rectilinear plans may be categorized as two-, three-, or four-aspects; that is, having two, three, or four sides used for rooms requiring perimeter location for natural light or ventilation.

While it is desirable to allow the VA a maximum of plan options within the building system capability it was found that certain examples, if included, would penalize the efficiency of the entire system; e.g., the circular cluster type plans.

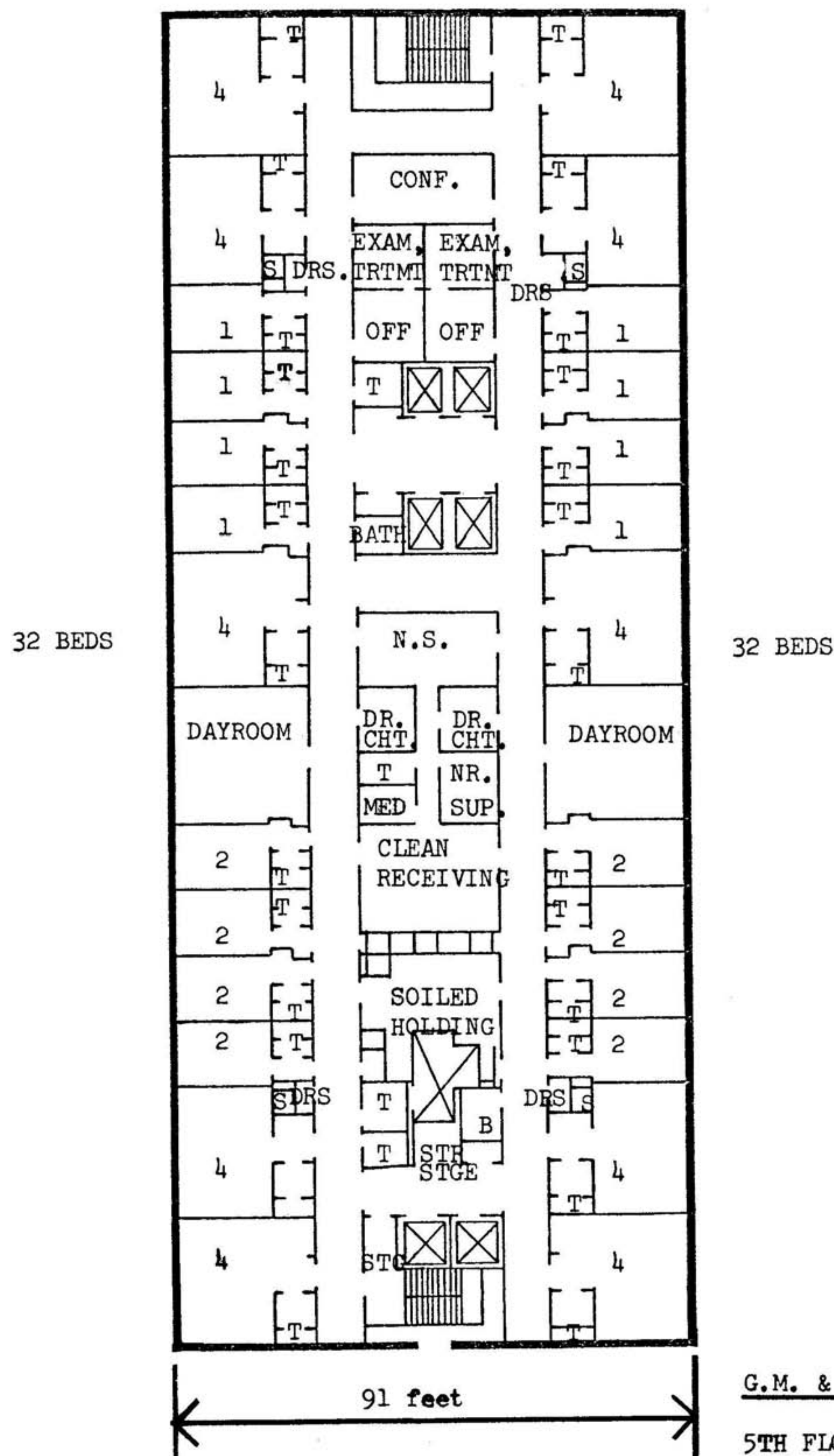
The circular cluster appears to have a number of disadvantages for the Veterans Administration in addition to imposing severe constraints on the building system.

1. The number of beds is directly proportional to the amount of support (core) area. Space for supporting facilities cannot be varied for a given number of beds.

2. A circular cluster cannot be joined to other modules or support areas except with a narrow link or at the expense of valuable perimeter.

3. The geometry requires a large number of angles by which structural members and partitions must be joined.

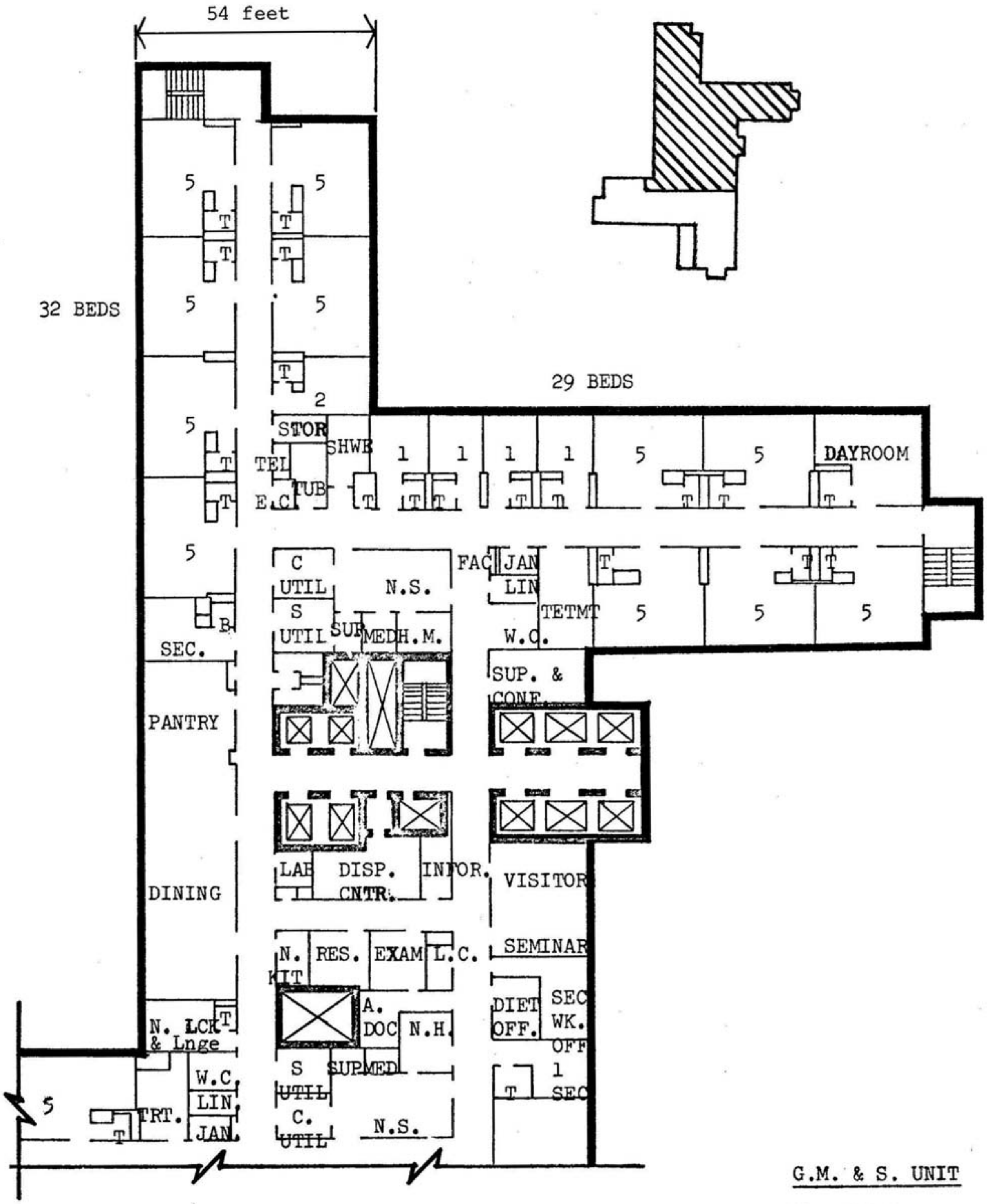
The advantages of a circular cluster plan can also be achieved by means of a rectilinear cluster solution.



CORE PLAN EXAMPLE

G.M. & S UNIT

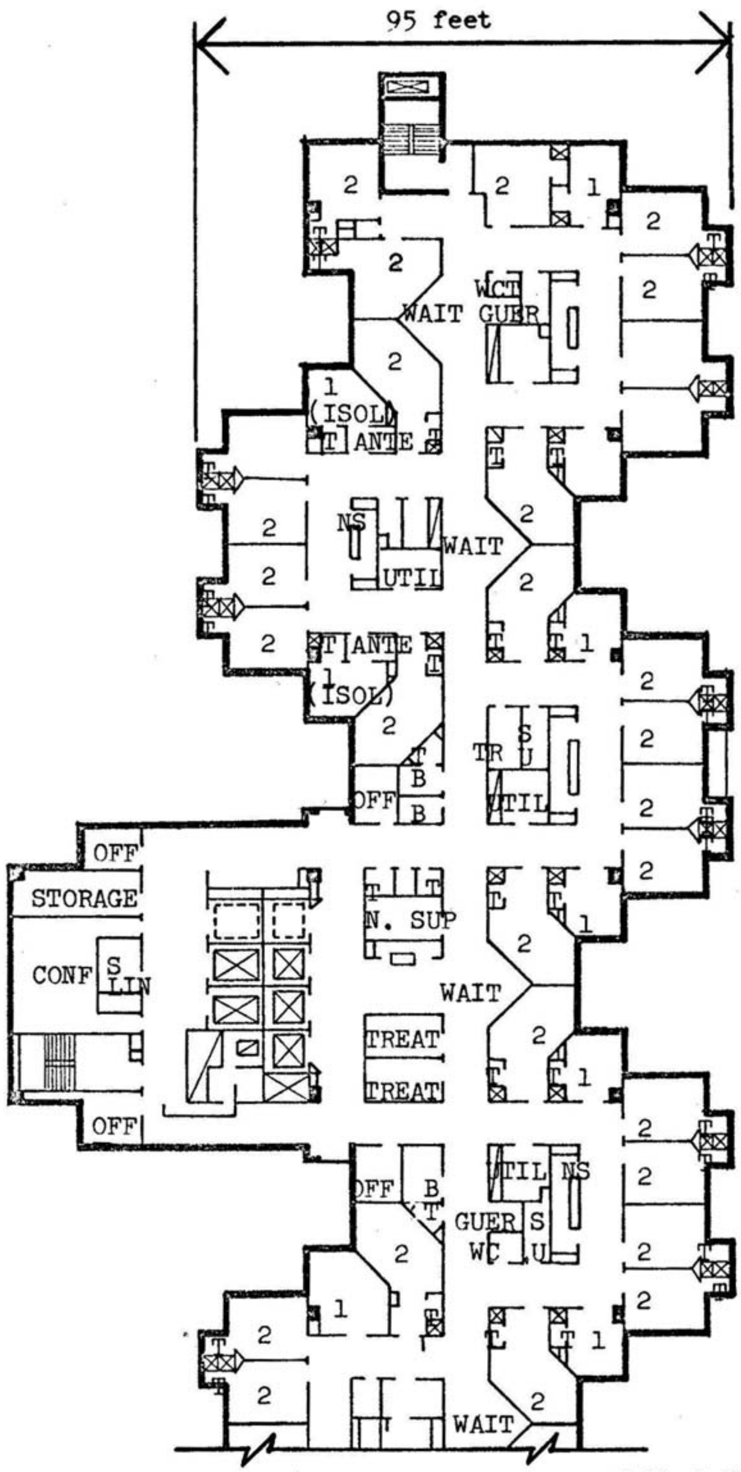
5TH FLOOR
V.A. HOSPITAL
ATLANTA, GEORGIA



DOUBLE LOADED CORRIDOR AND CORE
PLAN EXAMPLE

G.M. & S. UNIT

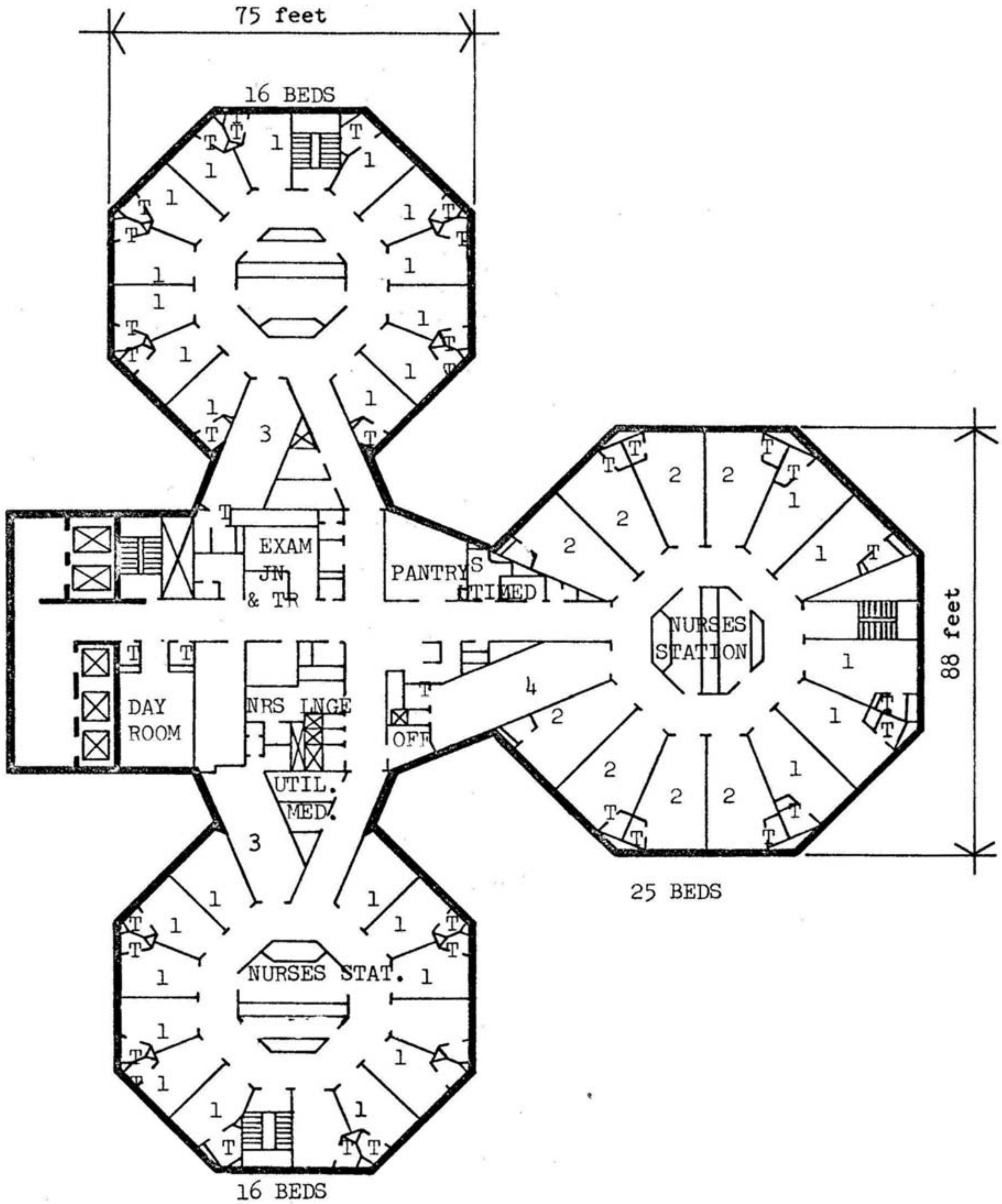
11TH FLOOR
V.A. HOSPITAL
MIAMI, FLORIDA



G.M. & S. UNIT

6TH FLOOR
PACIFIC MEDICAL CENTER
SAN FRANCISCO, CALIF.

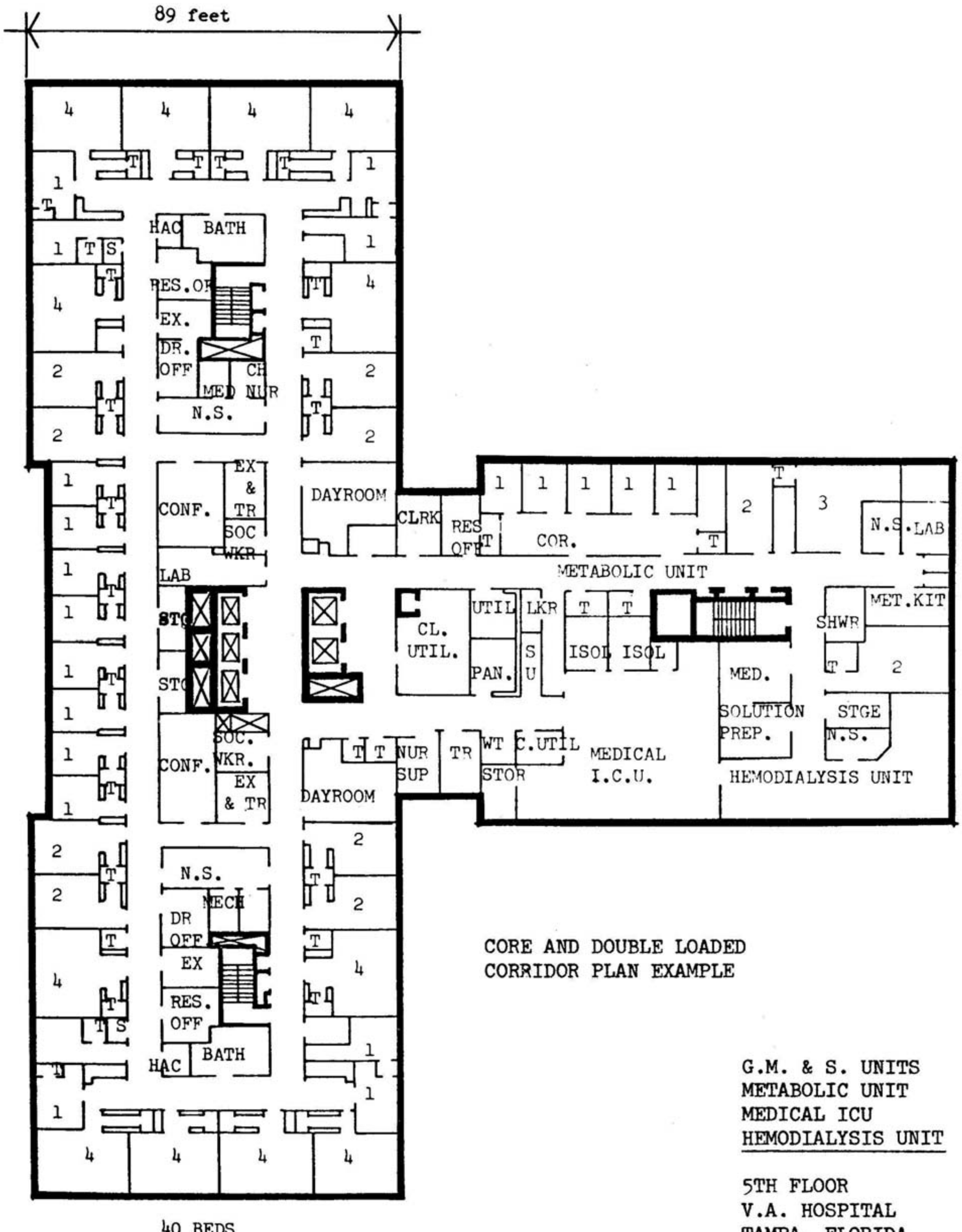
CLUSTER PLAN EXAMPLE



G.M. & S. UNITS

TYPICAL FLOOR
SCOTT-WHITE MEMORIAL HOSPITAL
TEMPLE, TEXAS

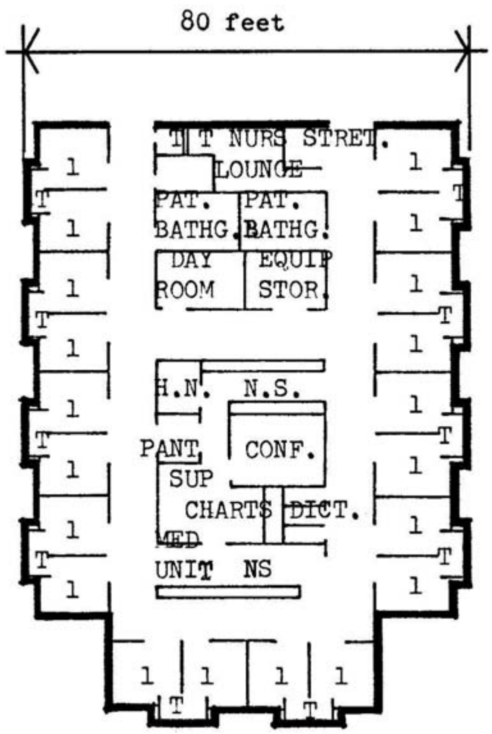
CLUSTER PLAN EXAMPLE



CORE AND DOUBLE LOADED
CORRIDOR PLAN EXAMPLE

G.M. & S. UNITS
METABOLIC UNIT
MEDICAL ICU
HEMODIALYSIS UNIT

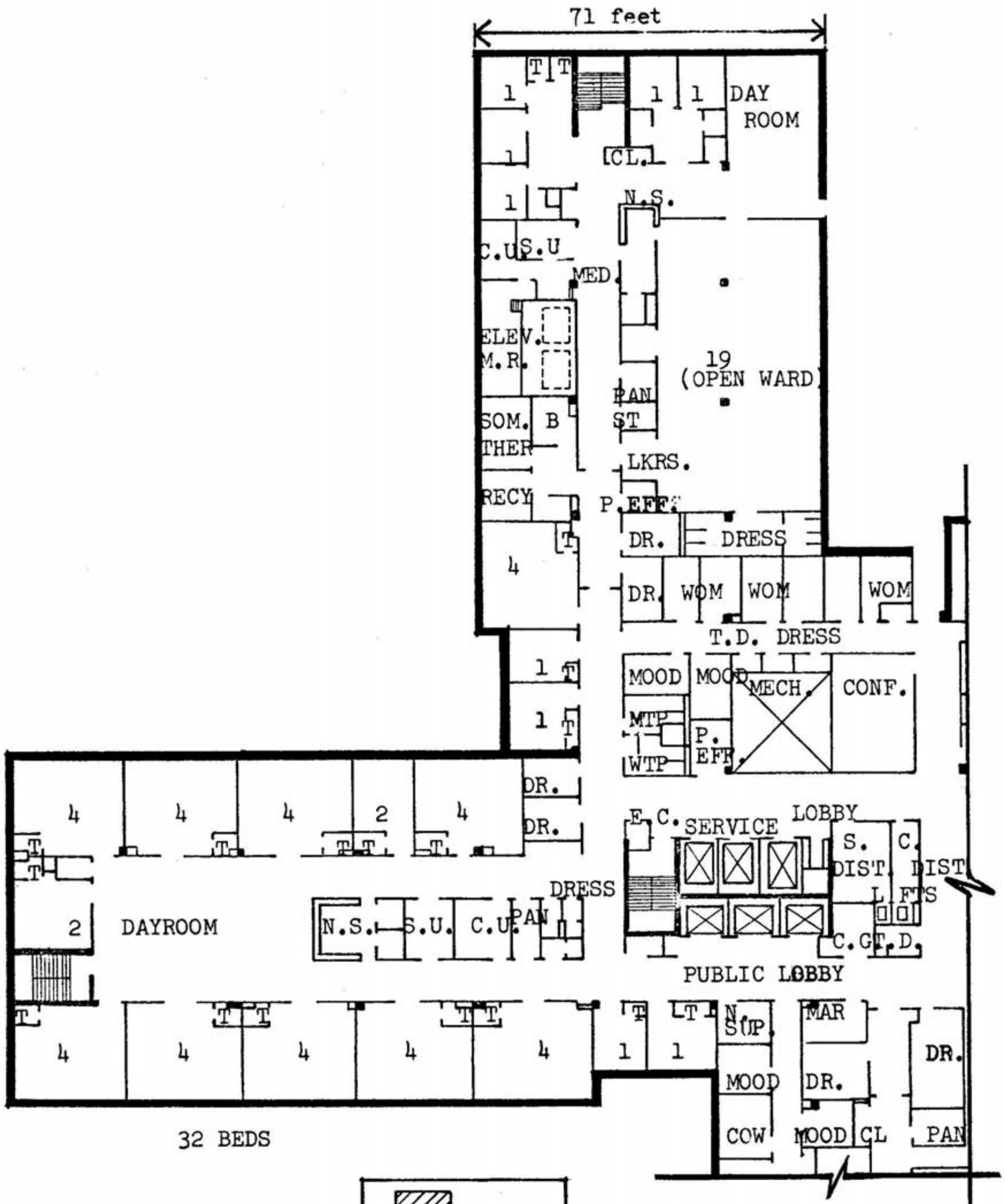
5TH FLOOR
V.A. HOSPITAL
TAMPA, FLORIDA



CORE PLAN EXAMPLE

INTENSIVE CARE

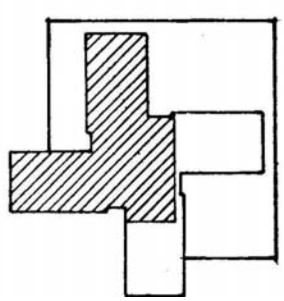
MONTEFIORE HOSPITAL
NEW YORK



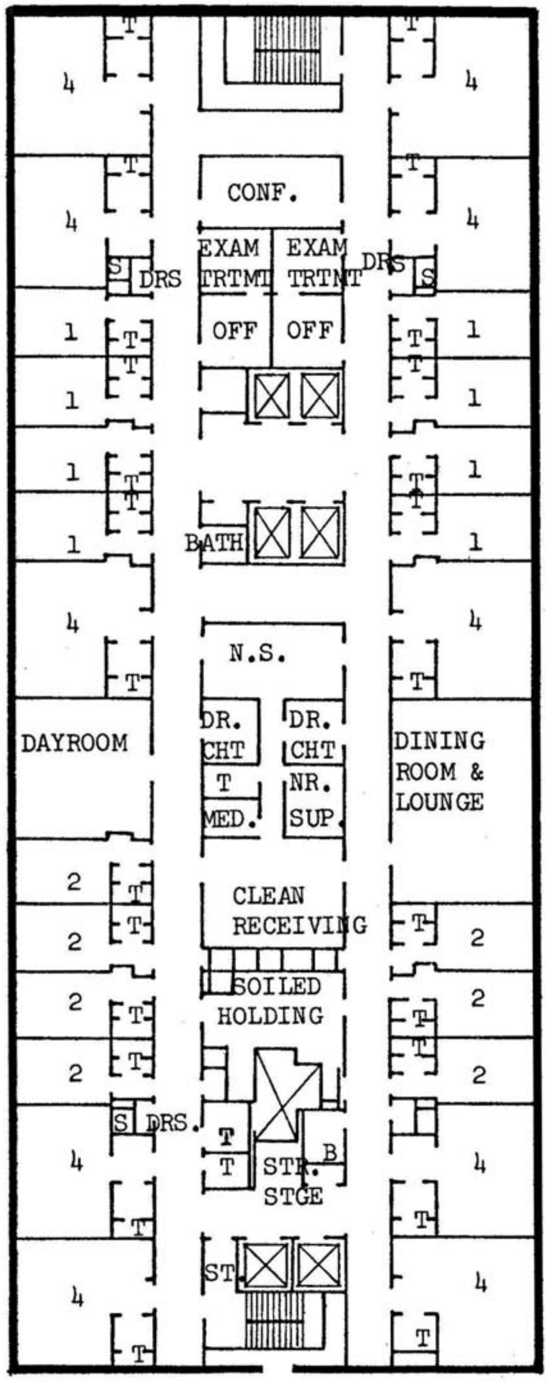
N.P. MEDIUM DISTURBED

PSYCHIATRIC UNITS

5th FLOOR
OAK KNOLL HOSPITAL
OAKLAND, CALIFORNIA



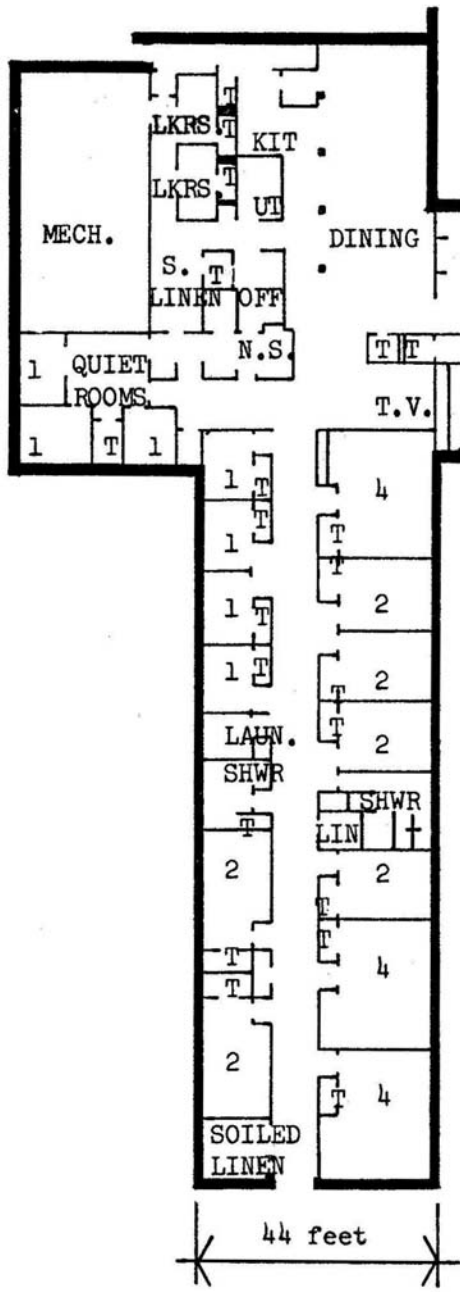
DOUBLE LOADED CORRIDOR
AND CORE PLAN EXAMPLE



PSYCHIATRIC UNIT

4TH FLOOR
V.A. HOSPITAL
ATLANTA, GEORGIA

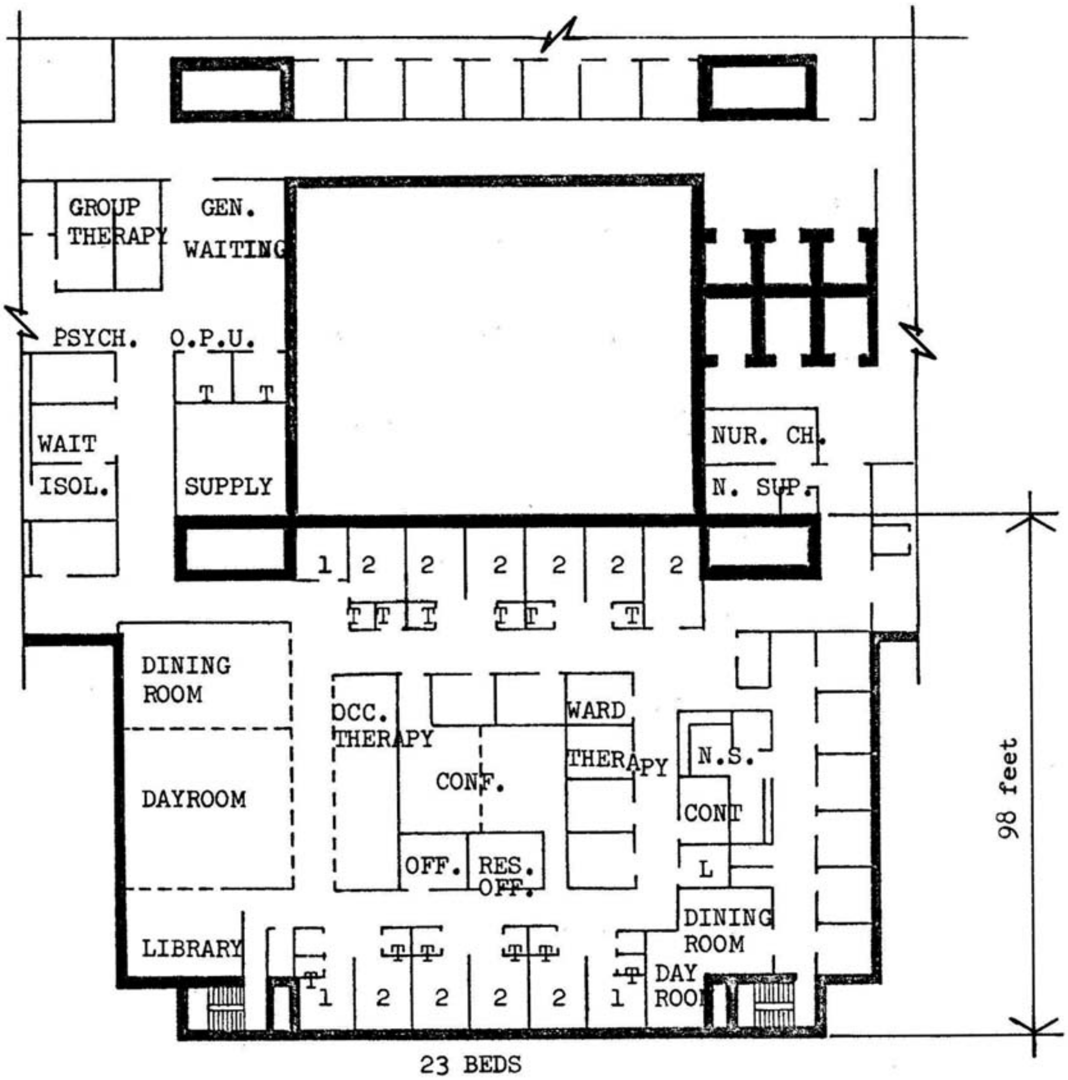
CORE
PLAN EXAMPLE

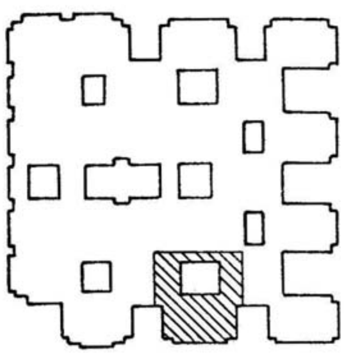


PSYCHIATRIC UNIT

ANDREW McFARLAND
ZONE CENTER
SPRINGFIELD, ILLINOIS

DOUBLE LOADED CORRIDOR
PLAN EXAMPLE

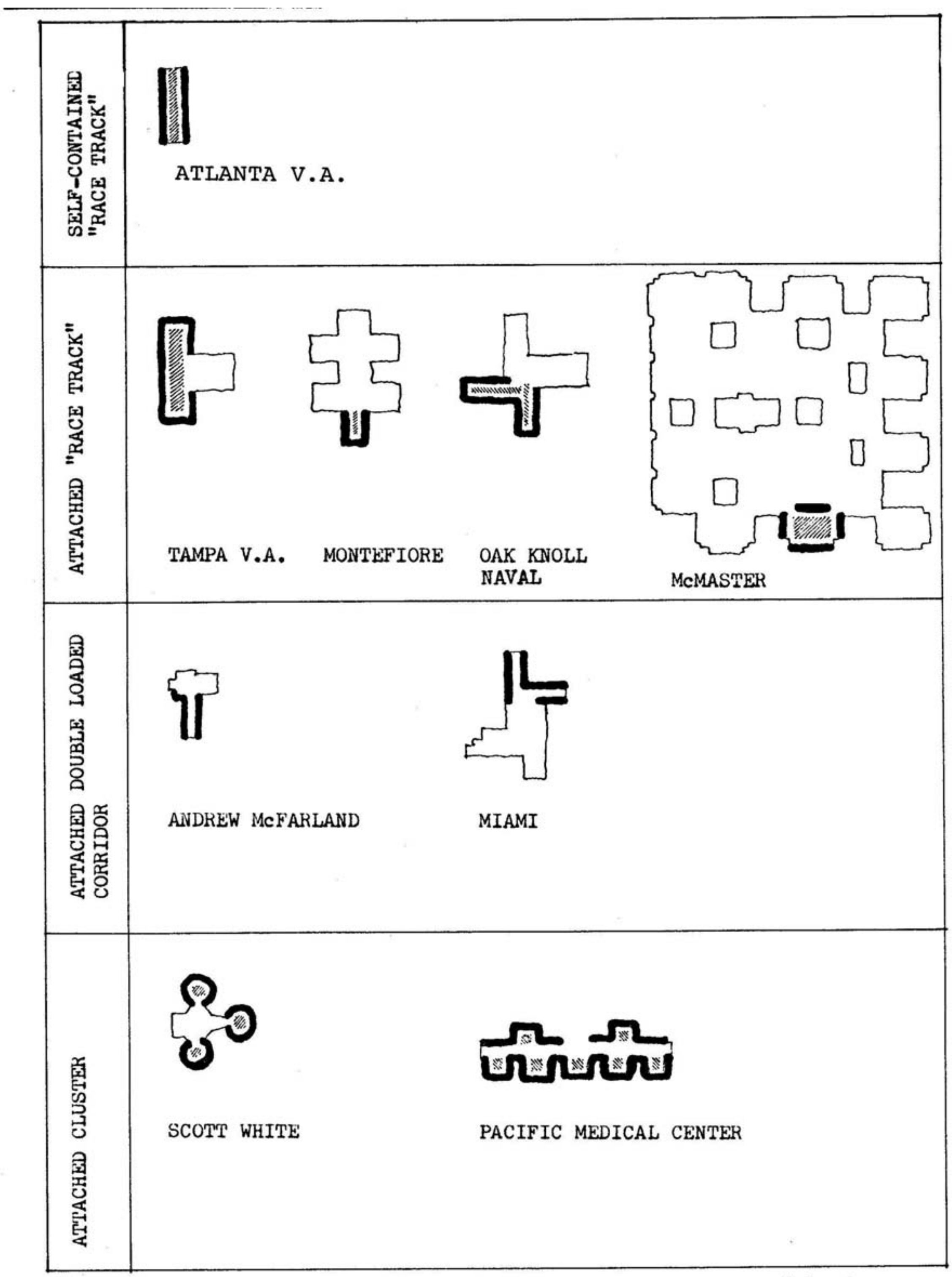




CORE PLAN EXAMPLE

PSYCHIATRIC ICU

3RD FLOOR
McMASTER UNIVERSITY
HEALTH SCIENCES CENTRE
HAMILTON, ONTARIO



CONFIGURATION TYPES 1"=400'

Architects for Example Nursing Units

Andrew McFarland	Phillips & Swager Hewitt & Bastian
McMaster University, Health Sciences Centre	Craig, Zeilder & Strong
Montefiore Hospital	Kelly & Gruzen Westermann & Miller
Oak Knoll Hospital	Stone, Marraccini & Patterson M. T. Pflueger
Pacific Medical Center	Stone, Marraccini & Patterson
Scott-White Memorial Hospital	Wyatt C. Hedrick Ellerbe Architects, Consultant
V.A. Hospital, Atlanta	Gregson & Associates Gordon A. Friesen Associates, Consultant
V.A. Hospital, Miami	Smith & Korach Beinswenger, Hoch & Arnold
V.A. Hospital, Tampa	Eliot C. Fletcher Frank S. Valenti Schmidt, Garden & Erikson, Associate Architects

712.1.5 Dimensional Characteristics

In the nursing tower plans studied, not only were certain patterns of organization relatively consistent, but also many dimensional characteristics remained constant or varied within narrow limits.

1. The dimension between the perimeter and the corridor (bedroom and sanitary zones) varies within a relatively narrow range and is dependent upon the specific building program. Variables include the number of beds per room and the type of sanitary facilities provided.

2. Corridor widths have generally been standardized at an eight-foot clear dimension. This is sufficient to allow a hospital bed to exit from a room perpendicular to the corridor wall.

3. The greatest variable in nursing unit width is the area for support facilities. In a teaching hospital, nursing units are generally attached to a larger central area containing functions related to patient care but which are not needed within the unit. Direct nursing support is found in the interior zone of core and most cluster plans. This interior zone or core area usually varies in width from a minimum of 12 feet to a maximum of about 30 feet and usually varies in approximate increments of standard room widths (12, 16, 24 feet).

4. Nursing unit length is usually a function of the perimeter necessary to satisfy a given program and often relates directly to the number of beds and bed rooms required.

712.2 DESIRED PERFORMANCE

712.2.1 Relation of Span to Space Use

1. The Desire for Structural Economy

   There is no doubt that totally column-free spaces provide the greatest degree of plan adaptability. However, it was desired, in the interest of economy, to identify precisely the minimum spans required for an acceptable degree of adaptability.

a. Clear sightlines in intensive care units.

Any space module may contain, or has the capacity to be modified to contain, specialty units such as intensive care. These units typically require the direct visual surveillance of all patients from a central nursing station. Planning studies indicated that this requirement could always be met if column-free areas measuring at least 40 feet in their short dimension were provided.

b. Free planning of narrow cores.

The support facilities in core-type space modules are contained in a central core which may vary in width from twelve to thirty or more feet. The core is typically divided into small rooms, and this division can be expected to change much more frequently than the partitioning of the bedrooms. When such cores are at the narrow end of the scale of widths, a column creates a significant impediment to plan adaptability, especially at the lower floors of a hi-rise tower. Columns are therefore to be excluded from narrow core type modules.

c. Possible changes in corridor location.

A common location for interior columns is along one side of the corridor. This location is undesirable as the corridor may move, either during the detailed planning stage (when the structure may already be under construction) or in future alterations. Examples in which the corridor may move include:

(1) An upgrading of bedroom sanitary facilities, say from lavatory only to lavatory, toilet and shower per bedroom.

(2) The conversion of a General Medical Nursing Unit to an Intensive Care Unit.

2. Identification of Permissible Column Locations.

a. Columns may occur at the perimeter of any building.

b. Columns may occur along the center line of any building 81 feet or greater in width. This satisfies the requirements stated above:

(1) Two column-free areas measuring at least 40 feet in their short dimensions are provided.

(2) The most narrow core possible (assuming the widest sanitary zone) is over 16 feet in width, i.e., a double row of small rooms. This core is wide enough to accept a central column.

(3) Corridor location is unaffected by the columns.

c. Columns may occur 18 feet (to column centerline) within the perimeter of any building 58’6” or greater in width. This also satisfies the requirements stated above:

(1) One column-free area measuring at least 40 feet in its short dimension is provided.

(2) The core is completely free of columns.

(3) Corridor location is unaffected by columns.

This column location, implying an asymmetric cantilever, is based on the fact that the most constant and predictable dimension on the nursing floor is the clear depth required for bedrooms. This has been set at 15’6”. (See ergonomic studies in Section 230.)

Eighteen feet is the sum of:

(1) the required clear space (inside face of exterior wall to outside face of column)

(2) one-half the maximum depth of the column (36”/2 = 18”)

(3) one foot maximum allowable thickness of exterior wall.

In this location the column will fall either on the boundary between the bedroom and the corridor (sanitary zone 1) or it will be absorbed within the sanitary zone (sanitary zones 2 and 3).

3. Sequence of Structural Types

   The placement of columns in these permissible locations produces a sequence of structural types - single span, cantilever and double span - which satisfies the planning requirements with great economy. (See Structural Rationale Section 720.)

4. Other Permanent Vertical Elements

   The requirements for uninterrupted space are also satisfied by the exclusion of other permanent vertical elements (air shafts, piping and electrical risers, equipment rooms, stairs, elevators and other transport systems) from the space modules.

712.2.2 Relation of Bay Width to Space Use

The coordination of bay widths with the critical dimensions of one-, two- and four-bed rooms (as described in Section 230):

1. Produces, in the case of a building programmed for one- and four-bed rooms, and possessing the capability to convert to two-bed rooms, an overall length which is significantly less than that required for a bay spacing designed to accommodate either a four-bed room, a pair of two-bed rooms or a pair of one-bed rooms.

2. Produces one-, two- and four-bed rooms which are very close to the recommended critical dimensions. The usual compromise solution produces one- and four-bed rooms which are wider than necessary, and a two-bed room which is not really wide enough to allow the passage of one bed past the second.

712.2.3 A Set of 11 Space Modules

Once the validity of the space module as a planning module is accepted, it still may be asked why there are eleven modules in the catalog, rather than twenty or more.

1. Full Range of Planning Options

   The eleven modules provide the desired range of options in:

   a. Internal organization.

      Both core and double-loaded corridor types have suitable applications and should therefore be included.

   b. Assembly characteristics.

      A full range of assembly possibilities is provided by including two- and four-aspect modules, each of which has different assembly characteristics. The four-aspect modules may be modified to produce three-aspect modules: either, a twenty-bed three-aspect unit by using one-half of certain modules or, a 40-bed three-aspect unit by increasing the length of the modules by one structural bay. (See Section 230)

   c. Program variation.

      The provision of a range of widths (spans) in each of the aspect- and organization-types provides for fluctuations in program for:

      (1) Sanitary facilities.

      (2) Support space on the nursing unit

2. Minimum Workable Number of Modules

   a. The clarity and simplicity of the system is increased as the number of modules is reduced to the minimum required to achieve the desired range of planning options.

   b. At any point in time, the current state of the continuing evolution of programs and standards within the VA may eliminate some of the eleven, reducing the number further.

c. As the system is applied and feedback received, dimensions may be revised and/or new space modules developed. For example, the building width of 63 feet (45' + 18' cantilever) has been dropped from the current set of space modules, as it does not appear to offer plan possibilities which differ significantly from the sizes above and below it. After further testing, the VA may decide to include this width in the set.

712.2.4 Additional Space

The concept of additional space has been developed to allow a finer tuning of space allocation in relation to VA space programs.

Currently, VA nursing unit programs are generally consistent from one facility to another. They are therefore more or less predictable.

However, the space associated with nursing units, but not necessarily an integral part of direct patient care, is highly variable from one facility to the next. A strict application of space modules to these areas would result in a relatively inflexible discipline. Therefore, the ability to obtain additional space, between modules or adjacent to them, which is incremental in structural bay units (22'6" by the module width) provides a valuable, small scale, space option.

713 VERIFICATION OF STRUCTURAL SYSTEM

713.1 STRUCTURAL COMPATABILITY

Once the minimum spans required for an acceptable degree of adaptability and an acceptable range of plan options had been identified for the bed care functions of the hospital, it was necessary to test these spans in terms of the requirements of the non-bed care portions of the hospital.

713.2 DIVERSITY OF REQUIREMENTS

713.2.1 Size

In contrast to the nursing unit, non-bed care functional units are less predictable. They vary widely in size not only from one unit to another but from one hospital to another, depending upon the relative number of beds served, outpatient load, degree of medical specialization, etc.

713.2.2 Internal Organization

Non-bed care units were examined to identify consistent patterns of organization which might be sufficiently extensive to justify a new structural discipline. No consistency of plan organization exists between functional units. Each is optimized in response to the medical and operational needs of a particular set of activities. It is unlikely, therefore, that any non-bed care unit or combination of units will become a generator of a new structural discipline.

713.2.3 Large Column-free Areas

Structural spans in the nursing tower system range from 40'6" to 58'6". Bay spacing is 22'6". Functional units were examined to determine individual spaces which exceeded 22'-6" in one or both dimensions and in which of these a clear, column-free area was required. Certain large areas such as auditorium, swimming pool, etc., must be column-free. Although relatively few in number, they must be accommodated within the building system.

The structural system provides bands of free space equal to the length of span. The minimum of 40'-6" can readily accommodate any auditorium with a seating capacity of up to 200 seats and a band of 58'6" can accommodate an auditorium with a seating capacity of up to 400 seats.

For height considerations of these special areas see Section 210: The Structural Bay.

713.2.4 Suites of Large Rooms

In addition to considering large spaces, non-bed care areas were reviewed to determine inherent relationships between spaces which might not be compatible with structural column locations. In the case of functional units such as Surgery and Radiology where there is a precise organizational pattern, it may become necessary to intersect a line of columns. In these areas, the 22'-6" bay spacing becomes critical. In the typical operating room there is no occasion where both dimensions exceed 20'-0".

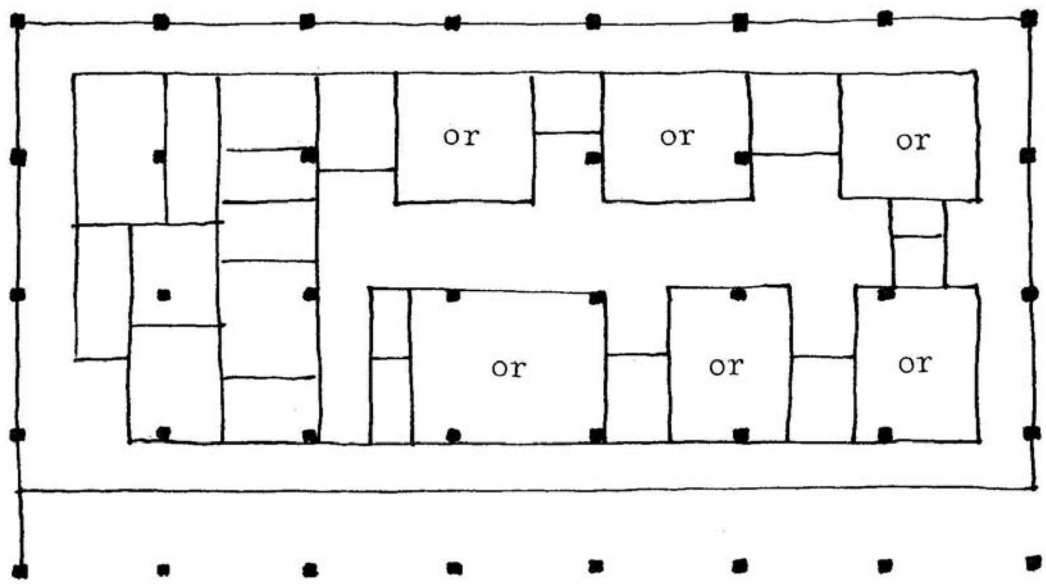
A review of existing VA hospitals indicates that the most typical surgical layout is that of operating rooms grouped around a central work corridor for staff and clean supply, with a perimeter corridor for patient access and egress.

A simulation study of three existing surgical suite layouts and three radiology suite layouts and superimposing these on the minimum size of structural bay, namely 22'-6" x 40'-6", demonstrates how the organization of these critical areas can be readily achieved within the constraints of the structural system. (See Figures 710-2, 3, 4, 5, 6, and 7)

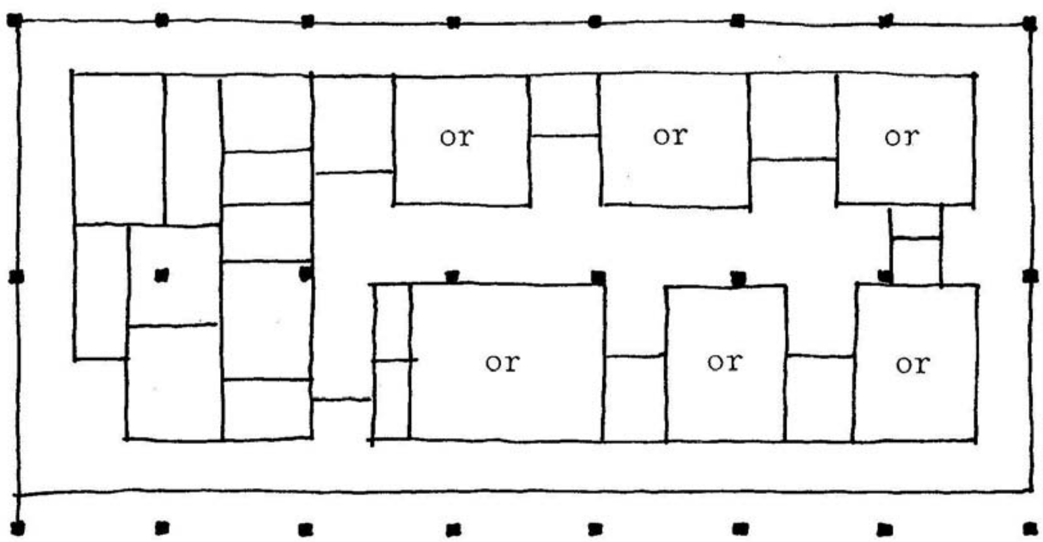
713.2.5 Other Areas

For other areas, it is obvious that any reduction in the number of permanent elements such as columns reduces constraints in planning. Current spans in VA and most non-VA hospitals are considerably shorter than those in the proposed structural system.

Figure 710-2. SURGERY SIMULATION
V.A. HOSPITAL, TAMPA, FLORIDA

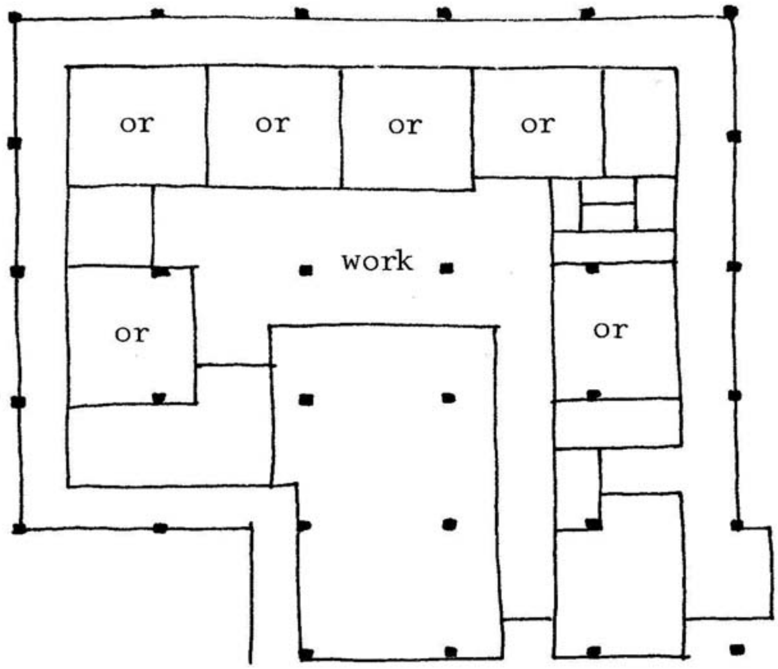


actual plan

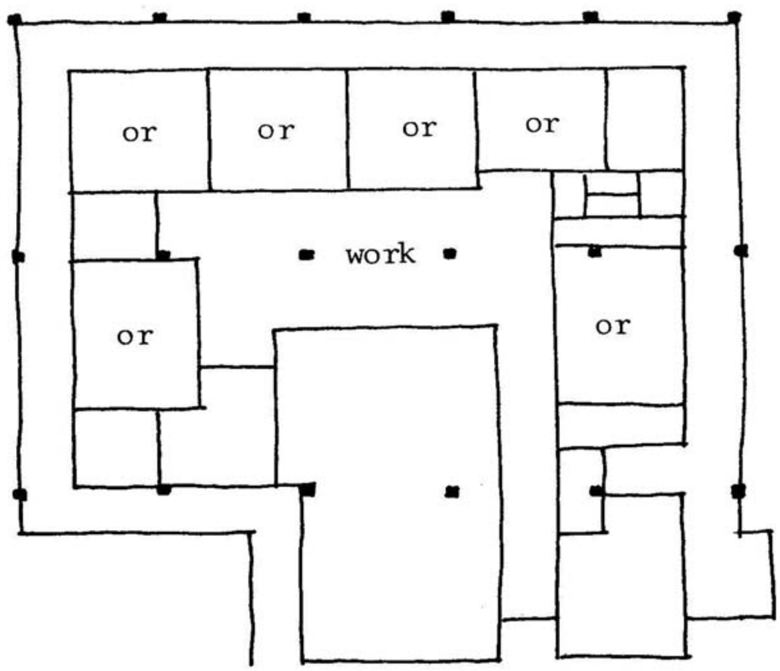


simulation

**Figure 710-3. SURGERY SIMULATION
V.A. HOSPITAL, MEMPHIS, TENNESSEE**

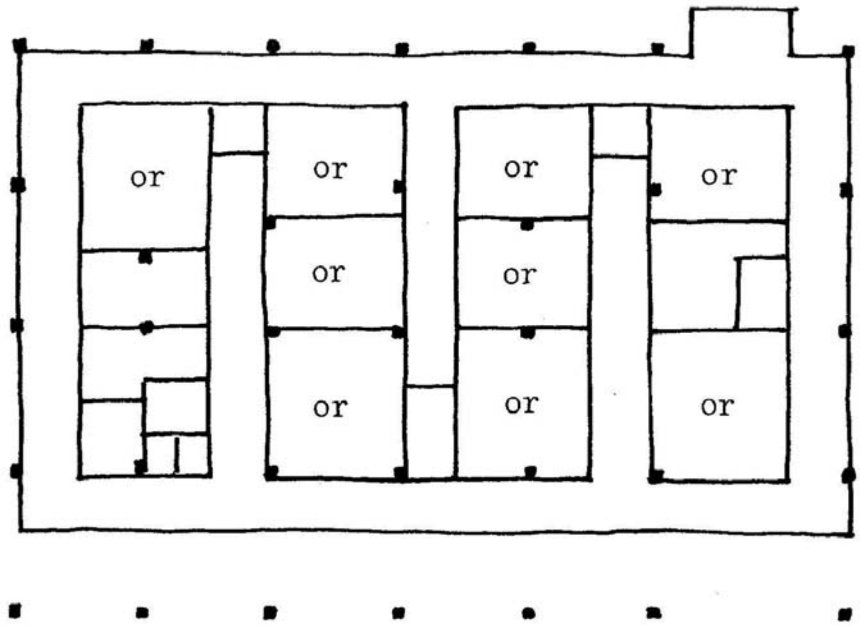


actual plan

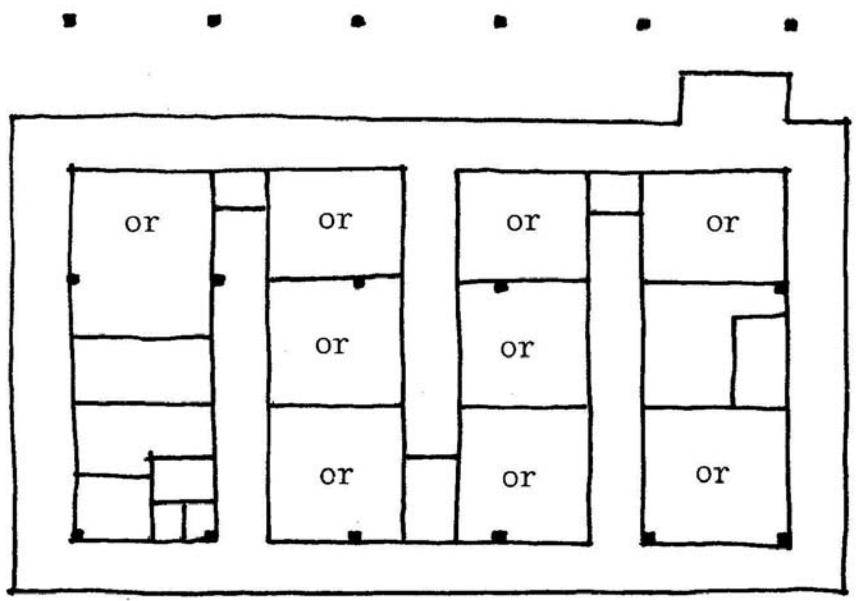


simulation

Figure 710-4. **SURGERY SIMULATION**
V.A. HOSPITAL, CLEVELAND, OHIO

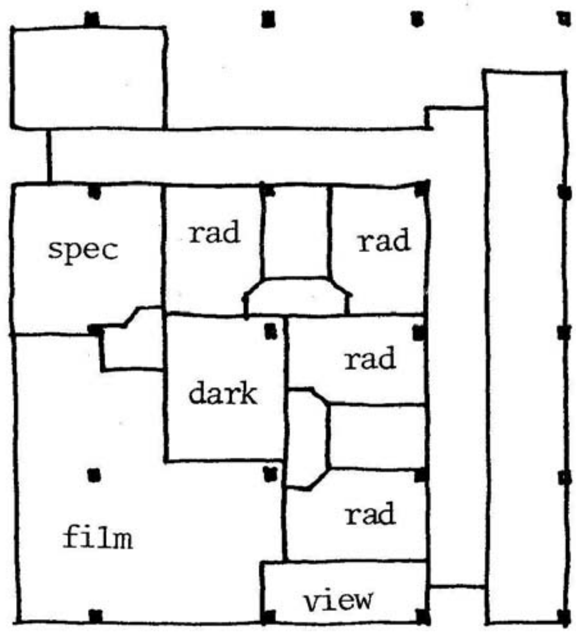


actual plan

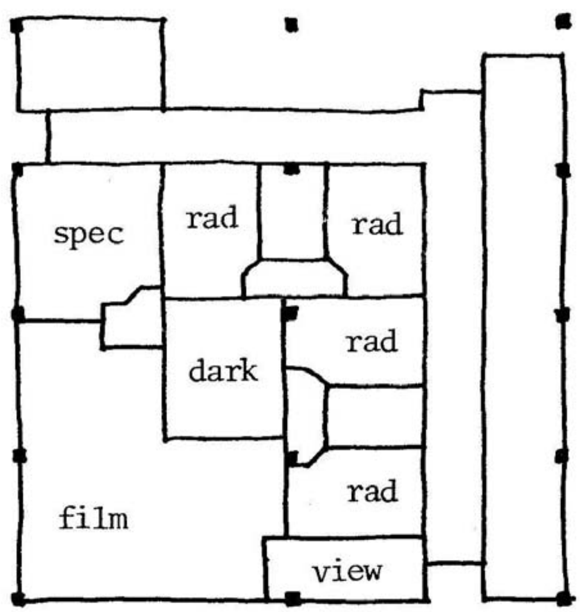


simulation

Figure 710-5. **RADIOLOGY SIMULATION**
V.A. HOSPITAL, TAMPA, FLORIDA

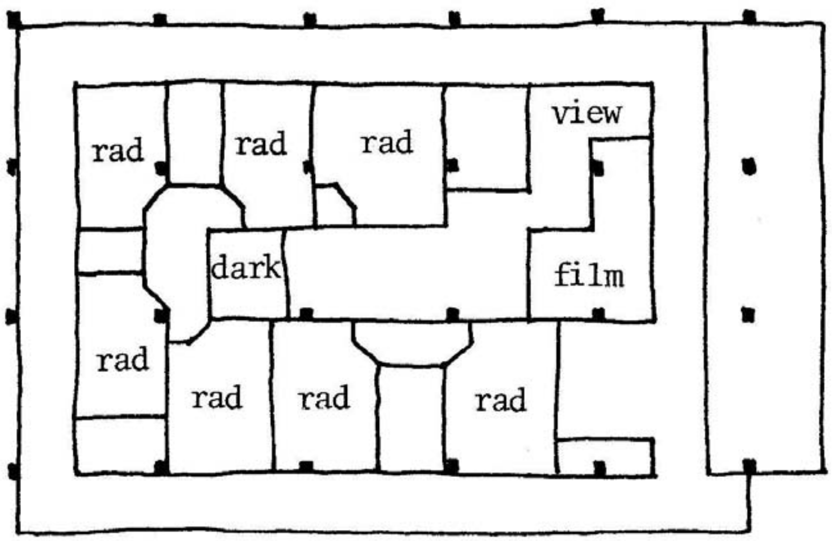


actual plan

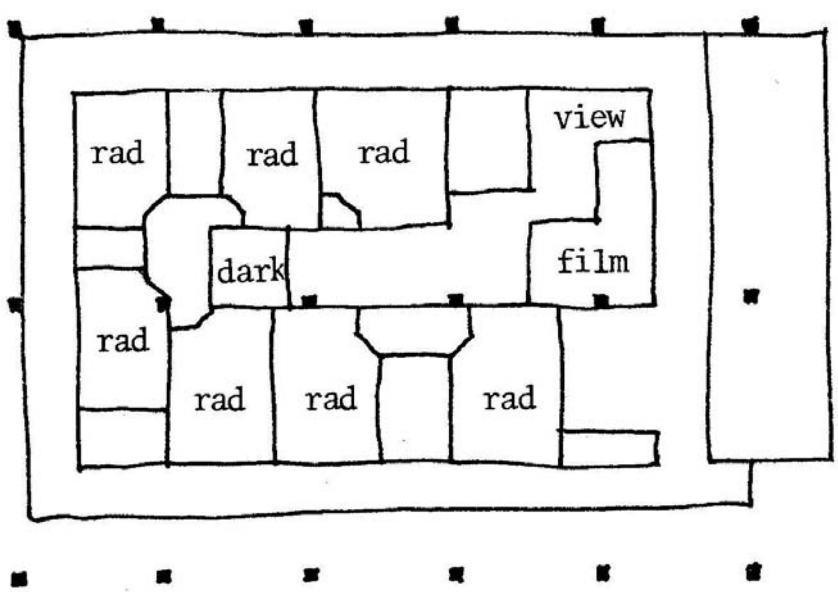


simulation

Figure 710-6 RADIOLOGY SIMULATION
V.A. HOSPITAL, MEMPHIS, TENNESSEE

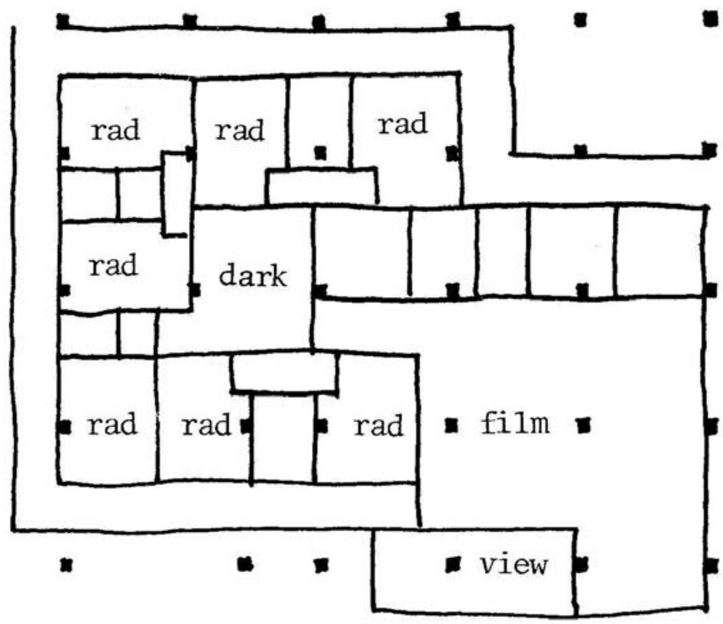


actual plan

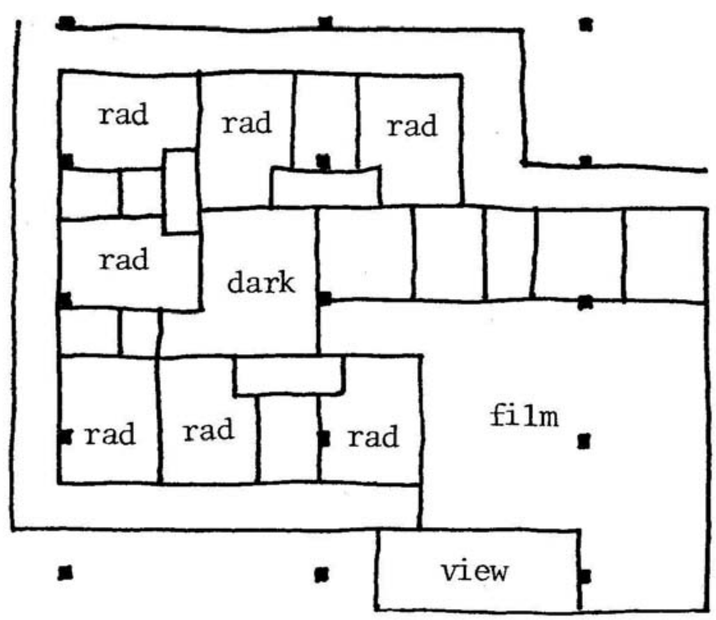


simulation

**Figure 710-7. RADIOLOGY SIMULATION
V.A. HOSPITAL, CLEVELAND, OHIO**



actual plan



simulation

714 CONFIGURATION STUDIES

Three existing VA hospitals were examined to demonstrate the applicability of the Prototype Design to the total hospital. They represent a cross section of nursing unit space module types and suggest different structural span and organizational variations.

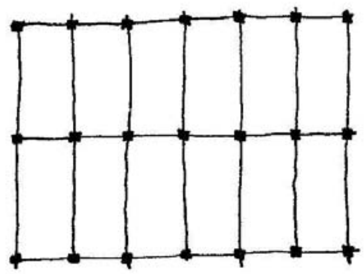
Although these examples are specific applications of the system, each can generally be compared to one of the configurations illustrated in Figure 250-2. The following hospitals were examined.

1. Columbia, Missouri (Figure 710-8) utilizes a single 45-foot span, a simple structural and mechanical component pattern, and is a simple assembly. This hospital plan is similar to configuration E-2 in Figure 250-2.

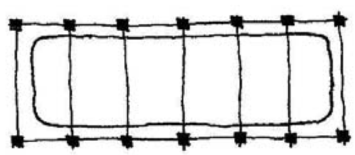
2. Wood, Wisconsin (Figure 710-9) utilizes a 54-foot span with an 18-foot cantilever, and a simple structural and mechanical assembly pattern. It can be directly related to configuration D-2 in Figure 250-2.

3. Lexington, Kentucky (Figure 710-10) utilizes a double 45-foot span and maintains a simple mechanical pattern. The structural pattern is compound as a result of the “t” shape of the nursing tower. The configuration can be related to configuration B-4 in Figure 250-2.

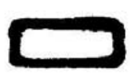
LEGEND (Figures 710-8, 9 & 10)



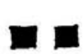
Structural Bays



Service Module



Service Bays



Elevators

Figure 710-8 V.A. HOSPITAL, COLUMBIA, MISSOURI

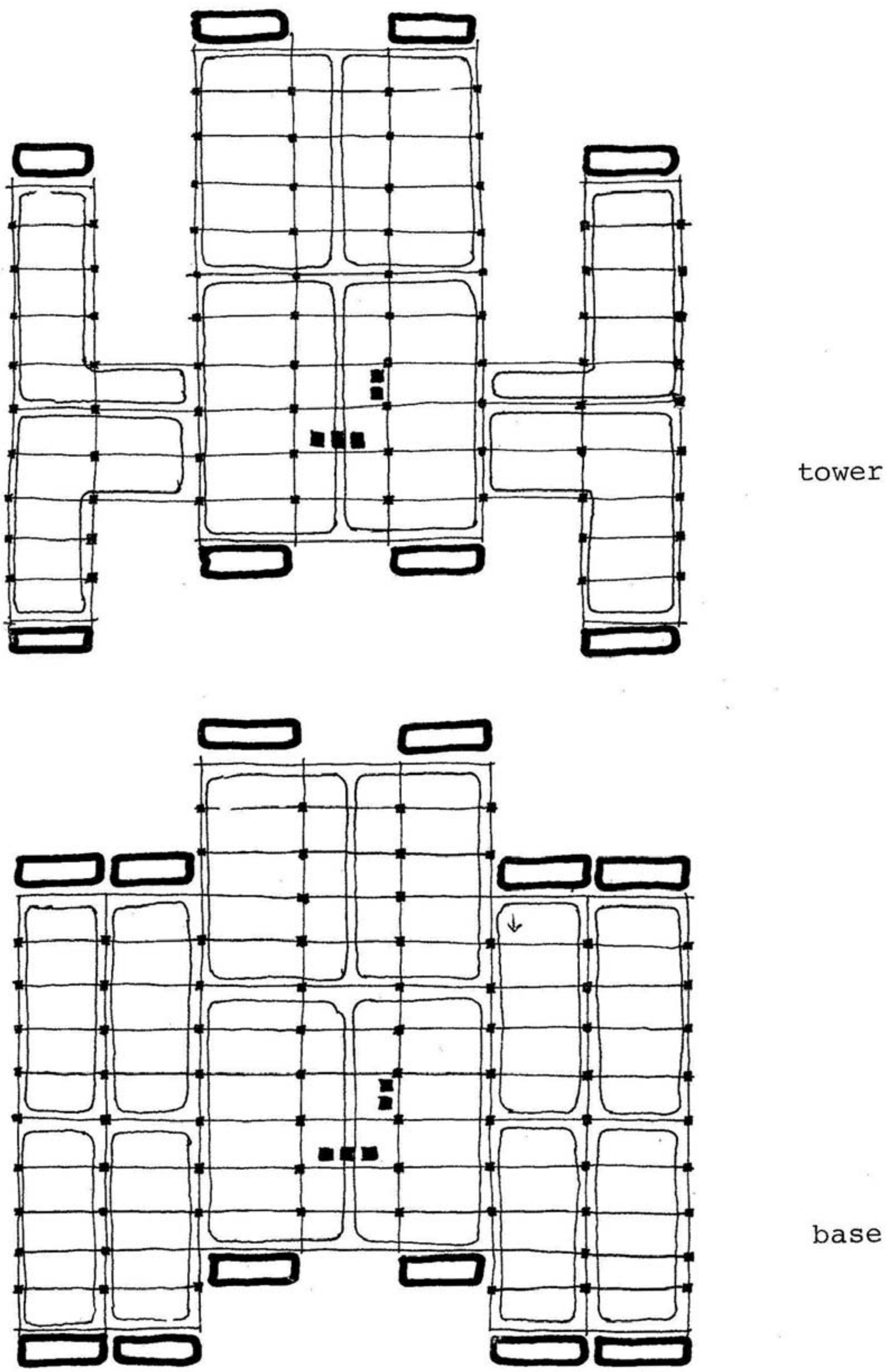
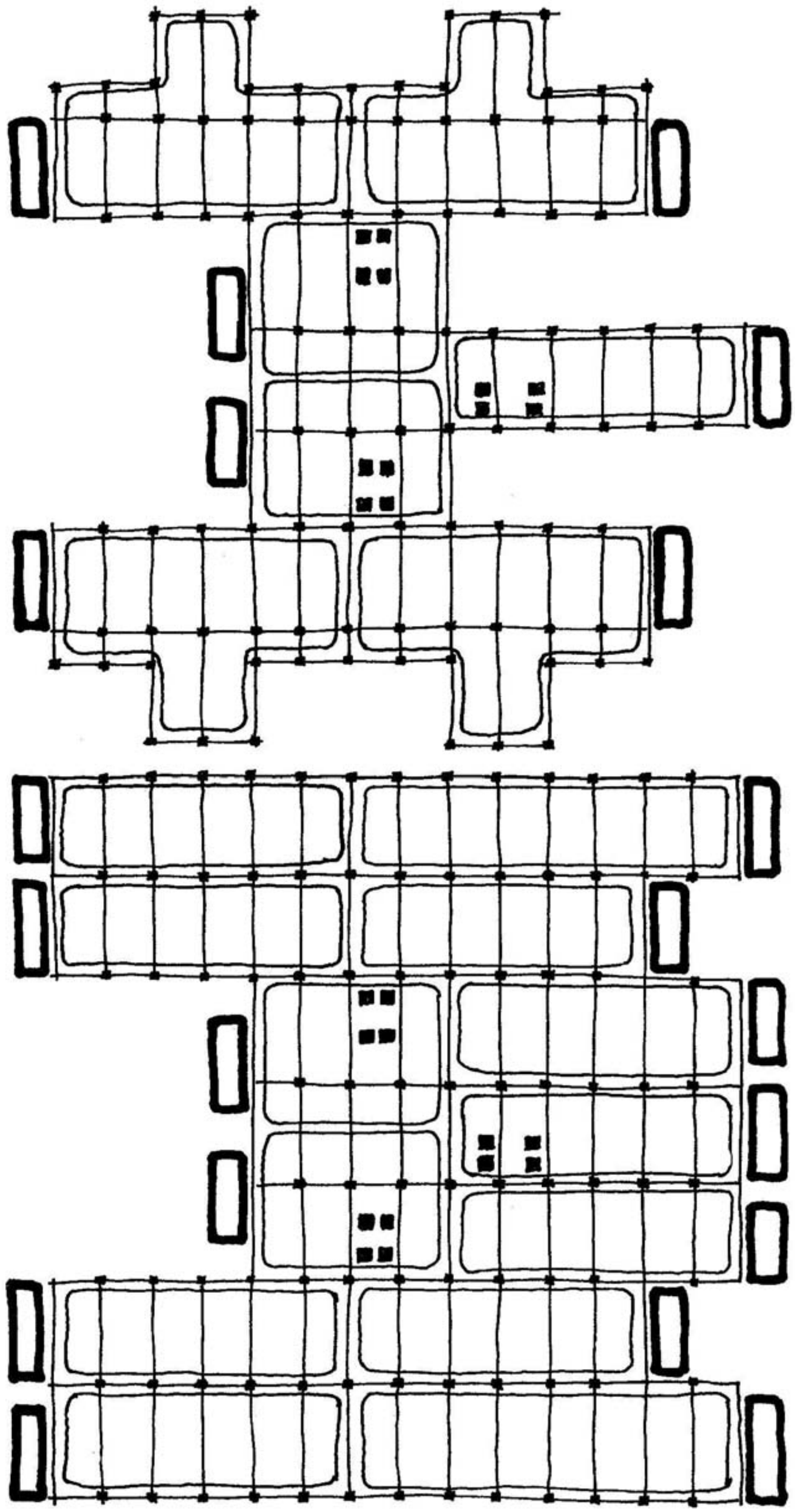


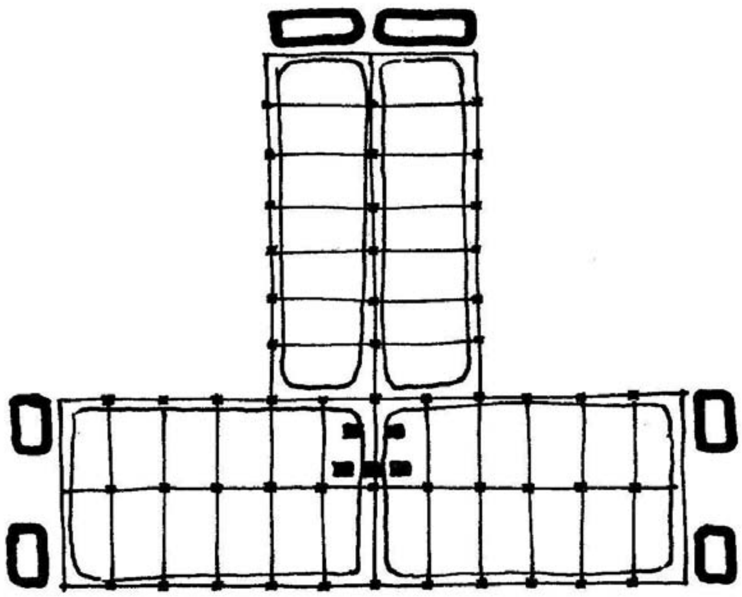
Figure 710-9 V.A. HOSPITAL, WOOD, WISCONSIN



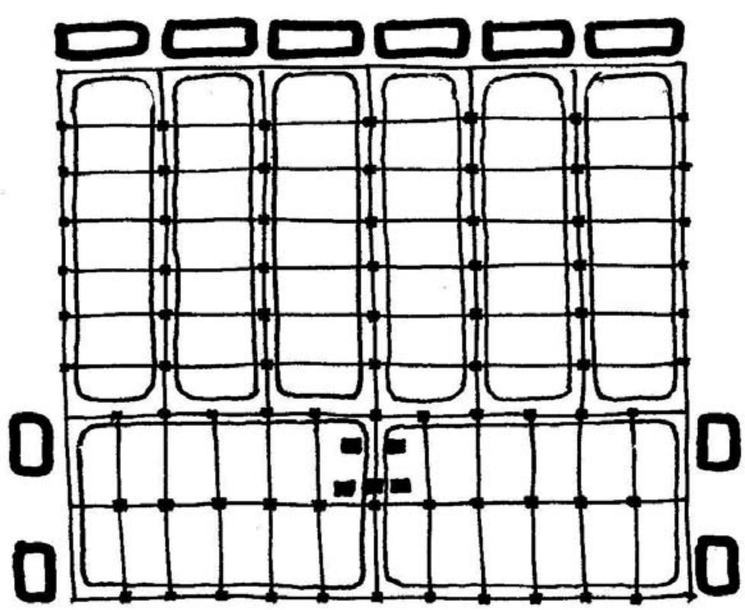
tower

base

Figure 710-10 V.A. HOSPITAL, LEXINGTON, KENTUCKY



tower



base

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720 Design Rationale, Building Subsystems

721 STRUCTURE

Many of the reasons leading to particular details in the structural subsystem of the Prototype Design are discussed in Section 310 of the Design Manual. This section consists mainly of those discussions considered too detailed to be included in the Design Manual.

721.1 CLEAR SPANS

721.1.1 Span Range

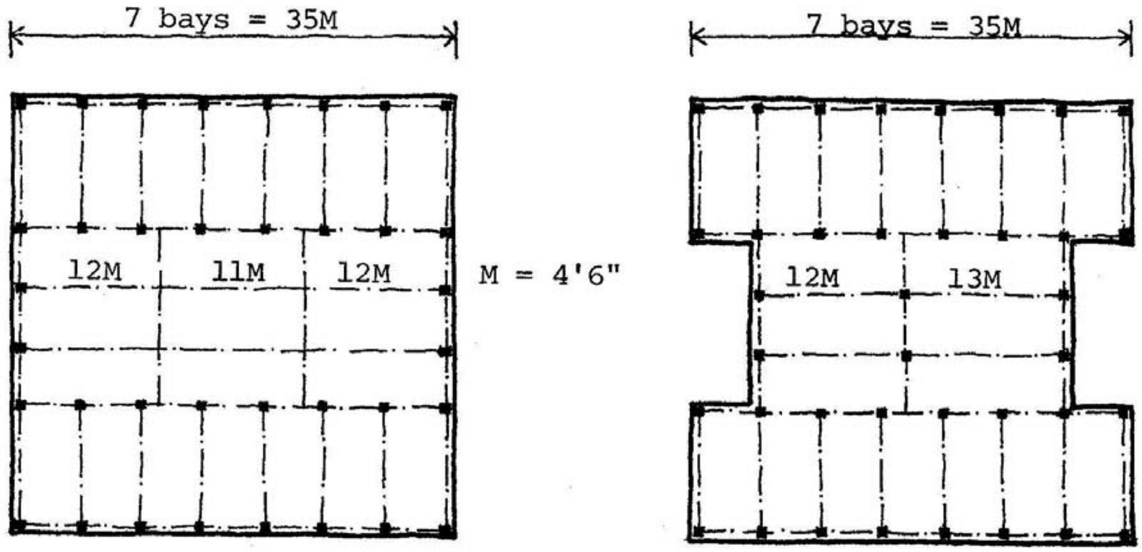
Before a basic framing system could be selected, it was determined that the clear spans required in the Prototype Design would fall within the forty- to sixty-foot range. This range was determined by identifying the maximum and minimum spans necessary for an acceptable degree of adaptability. (See Section 710.) The upper end of the range was also influenced by issues of cost since spans over sixty feet would have eliminated the more economical of the structural alternatives.

The clear spans in the Prototype Design are somewhat greater than those commonly found in current VA hospitals, but less than the spans seen in some recent projects, e.g., VA San Diego (80'0"); McMaster University Health Sciences Center, Hamilton, Ontario (73'6").

721.1.2 Spans in Modular Lengths

The actual spans selected vary in 4'6" increments from 40'6" to 58'6". These dimensions are based on the same module as the 22'6" bay width, namely 4'6". In other words, the bay width is always equal to five modules and the beam lengths range from nine modules to thirteen modules. An 18'0" cantilever extends the bay length by four modules.

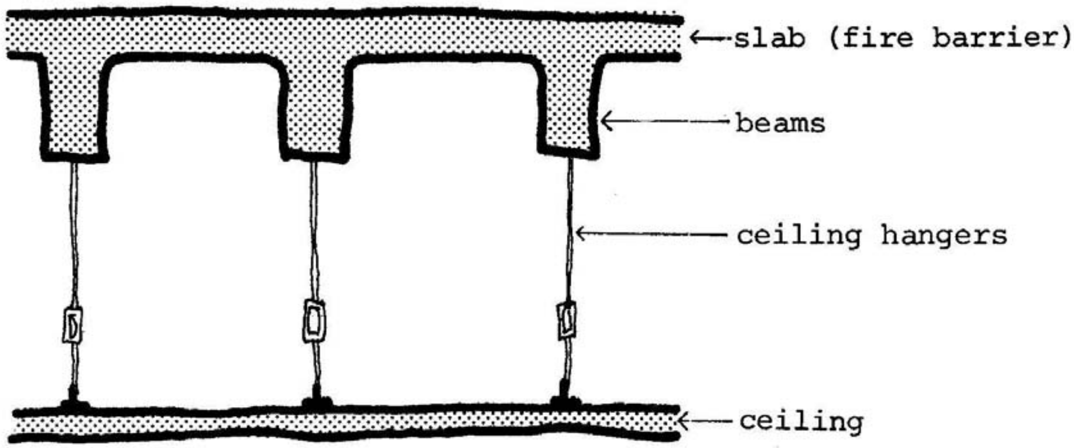
The small increments in the beam length allow adjustment of building width. Also, any number of bay widths above three can be matched in length by some combination of modular spans. Thus even a change of direction in framing can result in buildings with a simple configuration, as illustrated by the following examples.



721.2 FRAMING SYSTEM FOR VERTICAL LOADS

The basic design of the framing system was selected from various structural alternatives mainly in relation to service distribution routing and access. The pros and cons of four major design alternatives are:

721.2.1 Shallow Beams Combined with Suspended Ceiling-Platform



Pro:

1. Beams are simple to construct and economic in the span range in either concrete or steel.

2. Independence of depth of structure and depth of service zone allows each to be optimized in its own terms.

3. Ceiling hangers provide minimum obstruction to service distribution.

4. If one-way structure, space between beams may be reclaimed for service distribution.

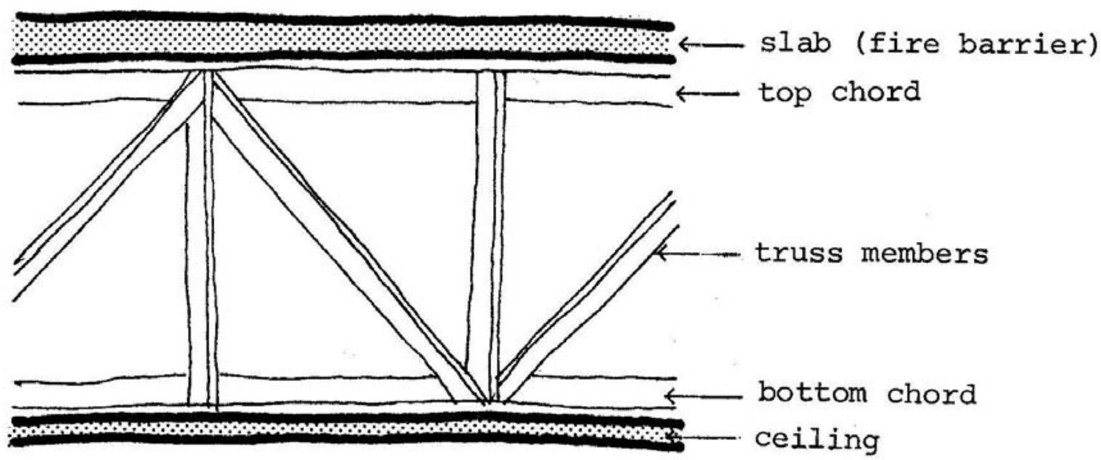
5. Service zone can be made deep enough for horizontal access.

Con:

1. Closely spaced beams impose restrictions on drops for drainage.

2. Substantial additional structure needed for walking surface on ceiling.

721.2.2 Deep Truss



Pro:

1. Allows longest clear spans (fewer columns).

2. Service zone can be deep enough for horizontal access.

Con:

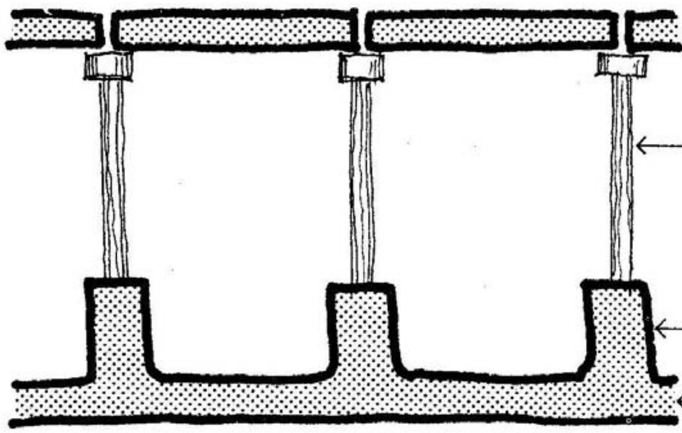
1. Uneconomic at shorter spans. More costly than beams at medium-range spans as well. Long spans, where truss is most applicable, are not considered necessary.

2. Truss depth controlled by depth required for service distribution (or vice versa).

3. Truss diagonals impose severe restrictions on service distribution and access, especially with fireproofing. Less inhibiting Vierendeel truss is inefficient

4. Truss solution weights system toward steel, ignoring regional differences which may favor concrete.

721.2.3 Access Floor



Pro:

1. All service distribution to one floor can be in the same service zone if air is served up from below.

2. Service zone can be deep enough for horizontal access.

3. Depth of service zone is independent of depth of beams.

Con:

1. Floor jointing may be problem in hospital.

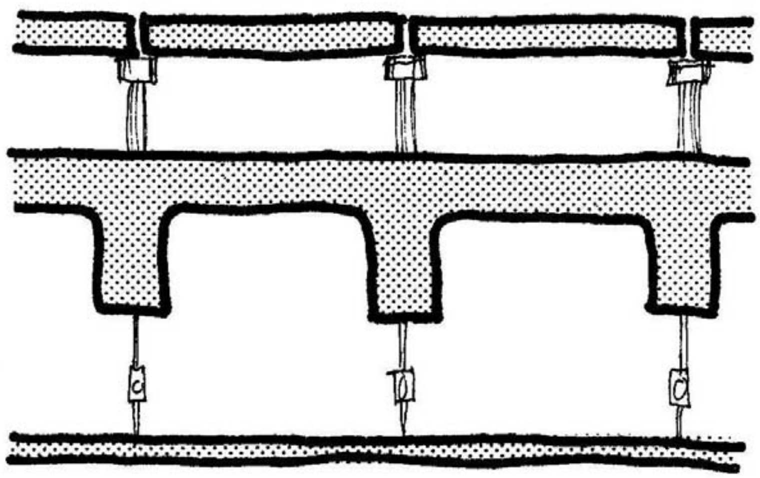
2. Air served from below implies extra duct cost, many large floor penetrations.

3. Air served down to the floor below creates fire isolation problem.

4. Floor struts impede service distribution more than ceiling hangers, although much less than truss members.

5. Structure must be level to serve as ceiling.

721.2.4 Combination Access Floor and Suspended Ceiling



Pro:

1. Access to all distribution systems for a floor is available from that floor. (Air feeds down through ceiling with no need for fire dampers. Drainage is through floor. Supply piping can be in either location.)

2. Ceiling leveling is inherent in the system.

Con:

1. Floor jointing may be a problem in hospital.

2. Performance requirement of access to service distribution systems without disturbing hospital functions cannot be met, i.e., horizontal access is not practical.

3. If a non-acoustically-rated ceiling is used, partitions must penetrate to slab to close flanking path.

721.3 USE OF SHEAR WALL AND/OR BRACED FRAME SYSTEM OF RESISTING LATERAL FORCES

There are two basic schemes for resisting lateral forces in building structures. The first is the shear wall or “box” system, consisting of solid walls (concrete) and/or braced frames subjected primarily to axial loadings (usually steel).

The second is the rigid frame system, in which the members and joints are capable of resisting lateral forces by bending.

The shear wall system is considered the more applicable for the structures of this study for the following reasons:

1. In general, for buildings up to approximately ten stories in height, shear wall lateral systems are more economical than rigid frame systems.

2. The size of vertical shafts normally required in hospital buildings suggests a concentration of lateral stiffness at these shafts, leading to a shear wall system. Often these shafts have concrete walls for fire protection, acoustical or maintenance reasons. In this case, the stiffness of rigid frames is incompatible with the stiffness of the shafts.

3. The spans generally contemplated for planning flexibility are not conducive to development of an economical rigid frame.

4. Prestressed concrete members cannot be used in rigid frames designed to resist earthquake forces because of the unknown ductility of the material. This would indicate shear wall systems wherever prestressed members are used to carry vertical loads.

721.4 BUILDING HEIGHT LIMITATION

Since the structural lateral force resisting system has been defined as a “box system”, a 160-foot height limit was set to coincide with the height at which the building code design requirements change.

In seismic zones 2 and 3, the Uniform Building Code requires buildings over 160 feet in height to have a ductile moment-resisting space frame capable of resisting not less than 25% of the required seismic force. This moment-resisting frame requirement would change the structural priorities and therefore affect the final system.

However, if for some reason it is extremely desirable to go over 160 feet with the system, it could be done, and the following directions should be considered.

721.4.1 Seismic Zone 1 (least susceptible to earthquake)

Buildings in Seismic Zone 1 fall into a code exception to the moment-resisting frame requirement and the system could be used intact to any height, limited only by the available shear walls' capacity to withstand local wind pressures.

721.4.2 Seismic Zone 2 (moderately susceptible to earthquake)

A ductile moment-resisting space frame is required to resist 25% of seismic forces in buildings over 160 feet. The moment-resisting frame could probably be incorporated into the concentrated shear element locations due to the small seismic force factor required. Thus each shear element would be designed for 100% of the required seismic or wind force working as a wall or braced frame, and 25% of the required seismic force working as a ductile moment-resisting space frame.

721.4.3 Seismic Zone 3 (most susceptible to earthquake)

A ductile moment-resisting space frame is required to resist 25% of seismic forces in buildings over 160 feet. Due to the large seismic forces generated, the entire building frame (i.e. all columns) would probably be required to satisfy the 25% moment-resisting frame requirement. This would cause no difficulty in the direction parallel to the girders, as the already required vertical load-carrying girder-column space frame would merely have to be designed for the additional lateral loads. However, in the direction parallel to the beams, difficulty would be encountered due to the long span, shallow beams, and lack of a rigid beam coincident with the columns. This could probably be overcome by shifting the beams to align with the columns and making the aligned beam heavier than the typical beam.

These deviations from the basic design will affect typical interface conditions with other subsystems, and will necessitate reconsideration of certain precoordinated details.

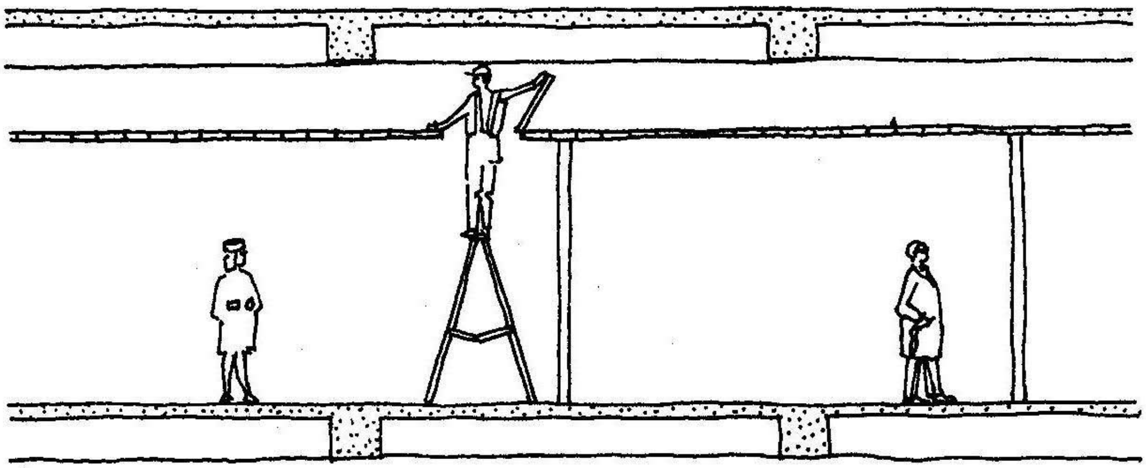
It should be pointed out that all members being used as part of the moment-resisting space frame must be ductile, either steel or ductile concrete, as defined by UBC.

722 CEILING

722.1 WALK-ON PLATFORM

A key characteristic of the Prototype Design is the walk-on platform, which was selected from three basic methods of gaining access to services above the ceiling: Vertical access from below, horizontal access in combination with catwalks, and horizontal access in combination with a walk-on platform.

722.1.1 Vertical Access

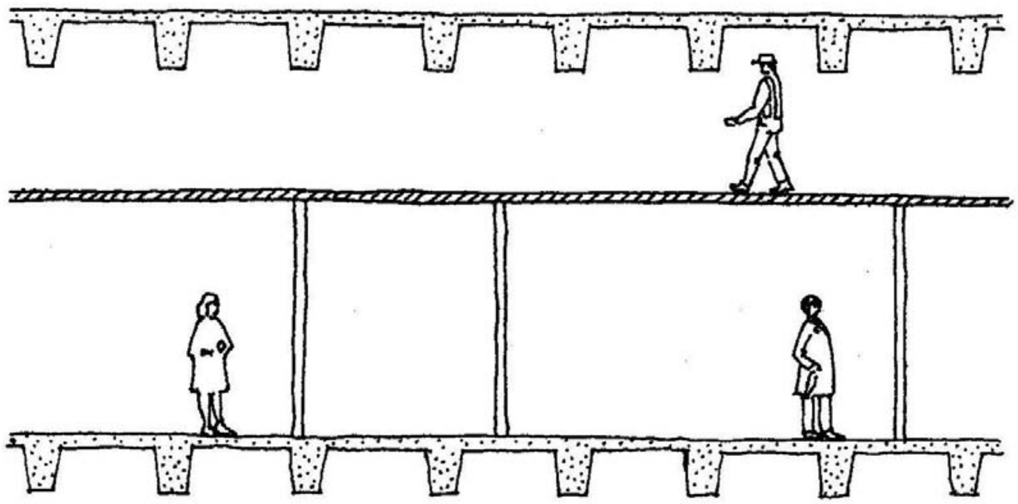


The advantages of this method are that services can be tightly packed under the structure so that floor-to-floor heights may be minimized. This is offset by the following disadvantages:

1. Any access to the space interferes with functional activities.
2. Dust and debris from work increases housekeeping and can mean that patients and personnel have to be moved while work is in progress.
3. Because services are cramped together, some become inaccessible.
4. Adding new services is difficult.
5. It is difficult to seal access panels if space is used as a plenum.
6. When alterations take place on one floor, interference with other floors is inevitable. For instance, if the alteration necessitates new drainage, the ceiling to the room below has to be opened up and two functional areas are affected by the alteration.

722.1.2 Horizontal Access

By increasing the space for services sufficiently to enable maintenance and repairs to be done above the ceiling, all the disadvantages of access from below are resolved. The additional space means better organization of services. The primary disadvantage is the added cost of the increase in floor-to-floor height.

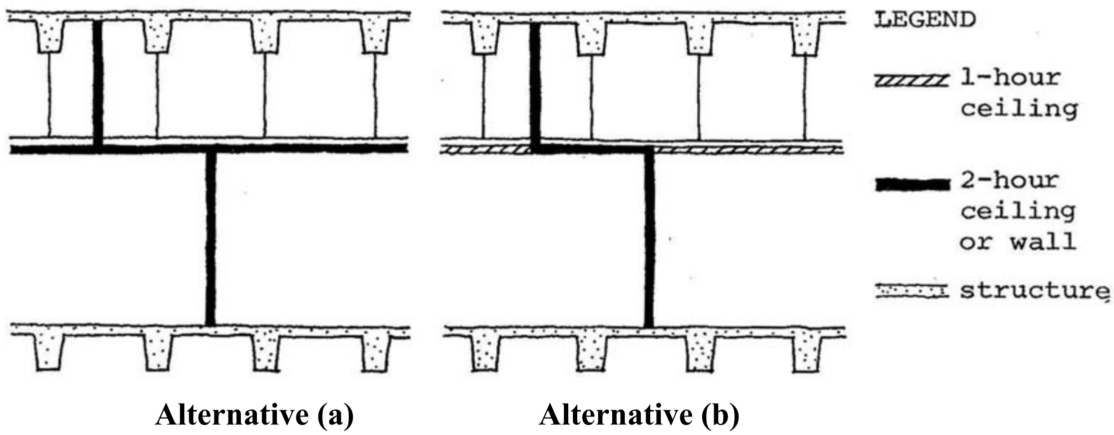


Horizontal access can be achieved by means of catwalks, or by making the whole ceiling capable of supporting the live load of people and materials. The latter option was selected because catwalks require services to be organized so that all controls, etc., are grouped within reach of the catwalk. This is often difficult and also increases the cost of services. The density of services precludes the use of movable catwalks.

722.2 THE PLATFORM MUST BE ONE-HOUR RATED

In order to facilitate change, partitions may not penetrate the platform. Except for two-hour fire barriers, all partitions stop at the ceiling-platform, including one-hour smokestop partitions. The ceiling-platform, therefore, must also be one-hour rated and smoketight. (See discussion in Section 326.)

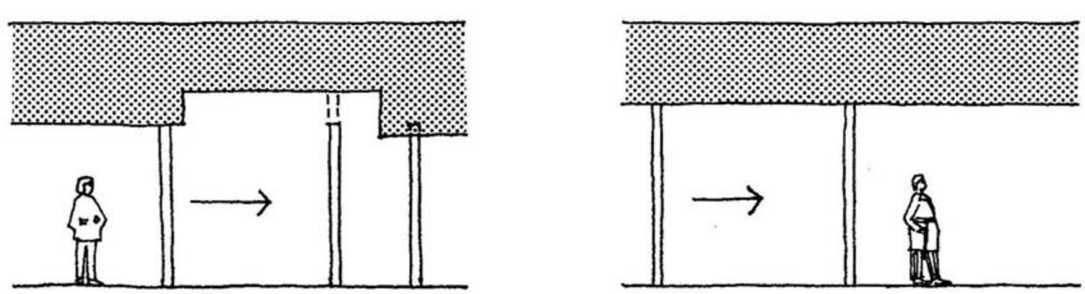
Other strategies for fire safety were considered. For instance, in the ideal situation, the ceiling would have a fire resistivity of two hours, thereby permitting two-hour fire barriers in functional zones also to be freely relocated. It may also be possible to achieve this freedom in planning by upgrading the fire resistivity of the ceiling from one to two hours in limited areas only. These two possibilities are illustrated below.



Both alternatives were rejected on the basis that they would cause unacceptable complications in the mechanical distribution system. The second is also impractical since the relationship of partitions in the functional and service zones would be appropriate only for the opening configuration.

722.3 THE PLATFORM IS A CONSTANT HEIGHT ABOVE THE FLOOR

Change is facilitated by the ability to relocate partitions easily, and to be able to change the functions of spaces from those typically having low ceilings, say, to those with higher ceilings. This change is made possible if a constant ceiling height is maintained and all partitions are the same height.



The recommended heights were determined on the basis of an analysis of the functional space requirements.

Limited areas which may have requirements for heights greater than those recommended should be located on the ground floor or in the basement where the extra height can be obtained by depressing the floor level. The alternatives are either to raise the height of a total floor or to raise the platform over a limited area. The former alternative is the most costly, and the latter would interfere with service distribution organization. (See Section 224.)

722.4 CEILING LIGHTING FIXTURES ARE SURFACE MOUNTED

The Prototype Design does not incorporate integrated lighting-ceiling systems. To be effective, these systems require:

1. A rigid planning module that imposes a strict discipline on partitions, as well as lighting and ceiling components.

2. Overall lighting intensities that can be averaged out. For example, the patient bedroom would be averaged out at about 30 foot-candles.

3. Standardization of fixture sizes to allow for interchangeability.

The variability of the lighting performance required throughout the hospital precludes this type of system as a standard design though it is possible to use it in limited areas. (See Section 322.2.3.)

723 PARTITIONS

723.1 SERVICES ARE PREFERABLY NOT HOUSED WITHIN PARTITIONS

In conventional construction, partitions typically perform at least two major and often conflicting functions; they serve as barriers - visual, acoustic or fire - and they serve as containers of services. The rate of change varies with respect to these two functions. By separating these functions, change is facilitated and the barrier function of the partition is improved. This separation is one of the key characteristics of the basic design in which the partitions act mainly as barriers, and the services are typically housed in a variety of surface mounted containers or “consoles”. (See Section 780.) Figure 720-1 illustrates the interface between partitions and services in both conventional design and the Prototype Design.

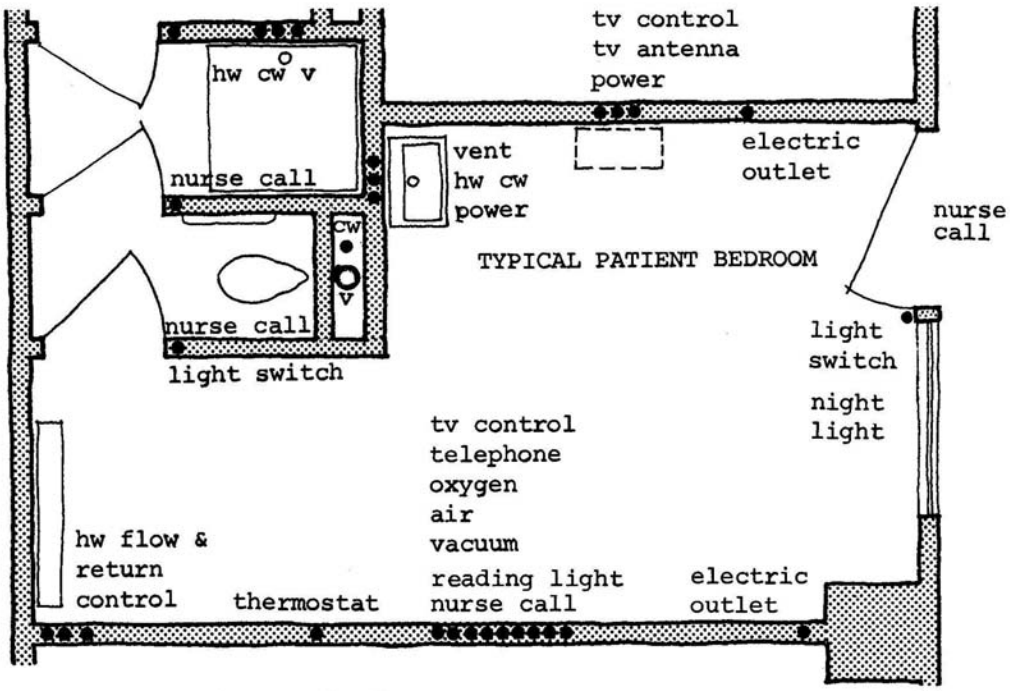
723.2 PARTITIONS TYPICALLY STOP AT THE CEILING

Another key characteristic of the Prototype Design is the fact that, with the exception of two-hour fire barriers, all components of the partition subsystem stop at the ceiling and are the same height on any one floor. In this way, partitions may be regarded almost as furniture or equipment, easily relocated in response to demand. The actual construction of the partitions will affect the degree of ease with which they can be relocated or removed, and this may vary in the different functional areas; but stopping the partitions at the ceiling makes any type reasonably removable and future alterations relatively simple.

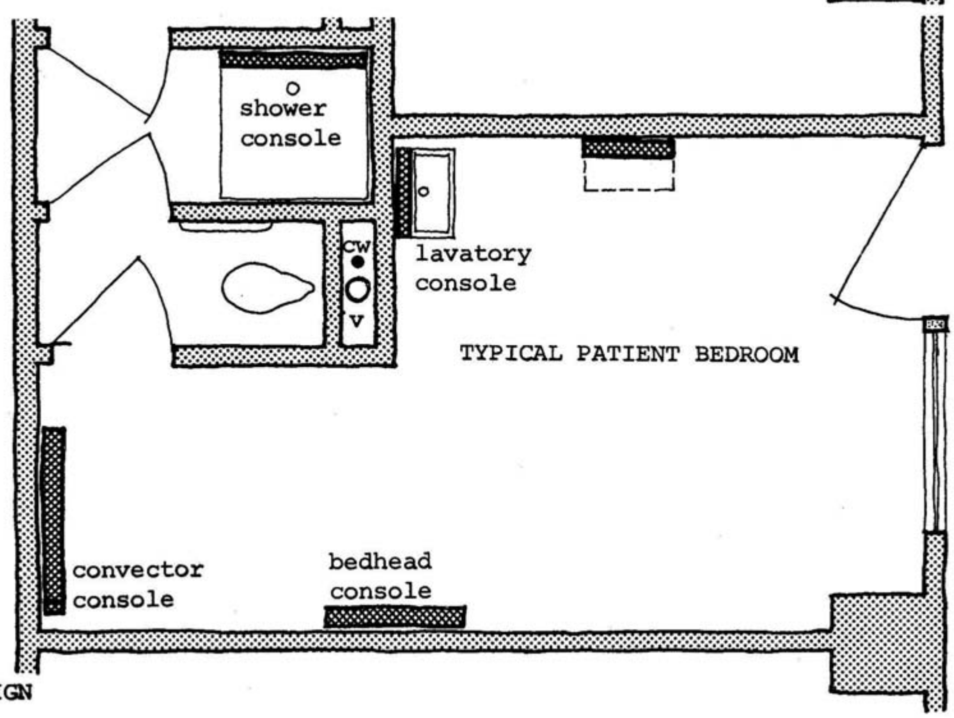
723.3 GENERIC DESIGN OPTIONS

On the basis of the wide range of performance required in hospitals, and of the particular performance requirements generated by the basic design, an evaluation was made of a variety of partition types including metal lath and plaster, block, metal faced panels, laminated gypsum board and gypsum board on metal studs. The latter two were selected mainly for reasons stated in Section 332.1. The other types are both more costly and have a less flexible performance range. For instance, metal-faced panels provide the highest level of accessibility, even where this level of performance is not required. At the same time, the acoustic performance of metal-faced panels cannot be upgraded beyond a certain point and the range of finishes obtainable is limited.

Figure 720-1. INTERFACE BETWEEN PARTITIONS AND SERVICES



PLAN A:
CONVENTIONAL



PLAN B:
PROTOTYPE DESIGN

The wet systems - i.e. metal lath and plaster, and block - are more difficult and costly to relocate; they are messy and little material is salvageable. One of the few disadvantages of the generic design options selected is relatively poor accessibility; but this is unimportant since, in the Prototype Design, services are not housed within the partitions. This also removes the comparatively messy and time-consuming task of cutting holes in the partition surfaces, increasing the salvageability of materials during alterations and speeding up the assembly process.

724 SERVICES

The three service subsystems are organized into discrete networks each serving a single service module. The point of entry into the service module is the service bay, where each service is controlled, zoned or valved, and equipment rooms are placed.

724.1 HEATING-VENTILATING-COOLING

A uniform system of air distribution throughout the entire service module, by its simplicity and generality, allows the greatest degree of adaptability.

724.1.1 Single All-Air Supply with Supplementary Perimeter Heating

When the many commonly used air-conditioning systems are each tested against the performance requirements, it is found that only all-air systems are capable of meeting all of them. All-air systems may be classified as:

1. single-duct terminal reheat
2. dual-duct
3. variable volume
4. multi-zone

The first three are similar in design and the fourth is eliminated from consideration only because the size, complexity and frequency of change of the areas served would require too great an extent of expensive ductwork and more temperature control zones than packaged multi-zone units could handle.

Variable volume systems are not considered as suitable as dual-duct and terminal reheat are for this application, as they cannot easily achieve the control of pressure differentials required in many areas. Variable volume systems are also less easily adapted to changes in plan and function than dual-duct or terminal reheat systems.

724.1.2 Supplementary Perimeter Heating

The most common mixed system uses dual-duct or terminal reheat distribution for interior zones, and fan-coil or induction systems for perimeter rooms.

1. Individual Fan-Coil Units.

   This type of unit has had wide application, particularly in patient rooms. Since fan-coil units recirculate part of the supply air within the space itself, they minimize the possibility of the spread of infection from room to room. Their drawbacks, however, include:

   a. low efficiency filters;

   b. impracticality of providing humidification;

   c. requirement for outside air to each unit, or a supplemental ventilation system;

   d. limited ability to meet changing needs, as units are built in standard sizes which fix their capabilities;

   e. difficulty in adjusting and maintaining system balance under changing conditions (greater than with all-air systems).

2. Induction systems, although superior to fan-coil systems, possess serious drawbacks as well:

   a. they are designed primarily for the exterior zone;

   b. they are provided in a few standard sizes, and thus suffer the same limited adaptability as the fan-coil units;

   c. they are also inferior to all-air systems in their ability to maintain system balance easily.

3. There are other systems which might be considered. However, they would require supplementation to meet the criteria. For example, radiant heating or cooling could be designed to maintain dry bulb temperatures, but a supplemental ventilation system must be provided. In this regard, the possibility is not excluded of a supplemental system even to an all-air system in areas having extremely cold winter conditions.

724.1.3 Air Velocity

Low- or medium-velocity systems are considered most appropriate in the Prototype Design. The S3 subzone at a depth of 36” in a 10,000 square foot service module will handle low-velocity ductwork. Low-velocity distribution requires less energy to move the air, and greatly reduces the noise generation problems found in high-velocity systems. High-velocity systems are considered inappropriate except with dual-duct systems where the mixing box can reduce velocity and noise in the system. The need for extra care in construction to avoid leakage and the limited contractor experience in some areas of the country would also limit their application.

724.1.4 Fan Units: Satellite versus Central Fan Room

1. Adaptability

   Satellite air-handling units may be changed to respond to changes in the areas which they serve without disrupting the operation of other functional areas. Breakdowns affect only local areas.

2. Quality Control

   Large central fan systems must be site-fabricated. Units of the size contemplated are assembled in the factory and trucked to the site for installation. Since VA hospitals are constructed in every part of the country, it is not always possible to find mechanical contractors experienced enough to guarantee top-quality on-site assembly of large central fan systems. The packaged units offer predictable quality.

3. First Cost

   In addition to predictable quality, factory-fabricated units offer predictable first cost. Several factors also tend to reduce the first cost of systems composed of small satellite units, compared to large central fan systems.

   a. Vertical supply air shafts are eliminated, as well as the pressure-reducing devices to the take-offs at each floor.

b. The use of factory labor for all but final installation cuts costs both directly and by adding to the certainty of scheduling.

c. Actual fan ratings (horsepower) can be reduced, as the additional friction to be overcome in the vertical shaft is eliminated.

It is impossible to predict the actual cost difference between a system of satellite units and a central fan system as it will vary considerably with building height and configuration. Higher buildings favor the system of satellite units.

4. Operating and Maintenance Costs

a. Energy expended in heating or cooling air should be the same in central fan systems and satellite systems, assuming similar distribution patterns at the local level.

b. As noted above, energy expended for air circulation will be reduced. In the case of a tall building, this differential is maximized. In that case, fan horsepower requirements are reduced ten percent by eliminating the vertical supply air shaft.

c. The satellite units still take advantage of the economics implicit in centralized energy conversion devices (boilers and chillers).

d. Maintenance costs can be expected to rise, as servicing is decentralized. The efficiency of maintenance, given a decentralized system, is maximized by providing highly accessible mechanical rooms with adequate clearances around equipment, which are stacked next to a stairway.

e. In the case of major mechanical malfunction, repair of the smaller units would be easier, and would not affect hospital areas beyond the service module in which the malfunction occurred.

5. Availability of Packaged Air-Handling Units

The following list of products is not exhaustive, but it demonstrates the ready availability of the type of component which is being considered.

a. Single-Duct Air-Handling Units (with heating and cooling coils).

Manufacturer & Model	**Space Served (sq. ft.) Based on 2 CFM/sq. ft.**
McQuay LA or LM Single Zone Season Master	500-19000
Dunham-Bush AH	500-19000
Trane Draw-Thru Climate Changer	500-23000
Carrier Weathermaker Model 39D	500-20000
Bohn HCS	500-19000
Chrysler Air Temp	500-17000
York Type A	500-18000

b. Dual-Duct Air-Handling Units (with heating and cooling coils).

Manufacturer & Model	**Space Served (sq. ft.) Based on 2 CFM/sq. ft.**
McQuay MS or MM Multizone Season Master	900-19000
Dunham-Bush MZ	900-19000
Trane Blow-Thru Climate Changer	1000-23000
Carrier Weathermaker Model 39C	1200-20000
Bohn HMZ	1400-19000
Chrysler Air Temp BD	1000-17000
York Type M	600-18000

6. Floor Area Required for Equipment

   More floor area will be required for equipment, but this increase is mitigated by two factors:

   a. Area required for supply air shafts is eliminated.

   b. Added area is distributed over all floors, reducing building height while increasing site coverage.

7. Air Intake per Floor

   a. Assuming one air-handling unit per service module, air intake per floor reduces ducting. When local conditions disallow intake per floor, the mechanical room will be replaced by a supply duct from a roof-mounted fan unit.

   b. The opening required for removal and replacement of the air-handling unit is always large enough for the required fresh air intake.

724.1.5 Return/Exhaust Systems

For the general return/exhaust system a plenum can be used.

Pro:

1. Elimination of exhaust/return trunk and branch ducts reduces HVC system cost by approximately 70 cents per square foot.

2. The ceiling required for a walk-on platform and acoustical barrier is easily sealed to provide air tightness.

3. The elimination of the exhaust/return ductwork eases access to other service distribution components.

4. Toilet, isolation room, fume hood, and other special exhaust air is separately ducted to an exhaust shaft to the roof.

5. The usual drawback of return plenums – an accumulation of dust which spills down through accessible-ceiling panels – is virtually eliminated because vertical access through the platform-ceiling can be limited to hatches in non-critical rooms.

In addition to this, the accumulation of dust can be cleaned up periodically since a man can comfortably reach every corner of the service zone.

Con:

1. Special precautions must be taken for the control of smoke in case of a fire.

2. Special devices must be used to control noise transference through the return air boots.

724.1.6 Exhaust Shaft to the Roof

Expelling exhaust air at the roof eliminates cross-contamination of the fresh air supply. If, for reasons of economy on a particular project, the expulsion of general exhaust air is desired on a per floor basis, it must be shown to be safe by wind studies based upon local conditions.

Special exhaust air (from toilets, isolation rooms, fume hoods and other heat and odor-producing functions) is always expelled at the roof through a separate shaft or shafts.

724.1.7 Adaptability

1. Supply and Return/Exhaust: Main Distribution

   The return/exhaust main is the largest duct. As other components pass over it, under it and beside it, and as it tends to be located toward the center of the service zone, it would be extremely difficult to remove and replace if its size had to be changed. It is therefore considered to be a permanent component. As such, this main duct must be sized for the maximum loading anticipated in the life of the building. This increases first cost somewhat, but actually reduces the fan horsepower required, as friction losses are diminished in an oversized duct.

2. Special Exhaust and Toilet Exhaust: Main Distribution

   The special exhaust ducts (isolation room, kitchen exhausts, etc.) are considered adaptable components, although they would probably rarely be altered unless a floor is converted to research use. In that case, an acid-resistant duct network is added to exhaust fume hoods. In order to make the main special exhaust ducts permanent, one of two conditions would have to be met:

   a. Install acid-resistant exhaust trunks of sufficient size throughout, in anticipation of the conversion of any floor to research use.

   b. Restrict research to a specified set of floors. Install the less expensive non-acid-resistant trunks on all other floors as permanent components.

3. Branch Ducts

   Branch ducts are considered adaptable so they may be sized and positioned precisely to suit the demands of the opening configuration.

   In alterations, many zone ducts and terminals will in fact be reusable. Any removal or installation of new ductwork can be handled quite easily, as ample work-space is provided within the service zone.

4. Fans and Air-Handling Units

   a. Fans sized for ultimate capacity in the opening configuration would increase first cost considerably. Also, a fan unit sized for a research laboratory would run quite inefficiently if it only had to serve a nursing unit (at perhaps one-half the air volume). For this reason, provision must be made to replace supply air-handling units and/or exhaust fans when air volume requirements change radically.

   b. Supply air-handling units and exhaust fans must be positioned to allow replacement in any case, as their predicted lifespan is far less than that of the structure itself.

724.2 PLUMBING

724.2.1 Independent Layouts for Each Service Module

Each service module contains its own layout of mains and branch distribution fed from the common risers in the service bays. This allows each service zone to have easily identifiable maintenance valving and controls. It also provides independent capacity to change pressure systems and branch layouts without interfering with adjacent modules.

724.2.2 Adaptability

The pressure systems and drainage main distribution runs should be oversized and have blanked-off tees at every hanger space. These mains can be considered permanent installations. But as the pipes are not difficult to add to or supplement like the HVC mains, the secondary subzone will contain enough room to allow modification of these mains in the future. All branch distribution can be considered adaptable as the runs are easily modified when change occurs in the functional zone.

724.3 ELECTRICAL

724.3.1 Distribution from Substations to Service Bays

The distribution of power from the main distribution boards must be via easily accessible busducts to the stacks of service bays. This will provide the necessary degree of freedom for adjustment of load for each service module as future functional requirements demand.

724.3.2 Independent Electrical Rooms and Distribution to each Service Module

The entry of the power distribution systems to each service module must be through an electrical room in the service bay where all circuits are controlled so that all changes for the module can originate there with no interference to other modules.

724.3.3 Adaptability

The main distribution wireways in the service zone can be considered permanent with the freedom to change branch circuits within the wireway. The wireways and conduit in the branch distribution and lateral runs are considered adaptable to change as required by functional zone demands.

730 Example Building Schematic Design

731 INTENT

The building schematic design is intended to demonstrate the application of the Prototype Design to the design of a complete hospital based on current VA needs and space requirements expressed in an updated master hospital plan (program) for Wood, Wisconsin.

For convenience, the existing Wood site and associated characteristics in terms of access, topography, relation to existing facilities have also been assumed for the purposes of the example. There is one exception, the location of the site has been hypothetically changed from Wood, Wisconsin to the San Francisco Bay area in order to facilitate the cost studies discussed in Section 760.

It must be emphasized that the selection of the Wood, Wisconsin, site does not imply any criticism of the existing VA facilities there which, in many ways, are eminently satisfactory.

732 PROGRAM ANALYSIS

732.1 EVALUATION

732.1.1 Ratio of Beds to Support

The updated program from Wood, Wisconsin is rather unusual in that the ratio of bed area to support is 1:1 whereas, typically, the ratio is more in the order of 1:2. There are 640 General Medical beds, 320 General Surgical beds, 102 Psychiatric beds, 56 Spinal Cord Injury beds, 26 Neurological beds, 8 Hemodialysis beds and 7 Medical and 6 Surgical Intensive Care beds giving a total of 1,165 beds to be accommodated. Given the general trend towards fewer inpatient beds, there is the possibility that some of the programmed nursing units may in the future be converted to other, possibly support, functions.

732.1.2 Ratio of Gross to Net

Net area requirements are converted to gross area requirements by a conversion factor which makes certain provision for mechanical services, circulation and other factors such as partition thicknesses, etc. In the Prototype Design, the planning modules represent gross space. However, in interpreting the net program in terms of the planning modules a larger than typical conversion factor should be applied, for two reasons:

1. In the interests of adaptability, the planning modules are generalized units of space which can only be approximately tailored to particular program requirements. This implies that net area requirements are generally rounded upwards.

2. The decentralized air-handling concept requires that a larger percentage of the overall gross is taken up by mechanical requirements.

In plan, the service module consists of the service bay and the functional zone (structural bays). From experience, a net to gross conversion factor can be applied to net area requirements in order to establish gross area requirements exclusive of any provision for mechanical services. This establishes a relationship between gross area requirements and the service module functional zone. The total gross area requirement is that figure against which the aggregate of service module functional zones must be tested.

In the bed care portion of the hospital a more precise interpretation of nursing unit net requirements can be made in terms of space modules. In addition to the gross area contained within the space modules, the gross area of each department can be calculated using appropriate factors which include consideration of the rounding up of net areas to accommodate the modular system of planning. The following program summary lists departmental net areas, the relevant net to gross conversion factor and the resultant departmental gross area.

732.2 PROGRAM SUMMARY

DEPARTMENT	TOTAL NET	EST. %*	TOTAL GROSS
Audiology & Speech Pathology Unit	1,230	1.45	1,784
Building Management Division	17,653	1.25	22,068
Canteen Service	10,658	1.25	13,325
Chaplain Service	3,453	1.25	4,428
Clinical Cardiac Laboratory	3,901	1.40	5,462
Clinical Pulmonary Laboratory	2,747	1.40	3,846
Clinical Services Administration	3,010	1.40	3,214
Contact Location	360	1.45	522
Credit Union	230	1.15	266
Data Processing	96	1.10	107
Dental Service	8,475	1.45	12,289
Dietetic Service	15,682	1.25	19,603
Directors Suite	1,860	1.45	2,697
Domiciliary Facility	530	1.30	690
EEG Unit	565	1.30	735
Engineering Division	7,690	1.25	9,613

* Estimated net to gross ratio exclusive of mechanical and general circulation.

DEPARTMENT	TOTAL NET	EST. %*	TOTAL GROSS
Eye & ENT. Exam Unit	1,860	1.45	2,697
Fiscal Division	2,205	1.45	3,197
Genito-Urinary Clinic	1,319	1.45	1,913
Hemodialysis Unit	3,611	1.50	5,418
Laboratory Service	16,840	1.30	21,892
Library Service	3,670	1.25	4,588
Lobby	950	1.10	1,045
Lockers, Lounges Toilets & Showers	13,162	1.35	17,770
Medical Administrative Division	15,130	1.45	21,939
Medical Illustration Service	1,785	1.25	2,231
Nuclear Medicine Service	5,275	1.45	7,647
Nursing Service Administration	1,770	1.45	2,567
Nursing Service Education & Training	600	1.45	870
Nursing Units Psychiatric	189,577	1.50	284,365
Nursing Units, Psychiatric	(20,976)	1.50	(31,464)
Organ Transplant Unit			
Orthopedic Clinic	1,385	1.45	2,008
Outpatient Psychiatric Service	(3,390)	1.45	(4,916)
Outpatient Service	11,194	1.45	16,232

ACTIVITY	TOTAL NET	EST. %*	TOTAL GROSS
Personnel Division	1,580	1.45	2,291
Pharmacy Service	3,540	1.25	4,425
Physical Medicine & Rehabilitation Service	19,324	1.30	25,121
Process & Distribution	7,200	1.40	10,080
Prosthetics Service	1,576	1.45	2,380
Psychology Service	2,510	1.45	3,640
Quarters, Residents	2,019	1.50	3,029
Radiology Service	9,689	1.40	13,577
Service Organizations	240	1.10	264
Social Work Service	3,470	1.45	5,032
Supply Division	26,599	1.25	33,249
Surgical Service	7,045	1.50	10,568
Voluntary Services	942	1.30	1,225
TOTAL	455,355	1.47	669,302

Departmental gross areas exclude any provision for mechanical services or general circulation.

NOTE: Areas indicated in brackets ( ) not included in totals.

733 SPACE MODULE SELECTION

733.1 THE GENERAL NURSING UNIT

The typical general medical and surgical nursing unit is the basis from which the eligible space modules are derived.

733.1.1 Program Breakdown

The net area requirements for the typical unit are reduced to the following categories:

1. Number and type of bed rooms

2. Sanitary facilities associated with patient bed rooms (Sanitary Zone).

3. Direct Care Support.

   Staff work spaces and other support facilities considered necessary to be immediately adjacent to patient beds.

4. Ancillary Support.

   Support spaces that are considered less critical in terms of their immediate adjacency to patient beds.

733.1.2 Figure 730-1 indicates how this breakdown may be presented.

733.2 ELIGIBLE SPACE MODULES

733.2.1 Sanitary Zone and Direct Care Support

Eligible modules are determined by the sanitary zone and the area required for direct care support. The Space Module Summary Sheet (Figure 730-2) identifies the sanitary zone and the core area available in each module for direct care support space. As the core areas are not directly comparable to the required net areas – they include partition thickness and columns – the space modules should possess a core area slightly greater than the required direct care support. Some additional core area may be useful to allow for future increases in direct support requirements. This area can be used for some ancillary support initially.

Figure 730-1

Typical Nursing Unit (40-bed general surgical and medical)

	Number	Sanitary Zone	Direct Care Support	Ancillary Support
4 bed rooms	6	2		
2 bed rooms	5	2		
1 bed rooms	6	2		
Bath	1		110	
Nurses Station	1		360	
Clean Utility	1		120	
Soil Utility	1		120	
Linen	1		60	
Supplies	1		40	
Nourishment Kitchen	1		60	
Wheelchair & Litter	1		120	
HAC	1		40	
Examination	1		140	
Physicians Office	1			120
Day Room	1			320
Residents Office	2		140	
Study Space	6			216
Classroom	1			300
Procedure Room	1			300
			1,310	1,256

733.2.2 Eligible Space Modules

The space module types whose available core area most directly relates to the required area of 1,310 square feet for direct care support are 6 and 11. The essential characteristics are:

1. Module type 6

   2 aspect, core

   Span: 58’6 plus 18’0 cantilever

   Core: 1,680 square feet (2 x 840)

2. Module type 11

   4 aspect, core

   Span: 58’6 x 2

   Core: 1,400 square feet.

733.2.3 Module Capability

The eligible space modules are then tested against the programs for other functional units. The catalog of space module capabilities (Section 233) provides an indication of the comparative ranges of plan performance for the selected module types.

734 CONFIGURATION OPTIONS

734.1 NUMBER OF SPACE MODULES

General nursing units can be directly translated into numbers of space modules. Special nursing units are not directly translatable and must be approximated.

Nursing Unit	Number	Number of Space Modules	
		SM6	SM11
40 bed G.M.	16	32	16
40 bed G.S.	8	16	8
26 bed neurology	1	1-2	1
28 bed spinal cord injury	2	2-3	2
34 bed psychiatric	3	6	3
8 bed hemodialysis	1	1	1/2
7 bed I.C.U. (Medical)	1	1	1/2
6 bed I.C.U. (Surgical)	1	1	1/2
		60-62	31-1/2 (32)

734.2 HEIGHT RELATIVE TO BEDS PER FLOOR

The structural system imposes a nominal maximum of nine floors on the height of the hospital. At this height, assuming a minimum of one floor for central support functions, the number floors available for nursing units is eight. Therefore, there must be a minimum of four nursing units per floor i.e. a nominal 160 beds per floor.

The total number of space modules can now be organized into optional nursing floor configurations based on the assembly characteristics of the eligible module types 6 and 11 (Catalog of Space Module Capabilities, Section 233) and numbers of beds per floor.

Figures 730-2 and 730-3 show some of the possible configuration options.

Figure 730-2. MODULE TYPE 6

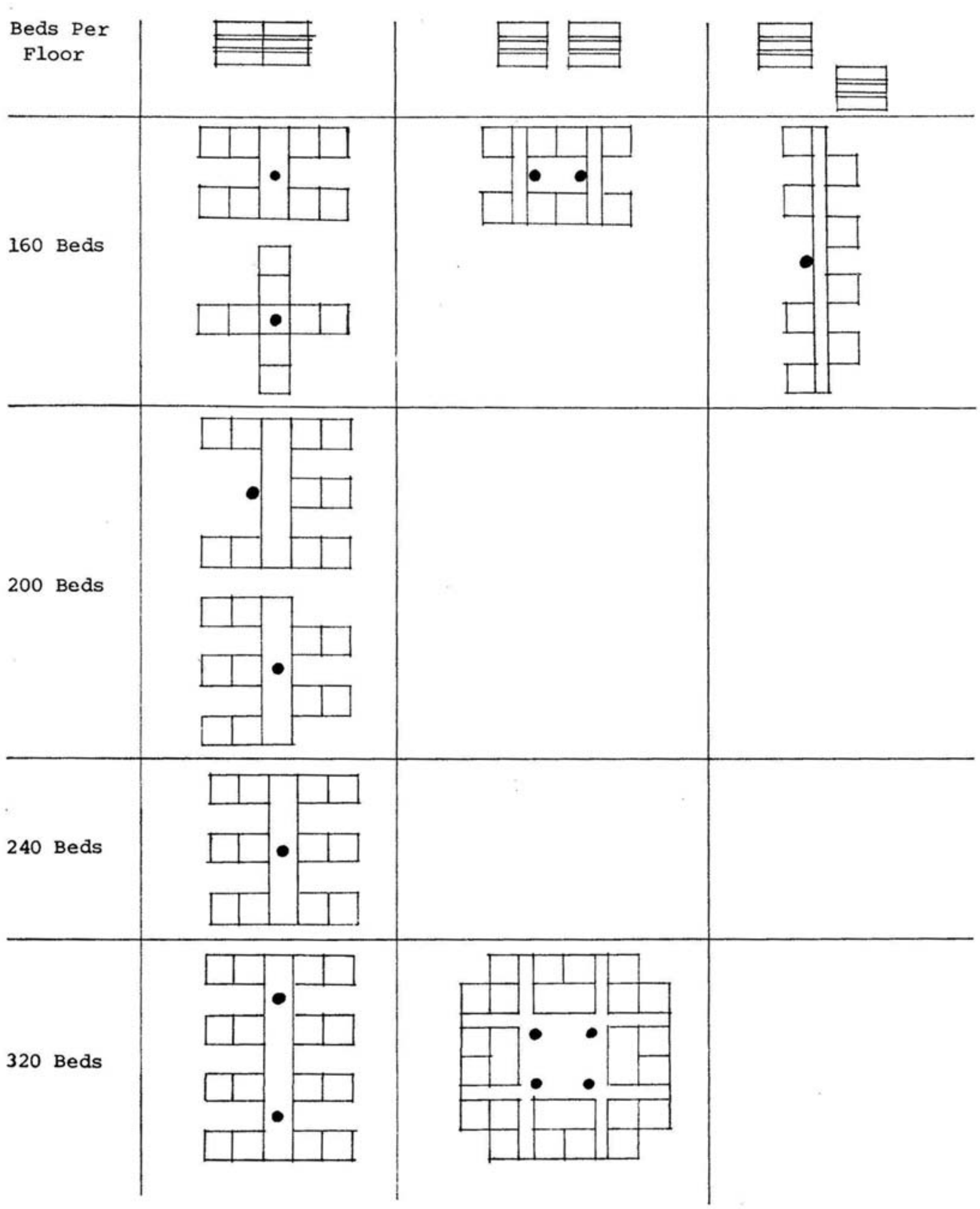
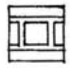
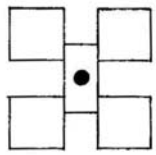
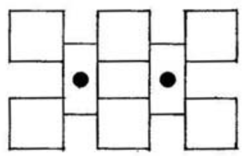
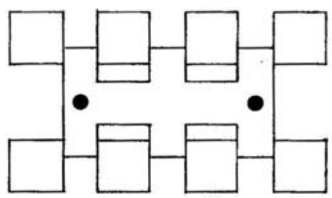


Figure 730-3. MODULE TYPE 11

Beds Per Floor	
160 Beds	
240 Beds	
320 Beds	

734.3 CHOICE OF CONFIGURATION

734.3.1 At this stage, the constraints of the site, access, topography, soil, existing facilities, together with the current medical philosophy expressed through the program in terms of functional relationships must be evaluated. All will have a fundamental influence on the choice of configuration.

Overall gross area, service module, functional areas, and gross departmental areas are all manipulated to arrive at appropriate configuration options. It is also possible, at this time, to undertake a comparative cost analysis of the favored options to confirm the choice of configuration.

734.3.2 The particular configuration chosen for the Building Schematic Design can be justified in those terms particularly with regard to the height of the hospital and the horizontal relationships between bed care and support. In addition, the Building Schematic Design presents an opportunity to illustrate, in greater detail, many system concepts which are discussed in general form in the report. The particular configuration serves to demonstrate:

1. A compound assembly.

2. External service bays and internal service bays.

3. Internal courtyards.

734.3.3 Thus, the building schematic design is based on module type 6 and demonstrates a low block configuration of 320 beds per floor with some of the beds overlooking internal courtyards (Figure 730-2, bottom line, center column).

734.3.4 This is essentially a closed configuration as it is unlikely that the number of beds will increase. Rather, as noted previously, they may in fact be reduced. However, central support functions may increase: either, by extending beyond the building perimeter on the lower floor or by extending into the courtyards on the lower floor or by expanding into nursing units that may become redundant.

735 DESIGN DESCRIPTION

735.1 DETAILED CONFIGURATION DEVELOPMENT

735.1.1 Additional Space

Given Module 6, zone 2, a 320-bed nursing floor and a height limit of four floors, the space program is now studied and gross space allocations made in conjunction with total nursing floor plan studies, in order to determine the extent of additional area necessary to achieve a balanced set of functions for each floor. Balanced, that is, in terms of achieving an equal area on every floor, optimum relationships with given constraints and a suitable organization of the major circulation and transportation elements. Obviously, some variation exists between this space allocation and the original program summary. One structural bay of additional space per 40 bed nursing unit is required to achieve the appropriate functional balance. The bays used are identical to those which comprise Module 6: 76’6” x 22’6”.

Gross configuration and gross space allocation are now established to the degree shown on the following diagram. Overall building dimensions are known with the exception of the vertical transport towers and the service bays (Figure 730-4).

735.1.2 Service Modules

Each floor is divided into the appropriate number of service modules to correspond as closely as possible with the other divisions of the floor:

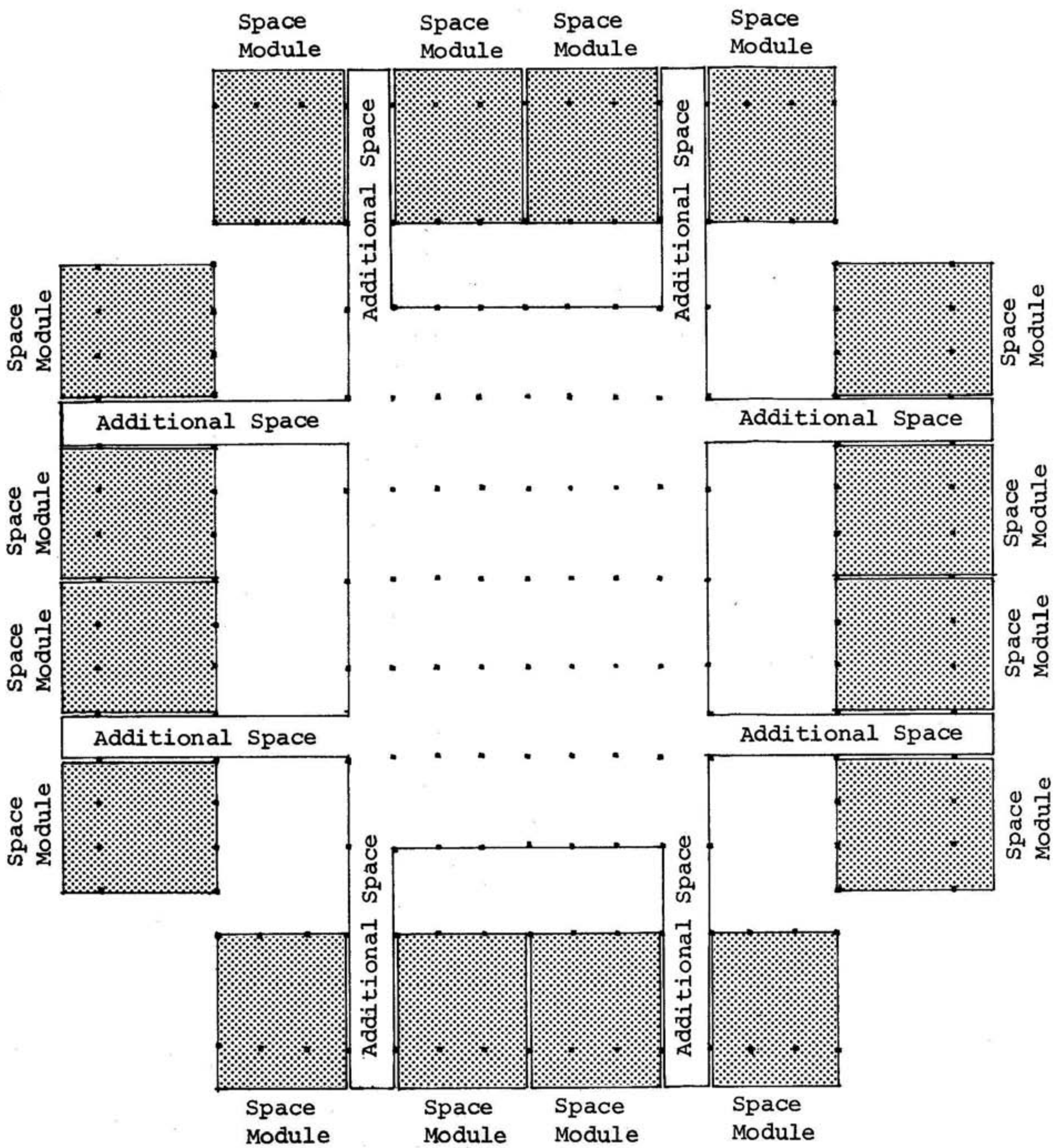
1. Functional Units

   In the nursing unit area, one service module embraces two space modules plus one or two structural bays of additional space. The service bays are external and contain the air-handling units on the same floor as the service module.

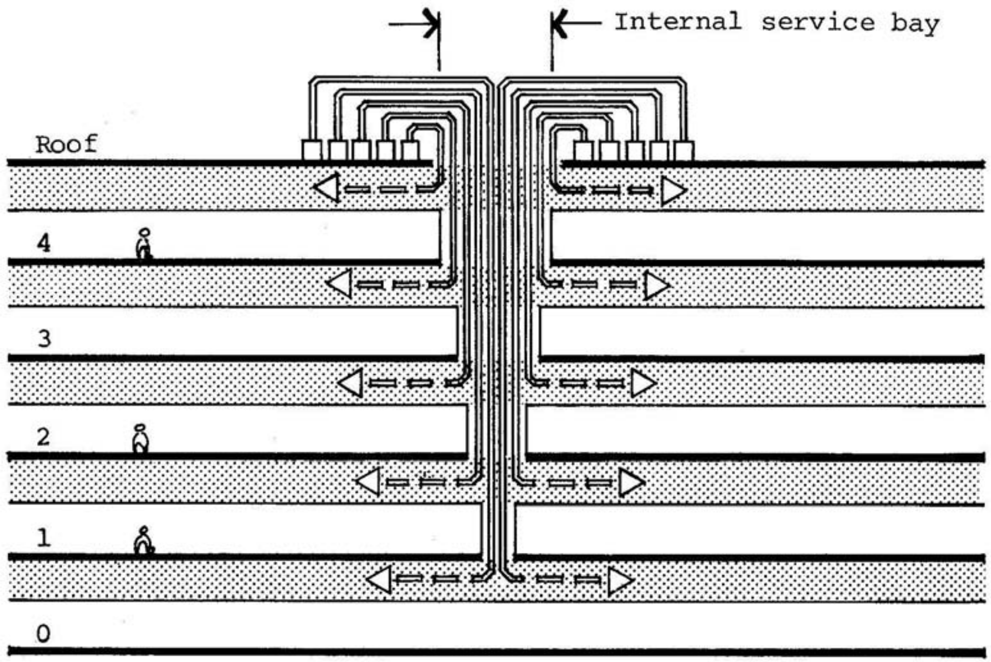
   In the central support area, the service bays are internal and create a service strip.

   The service modules are organized on such a way as to minimize the obstruction of the internal service bays on functional planning. Air handling units are located on the roof of the central area for easy access and vertical ducts distribute the air to their respective service modules.

Figure 730-4. GROSS SPACE ALLOCATION



The cross section of the vertical shaft is reduced on the lower floors as the ducts peel off into the service zone of the service strip to serve their respective modules.



2. Fire Sections

   The service modules are organized into fire sections in such a way that the permanent two-hour fire partitions cause as little obstruction as possible to the organization of the functional units.

3. Structural Units

   As the building dimensions exceed 300 feet, expansion joints are required. As structural continuity is interrupted by the internal courtyards, separation joints are required. In the structural layout, these joints are coincident. Where these joints are associated with shear walls, they occur at the boundaries of the service modules.

735.1.3 Transport Systems

From the number of floors and the respective floor occupancy ratings it is determined that six public elevators, 12 service elevators, and a trash-linen pneumatic system will provide an efficient transport and service distribution system. The separation of the public and service elevators provides a useful degree of traffic organization. The disposition of the service elevators to serve each floor quadrant provides a desirable symmetry in conjunction with the service bays in terms of structural shear considerations. These occur on the boundaries of the service modules.

Figure 730-5 shows a typical floor with service modules, expansion and separation joints, shear walls and the elevator towers.

735.1.4 Detailed Design

The next set of tasks are those which are required before the design of work below grade can begin. These include the identification and location of functional areas with special requirements such as extra heavy loads, floor slabs depressions, etc., and the detailed design of the service bays. As the design of the service bays varies with the size of service module, with the building configuration and with the space required for service equipment, it is designed uniquely for each specific building project. Section 740 presents an example of the detailed design of a service module and service bay.

735.2 RELATIONSHIPS

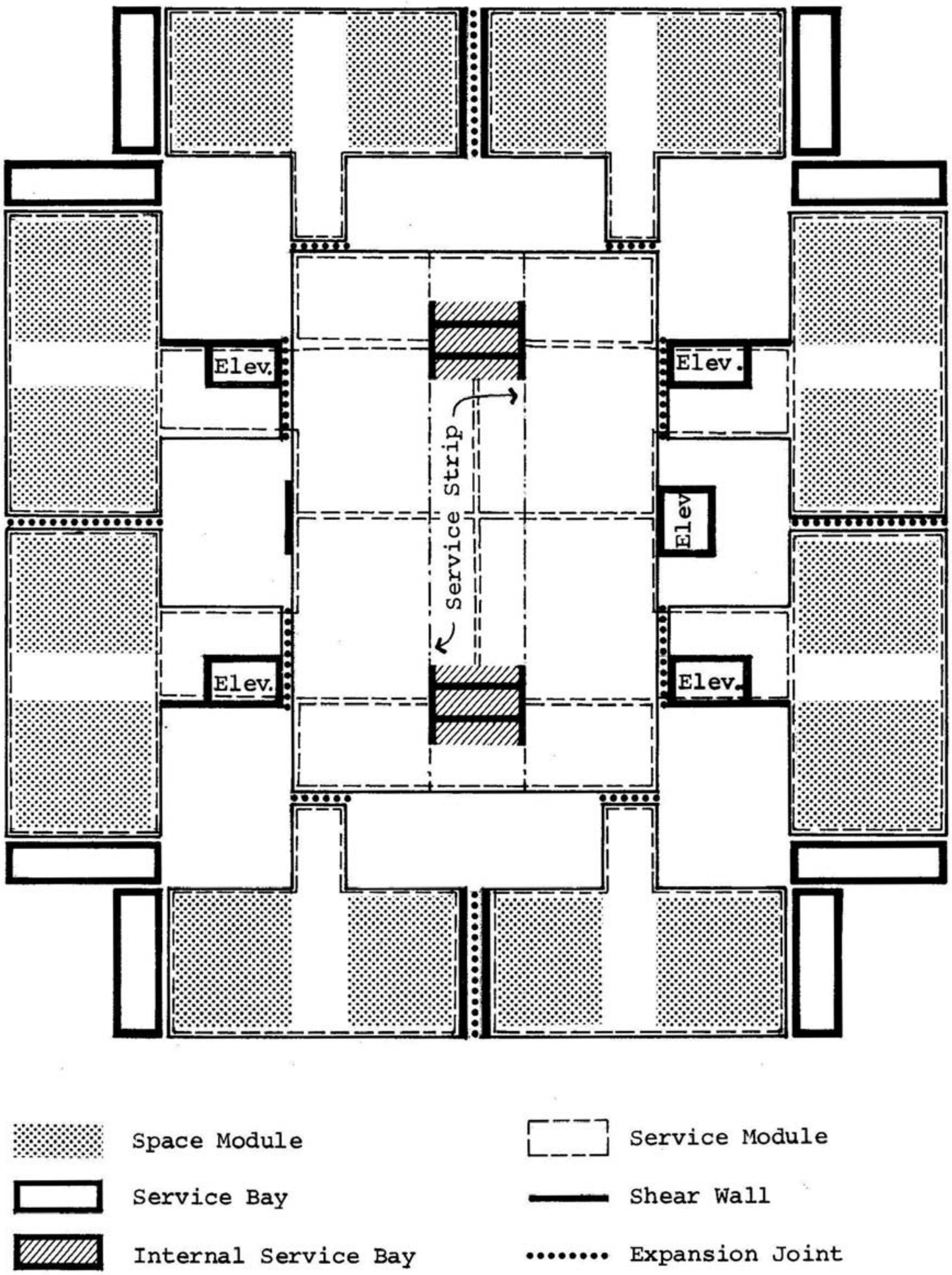
735.2.1 Level 01

This area forms the industrial zone of the hospital. Delivery of supplies and food, storage and processing, mechanical plant and maintenance shops are contained on this level. These functions are connected by a loop “street” which provides access to vertical circulation elements. Lockers and lounges for certain employees are also located on this level.

735.2.2 Level 1

This is the basic access level for patients, visitors and staff. In addition to outpatient clinics and administration, it contains certain long term care nursing units which are provided with direct access to the out of doors.

Figure 730-5. BUILDING CONFIGURATION



Horizontal connections to the adjacent psychiatric facility are provided on both this and the service level. Earlier program analysis determined that a separate, connected facility house psychiatric inpatient and outpatient services. That facility is established as a one-story building, and is hence a non-systems building, since the building system is applicable only to multi-story facilities.

735.2.3 Level 2

Level 2 is the intensive nursing level. It includes surgery, radiology and other diagnostic and treatment functions as well as nursing units for severely ill patients.

735.2.4 Level 3 and 4

These levels are reserved for less intensively ill patients as well as general supportive functions for the hospital.

735.2.5 Courtyards

Courtyards have been provided adjacent to the ring “street” on all but the service level. These will assist in defining the principal circulation routes of the hospital as well as providing a desirable and economical amenity for the hospital.

Figure 730-6

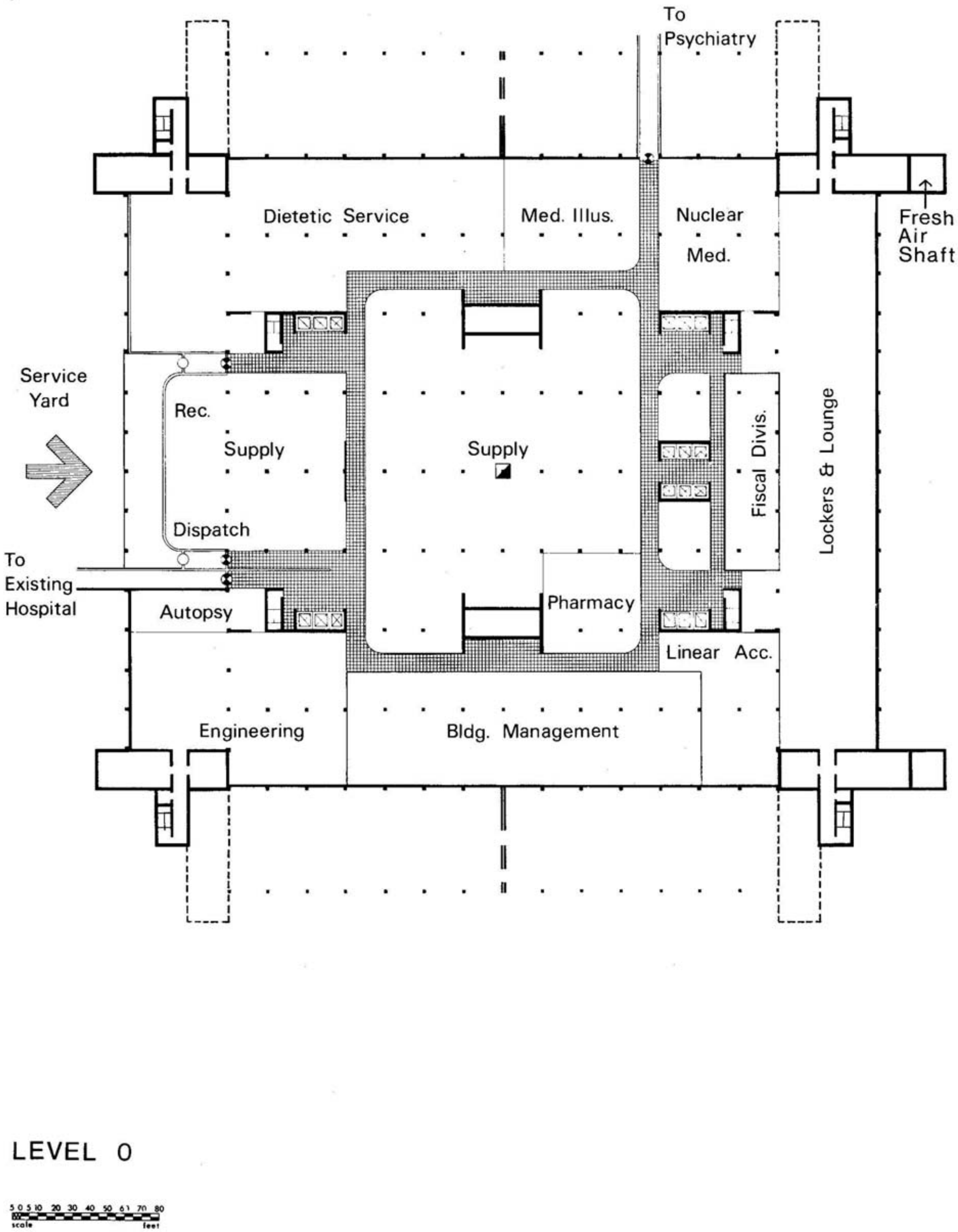

To
Psychiatry
Dietetic Service
Med. Illus.
Nuclear
Med.
Fresh
Air
Shaft
Service
Yard
Rec.
Supply
Dispatch
Supply
Fiscal Divis.
Lockers & Lounge
To
Existing
Hospital
Autopsy
Pharmacy
Linear Acc.
Engineering
Bldg. Management
LEVEL 0
scale
feet

Figure 730-7

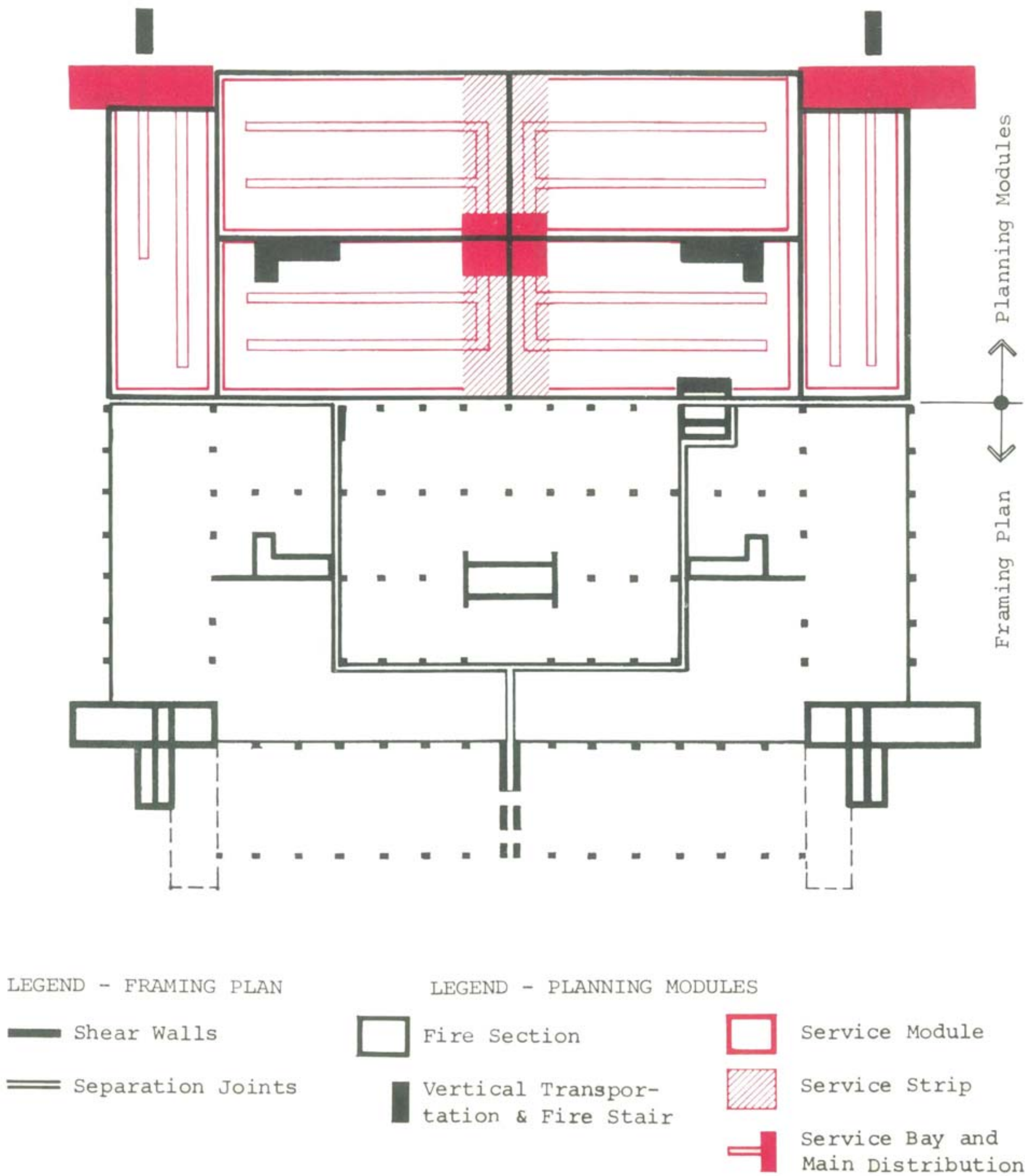

Planning Modules
Framing Plan
LEGEND - FRAMING PLAN
Shear Walls
Separation Joints
LEGEND - PLANNING MODULES
Fire Section
Vertical Transportation & Fire Stair
Service Module
Service Strip
Service Bay and Main Distribution

Figure 730-8

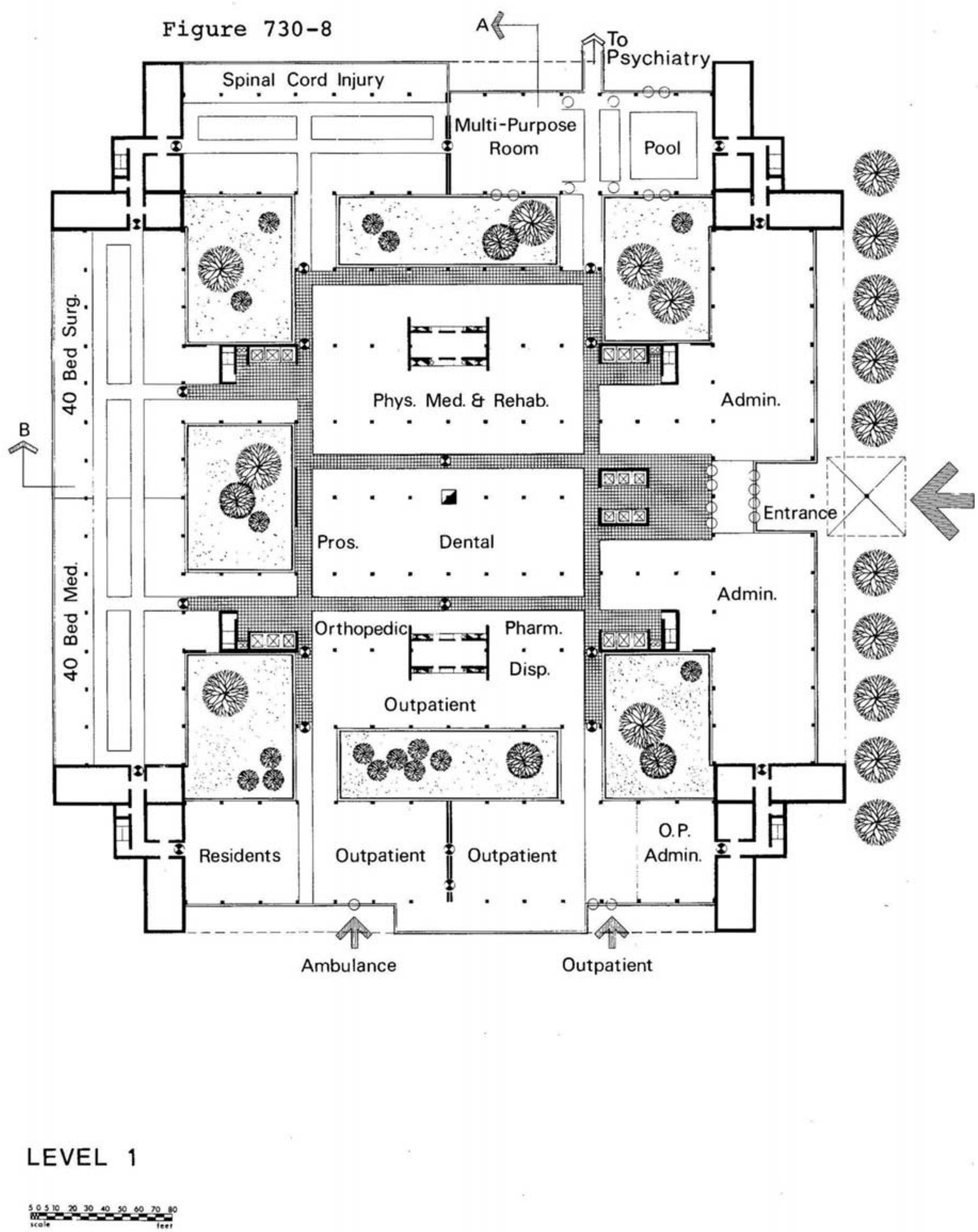


Figure 730-8
A
To Psychiatry
Spinal Cord Injury
Multi-Purpose Room
Pool
40 Bed Surg.
Phys. Med. & Rehab.
Admin.
B
Entrance
Pros.
Dental
40 Bed Med.
Admin.
Orthopedic
Pharm.
Disp.
Outpatient
Residents
Outpatient
Outpatient
O.P. Admin.
Ambulance
Outpatient
LEVEL 1
scale
feet

Figure 730-9

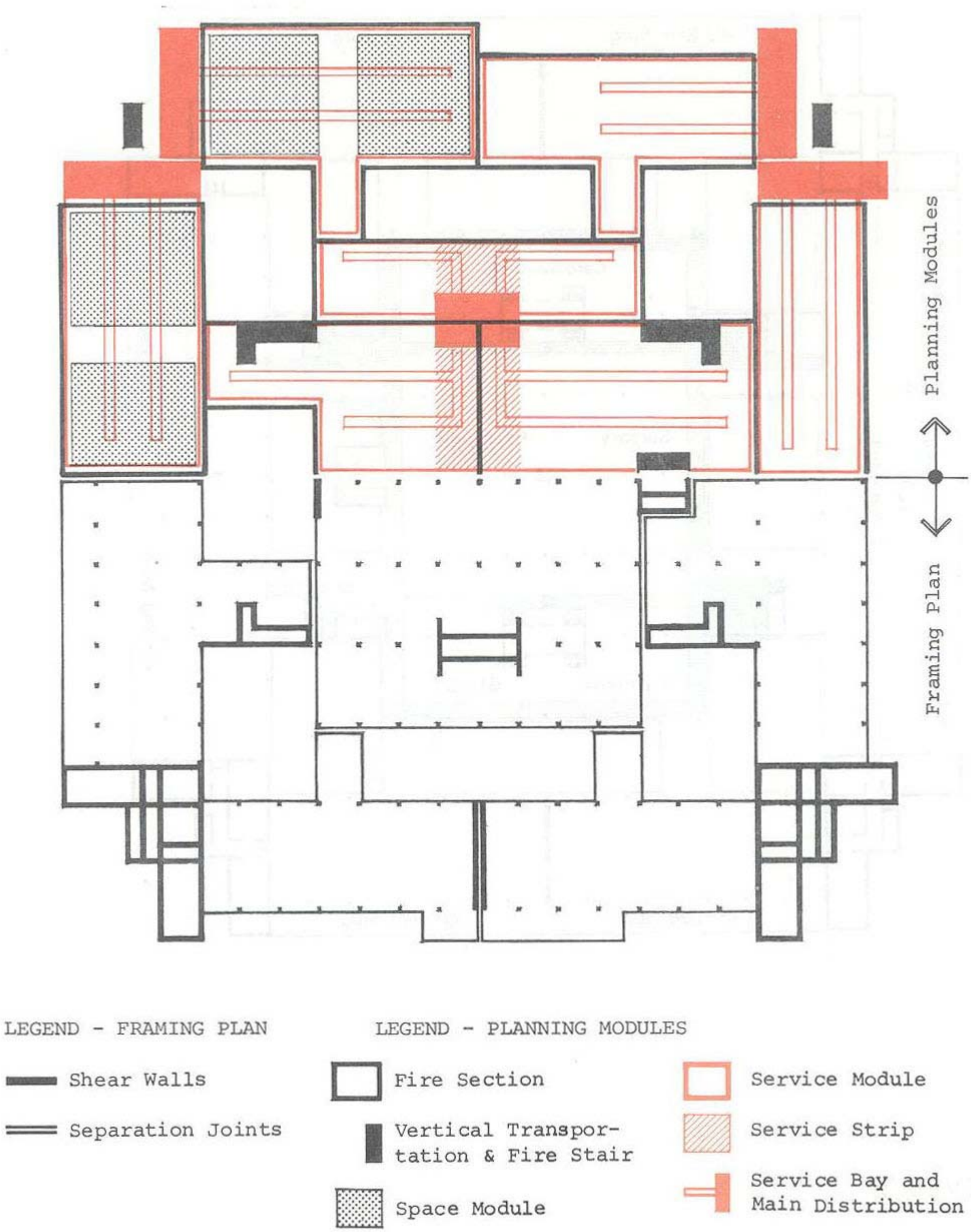

Planning Modules
Framing Plan
LEGEND - FRAMING PLAN
Shear Walls
Separation Joints
LEGEND - PLANNING MODULES
Fire Section
Vertical Transpor-tation & Fire Stair
Space Module
Service Module
Service Strip
Service Bay and Main Distribution

Figure 730-10

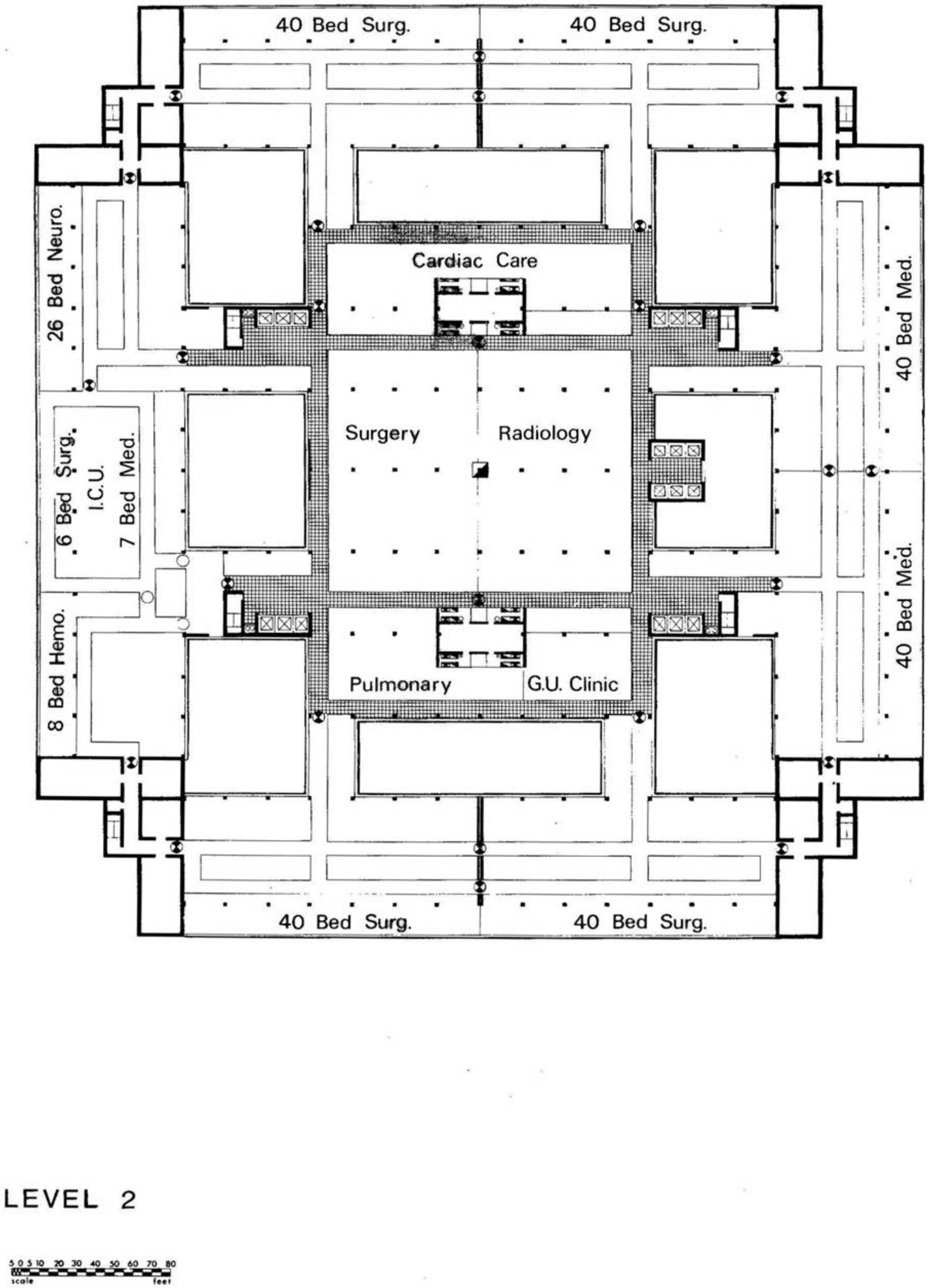


Figure 730-11

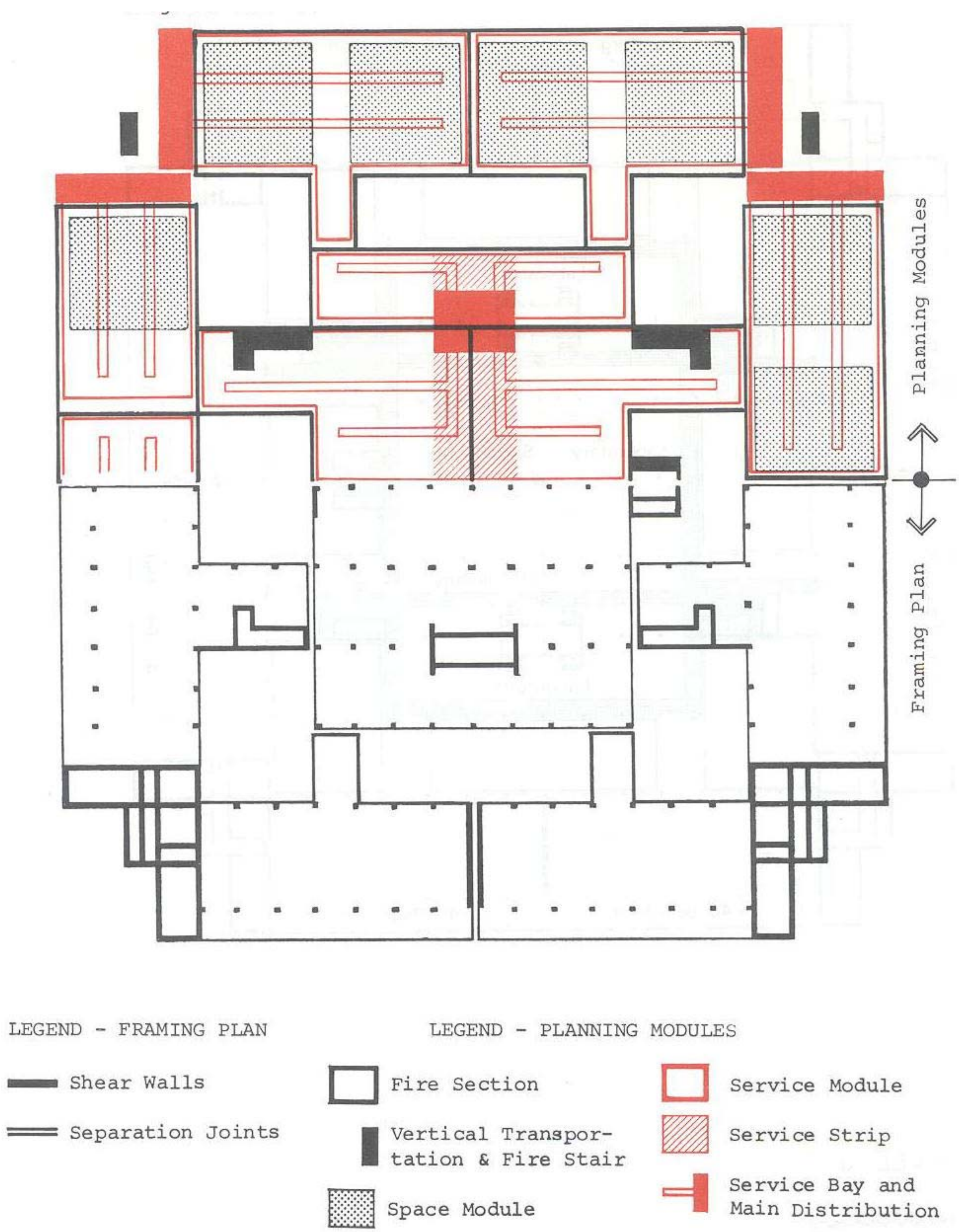
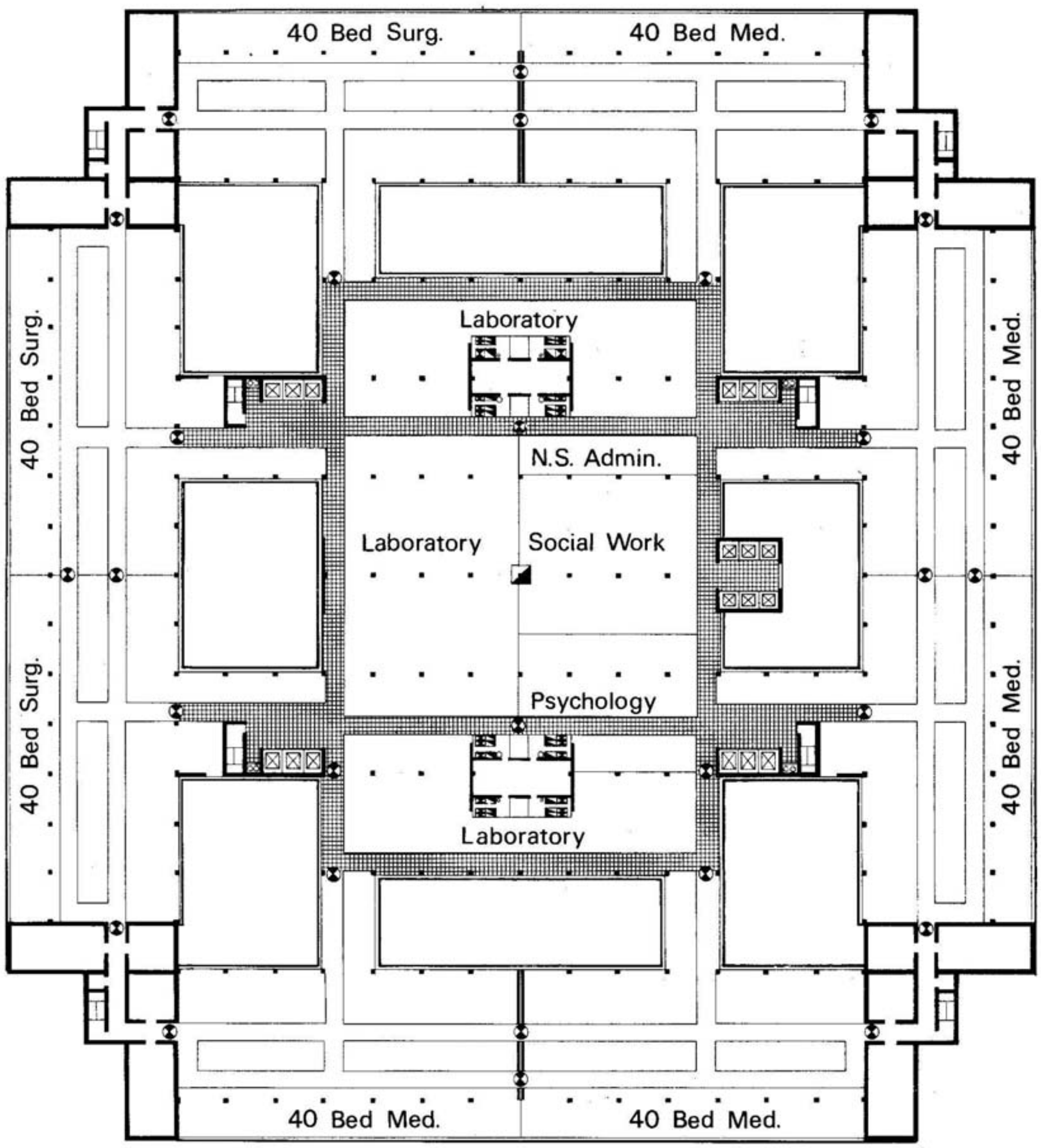


Figure 730-12

Figure 730-12



LEVEL 3

5 0 5 10 20 30 40 50 60 70 80
scale feet

Figure 730-13

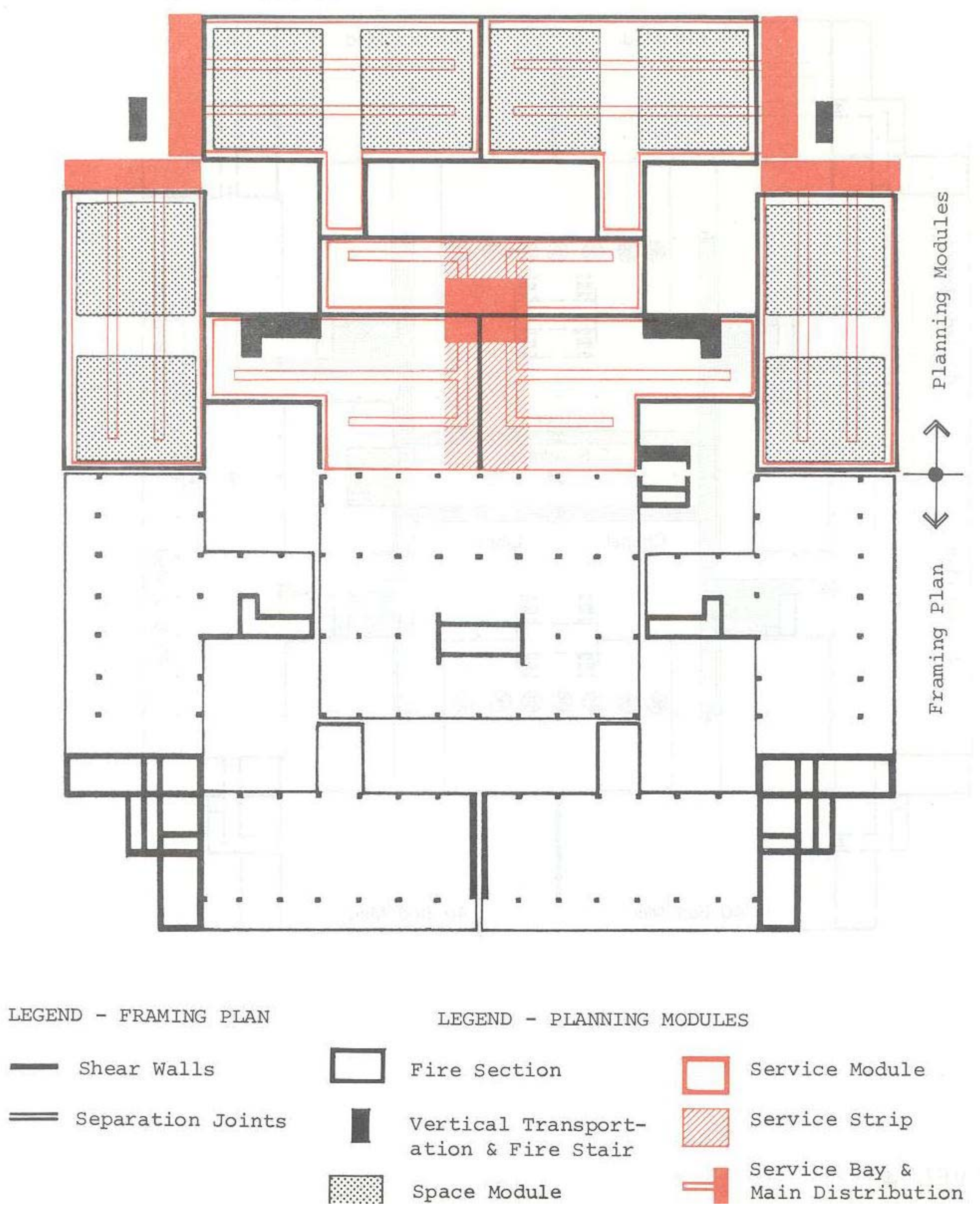
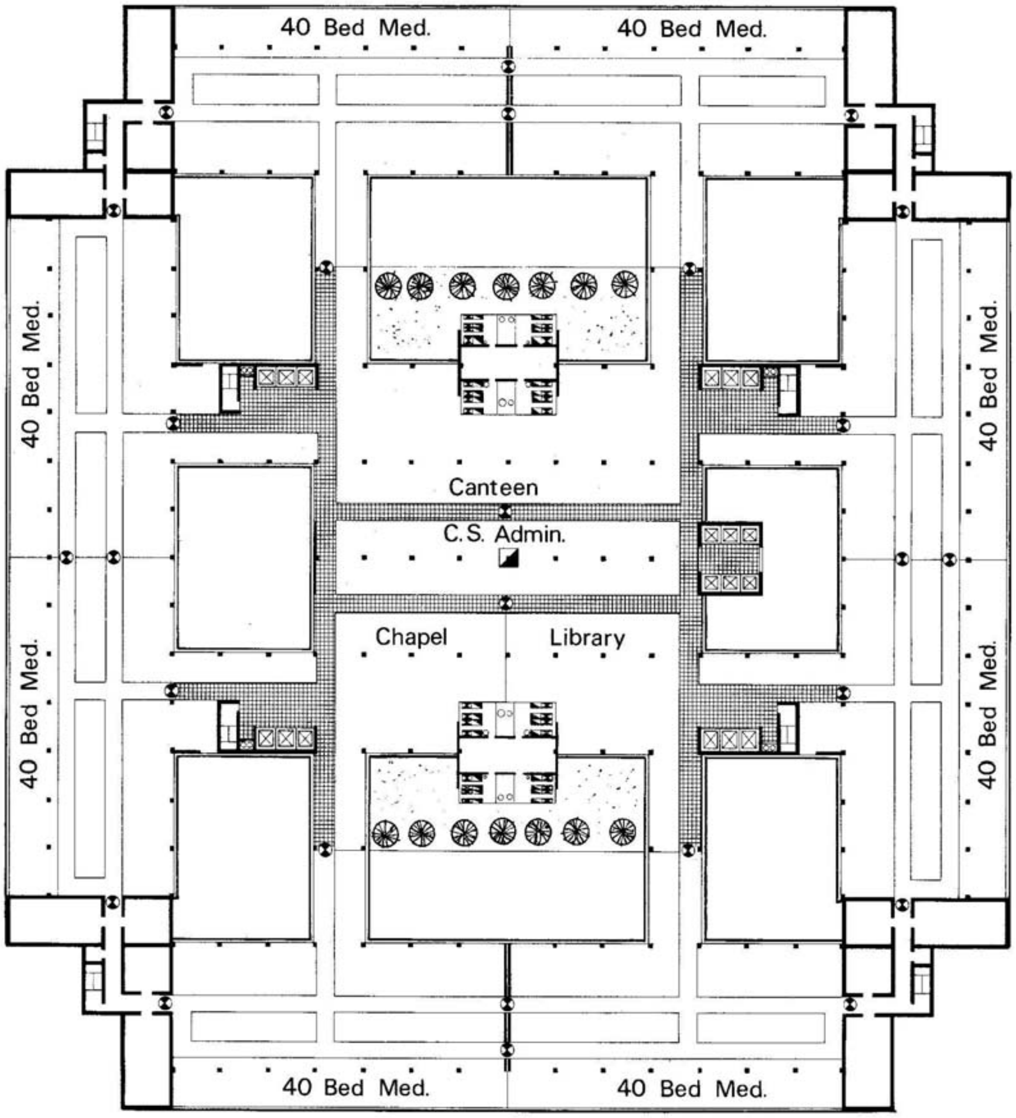


Figure 730-14



LEVEL 4

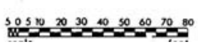


Figure 730-15

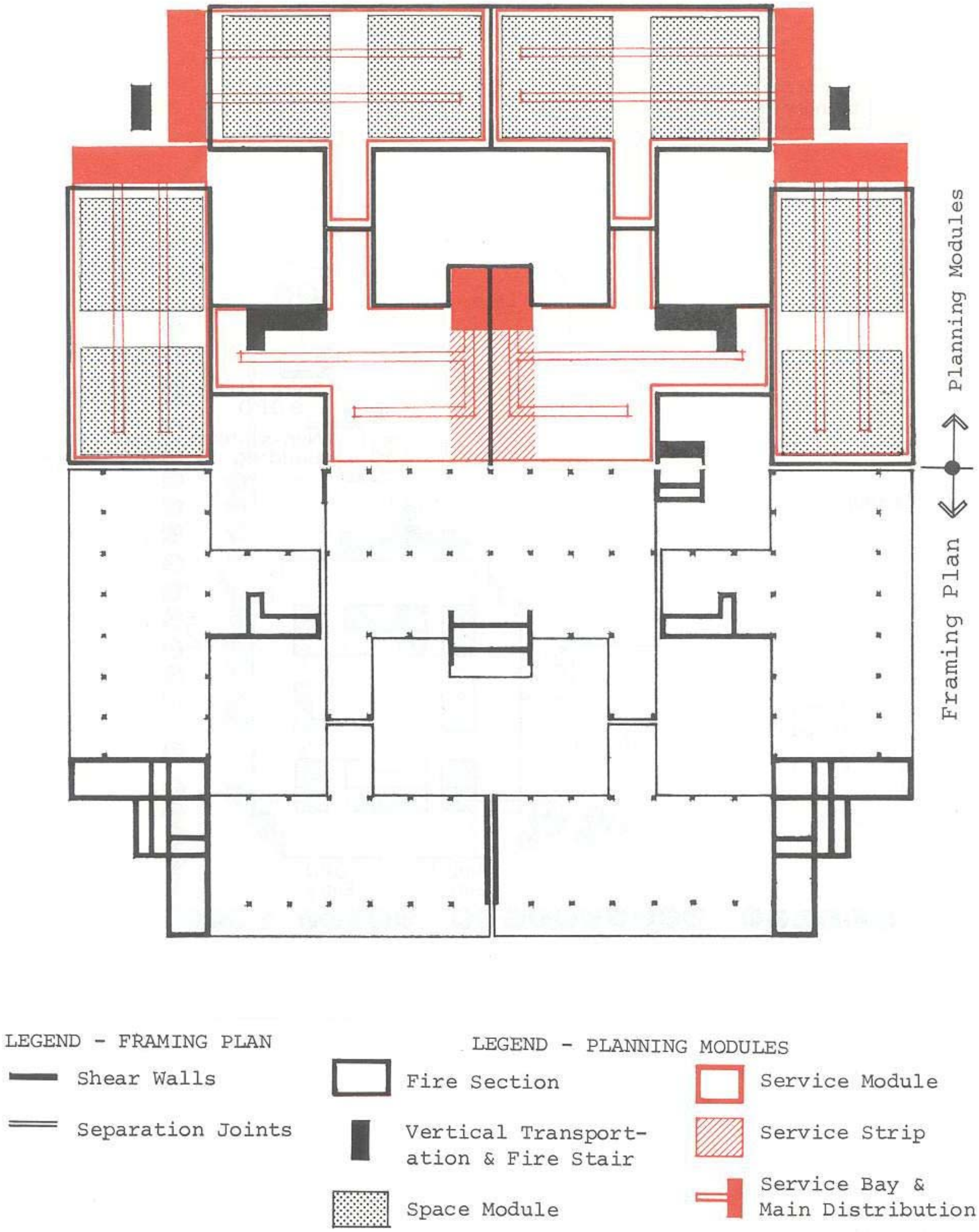
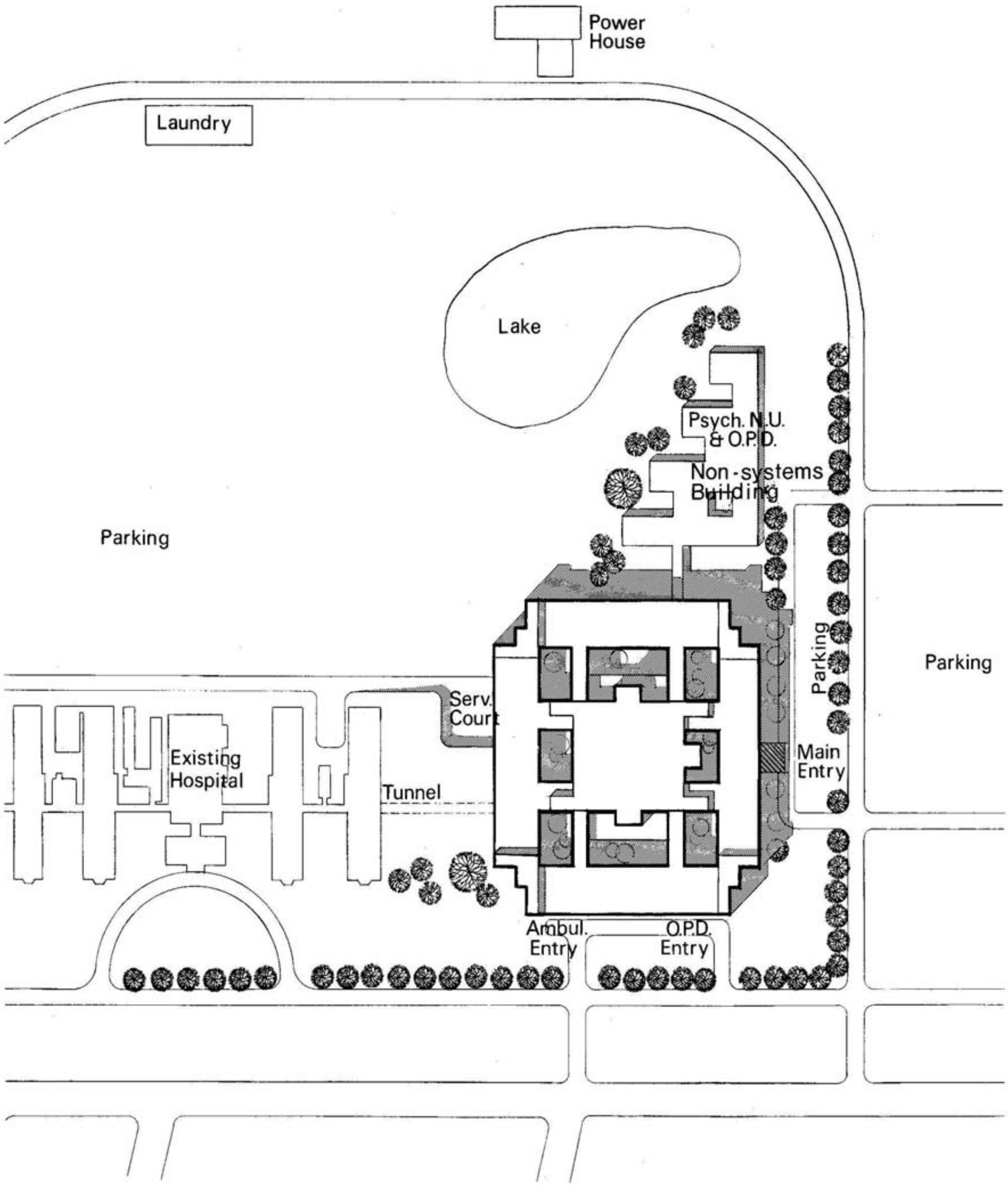
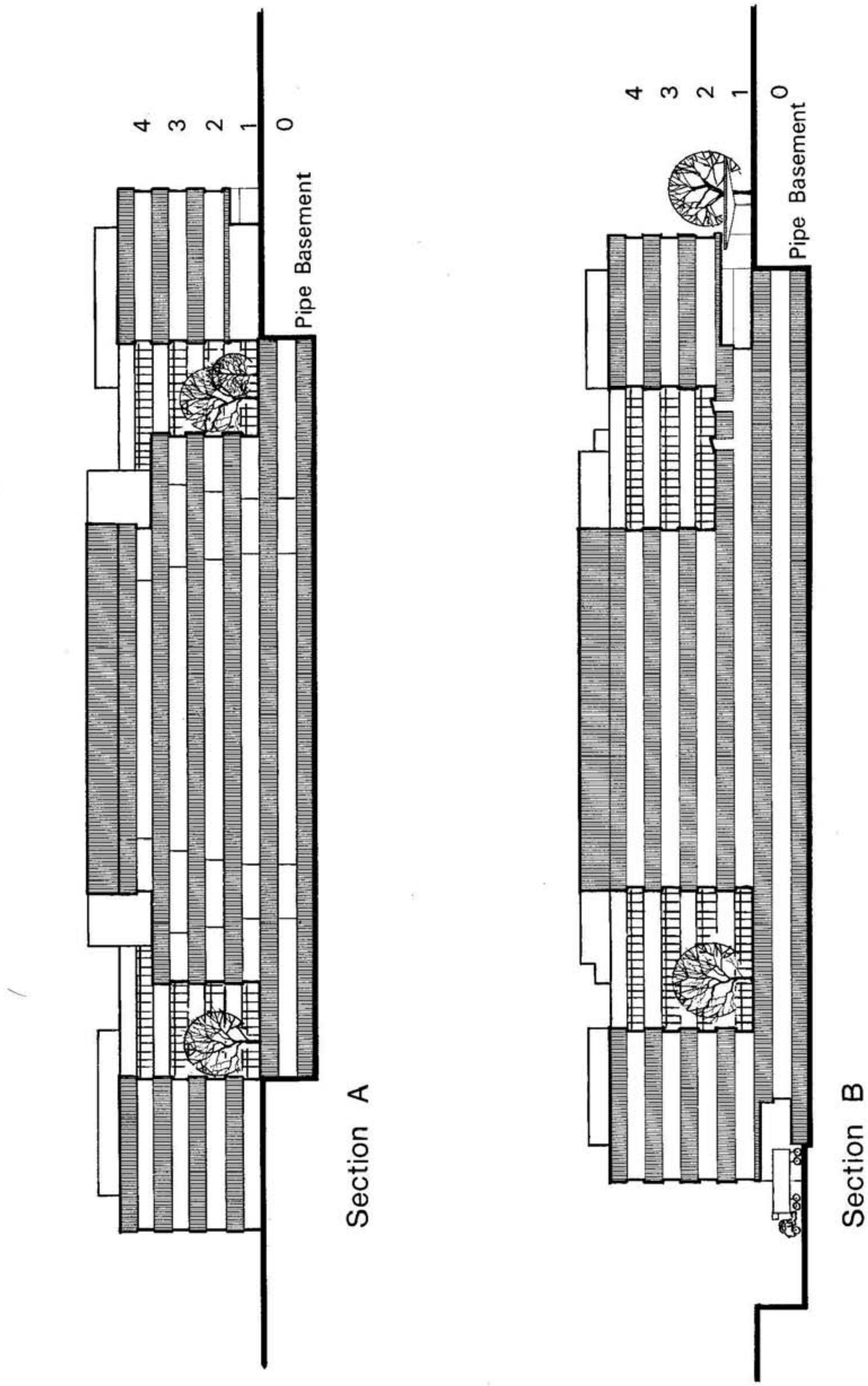


Figure 730-16



SITE PLAN

Figure 730-17



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740 Example Service Module

741 GENERAL CHARACTERISTICS

The following example of service module design is presented to illustrate an application of the principles recommended in the Prototype Design. It demonstrates a hypothetical layout of a functional zone, a subsequent plan change and the related organization of the services subsystems. The factors that need to be considered to arrive at the service distribution patterns are examined in the text and diagrams.

741.1 CONFIGURATION

A hypothetical service module five 22’6” bays in length by two 40’6” spans in width plus a service bay has been taken as the basis for the example. The gross floor area of the functional zone is 9,200 square feet, and it is assumed to have no exterior walls. The service bay has one wall at the edge of the building. The module is at a support function level on a lower floor of a nine-story building. It combines with a similar module, adjacent to its long dimension, to form a fire section of 18,400 square feet bounded by two-hour fire partitions. Between these two modules is a smokestop partition from floor slab to floor slab through the functional and service zones.

In practice, this service module would have been the result of studies of space modules for the nursing units, studies of typical functional layouts within the rest of the hospital program and the total hospital configuration that was selected for a particular project.

741.2 THE SHELL

Figure 740-1 illustrates the physical framework of the service module. It includes the structural members, the ceiling components and the mechanical rooms of the service bay, all of which are permanent components of the module. The configuration of these permanent components is a major constraint on the service distribution design.

The following selections were made for these components from the generic design options:

1. The structure is based on reinforced concrete construction, eighteen feet floor to floor with a ten-foot functional zone.

The beams are prestressed, cast-in-place at 5’7-1/2” centers and are continuous over the girders. The service bay is constructed of solid concrete shear walls as part of the building’s seismic bracing.

2. The ceiling subsystem is a poured gypsum deck supported on truss tees and I-beam strongbacks, the latter at 8’0” centers supported from the beams by hanger rods.

3. The partitions are gypsum board on metal studs and extend from the floor to the underside of ceiling. The radiology room partitions have lead backing and stronger metal studs to take the loading of the lead and wall-hung equipment.

4. The HVC mechanical room has set at least one wall which is exterior to allow a louvred opening for the fan unit as a direct air inlet, and also to permit external access when a fan unit needs replacement.

741.3 SERVICES

Figure 740-2 illustrates the layout of the equipment in the service bay and the main distribution of services in the service zone.

741.3.1 Service Bay

The service bay is laid out with the following assumptions:

1. The mechanical room could accommodate a 24,000 cfm supply fan unit and a 20,000 cfm exhaust/return fan, based on an assumed maximum service module requirement of 2.4 cfm/square foot. The items of equipment shown are an 11,000 to 18,000 cfm supply fan unit and an exhaust fan rated at 8,000 to 13,000 cfm, based on the functions in this module requiring approximately 1.5 cfm/square foot. The excess exhaust will be extracted by the toilet or special exhaust systems with their fans located at the roof level.

2. The general exhaust shaft has an area of 130 square feet and can handle about 100,000 cfm for the nine stacked service modules. The toilet exhaust shaft at twelve square feet will handle about 10,000 cfm. The special exhaust shaft could accommodate the equivalent of two ducted exhausts of 36” diameter for laboratory fume hoods, etc.

This would give a reasonable latitude to the planning of functions requiring special exhaust in service modules attached to this common stack of service bays.

3. The plumbing risers are grouped at one end of the mechanical room, with those services not required for this module valved and capped off for future availability. Drainage pipes drop vertically through the stack of service bays at their point of entry to the bay on either side of the module.

4. The electrical room houses all the equipment for normal, emergency and critical circuits. It is assumed in this module that critical distribution is only required for the HVC equipment. The transformers to provide the 277/120 volt service would be of the order of 75 KVA, and having the capacity to serve more than one service module, would not appear in every electrical room as shown here.

741.3.2 Main Distribution

The main distribution in the service zone at the S3 subzone level has been laid out to allow the most direct connections to equipment and risers in the service bay. The layout was also influenced by the constraints on penetrations through the shear wall between the service bay and service zone. The maintenance access is at either side of the module where branch distribution runs would be least dense.

The HVC subsystem is assumed to be a single-duct terminal-reheat system with a supply duct on each side of the central girder. The branch connections to each supply duct would be as far as possible from the same side of the duct to simplify the run of HVC plumbing to the terminal-reheat units. The exhaust system is shown as ducted to illustrate how it can be handled even though a plenum return could have been used. The only special exhaust required for this module is the toilet exhaust.

741.3.3 Branch Distribution

Figure 740-3 shows the proposed locations of the branch distribution of the services in each hanger space at the S2 and S4 subzone levels. In practice, this organization would need detailed consideration to optimize the locations and space assigned to each service to accommodate all routing conditions.

For instance, the HVC branches are placed only one branch per hanger space in this example. It could happen that the density of supply and exhaust branches in some hospital areas would require more. This can be done, and schemes with other beam and hanger spacings would need their own assessment. But to prevent local overcrowding of services and preserve reasonable future access through the ceiling, this kind of general constraint, such as limiting the number of duct branches, will be necessary. The S5 subzone is shown as approximately twelve inches deep to accommodate the lateral branches including the flexible duct connections to the HVC system. The latter are limited to a maximum of twelve feet in length and a maximum of ten inches in diameter.

Figure 740-1. THE SHELL: PLAN

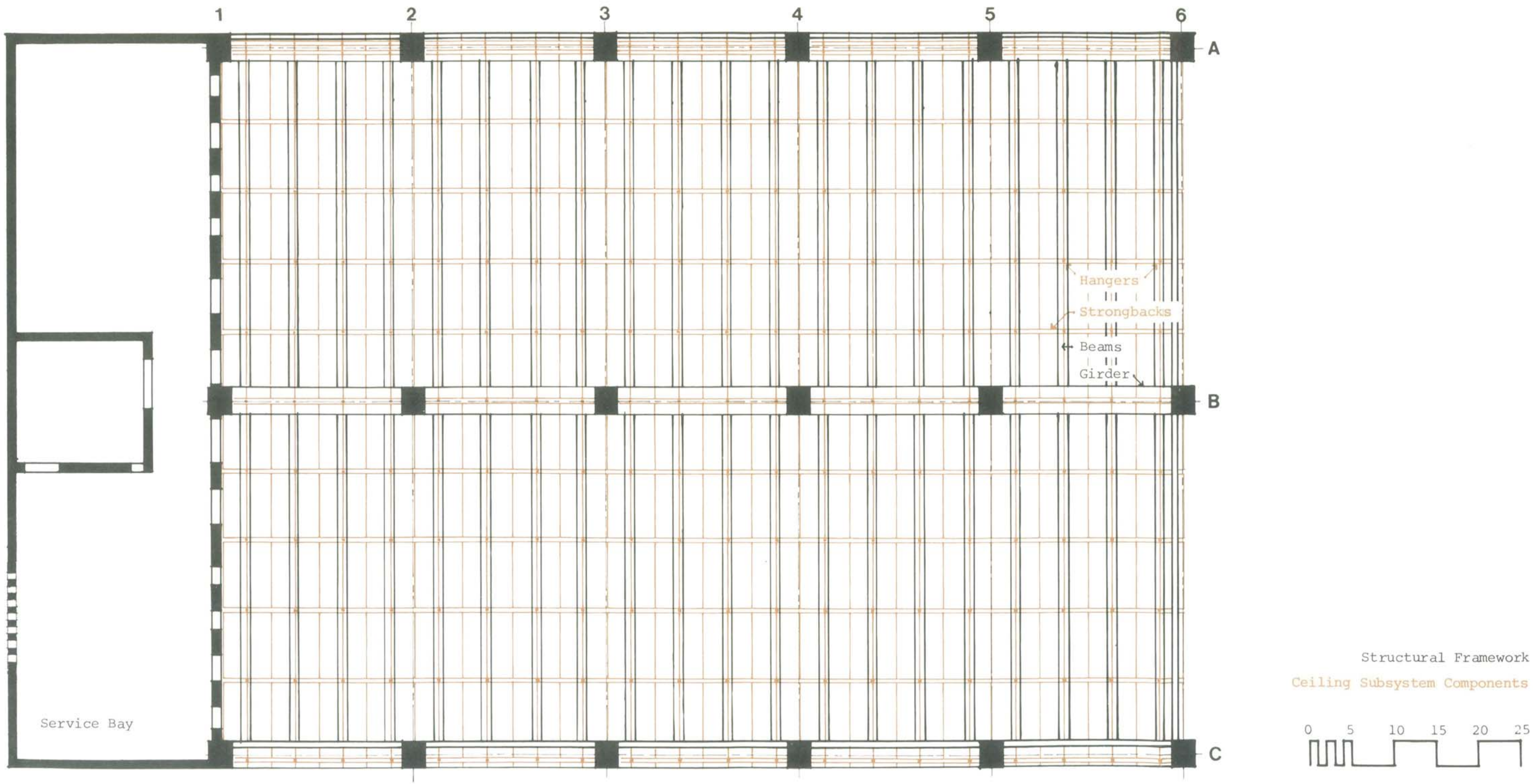
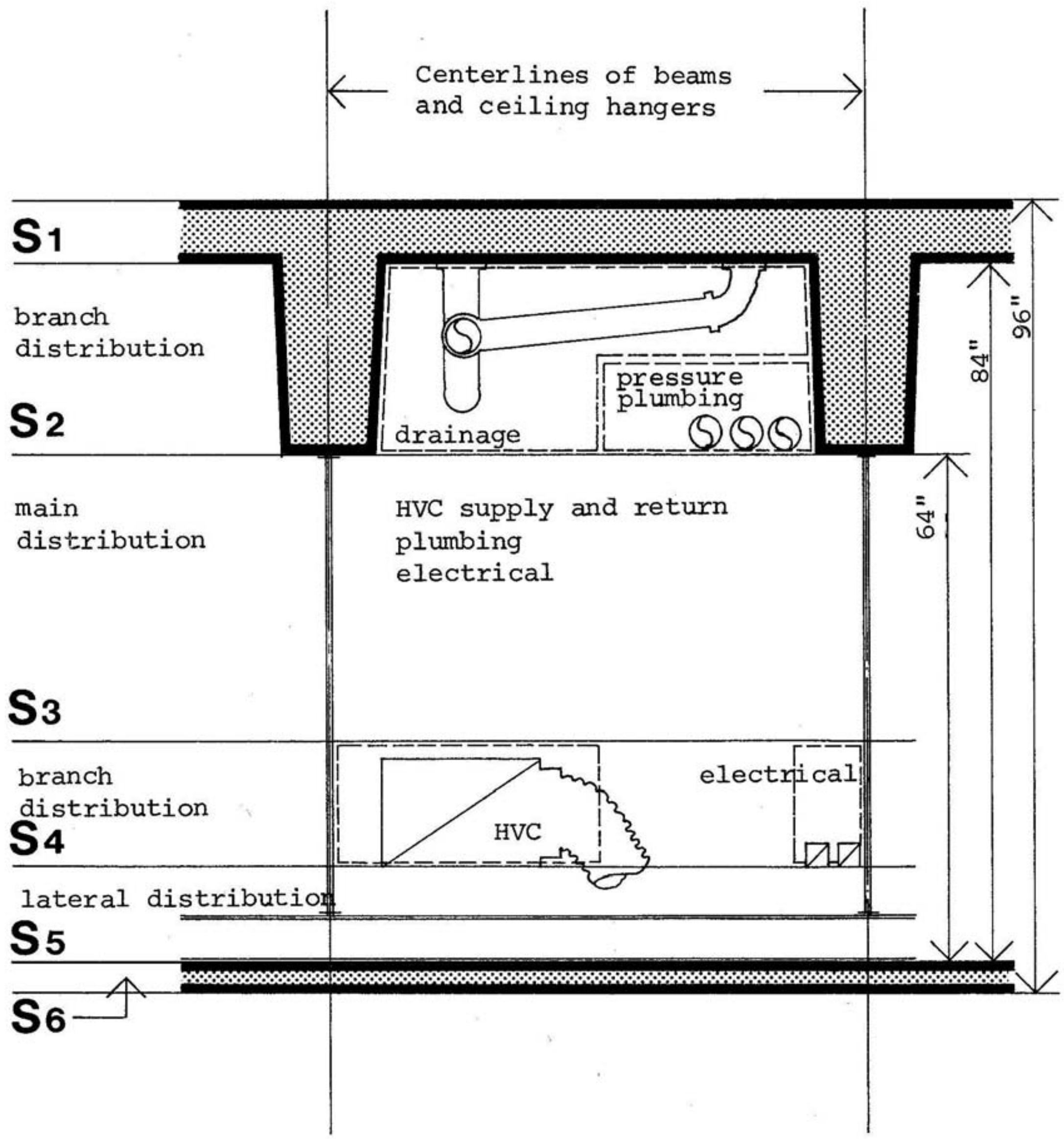


Figure 740-2. THE SERVICES: PLAN

Figure 740-3. SUBZONES: SECTION



742 OPENING CONFIGURATION

742.1 FUNCTIONAL ZONE

Figure 740-4 shows an assumed functional zone layout in the service module. It includes departmental offices, a small radiology suite, and the overflow from an outpatient department in the adjacent service module.

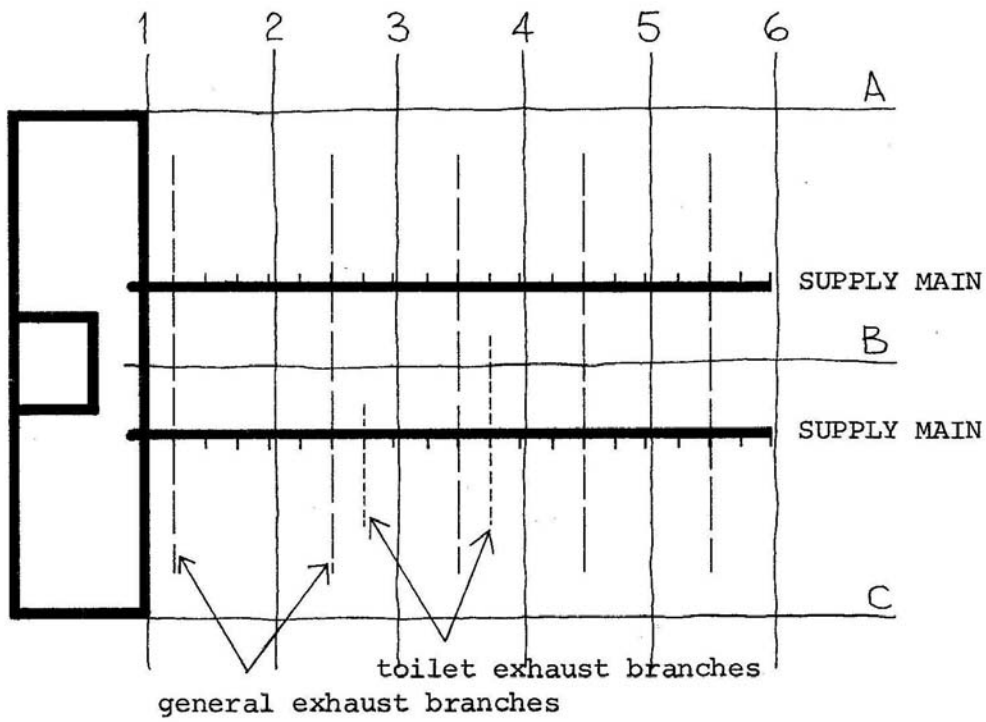
Service drops have been assumed in the rooms to give reference points for the layout of branch service distribution above the ceiling, and a representative ceiling-lighting pattern is shown in two of the bays to demonstrate conduit runs. No partition planning grid is necessary or assumed in this example, but the partition layout should be always planned with careful reference to the floor beam pattern where drainage is required, and to the ceiling construction where the service drops are expected. For example, service drops along the line of a trussed tee could be provided if required, but the predictability of these supports makes them easily avoided if they are considered during the layout planning.

742.2 HVC DISTRIBUTION

Figure 740-5 shows the layout of the main and branch distribution and flexible duct laterals of the HVC subsystem. The illustration is diagrammatic, but gives a complete picture of the required layout with the exception of the duct, diffuser and outlet sizes which would be added to a production drawing. This concise diagrammatic view would be possible for all service module layouts in a system hospital because of the predetermination of service layout shown on the preceding drawings. The branch distribution layout was produced in the following steps:

1. First, the number of required supply zones was established for the functional zone layout. In this case, 24 were identified, including corridors, some grouping of offices and generally separate zoning of radiology suite rooms.

2. Next, the general exhaust duct branches were placed at one per 22’6” bay. Two special exhaust branches were required for the toilet areas. The following sketch resulted:



HVC Zone Analysis

3. The number of possible branch supply duct locations in this service bay is forty, based on two main supply ducts, five bays long, each with four hanger spacings per bay (assuming one HVC branch per spacing); that is, 2 x 5 x 4 = 40.

4. Each general exhaust branch would occupy two of these possible locations per bay, and the two special exhaust branches one each, as shown on the sketch; that is, (5 x 2) + 2 = 12.

5. The resulting 28 remaining locations were then organized to provide the 24 supply zones, with the use of flexible duct connections in the S5 subzone as required.

It is recognized that there may be areas of a hospital where several small adjacent rooms requiring separate zoning would require a modification of this pattern. In such cases, supply branch ducts could be taken from both sides of the mains, or more than one branch per hanger space could be allowed.

Nevertheless, acceptance of the simple rule demonstrated here will greatly ease location and installation in the majority of cases. Special cases can be pointed out in the contract documents and provision made accordingly.

742.3 PLUMBING DISTRIBUTION

Figure 740-6 shows the layout of the main and branch distribution of the plumbing subsystem. The plumbing for this functional zone is relatively simple but shows the general principles. The drainage is collected at separate mains on each side of the central girder. (The drainage mains actually serve the floor above, which for this example is assumed to have drains in the identical location as the radiology suite.)

All the branches are in the S2 subzone between the beams. As discussed in the following section, electrical work is heavy in the radiology suite areas and some large branches are required for this service. In this example, it was found quite possible to use hanger spaces other than those occupied by the large electrical runs, thus avoiding a conflict between plumbing drops and the large wireways below. This is a consideration which is likely to occur between the two services in most areas of the hospital.

As discussed under HVC distribution, the layout is shown diagrammatically. Plumbing layouts are not shown to this degree of specificity traditionally, but to achieve the coordination required by the Prototype Design, such layouts are essential. The simplicity of general predetermined routing makes the diagrams feasible and effective working documents.

742.4 ELECTRICAL DISTRIBUTION

Figure 740-7 shows the layout of the electrical mains and branch distribution. Communications, which has not been considered in this project as an integrated subsystem, has been shown to illustrate its layout in relationship to the electrical power and lighting runs.

Two electrical systems are carried in the main wireways in this service zone, normal and emergency. In general, each bay has one pair of 2-1/2" square wireways carrying normal distribution of 208/120 volts and 480/277 volts. Wireways carrying emergency distribution are provided in separate hanger spacings as required; in this example for corridor lighting, one radiology room and the radiology viewing room.

Each radiology room has a special wireway carrying power at 120/207 volts to a position over the circuit breaker and control room. The circuitry to transformers and equipment is assumed to be within the functional zone. The large group of control wiring is shown distributed from the control room over the ceiling-platform in S5 to the drop positions in the radiology room. The wiring could be housed in either conduit or wireways along this route. The voltage transformers are assumed within or adjacent to the radiology room.

The branch communication wireways have been shown in separate hanger spaces from the electrical. This arrangement is not mandatory but is desirable for clarity of layout where it can be achieved. In this example, the wireways would primarily carry telephone lines.

The conduit runs from the branch wireways for lighting and power drops to the functional zone have been included in the first two left-hand bays to indicate the kind of pattern that would develop in the S5 subzone.

In several instances, the subzone available in a hanger space for electrical branches is not used. This moderate use would be generally true in some areas of the hospital. But immediately adjacent to the radiology rooms the heavy demand on wireways for power and control circuits would require more room, in this case the equivalent of two 4” x 4” or 6” x 6” wireways. Such local conditions are easily handled. Here the plumbing branches are excluded from those hanger spaces where this condition occurs to allow more dimensional freedom.

Again, a much higher specificity of detail is shown in the diagrammatic representation than is normally found in traditional work, and is very necessary for the success of the highly integrated service layout in the building system.

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Figure 740-4. FUNCTIONAL ZONE: OUTPATIENT AND RADIOLOGY

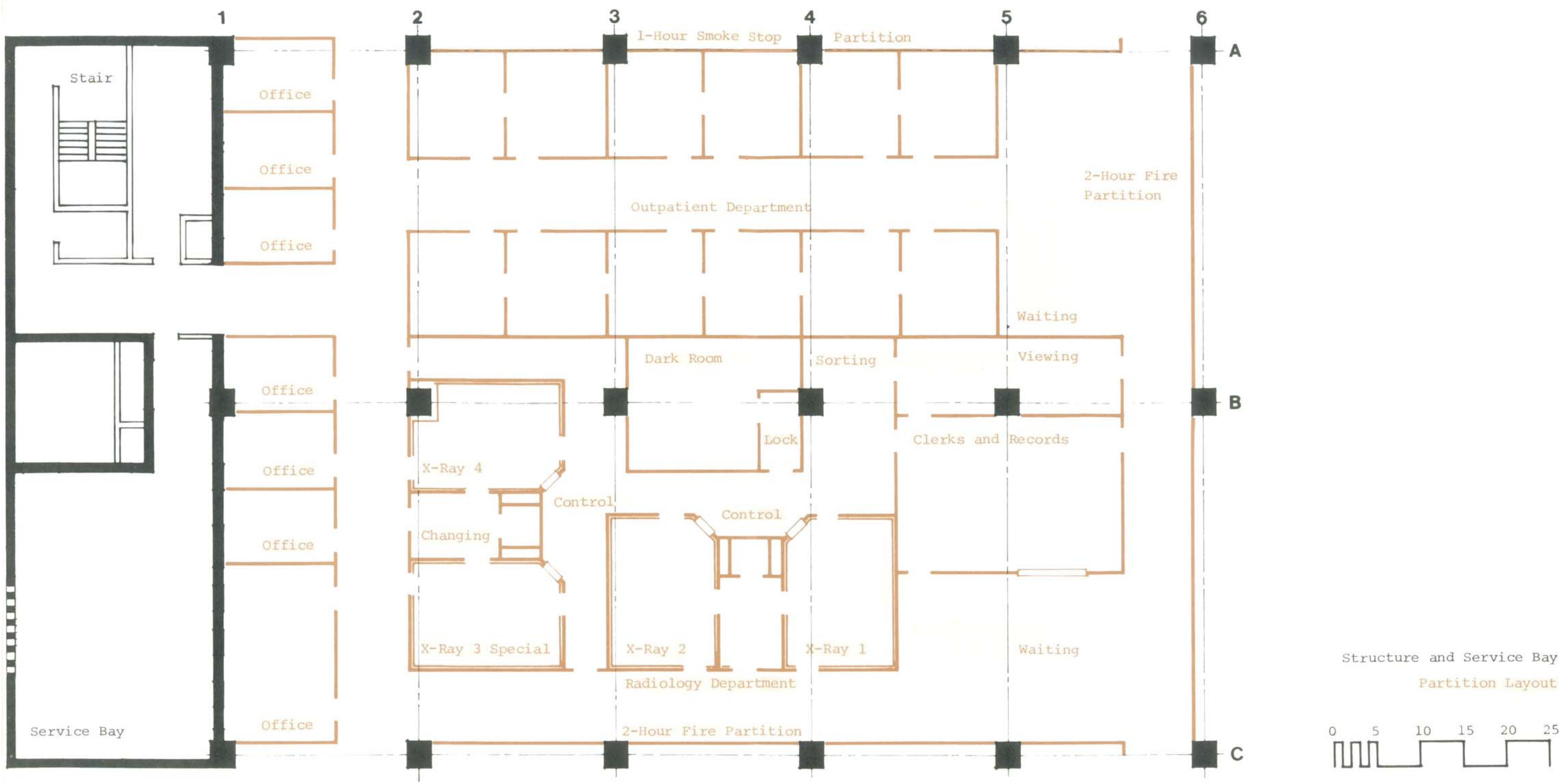


Figure 740-5. SERVICE ZONE: HVC SUBSYSTEM

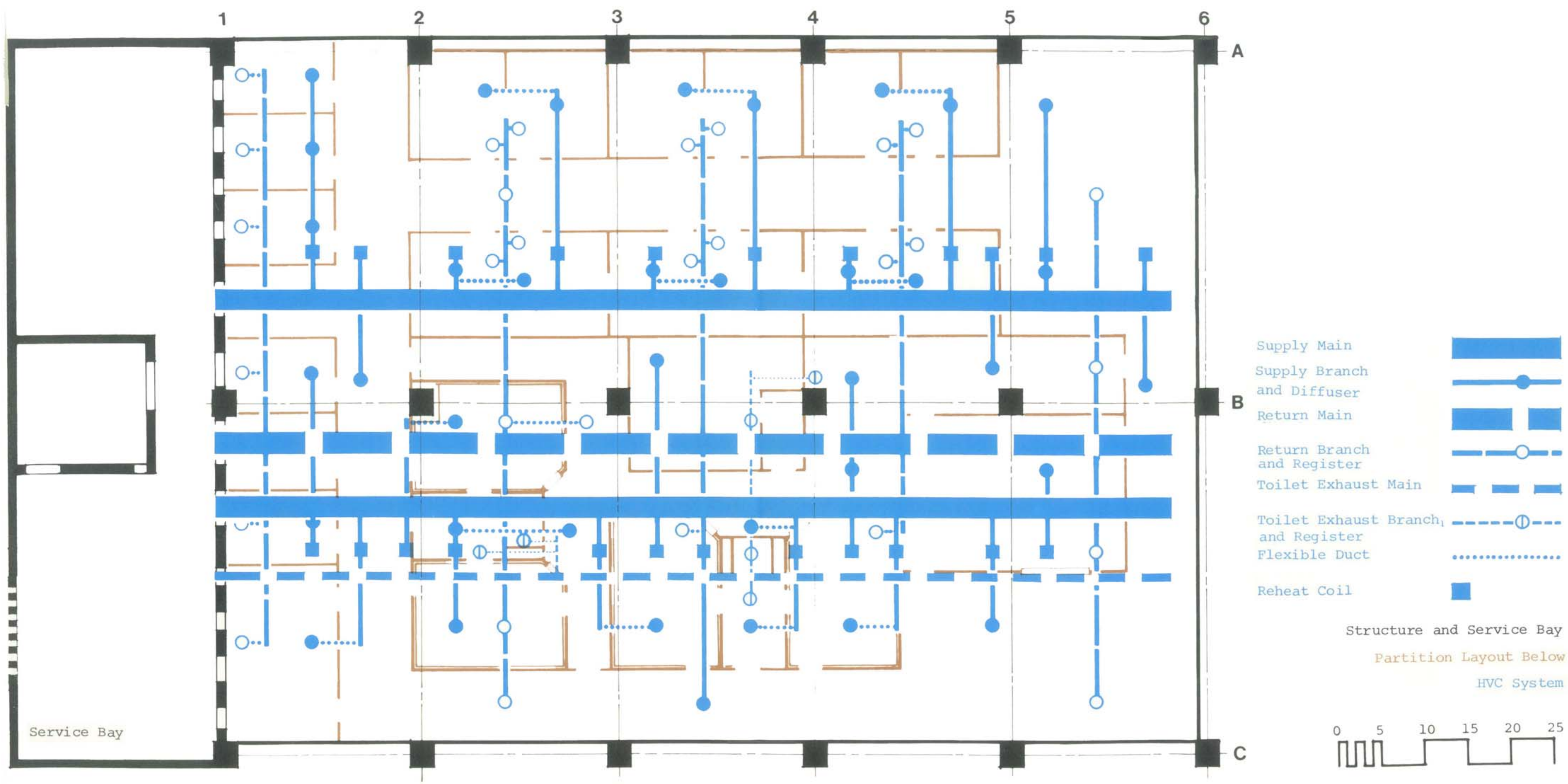


Figure 740-6. SERVICE ZONE: PLUMBING SUBSYSTEM

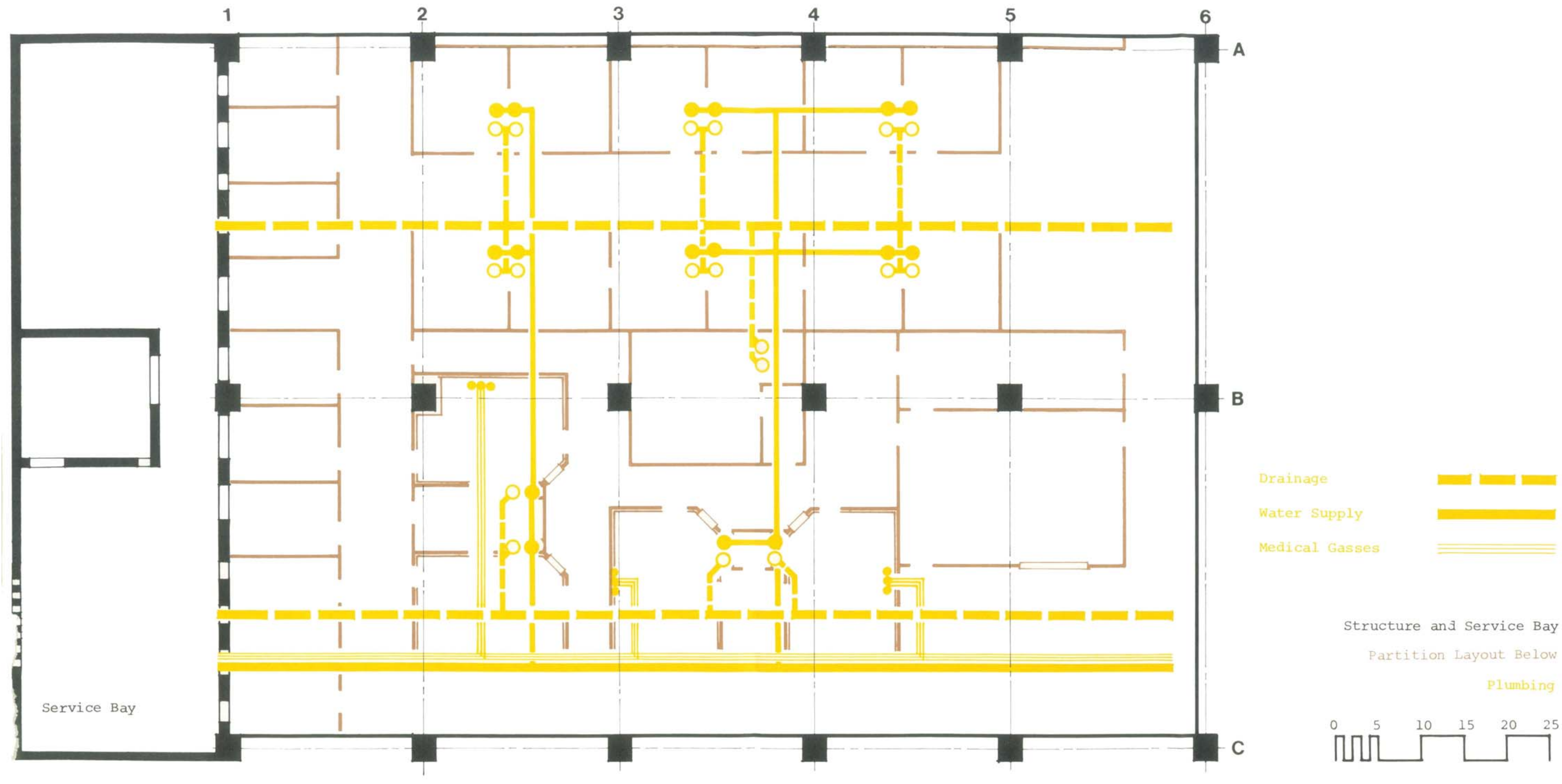
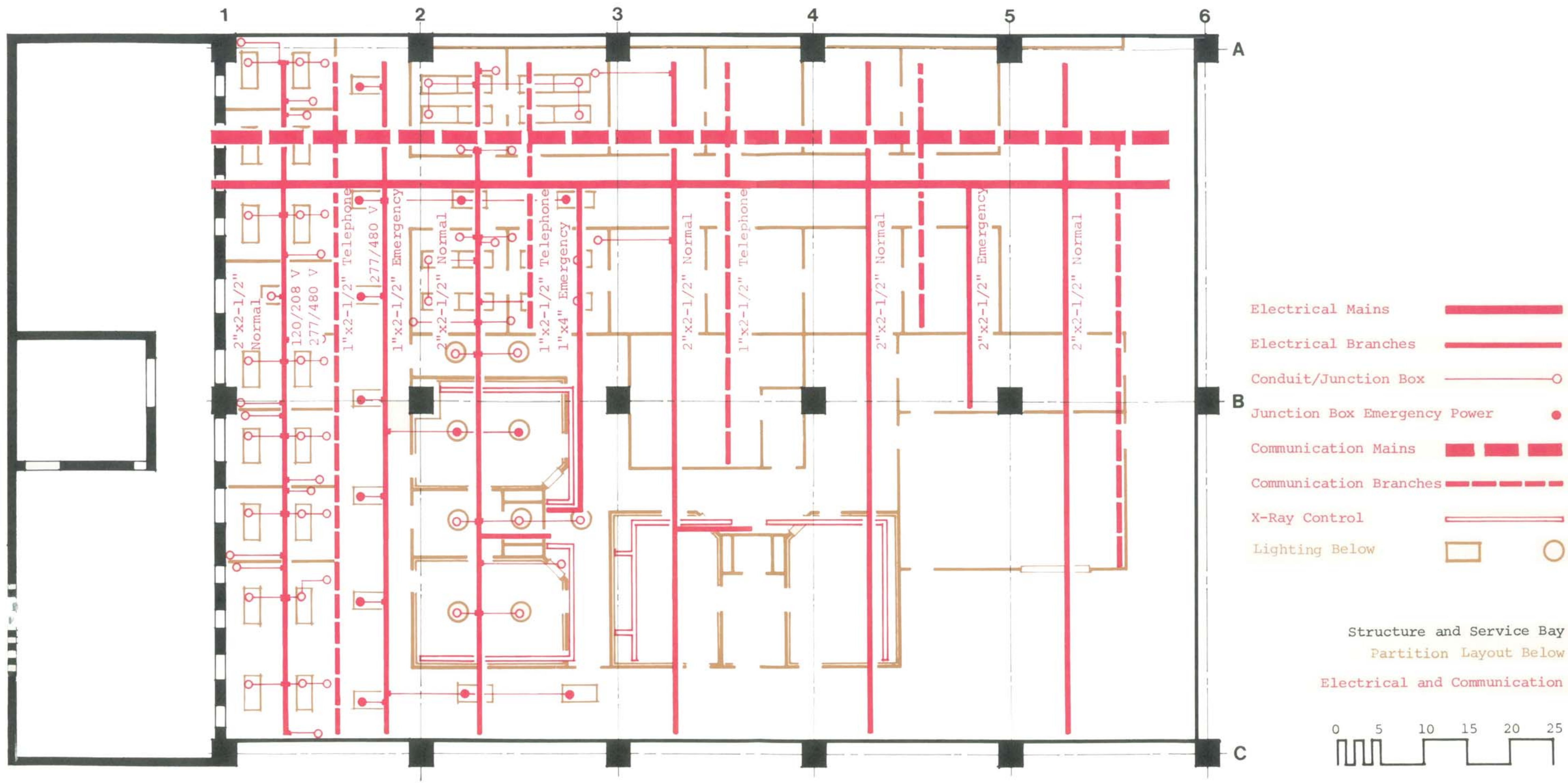


Figure 740-7. SERVICE ZONE: ELECTRICAL SUBSYSTEM



743 ALTERATION

743.1 FUNCTIONAL ZONE

To demonstrate the effect of functional zone replanning, it is assumed that the radiology suite in the opening configuration requires expansion to nearly twice its original size, from four to seven radiology rooms, including a special procedures room. To achieve this, the outpatient department is relocated elsewhere and some offices taken over to supplement the departmental offices.

The change of use of the offices causes little alteration to service layouts, but the new radiology rooms require complete alteration of the branch services in that area.

Figure 740-8 shows the revised layout with proposed service drops in the area affected by the change.

743.2 SERVICE ZONE

Figures 740-9, 10, and 11 show the revised layouts for the three services. In each case, the main distribution remains unchanged.

743.2.1 Main Distribution

The HVC supply and general exhaust/return main ducts are all permanent installations sized to handle up to the maximum air flow of 24,000 cfm and the alteration of functions in this example does not significantly change the cfm requirement from before. The slight increase in toilet exhaust requirement can be handled by the original duct.

The electrical and plumbing main distribution remain constant with some circuit variation in the wireways, and the generally oversized plumbing mains are capable of handling the increase in load.

743.2.2 Branch Distribution

The branch distribution in the changed area requires either extension or replacement.

For the HVC branches, the procedure described above for the opening configuration was repeated, except that the remaining branches of the existing layout were taken into account to minimize the new branches required. Twenty-two supply zones were found to be necessary to serve this new functional zone layout.

The plumbing branch change are a simple cutting back of domestic water runs and extension of the medical gas lines to the new radiology room locations.

The electrical branches are virtually unchanged except for cable variations within each wireway. But the short conduit runs and junction boxes to the final lighting and power drops would vary heavily from the original layout.

Figure 740-8. FUNCTIONAL ZONE: RADIOLOGY DEPARTMENT

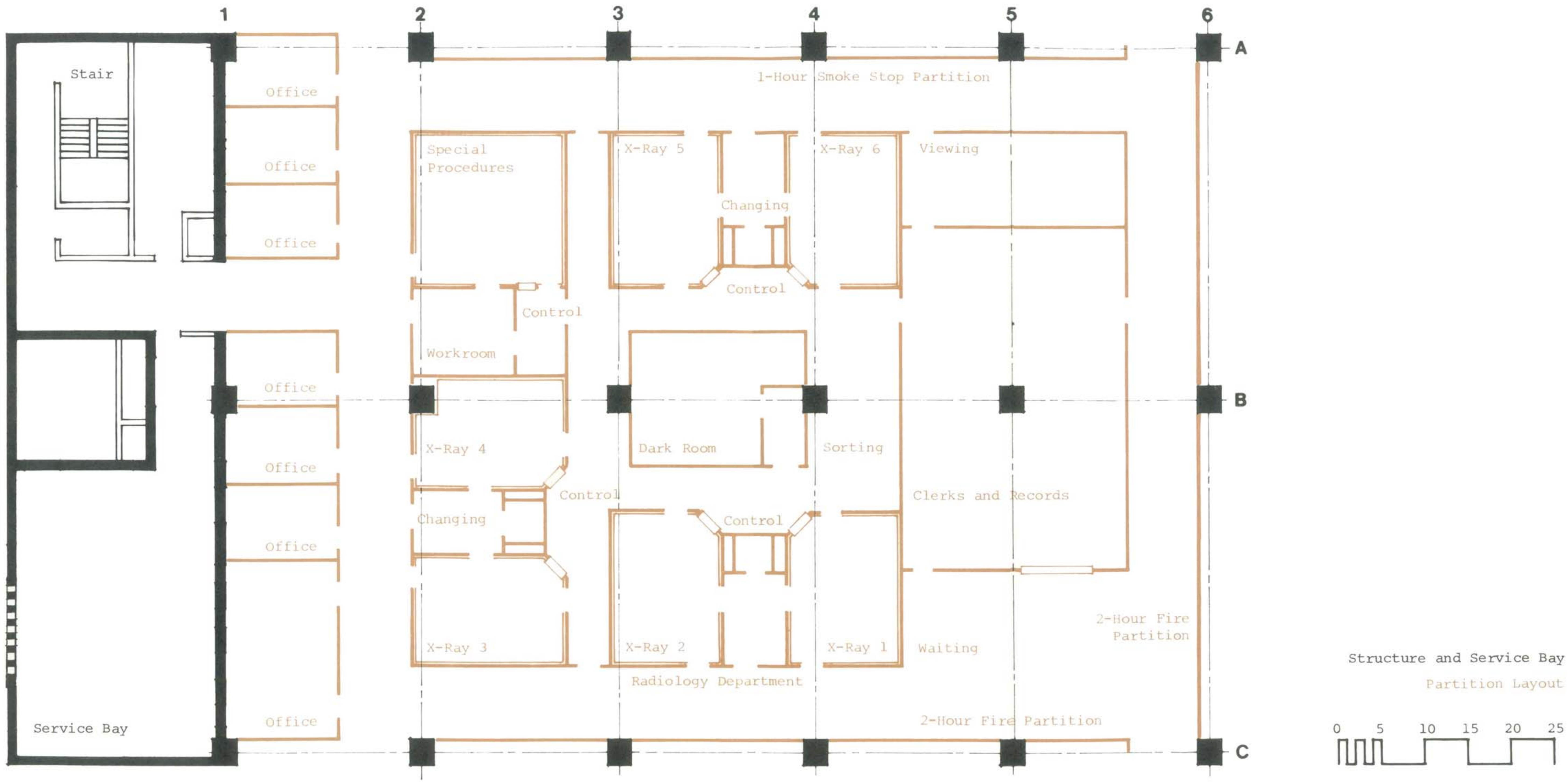


Figure 740-9. SERVICE ZONE: HVC SUBSYSTEM

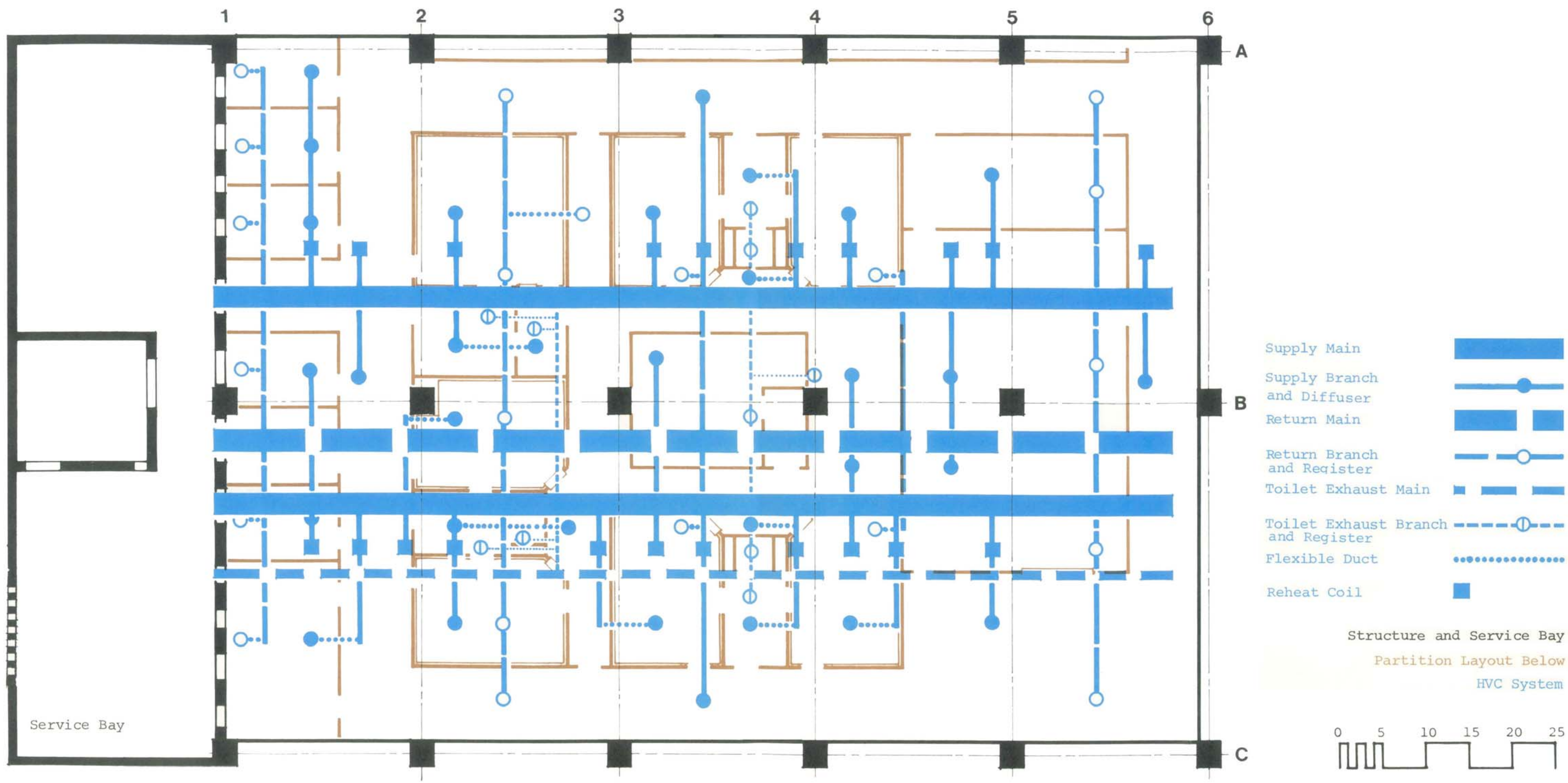


Figure 740-10. SERVICE ZONE: PLUMBING SUBSYSTEM

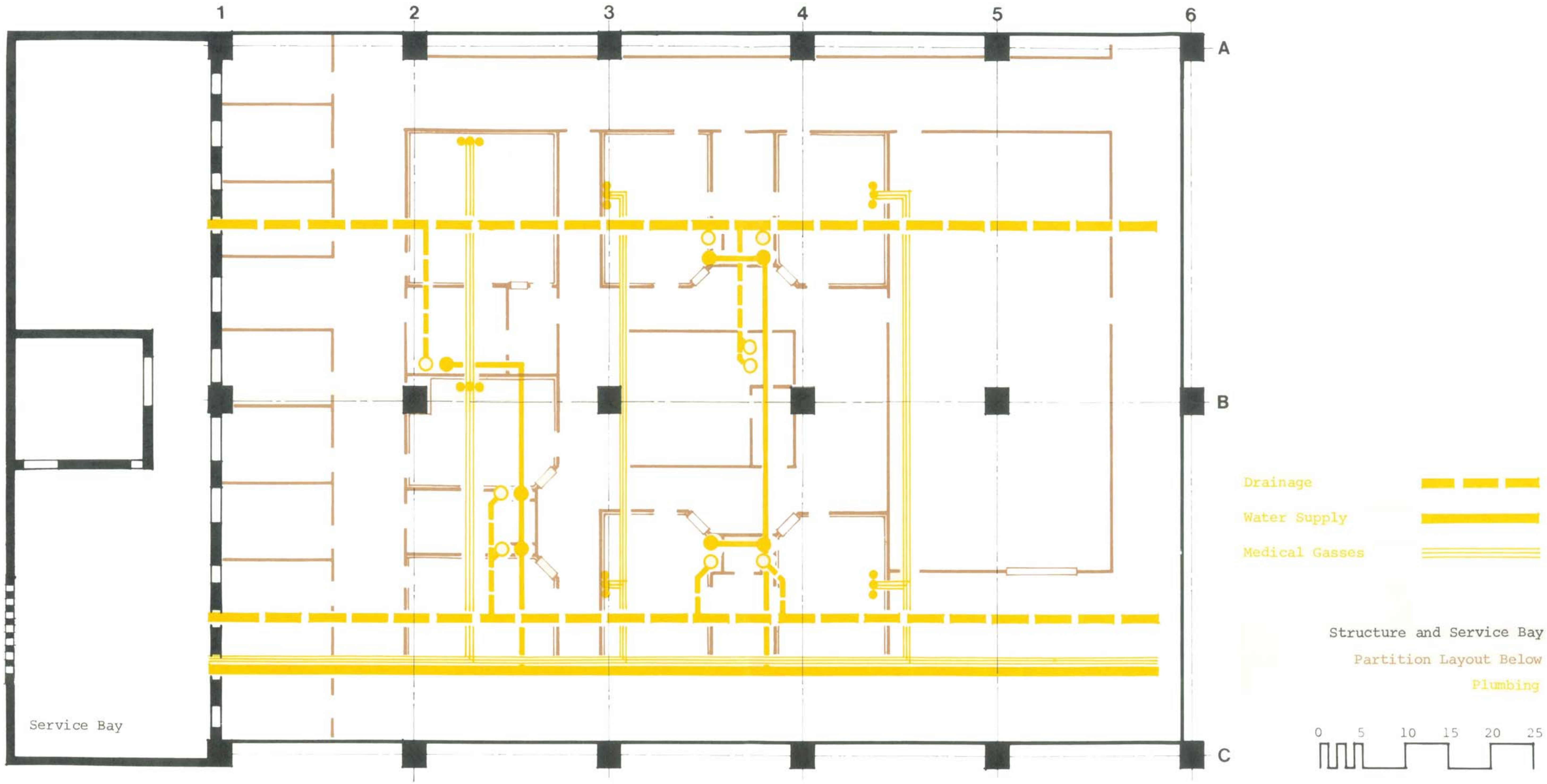
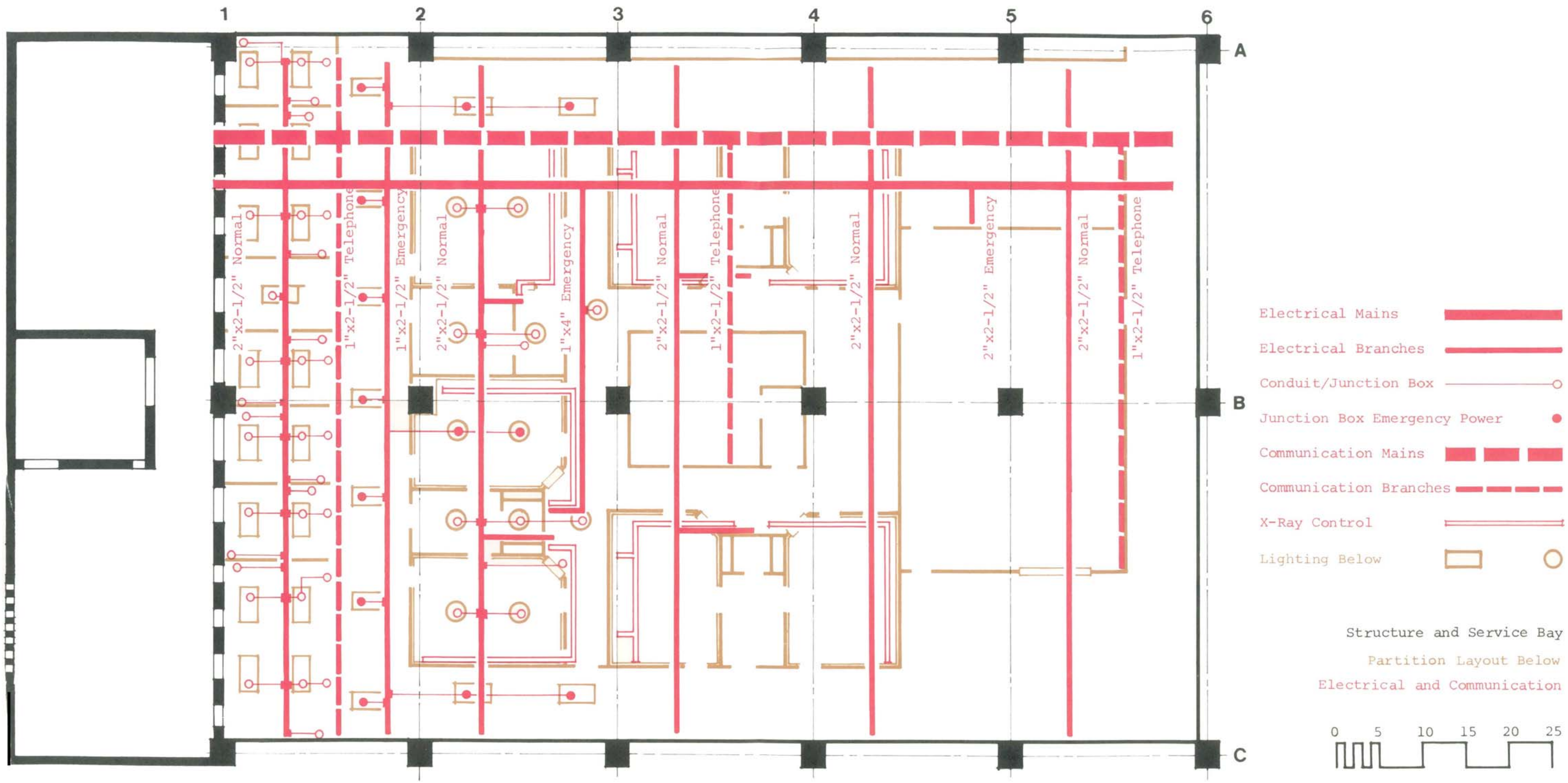


Figure 740-11. SERVICE ZONE: ELECTRICAL SUBSYSTEM



744 CONCLUSION

This example does not pretend to give a comprehensive picture of the total service module distribution problem. It has attempted to show a general approach to a solution. The successful integration of the subsystem layouts in a rational network depends on early study of the immediate and potential requirements for service. The general character of the service layouts needs to be developed simultaneously with structural and functional decisions. If this design procedure is followed, it will result in:

1. simplified layout drawings with a high content of diagrammatic detail for contract documents;
2. precise location of restrictions on service drops during functional zone planning;
3. simpler coordination and installation during construction stages;
4. simpler service change procedures during the life of the building.

745 MODEL AND MOCK-UP DEMONSTRATION

During the development of the example service module, a model of part of the service module was built to study the general organization of space and the layout of services. Also a full size mock-up was constructed representing a small area in the service zone of just over two hanger spaces in each direction. A congested service area was chosen deliberately to test general access and installation of services.

The group of photographs which follow show various aspects of both the model and the mock-up.

Figure 740-12. MODEL: THE SERVICE MODULE

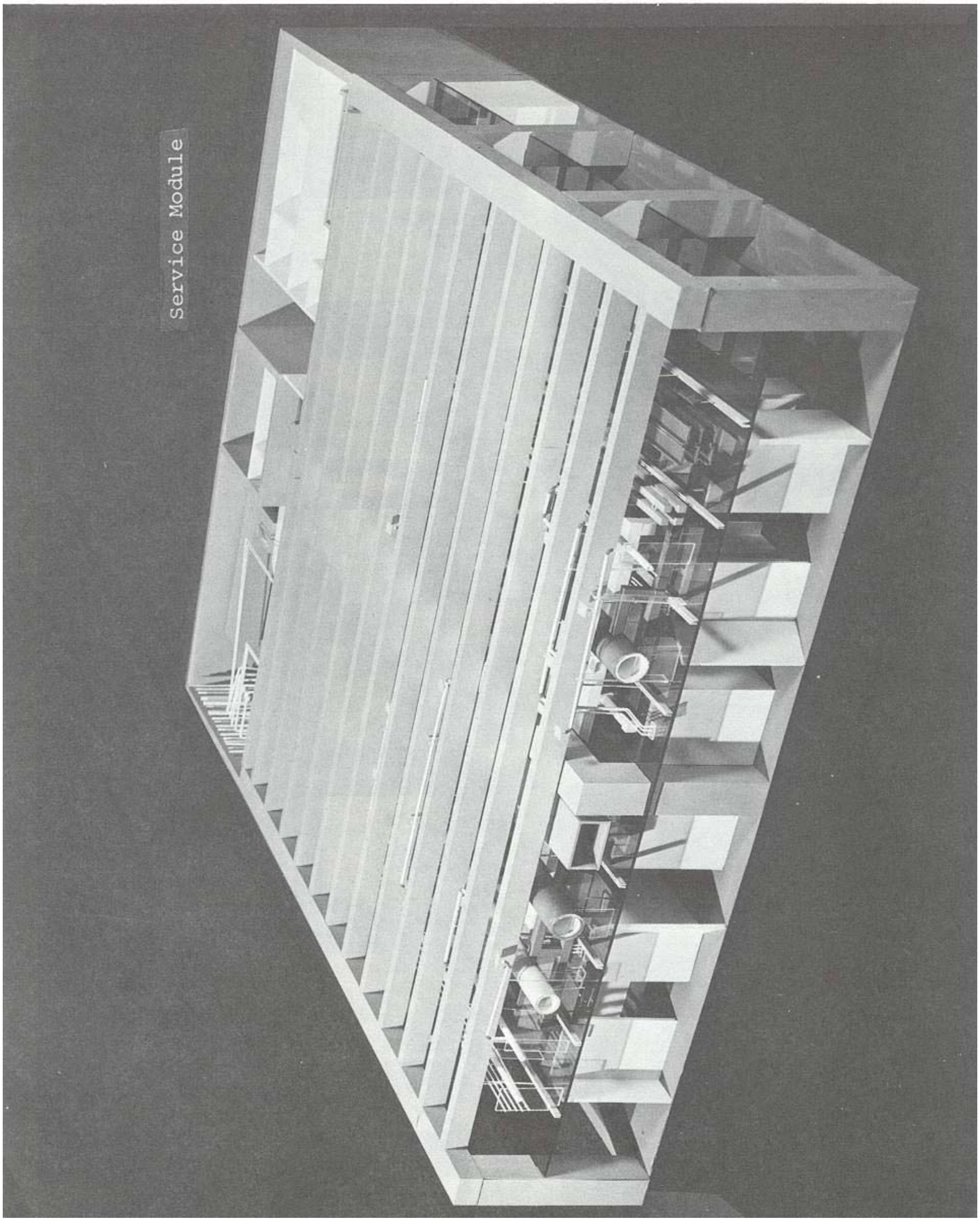


Figure 740-13. MODEL: CROSSECTION

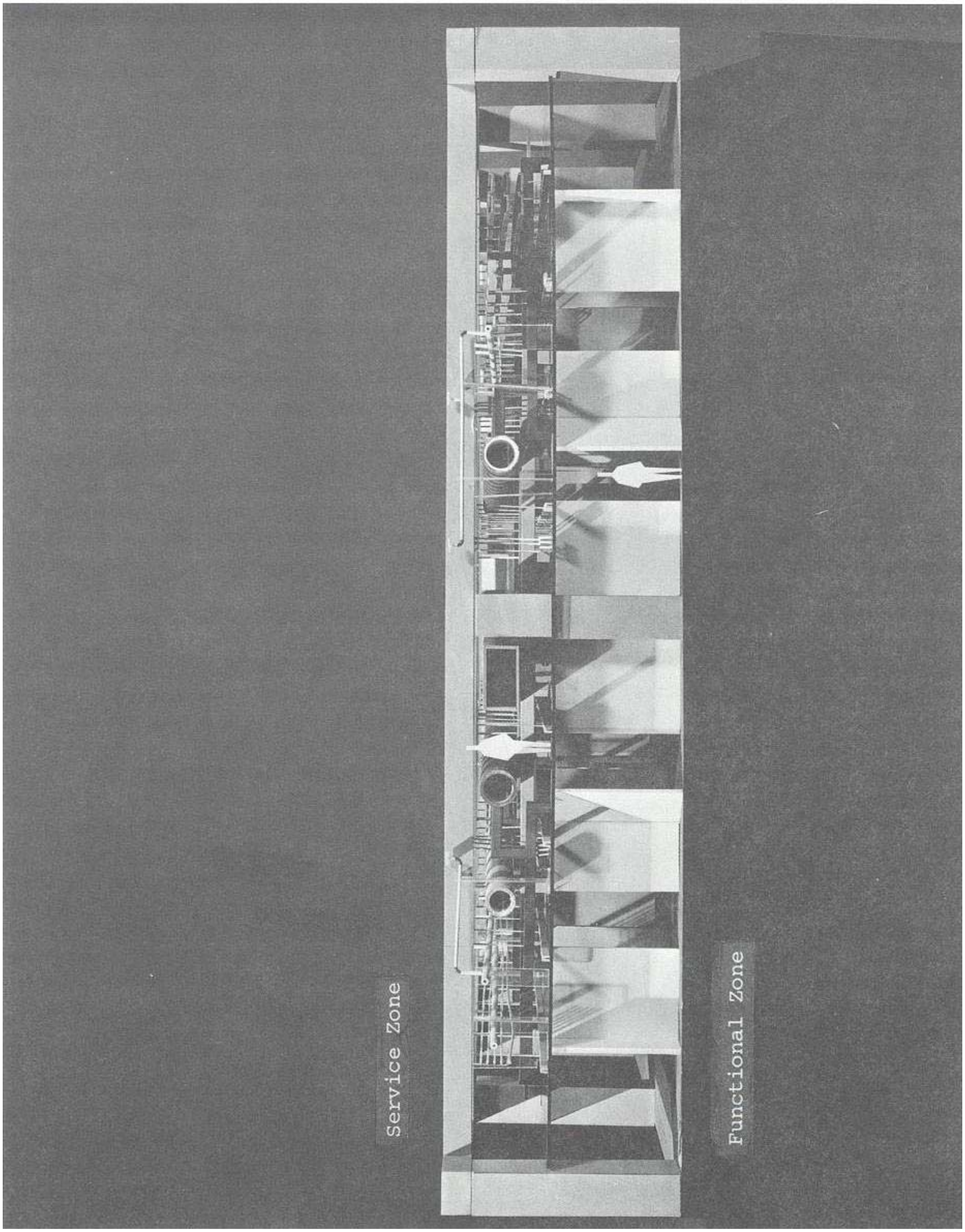


Figure 740-14. MODEL: HVC SUBSYSTEM

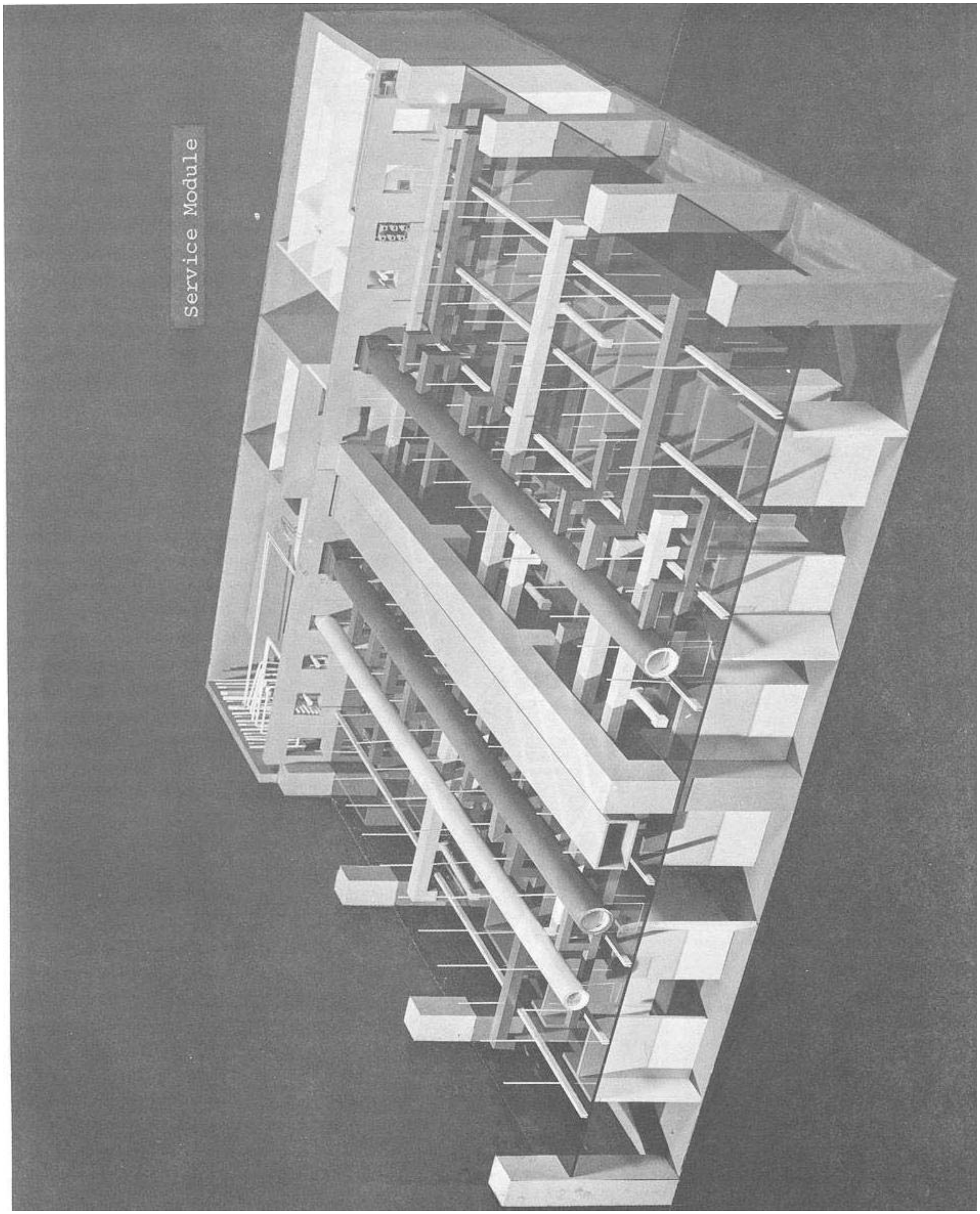


Figure 740-15. MODEL: PLUMBING SUBSYSTEM

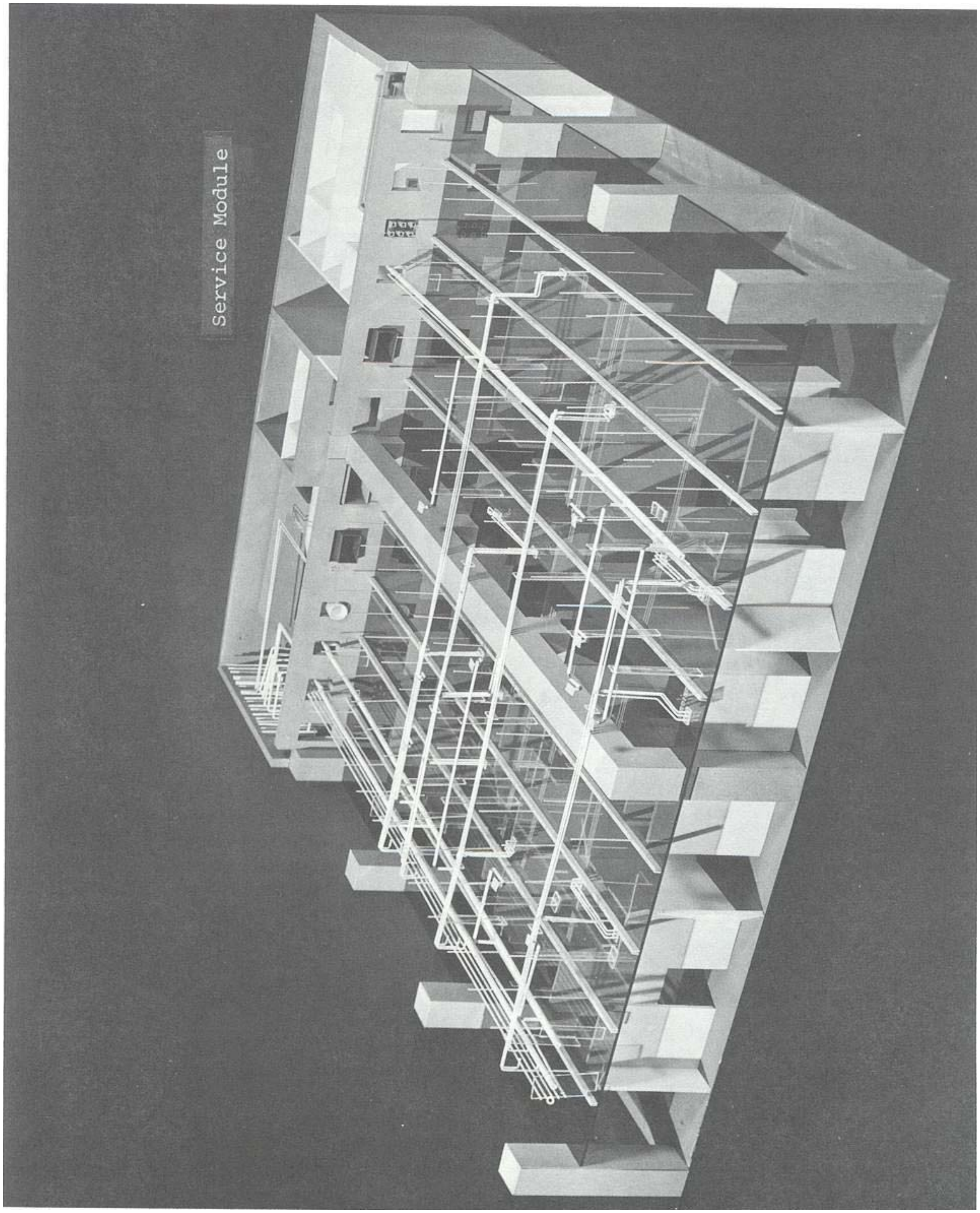


Figure 740-16. MODEL: ELECTRICAL SUBSYSTEM

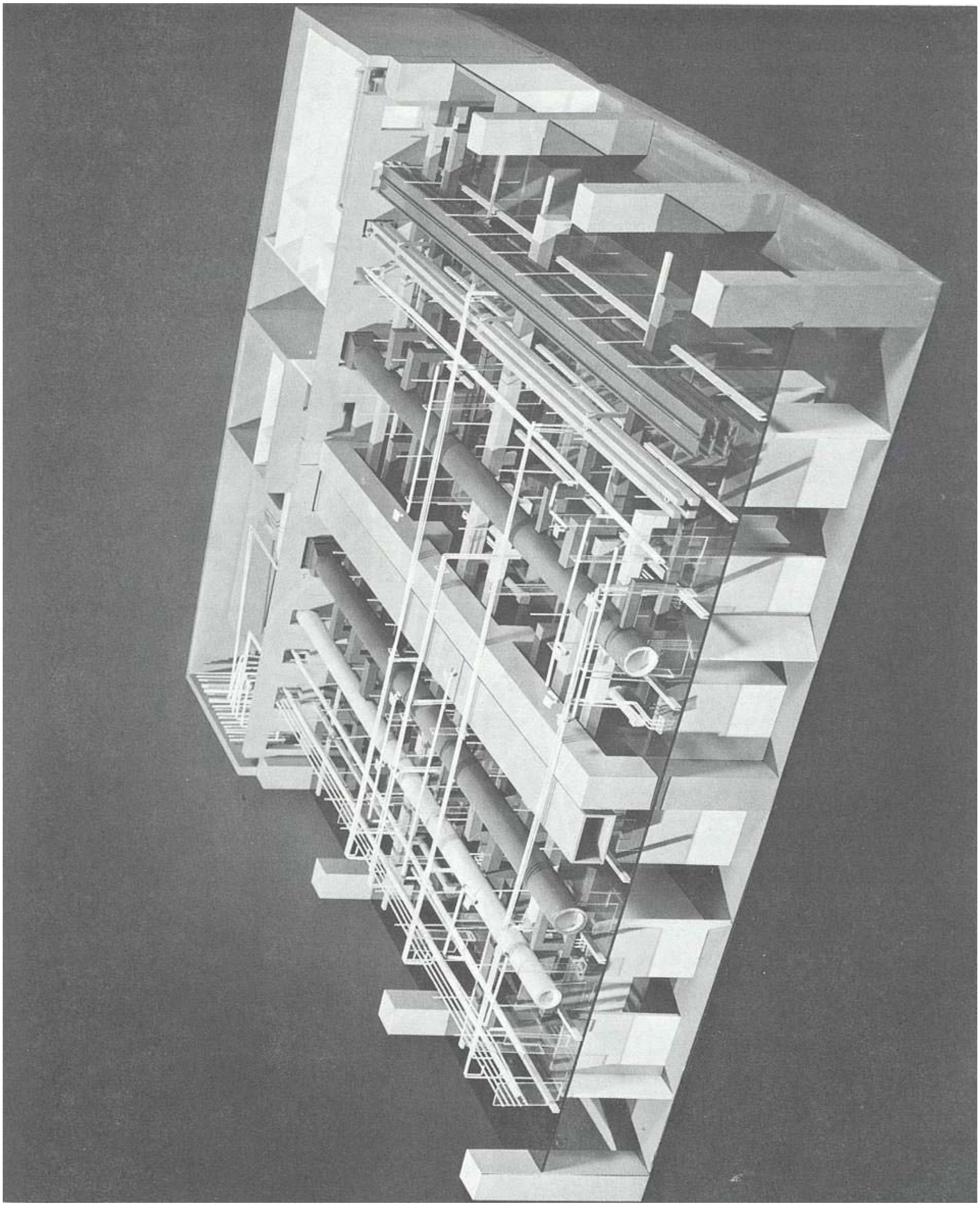


Figure 740-17. MODEL: COMBINED SUBSYSTEMS

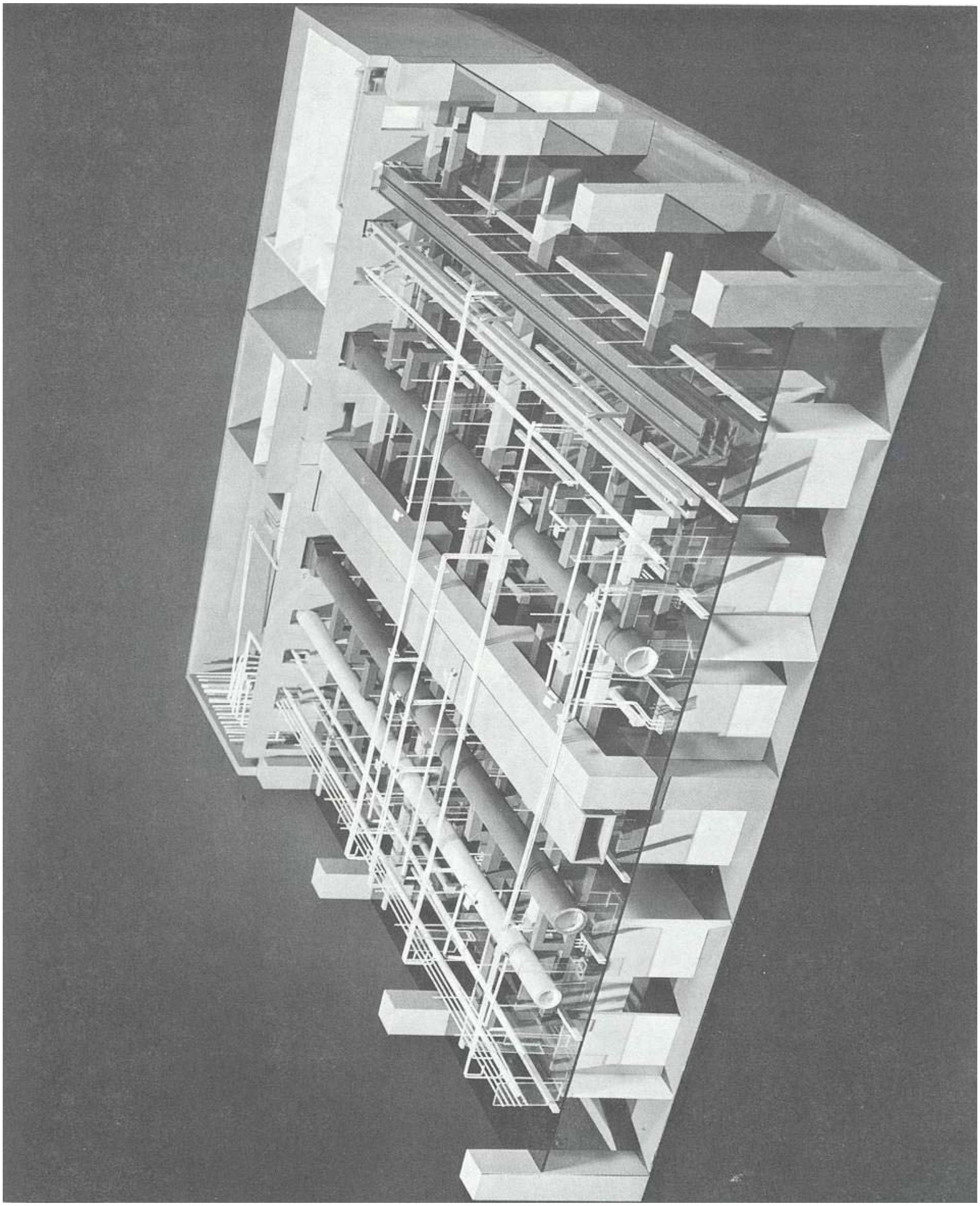


Figure 740-18. MODEL: SERVICE BAY

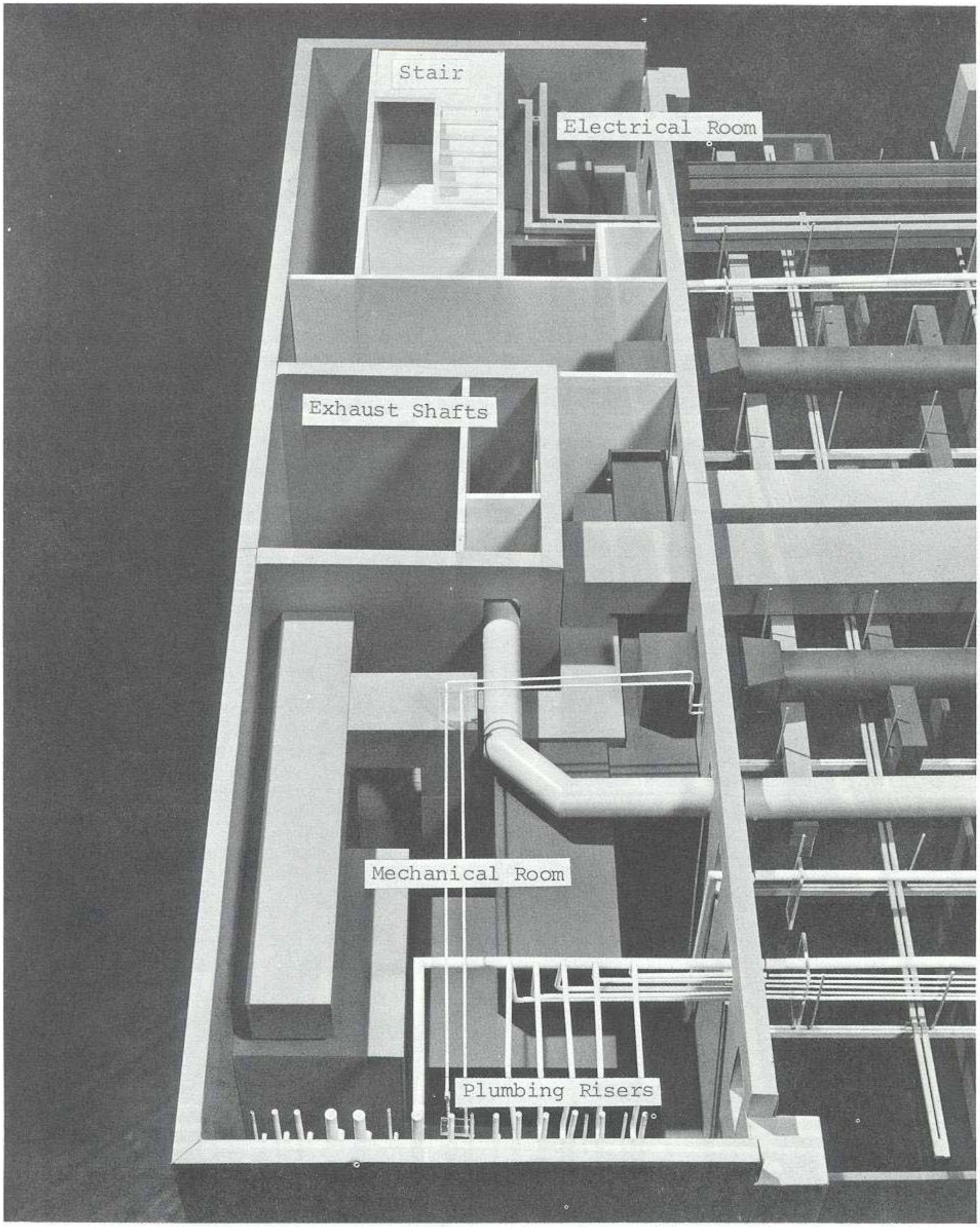


Figure 740-19. MODEL: CLOSE UP

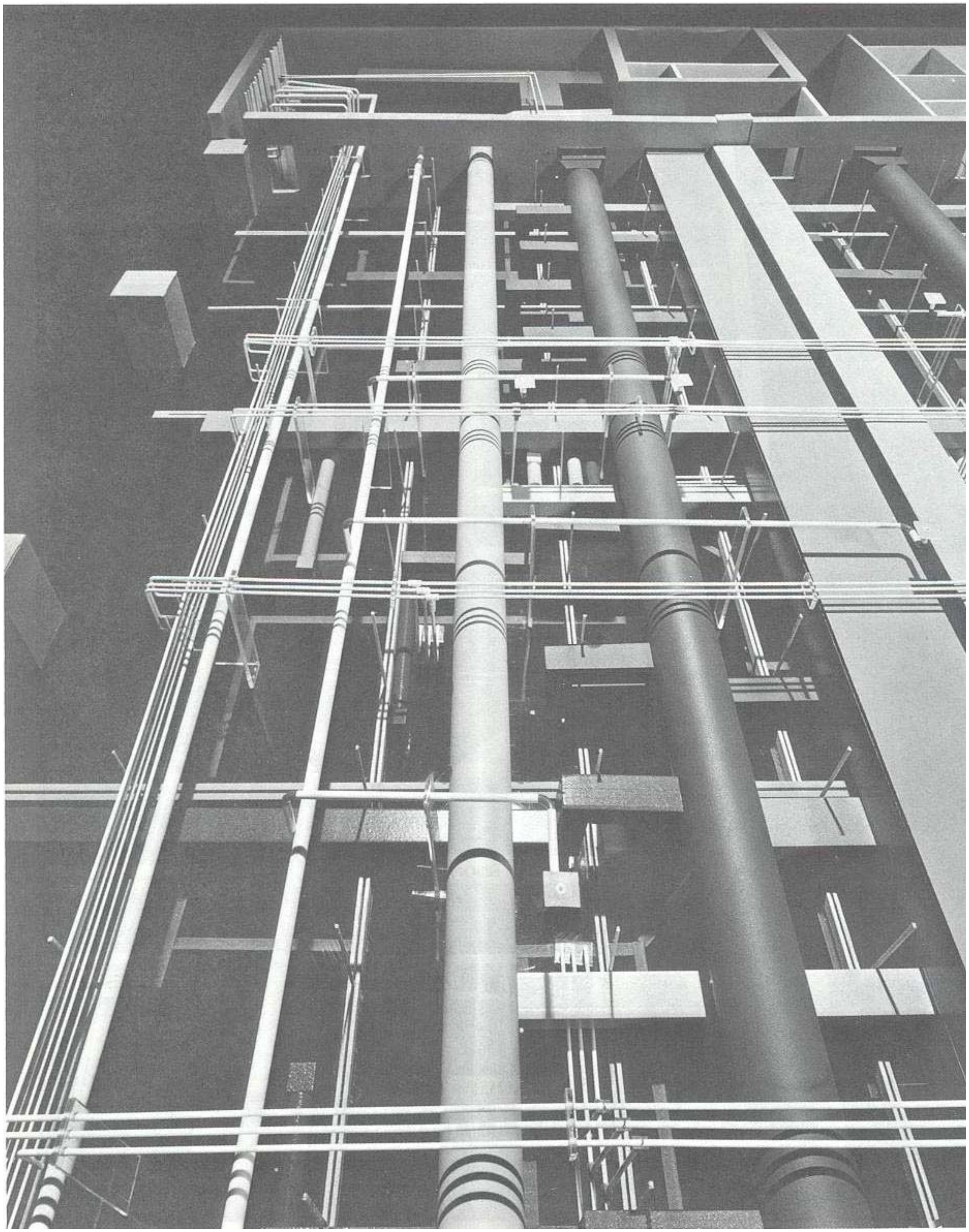


Figure 740-20. FULL SIZE MOCK UP OF SERVICE ZONE

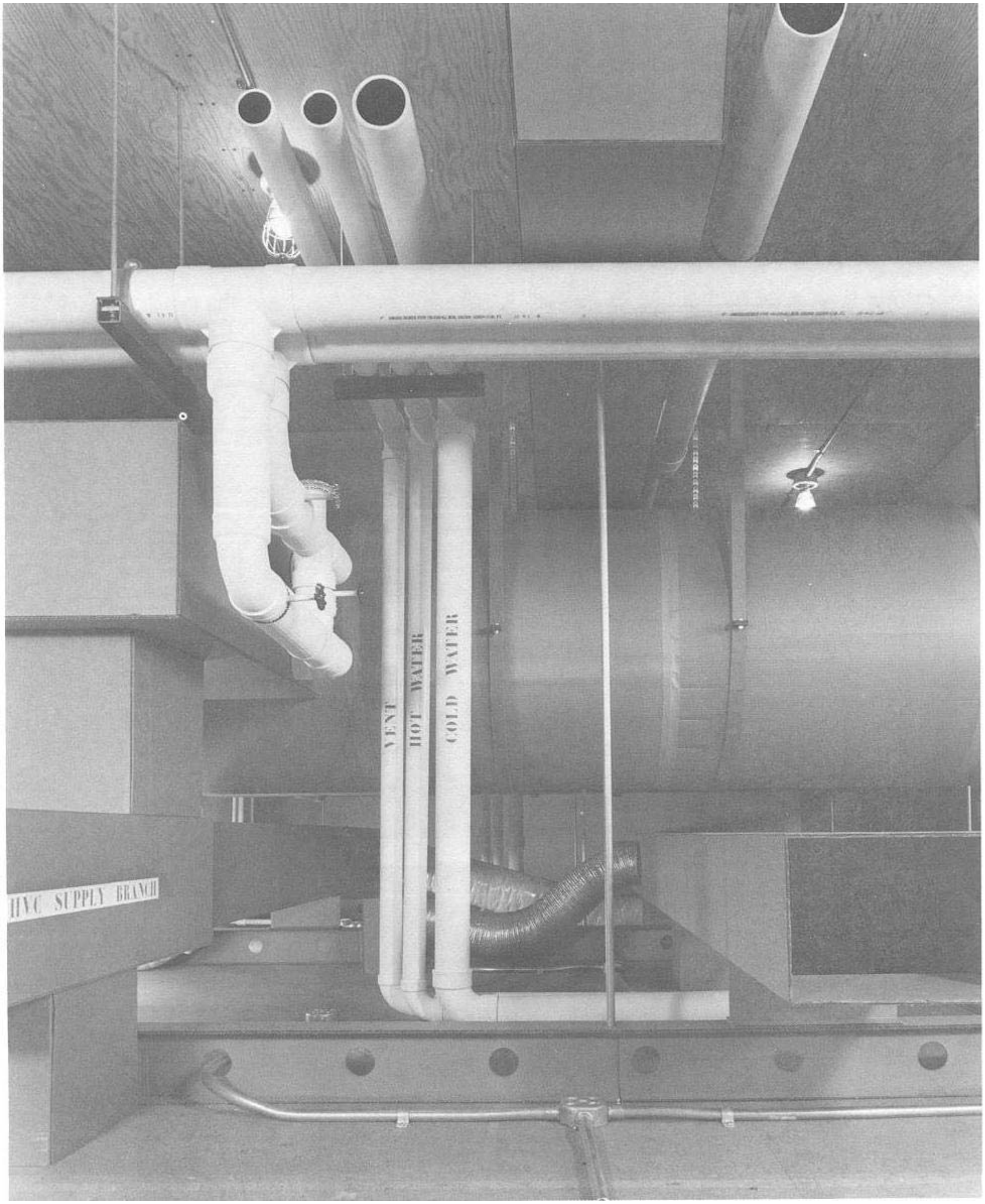


Figure 740-21. FULL SIZE MOCK UP OF SERVICE ZONE

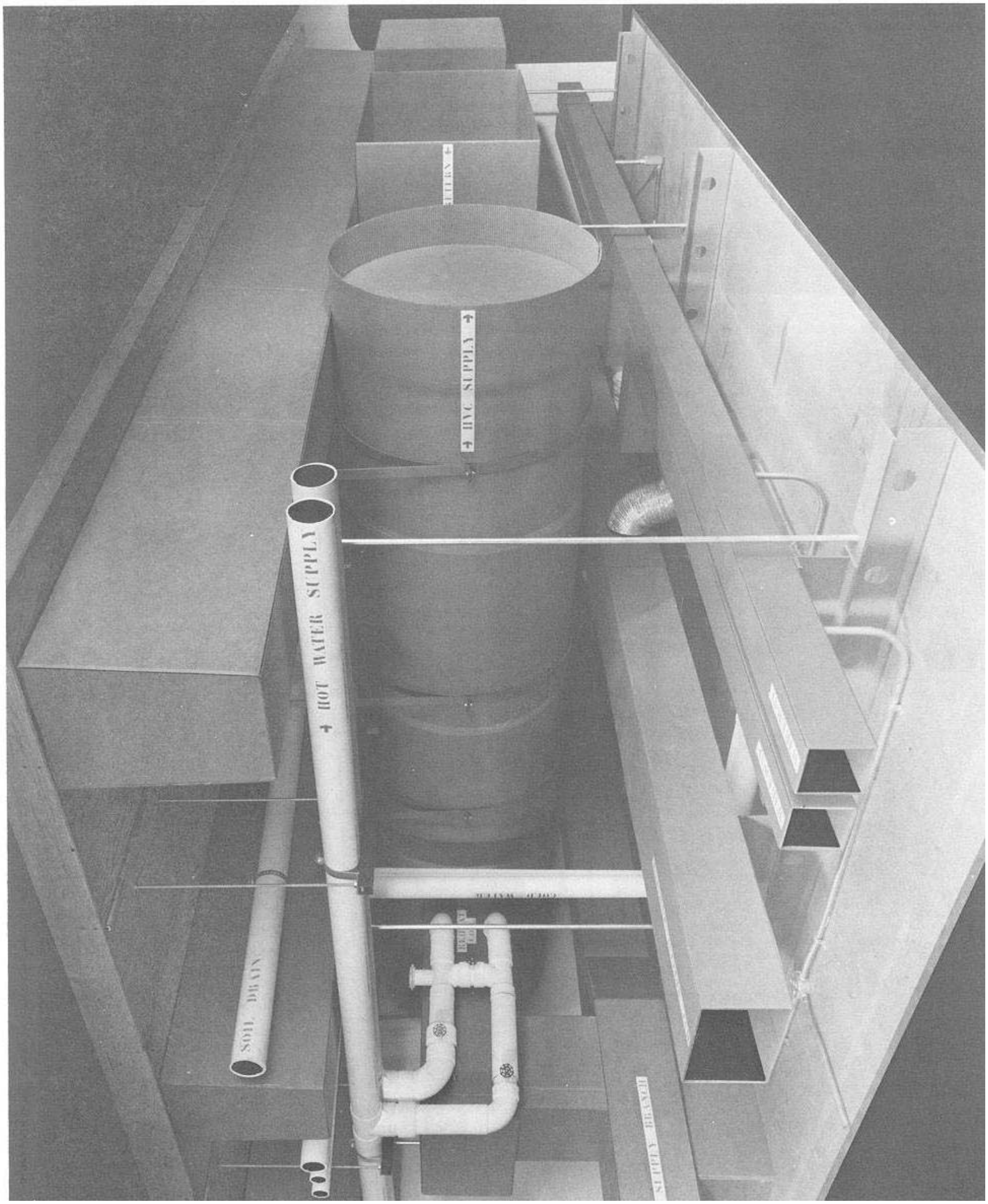


Figure 740-22. FULL SIZE MOCK UP OF SERVICE ZONE

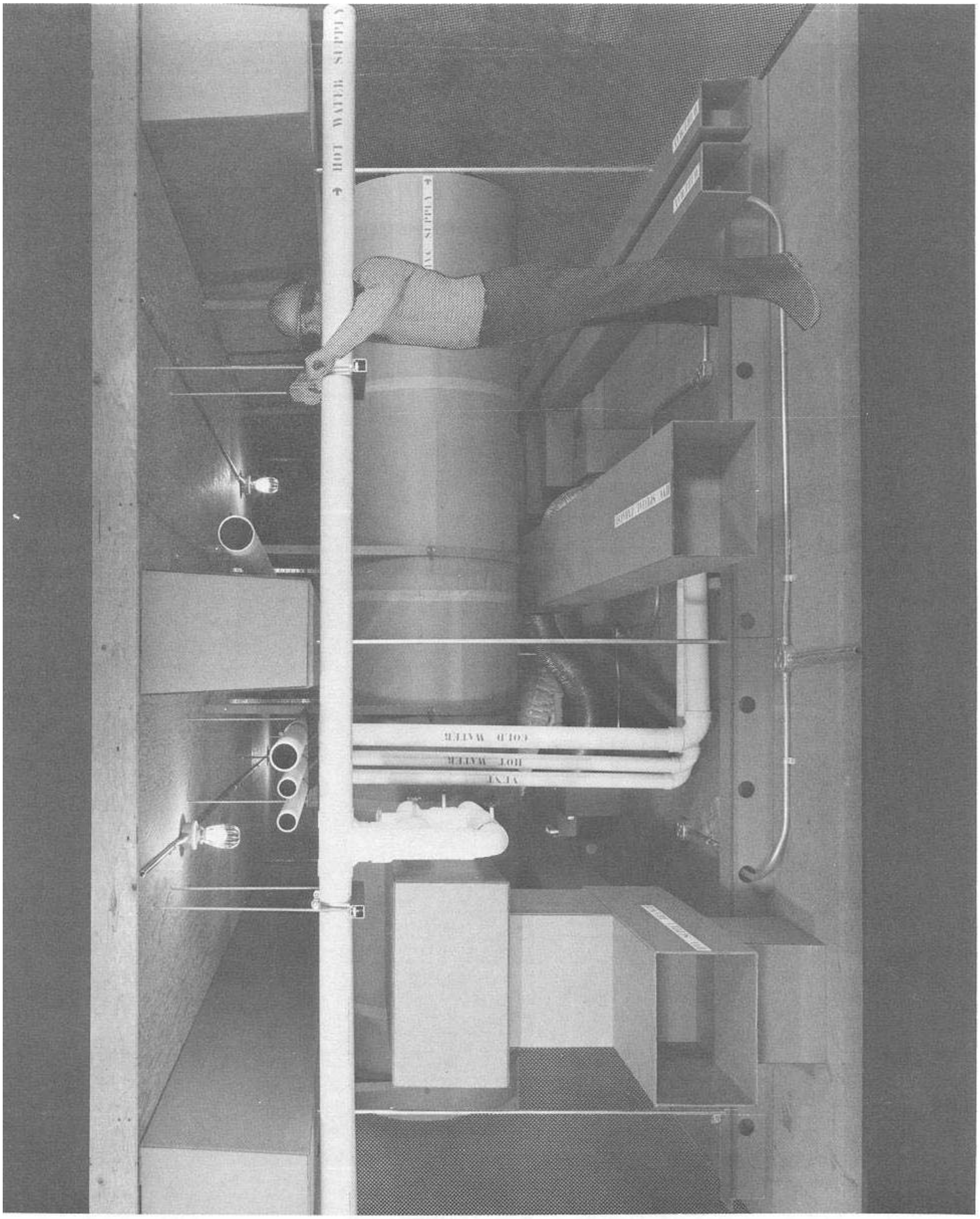


Figure 740-23. FULL SIZE MOCK UP OF SERVICE ZONE

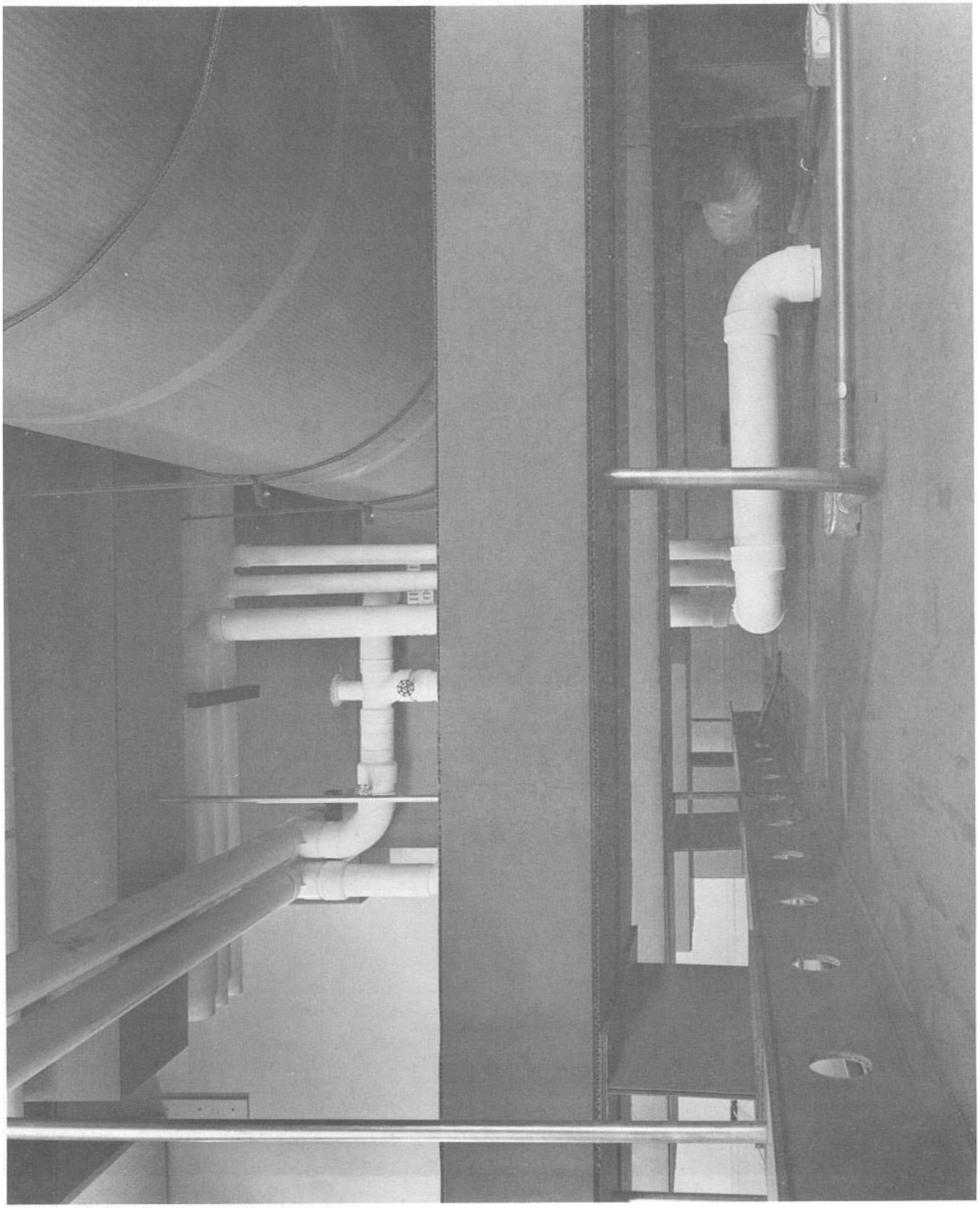
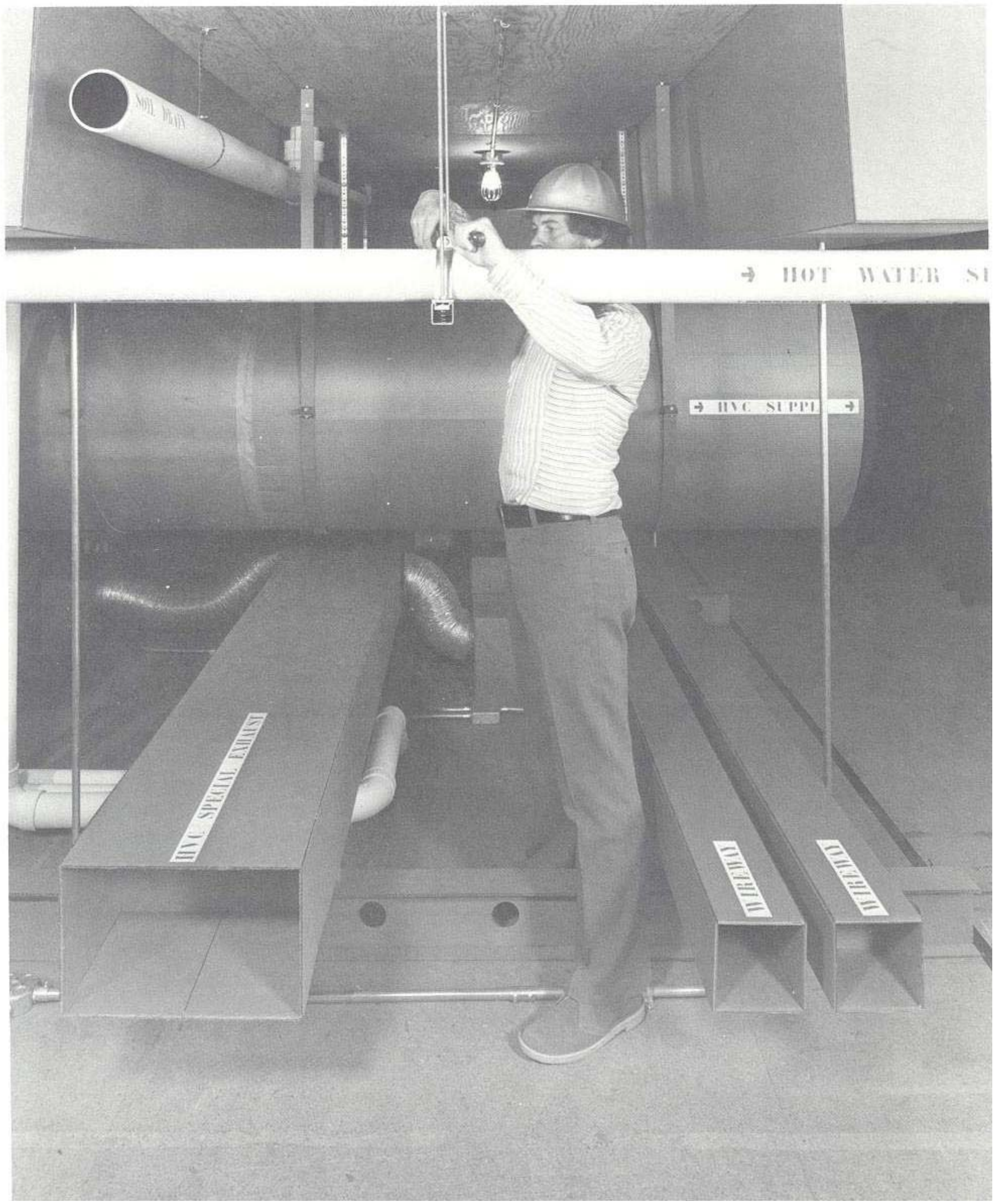


Figure 740-24. FULL SIZE MOCK UP OF SERVICE ZONE



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750 Cost and Time Analysis

751 FIRST COST

751.1 EXAMPLE BUILDING SCHEMATIC DESIGN

751.1.1 The cost estimate for the example building schematic design (Section 730) is based on material and labor costs prevailing in the San Francisco Bay Area with the national ENR Building Cost Index at 960. All figures include the general contractor's and subcontractor's overhead and profit. The estimate is for the entire building to a point five feet beyond the building line, except for the figures for central plant and laundry, which are not in the example schematic design, but have been added to make the total comparable in scope to the cost base (the six hospitals analyzed in Section 530). The outside gross area of the example schematic design is approximately 843,000 square feet. (See Table 750-1.)

751.1.2 Structure, exterior wall, ceiling, fire partition and corridor partition quantities were measured on the plans. Other partition quantities were based on the average functional area quantities of the Miami and Memphis field stations. (See Section 534 for explanation of functional area breakdown.) Mechanical, plumbing and electrical costs were based on functional area take-offs, with unit prices established for each type of functional area. Items such as casework, conveyors, hospital equipment, lighting, communications and building specialties were prorated from the Miami and Memphis analyses.

751.1.3 Direct comparison of the total unit cost of the example schematic design ($40.79) with the basic construction cost established in the cost base ($48.60) could be misleading because the example schematic design has a higher gross-to-net-area ratio than is typically the case in VA hospitals. The additional gross area is in the more generous service spaces and shafts, and in "incremental" assignable space introduced by the use of large-scale planning modules. (The latter type of space is not really gross, but is in addition to "programmed" net.)

The exact gross-to-net ratios for the six hospitals analyzed in the cost base were not calculated, but based on VA standards current at the time, these ratios probably average about 1.6. The equivalent ratio for the example schematic design is 1.9.

Table 750-1. CONSTRUCTION COST ESTIMATE, EXAMPLE BUILDING SCHEMATIC DESIGN

Integrated Subsystems	Total $	$/OGSF	Sub-total
Structure	8,118,000	9.63	
Ceiling	2,009,000	2.38	
Partitions	3,060,400	3.63	
Heating-ventilating-cooling	4,007,900	4.75	
Plumbing distribution	1,803,000	2.14	
Electrical power distribution	1,945,400	2.31	
			24.84
Non-System Components			
Excavation, backfill, shoring	618,000	.73	
Basement waterproofing	72,600	.09	
Foundations and basement	1,474,000	1.75	
Exterior wall	2,558,200	3.04	
Penthouse and soffits	254,300	.30	
Miscellaneous metals	440,000	.52	
Roofing, insulation and deck surface	344,500	.41	
Non-system partitions	139,500	.17	
Non-system ceiling	2,700	.01	
Finish flooring	457,600	.54	
Casework	83,600	.10	
Elevators and conveyors	927,300	1.10	
Misc. building specialties	880,000	1.04	
Hospital equipment	1,400,000	1.66	
Plumbing fixtures and fittings	751,000	.89	
Sterilizers, fume hoods, etc.	463,600	.55	
Finish electrical and control station	927,200	1.10	
Communications and fire alarm	154,000	.18	
			14.18
Items Outside Building			
Central plant and laundry	1,496,300		1.77
TOTALS	$34,388,100		$40.79

A more meaningful parameter for comparing the example with the cost base hospitals would be dollars per programmed net square foot ($/PNSF).

Cost base hospitals: $48.60/OGSF x 1.6 = $ 77.76/PNSF

Example design: $40.79/OGSF x 1.9 = $ 77.50/PNSF

Taking into consideration the small statistical base and the degree of accuracy possible with the type of cost estimate involved, the conclusion suggested by these figures is that, for practical purposes, the cost of the "systems" hospital would be about the same as a conventionally designed and constructed hospital with the same programmed area.

751.1.4 Another parameter which can provide an interesting comparison is dollars per departmental gross square foot ($/DGSF). For purposes of this analysis, departmental gross area is defined as the outside gross area of the hospital, minus the area of all space in the "zero" functional area category established for the cost base. The zero category includes mechanical rooms, stairways, elevators, etc. (See Section 534.) This parameter has been quantified for the Miami and Memphis hospitals as well as the example schematic design.

Miami: $49.30/DGSF

Memphis: $48.59/DGSF

Example: $48.70/DGSF

Since departmental gross area is "actual" rather than "programmed", it includes any extra assignable area that may be inherent in the particular building design. This comparison, like the previous one, indicates a "systems" cost essentially the same as conventional. When the two comparisons are considered together, therefore, they imply that an attempt to modify the system building design to force the actual net area closer to the programmed net would have very little impact on total first cost. This conclusion is reinforced by the analysis of "incremental space" in Section 751.3.2 below.

751.1.5 There is an aspect of the cost estimate of the example schematic design which raises a further question of comparability with the cost base.

The cost of the non-system components in the example design is only $15.95/OGSF (the sum of $14.18 and $1.77 from Table 750-1), whereas the average cost of the equivalent portion of the six hospitals in the cost base was $23.05. (See Table 530-1.) Thus the non-integrated subsystems account for only 39% of the total cost of the example schematic design as compared to 47% in the cost base. Even when adjusted to dollars per programmed net square foot, the non-system portion of the building would cost 17% less in the system example than in the cost base.

Cost base:	$23.05/OGSF x 1.6 = $36.88/PNSF
Example design:	$15.95/OGSF x 1.9 = $30.30/PNSF
Difference:	$6.58/PNSF

Unfortunately, the cost base figure was not obtained by direct estimate; it is simply the result of subtracting the estimates for the integrated subsystems from the contract cost in each case. The example design figure, on the other hand, is based on a direct estimate, as indicated by the breakdown in Table 750-1, which in turn is based on a scope assumed to be approximately the same as that included in the non-system portion of the contract costs of the six cost-base hospitals. The considerable discrepancy in the two figures seems to challenge this assumption of equivalent scope.

We can introduce an additional safety factor into our comparisons by examining the effect of arbitrarily adding the $6.58/PNSF difference to the total estimate for the example design, on the theory that this figure represents an actual discrepancy in the assumed scope. The “adjusted” figure would then be $77.50 + $6.58 = $84.08/PNSF, which puts the example design now 8% higher than the $77.76 computed for the cost base. (See Section 751.1.3 above.) It can be shown that even if this was in fact the marginal extra cost of a systems building, the difference can be easily recovered by anticipated savings in maintenance and alterations. (See Sections 752.2 and 752.6 below.)

If the difference in non-system estimates is taken directly in dollars per outside gross square foot and added to the total figure for the example schematic design from Table 750-1, the result is still about 1.5% less than the basic construction cost given by the cost base.

Cost base:	$48.60/OGSF
Example design:	$40.79 + (23.05-15.95) = $47.89/OGSF
Difference:	$ .71/OGSF

751.2 BUILDING SUBSYSTEM TARGET COSTS

751.2.1 Structure

The target cost range for structure is between $8.60 and $11.30/OGSF, or from $8.00 to $10.45 per square foot of structural framing. These figures are higher than the comparable cost base range of $5.86 (Martinez) to $8.10 (Atlanta) due to increased floor-to-floor height, longer spans, higher uniform live loads, and the addition of a three-inch topping slab.

The major variables affecting these costs are:

1. Building Height. Up to four stories, unit costs change very little. From four to nine levels, the unit cost increases from five to ten percent.

2. Beam Spans. When the longer of the modular spans (49'-6" to 58'-6") are used rather than the shorter spans (40'-6" and 45'-0"), unit cost will increase from three to six percent. The cost will also be affected by the efficiency of the structure in terms of the number of continuous spans and the use of cantilevers. A single span is the least efficient whereas beams continuous over three or more spans are the most efficient. The cantilever is most effective for economy of structure when used in conjunction with the longer beam spans which are also continuous over two or more supports.

3. Shear Elements. In high seismic load zones, the cost of shear resisting elements will be approximately $0.55 to $0.80 per square foot of structural framing for a four-story building, and $0.90 to $1.20 for a nine-story building. In low seismic load zones, these costs will be reduced by approximately 50%.

4. Generic Design Option. Generally speaking, the concrete options will cost up to fifteen percent less than steel. However, the shorter construction time required for steel framing may under some circumstances provide a lower cost.

5. Building Configuration. Simple assemblies of service modules will generally be more economical than compound assemblies due to the change in direction of structural framing and/or internal service bays in the latter case. (See Section 411.2 for a discussion of simple and compound assemblies.) Cost will also be minimized by utilizing a simple building perimeter with few setbacks or projections.

751.2.2 Ceiling

The target cost range for ceiling is between $2.10 and $3.85/OGSF, or from $2.50 to $4.55 per square foot of ceiling. These figures are higher than the comparable cost base range of $1.11 (Memphis) to $1.71 (Washington) due to the provision of better acoustic separation and strength (to give lateral support to partitions and a continuous walkable surface). Cost is also added for special fire protection of the supporting framework.

The cost per square foot of ceiling is broken down as follows:

Item	Low	High
Platform, supporting framework, hangers and attachments to structural beams	1.45	2.50
Finish ceiling	.65	.85
One-hour protection of hangers	.15	.80
Subtotal	2.25	4.15
Contractor's overhead and profit, 10%	.22	.41
Total (to nearest $.05)	$2.50	$4.55

The low total assumes the use of a reinforced poured-gypsum platform. Half of the finished ceiling is acoustic tile and the remainder is painted gypsum board except where no finished ceiling or special finishes are required. Finishes are continuous and glued on except where the acoustic tile is interrupted by strips of gypsum board to accommodate partition heads, which is assumed to be about one-half of all cases. (See options 1 and 2a in Section 322.2.) The hangers are fireproofed with a factory application of intumescent mastic, and the strongbacks are protected with field-applied “Monocoat” (vermiculite and gypsum sprayed-on coating) plus a hardcoat finish to provide physical protection.

The high total assumes a lightweight precast concrete platform and 70% accessible acoustic tile finished ceilings. All finishes are interrupted by the partitions and mechanically attached to the platform. A sprinkler system is used throughout the functional zone to provide indirect protection of the supporting framework.

The major variables affecting the cost of the ceiling subsystem are the materials selected for the platform, the method selected for fire protection of the ceiling hangers, and the type and quantity of various finished ceiling materials used. The latter varies not only in the material and finish itself, but also in the way in which it is attached to the ceiling and whether it is continuous or interrupted (See Section 322.2).

751.2.3 Partitions

The target cost range for partitions is between $3.33 and $5.88/OGSF, or from $31.75 to $56.00 per lineal foot of partition. These figures are lower than the comparable cost base range of $4.26 (Memphis) to $6.35 (Washington), and the average cost per lineal foot of $43.85 for the system compares with $47.50 for conventional design and construction. This reduction is due primarily to the use of less vinyl wall covering, the substitution of drywall for block and lath and plaster, and stopping the partitions at the ceiling. The full effect of these characteristics has been offset by additional items such as continuous back-up plates, furring around services, special details required to accommodate the greater deflections resulting from increased structural spans, and the need for two layers of gypsum on both sides of corridor partitions. (See Section 336.1 for an explanation of this last requirement.)

The costs do not reflect any savings which would result from the more rapid installation of the system partitions as compared with conventional partitions because these savings are not likely to be reflected in the subcontractor’s prices in the first few projects using the Prototype Design. Indirect savings will be evident through a contraction of construction time.

The cost per lineal foot of partition is broken down as follows:

Item	Low	High
Average 9'-6" partition	12.50	15.00
Finishes	7.60	18.00
Doors and miscellaneous	7.00	12.50
Prorated cost for furring around surface mounted services	.55	1.40
Prorated cost for non-structural two-hour fire barriers	1.24	3.10
Continuous backing plates	0	.90
Subtotal	28.89	50.90
Contractor's overhead and profit, 10%	2.88	5.09
Total (to nearest $.05)	$31.75	$56.00

These figures are based on the following assumptions:

1. The average hospital has .10 lineal feet of partition per OGSF (from measurements of Miami, Memphis, and the Phase 2 Example).

2. The areas of the hospital with 10'-0" high ceilings will constitute no more than 50% of the area, resulting in a 9'-6" high maximum average height of partition (excluding slab-to-slab two-hour fire barriers).

3. The cost range of the partition finishes in the Prototype Design is lower than that in typical VA hospital construction as reflected in the cost base. The low end of the target cost range is based on the partition finishes selected for the Building Schematic Design. The high end of the range is the average cost of partition finishes in the hospitals analyzed in the cost base. The reduction in the cost of finishes is mainly attributable to the reduced quantities of vinyl wall covering considered necessary. It includes heavy vinyl wall covering in corridors and ceramic tile in areas requiring aseptic conditions or resistance to moisture.

4. The cost range of the doors per lineal foot of partition in both the Prototype Design and conventional design and construction will be equal. The higher cost of the floor-to-ceiling door sets will be offset by the reduction in the cost of the partitions which will not need to be cut around the door head.

5. The number of clusters of services to be furred out will be approximately one per 40 lineal feet of partition in the nursing areas and one per 200 lineal feet in the support areas of the hospital. On the basis of the distribution of partitions assumed for the Example Building Schematic Design, there will be approximately one cluster of furred-out services for every 70 lineal foot of partition.

6. The number of lineal feet of two-hour non-structural partitions will vary between 40 and 100 per 10,000 OGSF.

The major variables affecting the cost of the partitions are:

1. The number of lineal feet of partition per OGSF of building, which varies in the different functional areas of the hospital between approximately .05 and .12. The size of these various functional areas will therefore affect the quantity of partitions in relation to the total area.

2. The variability in the finishes specified. In VA hospital projects this variability is reflected in the difference in the cost of finishes in the “nursing towers” at Memphis and Washington, i.e. $1.72 to $3.20 per OGSF, adjusted to an ENR Index of 960 from the Phase 2 Report. This is the equivalent of $14.40 to $21.59 per lineal foot of partition.

3. The number and type of doors specified, which can affect the cost of doors per OGSF by as much as 50%. For instance, Section 350 of the Phase 2 Report shows a range between $1.21 per OGSF and $1.86 per OGSF. This is equivalent to $7.00 and $12.55 per lineal foot of partition.

4. The number of clusters of services enclosed with furring. This type of cluster will typically occur in patient bedrooms, examination rooms and treatment rooms.

5. The number of two-hour fire barriers which must also act as shear elements and are therefore included in the structural subsystem.

751.2.4 Heating-Ventilating-Cooling

The target cost range for HVC is between $4.00 and $6.50/OGSF. These figures are below the cost base range of $4.92 (Miami) and $8.62 (Watsonville) because of the reduced amount of ductwork in a decentralized arrangement, and reduced labor costs during installation due to less conflict with other trades (organized arrangement of services in a deep service zone) which more than offsets increased costs for redundancy in service distribution and size of equipment and ductwork and decentralization of air-handling units.

The lower end of the target range is the estimated cost of a single-duct, terminal-reheat system with plenum exhaust/return, but without a supplementary perimeter convector system, in a building of simple configuration in a mild climate. The upper end of the range would be appropriate for a dual-duct, mixing-box system, plus ducted exhaust/return and a perimeter convector system, in a building of complex configuration, including interior service bays, located in an extreme climate and containing a relatively high proportion of functional areas with special HVC requirements.

The cost effect of a compound assembly (complex building configuration) as compared with a simple assembly is to add about $0.25/OGSF for ducting into the internal service modules (assumed to be one-half of all modules at most). The use of supplementary perimeter convectors adds about $0.40/OGSF.

751.2.5 Plumbing Distribution

The target cost range for plumbing distribution is between $2.00 and $3.00/OGSF. These figures imply a typical cost slightly higher than those estimated for Memphis and Miami, $2.09 and $2.20 respectively. This rise can be attributed to the increase in the number of horizontal mains and the oversizing of permanent runs to allow for demand increases.

Labor costs will rise because of the capped tees introduced for future modifications. Branch distribution costs will also be greater as the plumbing will not necessarily follow the shortest possible routes to its destination because of the sub-zoning organization. No attempt has been made to assess the savings that could result from reduced installation time made possible by the service zone organization, including some degree of prefabrication.

The low figure represents a plumbing system in a hospital of simple configuration with a small proportion of special plumbing requirements. The high figure indicates the possible cost in a complex building with a large proportion of functional areas with special plumbing requirements, plus the use of sprinklers for fire protection throughout the entire hospital. A typical breakdown would be:

General piping:	1.50
Medical gases:	.50
Fire protection:	.30
Equipment:	.04
Total:	$2.34/OGSF

The effect of total sprinklering is to add about $0.50/OGSF. It is considered that the use of standardized pre-plumbed items such as service consoles and service walls would not seriously change the cost target figures. The first cost of these units is higher than standard fixtures, but installation costs are substantially less.

751.2.6 Electrical Power Distribution

The target cost range for electrical power distribution is between $2.00 and $2.50/OGSF. Comparison with the Memphis and Miami estimates, $2.08 and $2.13 respectively, indicate a systems cost about equal to conventional design and construction.

Busducts, which are to be used extensively for the horizontal and vertical feeders, cost more than the comparable conduits and cables used in conventional construction, but installation costs should offset the increase. This will remain true even when installed busducts are sized for future predicted loads.

There will be a slight increase in cost through the use of wireways in the service zone horizontal distribution.

The use of service containers or service walls and surface mounted wireways in the functional zone will increase first costs, but again ease of installation should eliminate the extra cost overall.

The target figures do not reflect the cost of the console casings which could average about $150 per unit excluding wiring and plumbing. Dynamic grounding for techniques such as fibrilation would add about $3,000 per installation to the total electrical costs.

751.3 MISCELLANEOUS COST-BENEFIT ANAYLSES

751.3.1 Increased Floor-to-Floor Height

To account for the increased total cost of building construction due to the greater floor-to-floor height required by the Building System Prototype Design, an estimate of the additional cost of the extension of all vertical elements passing through the service zone has been made on the basis of an assumed increase of five feet over conventional design and construction. The figures are tabulated below in dollars per outside gross square foot.

Component	Additional Cost
Columns	.288
Shear walls	.184
Exterior wall	.899
Ductwork	.084
Stairs	.058
Elevators	.178
Electrical risers	.062
Lighting in service zone	.298
Piping	.064
General contractor	.318
Total five-foot increase:	$2.43

What this means is that increasing the floor-to-floor height of a hospital by five feet increases the overall cost of construction by $2.43 per square foot. This is best compared to the basic construction cost in terms of cubage. It the basic construction cost of $48.60 is distributed over a typical twelve-foot floor-to-floor height, the cost of space is $4.05 per cubic foot. But the cost of the additional service zone space is one-fifth of $2.43, or $.49 per cubic foot. Thus, the additional space and all its benefits can be purchased for about 12% of the basic construction cost.

751.3.2 Additional Space Resulting from the Use of a Structural Module

The criticism of "waste space" could be directed at the use of modular structural dimensions that allowed building width to vary only in rather large increments such as the 4'6" structural module of the Prototype Design. That is, if conventional design procedures working with standard area formulas produced a building width which could not be reduced further than, say, 74'6", the next larger modular dimension, 76'6", would have to be used. However, if it is assumed that the extra foot of space on each side of the building was not used for increasing the number of rooms but was simply added to some of the original rooms, only "raw space" costs are involved, e.g., structure, ceiling, finishes, partitions without doors or services, etc. The following items should be deducted from the basic construction costs of the total building:

Cost Item	**$/OGSF**
Heating-ventilating-cooling	4.50
Plumbing	3.50
Electrical	4.00
Casework, building equipment, etc.	4.00
Vertical transportation	1.00
Site work	1.25
Services (medical gasses, etc.)	1.75
Total non-applicable costs	$20.00

Subtracting from $48.60, the incremental space is priced at only $28.60, or about 60% of the overall cost of the minimized configuration. It must be emphasized that "raw space" costs apply only to increments of space small enough that lighting, HVC, plumbing, etc., are not affected.

The effect of this added space on the total cost of a hospital can be illustrated by application of these figures to the Example Building Schematic Design presented in Section 730. The total area of the building shown in about 843,000 square feet. It the nursing wards are composed of space modules which could have been four feet narrower in width if not constrained by modular dimensions, then about 18,000 square feet of incremental space has been added to allow conformance to the module. That is, the total area has been increased by 2.2%.

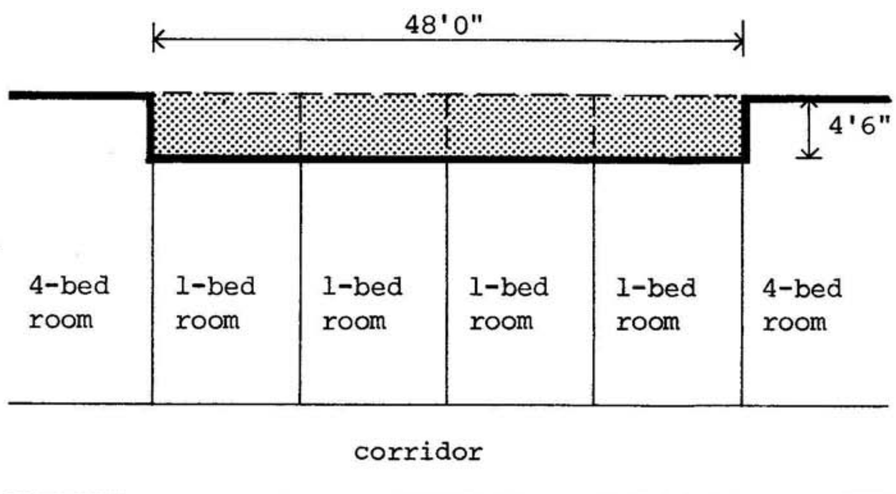
The original area would have been 843,000-18,000 = 825,000 square feet, which at $48.60 per OGSF would have given a total cost of $40,095,000. The incremental space added would cost 18,000 times $28.60 or $514,800, bringing the actual total cost to $40,609,800. This is an increase of 1.3% in the total cost of the hospital to add four feet of width to every nursing ward.

751.3.3 Simple vs. Complex Perimeter

Another criticism of the use of dimensionally predetermined planning modules might be that the absolute optimization of the efficiency of an opening configuration is not possible. That is, in conventional design it is common practice to adjust the perimeter of the building to allow tight packing of the various interior spaces, each of which has had its area set by a formula for minimum requirements and/or maximum allowable size, thus producing the most favorable gross-to-net-area ration. The answer to this criticism is that the time-saving and adaptability characteristics of the space modules are worth the price of some “redundant” space.

To get some idea of what this kind of incremental space might cost, the following model has been used as a basis for estimating:

Four adjacent one-bed rooms are located between two-or-four bed rooms along a corridor of constant width in a typical nursing unit. The one-bed rooms require 4’6” less depth than the others, so there is a recess of that dimension in the building perimeter. Since the one-bed rooms are each twelve feet wide to partition centerlines, the recess is about 48 feet wide overall. The horizontal area of the recess is 4’6” by 48’0” = 216 square feet.



If the dimensions of the multi-bed rooms, the corridors and the core cannot be reduced, the only way to simplify the perimeter is to eliminate the recess and arbitrarily assign the added space to the one-bed rooms. It can be assumed that since to new rooms are added and room function does not change, no additional services are required. It is further assumed that the reduced building perimeter compensates for the added space as far as HVC requirements are concerned. Dimensions are based on the Prototype Design, e.g., floor-to-floor height is seventeen feet. The same reasoning given in Section 751.3.2 above concerning deductions from basic construction cost applies to this case except that certain adjustments must be made for the effect on the exterior wall.

Add:

Interior partitions (without doors)	9 lf @ $25.00	= $225

Deduct:

Exterior wall	153 sf @ $ 6.00	= $920
Corners	68 lf @ $ 6.00	= 400
Interior furring	80 sf @ $ 1.00	= 80
		$1400

This amounts to an additional deduction of $1175 distributed over 216 square feet, or $5.45 per square foot. Subtracting from the figure given in 751.3.2, we have $28.60 - $5.45 = $23.15 per OGSF, or about 48% of base construction cost. The effect of this kind of incremental space on the total cost of the hospital obviously depends on how much of it is added in any particular case, but it would typically be of the same order of magnitude as that indicated in 751.3.2 above.

751.3.4 Beams vs. Trusses

The beam and suspended ceiling approach for providing a deep service zone was preferred to a truss and directly attached ceiling for the Prototype Design primarily for functional reasons. Also, it was assumed that since for planning purposes spans over sixty feet were not required, beams would always be more economical than trusses. In fact, it was this very consideration of a cost break that led to a careful planning study of how interior columns could be located to minimize the constraints to planning and adaptability.

To check the cost break assumption, three general structural types were carried through detailed design on the basis of a single bay of 22'6" with a span of 58'6" plus an 18' cantilever. Appropriate items were added to each to make final figures comparable, e.g., cost of hangers added to beams and fireproofing added to steel. The conclusion was that concrete beams are much lower in cost than steel trusses at these spans, and steel beams are slightly less than trusses. The following figures include 10% contingency and 10% contractor's overhead and profit, but cost savings attributable to speed of construction were not estimated.

Structure-Ceiling Solution	$/OGSF
Cast-in-place concrete beams and ceiling	8.00
Steel beams and suspended ceiling	10.25
Steel truss and directly attached ceiling	10.50

The functional advantages of the beam-and-hanger solution are:

1. Service zone more efficiently utilized by ductwork, etc.

2. Less obstruction to movement of workmen and equipment.

3. Independence of structural depth and service zone depth.

Trusses also have some advantages:

1. Less deflection.

2. Less weight.

752 LIFE COST

752.1 THE PROBLEM OF MEANINGFUL COMPARISONS

The costs of financing, operating, maintaining and altering buildings usually exceed their first cost. The total long term (forty years) cost of VA hospitals runs eight to ten times their construction cost. No one denies that an attempt to reduce first cost to an absolute minimum without regard to these other long term factors would be false economy. But there are several difficulties in applying this principle.

First, capital and operating budgets are maintained separately for administrative purposes, introducing motivations in conflict with trade-off efforts. Second, capital funds are committed to specific projects so far in advance that they become severely constrained by escalation of construction costs. And third, current methods of operations cost accounting do not readily yield data that can be exclusively assigned to specific subsystems and components. So, although the various elements of long term costs are the subjects of considerable individual management discipline, it has been impossible to optimize their total effect, and especially difficult to justify higher first cost in terms of potential long-range savings. The problem of meaningful comparisons is further complicated by the following difficulties:

1. The Prototype Design developed in this study does not consist of a specific list of building products. Rather it provides a framework of coordinated generic subsystem designs within which the VA and the A/E can derive the optimum detailed design for each specific program, time and place through a rational process of trade-offs. Cost projections can only be approximations based on the generic solutions.

2. Actual long term costs will depend to a considerable extent on geographical and other project-specific factors. For example, mechanical operating costs will vary with climate, exterior wall design, building orientation, local utility rates, etc.

3. A major part of the design effort has been on the organization of service distribution, the provision of convenient access for maintenance, repair and replacement, and the control of interface conditions for ease of alteration.

The theory is this discipline will pay off in the long run. But an attempt to reliably predict actual cost savings in these areas is not feasible. There are too many variables involved, and not enough field experience with the particular kind of solution proposed. Not is there any reasonable way to estimate what it is currently costing the VA to not have properly accessible and adaptable spaces in terms of physical plant utilization.

4. In a project constrained to use currently available non-proprietary products, but directed to improve performance, some increase in first cost over present methods is implicit. There are prospects of compensating for this effect quite directly through significant reductions in design and construction time made possible by the deliberate detailing of the system for that purpose. But how much of a savings is realized depends on how far the VA is willing to go in the way of altering customary decision-making procedures, how well A/E's and building contractors understand the scheduling benefits of the system, and on what theoretical basis time savings is translated into cost savings.

752.2 RELATION OF LIFE COST TO FIRST COST

752.2.1 To be justified solely on the basis of long-term cost, any additional first cost must be "paid for" by savings in housekeeping, maintenance, and minor and major alterations. The amount of savings required can be calculated from the additional first cost by discounting it at, say, 5% over forty years. The trade-off factor under these conditions is 17:1.

752.2.2 For example, if the marginal cost of a systems hospital over conventional design and construction in a particular case is 8%, then 1/17th of that amount, or about 0.5% of the first cost of the building must be saved each year from operating, maintenance and alteration costs to break even in forty years.

752.2.3 There are many items of operating cost that will not be materially affected by the Prototype Design, such as dietetic equipment, engineering supervision, utility costs and elevator maintenance. The three areas where savings are anticipated are housekeeping, maintenance (including minor alternations), and major alterations. In the Phase 1 (feasibility) study, these costs were reviewed for eleven VA hospitals over a three-year period.

When conservative escalation rates were applied to the data for a forty year period, it indicated that the total average annual cost of these three items alone would amount to about 12.5% of the original construction cost. If the 0.5% marginal first cost of the system building is to be paid for out of an item costing 12.5% of the same base figure, then 1/25th, or 4%, of that item must be saved each year.

752.2.4 To summarize, if a systems hospital cost 8% more than an equivalent conventional hospital, then it must allow a 4% reduction in the annual total cost of housekeeping, maintenance and alterations to break even after forty years.

752.3 ANALYSIS OF EXISTING VA HOSPITALS

752.3.1 The field change orders, Central Office change orders and the station-initiated completion items for each of the five hospitals studied for the cost base (Section 530) were reviewed with the intent of relating them to the integrated subsystems. The results of this attempt, however, were inconclusive to the point that tabulations would be worthless.

752.3.2 It is apparent that since most of the hospitals are relatively new, there is a conflict between the needs for changes resulting from "settling down" and those dictated by new technology or other new requirements. The time lapse of at least seven years from inception to occupancy increases this conflict. At any rate, none of the subsystems provided for any form of adaptability in spatial arrangements or performance characteristics. The oldest hospital studied, Martinez, was constructed under a policy of only partial air-conditioning. Expanding the cooled areas of this hospital has been very costly. It is interesting to note that, in spite of the restricted cooling in the initial design, the original cost of this installation is among the highest. (See Section 532.4.7).

752.3.3 There have been very few additions to the hospitals studied, in terms of adding space. There have been, however, numerous instances of conversion of ward areas to other uses. This has resulted in the fact that many of the hospitals do not contain the number of nursing beds required by their original design program. An outstanding example of this is a complete floor of the tower at Miami which now contains administrative offices created by merely adding doors and partitions in the five-bed ward areas. Such situations appear to be characteristic; their scope and costs practically impossible to identify.

752.3.4 As mentioned in Section 752.2.3 above, eleven VA hospitals have been analyzed in terms of those particular items of life cost on which the Prototype Design is expected to have some beneficial effect. The breakdown was as follows:

1. Maintenance and minor alterations cost an average of $1.46 per OGSF annually for the eleven hospitals in the years 1965, 1966, and 1967. Bringing this figure up to 1971 and projecting the average annual cost for the next forty years results in an average annual cost of $3.62 per square foot at an average compounded escalation of three percent per year.

2. Housekeeping costs for the same period were $ .54 per OGSF. Projected for the next forty years at an average compounded escalation of three percent per year, this would average $1.34 per year.

3. Major rehabilitation accounted for an average of $.31 per OGSF per year. (The only data giving a long enough rehabilitation record to be useful was obtained at Salt Lake City.) The average annual cost for forty years, with an average compounded construction cost escalation of four percent per year, would be $1.09 per year.

The total of these items of operations and maintenance amounts to $6.05 per square foot per year; for forty years this totals $242.00 per square foot for the assumed useful life of the building, or five times the first-cost average of $48.60 for the six-hospital cost base (Section 351).

752.4 OPERATIONS AND MAINTENANCE

The total average annual cost of maintenance and minor alterations and housekeeping has been estimated at $4.96 per OGSF. (Sum of the first two items listed in 752.3.4 above.) An overall savings of 5% may be reasonably expected for these items, mainly due to accessibility and relocatability of service elements, and reduction of down time during alterations and repairs. Also, the HVC subsystem does not utilize induction units, so filters are centralized at the air-handling units.

Applying the trade-off factor described in Section 752.2.1 above, the annual savings of $.25 per OGSF would pay for $4.25 per OGSF of additional first cost in forty years.

752.5 MAJOR ALTERATIONS

752.5.1 To obtain some measure of how the Prototype Design might affect the cost of major alterations, a cost estimate was made for a hypothetical alteration to the Example Service Module Design (Section 743). The cost assuming conventional design and construction (Table 750-2) was compared with the cost assuming a systems application (Table 750-3). In dollars per gross square foot, the systems cost was $14.54, whereas the conventional cost would be $17.86. The difference of $3.32 represents a savings of 18.6%.

A similar estimate was made for the Phase 2 study, analyzing an alteration to a GM & S nursing ward. (See Section 361.2 of the Phase 2 report.) In that case, the saving was 42%.

If actual alteration costs averaged 20% less than with conventional design and construction, the average annual cost of $1.09 per OGSF calculated for this item in the eleven-hospital study (Section 752.3.4) would be reduced by $ .22. This can be considered a conservative figure because the frequency of demand for changes and the complexity of the types of change required may be expected to increase steadily over the foreseeable future. Also, the actual construction cost escalation rate over the last few years has been much higher than the four percent used in the calculations.

Application of the 17:1 trade-off factor results in an equivalent first cost of $3.74 per OGSF which can be justified by this saving in forty years.

752.5.2 The cost estimate in Table 750-2 is based on the following assumed conventional conditions:

1. Structural metal studs with metal lath and plaster over lead-lined plywood for shielded walls.

2. Sheet metal studs with metal lath and plaster for other partitions. Corridor partitions extend from slab to slab.

Table 750-2. ALTERATION COST ESTIMATE, EXAMPLE SERVICE MODULE DESIGN, CONVENTIONAL DESIGN AND CONSTRUCTION

Work	Cost	Totals
Remove:		
Corridor partitions (to structure)	$1,050	
Room-to-room partitions	630	
Office doors and frames	200	
Acoustic ceiling	350	
Flooring	880	
Plumbing, lavatories	600	
Lighting fixtures	900	
HVC diffusers	70	
Ductwork, reheat coils and piping	360	
		5,040
Install:		
X-ray partitions, corridor	$3,800	
X-ray partitions, room-to-room	8,180	
Other corridor partitions	1,560	
Other room-to-room partitions	1,110	
Lead-lined doors	3,120	
Rehang doors and frames	350	
Lead glass windows	900	
Ceramic tile	610	
Ceiling	3,500	
Vinyl asbestos flooring	2,630	
New water closet	600	
Relocate lavatory	500	
Toilet exhaust	300	
Supply and return diffusers	1,000	
Ductwork and insulation	4,500	
Temperature controls	750	
Reheat coils and piping	3,000	
Light fixtures	2,380	
Switches and outlets	1,500	
X-ray wireways and power wire	2,000	
X-ray control conduit and boxes	6,000	
Suction, air and oxygen	2,480	
		50,770
Subtotal, remove plus install		55,810
General contractor, 12%		6,700
Total cost, conventional		$62,510

Distributed over 3,500 square feet = $17.86/sf.

Table 750-3. ALTERATION COST ESTIMATE, EXAMPLE SERVICE MODULE DESIGN, BUILDING SYSTEM PROTOTYPE DESIGN

Work	Cost	Totals
Remove:		
Partitions	800	
Doors and frames	200	
Acoustic ceiling tile	180	
Service container furring	30	
Lavatories	600	
Lighting fixtures	720	
Outlets and switches	370	
HVC diffusers	190	
Ducts, reheat coils and piping	240	
		3,330
Install:		
X-ray partitions, corridor	3,070	
X-ray partitions, room-to-room	6,840	
Other corridor partitions	1,630	
Other room-to-room partitions	1,060	
Lead-lined doors and frames	3,920	
Lead glass windows	900	
Relocate doors and frames	350	
Ceramic tile	610	
Replace ceiling tile	600	
Protect and patch flooring	350	
New water closet	350	
Relocate lavatory	200	
Light fixtures	1,700	
Switches and outlets	1,500	
Toilet exhaust	230	
HVC diffusers	1,000	
Patch gypsum platform	250	
Ductwork and insulation	4,050	
Temperature controls	750	
Reheat coils and piping	3,000	
X-ray control conduit and boxes	6,000	
X-ray conduit and power wire	1,000	
Suction, air and oxygen	2,480	
		41,840
Subtotal, remove plus install		45,170
General contractor, 12%		5,420
Total cost, Prototype Design		$50,590

Distributed over 3,500 square feet = $14.54/sf.

3. Suspended mineral time ceiling, one-hour rated in corridors, completely removed because of penetrating partitions.

4. Flooring interrupted by partitions.

The cost estimate in Table 750-3 is based on the following assumed system conditions:

1. Lead-lined gypsum board on structural metal studs for shielded walls.

2. Gypsum board on sheet metal studs for other partitions. All partitions stop at the ceiling-platform.

3. Accessible acoustic tile on modular runners attached to poured-gypsum platform. Only areas disturbed by partitions and diffusers need to be replaced.

4. Flooring uninterrupted beneath partitions.

752.6 TOTAL EFFECT ON LIFE COST

Assuming that no other items of long-term cost other than those discussed above are affected by the Prototype Design, and the annual savings suggested are actually realized, the total savings of $ .47 per OGSF will pay for $7.99 of additional first cost. This total savings is 8% of the three items of life cost considered, which is enough to pay for 16% of additional first cost. (See Section 752.2.4 above.)

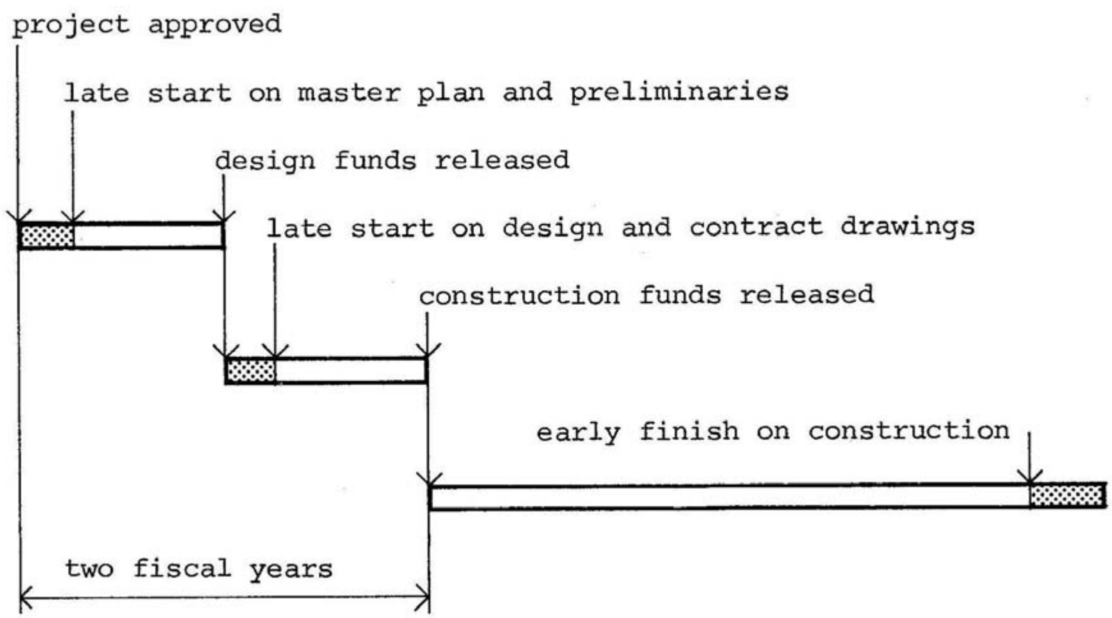
753 TIME REDUCTION

753.1 ADVANTAGE OF THE PROTOTYPE DESIGN

If all system characteristics are fully exploited for time reduction within the current schedule for obtaining funds, there are two main benefits:

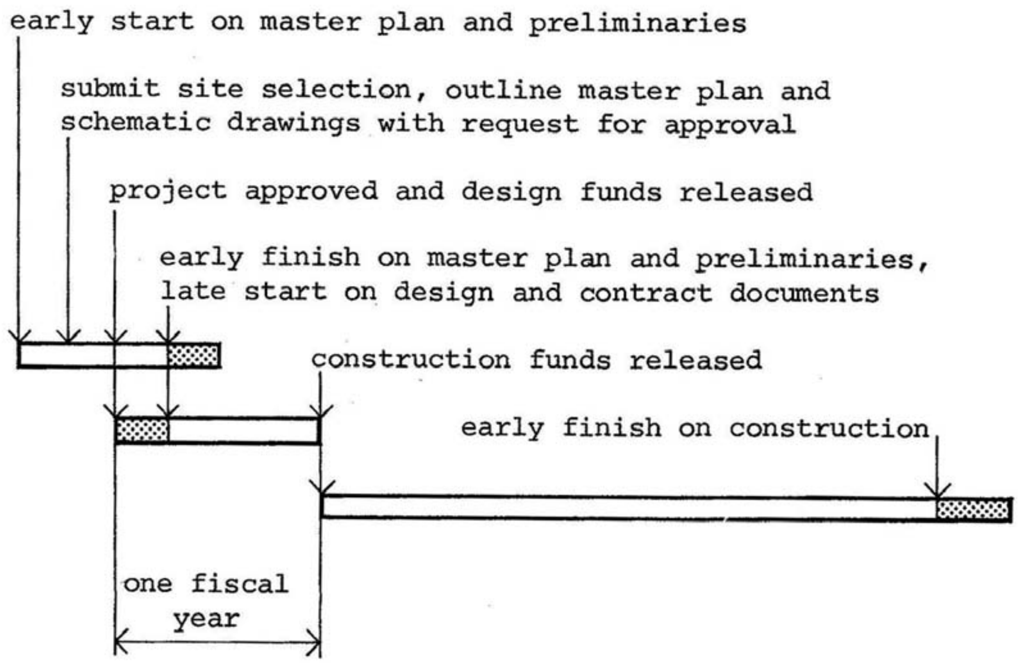
1. Master planning and preliminary design may be started later than normal for purposes of obtaining design funds in a given year, and detailed designs and contract documents can get a later start for purposes of releasing construction money.

2. As much as six months may be saved during construction.



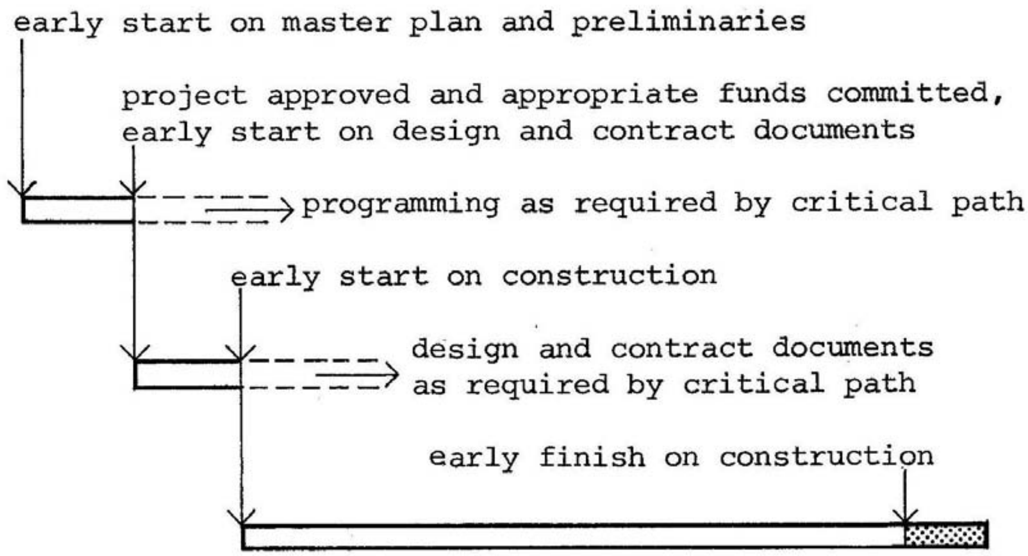
753.2 ADVANTAGES OF SPECIAL FUNDING

A much more significant time saving can be realized if design and construction funds are released earlier than the present schedule allows. Since such funds are normally available only at the beginning of a fiscal year, the schedule may be most readily altered, if at all, in one year increments. For example, if both design and construction money could be obtained one year early, and six months are saved during construction, the present six-year minimum schedule would be reduced by eighteen months.



753.3 ADVANTAGES OF PHASED BIDDING

If all available time-saving opportunities are fully utilized, and all necessary funding can be obtained in a timely manner, regardless of fiscal year considerations, still further reduction is possible. This arises from the fact that site work and erection of structure can begin without a complete set of working drawings for the finished building. Furthermore, working drawings for site work and structure do not require detailed design of the finished building. Finally, design of the site and structure does not require a detailed master plan for the finished building. That is, sufficient information can be developed to allow construction to begin prior to final completion of programming, design and contract documents. After sufficient experience with streamlined decision-making processes has been obtained over several projects, a skilled management team might reduce total production time by about two years. For a discussion of accelerated scheduling techniques, see Section 761.



753.4 IMPLICATIONS OF TIME REDUCTION

It must be emphasized that although the planning modules and the integrated subsystems allow certain time reductions and facilitate accelerated scheduling, they do not reduce the actual amount of work to be done. They simply allow the work to be carried out more efficiently. They in no way substitute for the knowledge, skills, or decision-making capabilities of administrators, architects, engineers, technical consultants and construction contractors and sub-contractors. The intent is to assist all parties concerned in making more effective use of their time.

It must also be pointed out that it is highly unlikely that all the potential advantages of these devices will be fully obtained on the first building project. Since many features of the proposed system are innovative or theoretical, there is no way to accurately predict their performance in the field. It must be expected that actual cost and time savings will be subject to the typical learning curve of any new production process.

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760 Special Procedures

761 ACCELERATED SCHEDULING

761.1 THE PRINICIPLE OF "FAST-TRACK"

To obtain the earliest possible construction start, not only must funding be provided sooner than current practice permits, but bidding must proceed before completion of all contract documents, in fact, before the building is completely designed. This technique is known as "fast-track", and is commonly used in private construction, but is usually precluded in public work by elaborate approval procedures and safeguard measures. (See Figure 760-1.)

Obviously, this approach requires early commitment to certain key decisions which cannot be reversed subsequently without serious loss of time and resources. Some of the opportunities for second thoughts which are inherent in conventional design and construction must be foregone.

This discipline has a secondary payoff, however: many detailed decisions which had to be made years before they could be put into effect can now be postponed until immediately prior to their implementation, thus providing a powerful hedge against obsolescence.

761.2 BIDDING PROCEDURES

761.2.1 Unit Prices

If construction is to start prior to completion of all contract documents, bidding must proceed in some manner different from current VA practice. In theory, general construction contractors could provide single lump sum bids for an entire project based on the following documents:

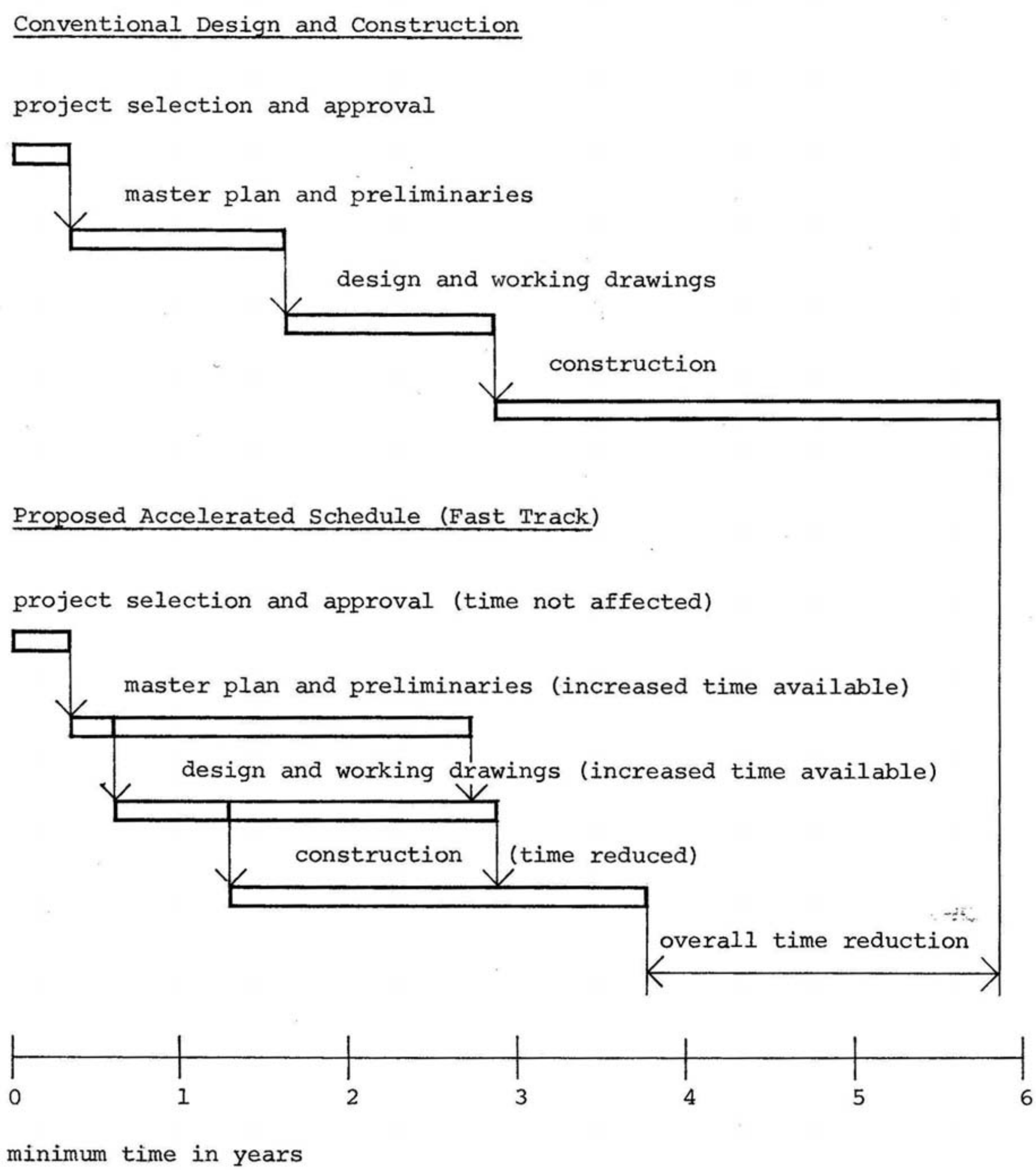
1. Schematic or preliminary drawings of the whole building. Complete specification for all work.

2. Working drawings for site work and foundations.

3. Estimated takeoffs (quantity surveys) and standard details for all other work.

Sub-contractors' bids would be translated into unit prices guaranteed within a specified range of the bid quantity and subject to a specified escalation rate.

Figure 760-1. COMPARATIVE SCHEDULES



If actual quantities required by final design fell outside the range, prices would be subject to negotiation.

There are a number of drawbacks to this approach:

1. The necessity for specifications and standard details at the time of bidding can seriously constrain subsequent design development, thus partially defeating the objective of reduced obsolescence.

2. The specifications and details may have to be more elaborate than usual to cover some range of future detailed design conditions, and the time required for their complete development might delay construction start.

3. Contractors may increase their normal contingency factors in bid calculations due to the uncertainty of future conditions. (One of the benefits of accelerated scheduling should be the reduction of the contingency and escalation factors that contractors and sub-contractors must take into account.)

761.2.2 Phased Bidding

The most rational approach to design and construction efficiency involves breaking up construction work into a series of relatively small bid packages which are released only as required to provide sufficient lead time to keep construction on schedule. This technique has some significant advantages:

1. The scope of the various bid packages can be tailored to the particular characteristics of the project, e.g., local contractor capabilities, labor conditions, critical path considerations, etc.

2. Latest possible development of each package reduces obsolescence.

3. Latest possible bidding by each specialty contractor allows relatively low contingency factors in bid calculations.

4. The quantity and quality content of each successive package can be controlled through tradeoff considerations by the VA and A/E to adjust for deviation of current actual costs from budget estimates.

5. Since each package is much smaller than the typical total construction contract, many small contractors who would normally not be bondable would now be eligible, thus improving the competitive situation to the VA's advantage.

The associated disadvantages are:

1. At the time of construction start, there is no guarantee of the final cost of the building equivalent to the traditional prime contractor's lump sum bid.

2. The VA must deal with a series of individual contracts rather than with a single prime contractor. However, this problem may be alleviated through use of a "construction manager." (See Section 762 below.)

3. Successful management of phased bidding requires a serious team effort among persons who are generally accustomed to more traditional procedures. The VA and its typical A/E contractors may not presently have the internal resources required in terms of skills and experience. Although these can certainly be developed over time, the problem is how to get started. Again, the use of a construction manager in lieu of a prime contractor can provide the necessary capability.

762 CONSTRUCTION MANAGEMENT

762.1 One of the present major sources of production delay, not to mention difficulty of cost and quality control, is the fragmentation of project management brought about by the traditional shifting of the major burden of responsibility, first from the VA to the A/E and then to the general construction contractor. If phased bidding, with consequent elimination of the single prime contractor, were to be introduced directly into this context, it could do more harm than good.

762.2 First, the construction management role of the prime contractor must be preserved even though the person or group assuming this role does not contract with the VA on the basis of a lump sum bid for the delivery of a completed building. He may be by profession a general construction contractor, and he would have a contractual arrangement with the VA for provision of management services on a fee basis, but he need not personally provide any portion of the actual construction work. He is simply a "construction manager."

762.3 Second, the relation of the construction manager to the series of contractors introduced by phased bidding must be recognized as different in certain key respects from the traditional relation of a prime contractor with his sub-contractors. The construction manager would recommend to the VA the specific way in which work is to be subdivided into bid packages, and he would manage the phased bidding procedures in accordance with his knowledge of local conditions. All contracts are directly with the VA, but the construction manger would act as the VA's agent in ensuring that each contract is properly executed, e.g., he may control progress payments.

762.4 Finally, the role of the construction manager must be expanded to include consulting services to the Office of Construction and the A/E Contractor. In fact, the O/C, the A/E and the construction manager should constitute a management and production team following the entire project through without any major shifts in burden of responsibility along the way. It is conceivable that A/E's and construction managers may offer joint services so the O/C may deal directly with an "A/E/M Contractor."

762.5 These procedures are possible because it is not necessary to wait for completion of conventional working drawings and specifications to bring the capabilities of a local general contractor to bear on the development of cost-effective design solutions; he may be retained as the construction manager at about the same time as the A/E contract award. If construction funds are not immediately available, he could be paid out of design funds.

763 PRODUCT EVALUATION

763.1 RESPONSIBILITY OF THE A/E CONTRACTOR

763.1.1 Select Generic Design

The Prototype Design provides a small number of generic design options for each integrated subsystem except plumbing and electrical distribution. If the VA has not specified which option is to be utilized in each case, the A/E must make a selection. This selection may be obvious under the circumstances of the particular project, or it may require cost-benefit analysis. Parallel selections of generic solutions for the non-integrated subsystems must proceed by conventional procedures, with particular emphasis on compatibility with the Prototype Design.

763.1.2 Develop Detailed Design

Detailed design of all subsystems proceeds in conjunction with product evaluation in a more or less conventional manner except that products under consideration for the integrated subsystems must be able to meet the design criteria. Similar criteria may be established by the VA for the non-integrated subsystems (see VA Construction Standard CD-31 re curtain walls).

763.1.3 Record and Submit Data

The results of all evaluations should be tabulated in terms of cost and performance in a manner allowing direct comparison and submitted to the VA for inclusion in a building product data base. This may be done on standard formats provided by the VA. The A/E's of successive projects can draw on this resource and contribute to it in turn. (See Section 635.5.)

763.1.4 Supervise Product Development

In the event that the VA wishes to proceed with any special product development programs, these may be organized and/or managed by the A/E. (See Section 764 below.) This could involve development of performance specifications such as those provided in this report for a platform-ceiling (Section 770 below).

763.2 RESPONSIBILITY OF THE CONSTRUCTION MANAGER

If the VA elects to attempt a highly accelerated design and construction schedule through use of phased bidding and a construction manager (See Sections 761 and 762 above), the manager could assist the A/E in product evaluation, including selection of generic subsystem designs. He would organize the sub-division of all work into appropriate contract packages, manage the bidding and supervise execution of the contracts. He would also assist the A/E in managing special product development programs, or he could manage them directly.

764 PRODUCT DEVELOPMENT

764.1 FROM PROTOTYPE TO PRODUCTION LINE

The Prototype Design provides an intermediate step toward the ultimate objective of an industrialized building system specifically organized for the construction of hospitals. It has been carried in this direction as far as possible within the scope of the systems integration program. Further development can take place at the level of specific components and subsystems through various kinds of manufacturer incentive programs. A number of these were described in the Phase 1 (feasibility) study. Since any of these methods could be applied to the Prototype Design, they are reprinted here in full (Section 764.2).

764.2 PAYING FOR RESEARCH AND DEVELOPMENT

“By identifying the product needs and committing a potential sales volume, it is possible to provide manufacturers with the incentive to undertake the sizeable financial risks attendant to product innovation.

“Four basic processes which have been used to provide the incentive for new product development are described below:

764.2.1 “The ‘Guaranteed Market’ Approach

“The potential consumer (in this case, the Veterans Administration) would guarantee a minimum volume of sales to the manufacturer who satisfies performance specifications and has the best price.

“As a prerequisite, the customer must guarantee the market in advance of research and development activity. Since research and development usually requires from two to four years, this means that the customer is guaranteeing a future building market some three to five years distant.

764.2.2 “Subsidized Research and Development

“A common practice for the Federal government is to contract for all or part of the research and development effort, due to Federal regulations which make it difficult to guarantee future markets. For example, in weapons systems development, a prime contractor is chosen on the basis of preliminary design/cost submissions.

He is then given a contract to develop and test prototypes, which, if successful, the government may then order in volume. In this way, the manufacturer is guaranteed the bulk of development costs, and no commitment on purchase of the final product is required. A major disadvantage to the building industry is that the resultant designs and processes are in the public domain. This denies the manufacturers the right to patent, which is an important competitive incentive. It becomes difficult to convince manufacturers to undertake such efforts if no competitive advantage results.

764.2.3 "Predesign and Competitive Bidding

"As a compromise between the above approaches, partial subsidy of innovation may be considered. One approach might be to contract for product design. For example, the Veterans Administration might contract with a professional organization or joint venture combining systems and medical architecture/engineering capability to complete design of a component system. Competitive bidding for production of components would then take place. Components, as produced by alternative manufacturers, might then be placed on a supply schedule similar to a GSA schedule, and could then be purchased as required. No guarantee market would be mandatory, though it would be preferable. Even though the manufacturer is spared design cost, he would still face plant, equipment, tooling and testing costs, and he may not be willing to bid unless he sees a market, or unless his designs require relatively little innovation, minimizing such costs.

"A potential disadvantage is that the design team may not posses the full technical expertise of a team of designers within the manufacturer's own operation.

764.2.4 "Sales Payback

"Another innovative approach was developed by the Federal government in cooperation with industry for the development of the supersonic transport aircraft. A prime contractor was selected on the basis of preliminary design and cost information. The government loaned him the money for research and development, on the stipulation that this loan would be paid back out of sales revenue. The rate of payback is geared to sales volume. Thus, if total sales are as the government predicts, they will recover the entire loan.

If sales are less than predicted, the manufacturer is protected against major losses, as he would not be required to make full payback. Such an approach guarantees the risk costs, while not specifically guaranteeing the market."

764.3 LIMITED PROGRAMS

764.3.1 If these kinds of programs are not feasible for the VA for the time being, the constraints to new product development are considerable. Research and development must occur within the scheduling as well as economic framework of a single building project or small group of projects in the design stage at any one time. Projects already in the construction phase could only benefit from development of products scheduled for installation near time of completion. On the other hand, work started during the design phase might suffer from uncertainty of construction funding. Such programs also imply proceeding with design, and probably construction, without complete knowledge of the detailed characteristics of certain subsystems and components. It is quite possible to do this, but it may require commitment of construction funds without completely detailed working drawings and specifications in the conventional sense.

764.3.2 The primary vehicle for defining the scope of manufacturer research and development work, whether based on one or many building projects, is the performance specification. To qualify as bidders, manufacturers must first submit their proposed designs in sufficient detail to allow reasonable judgment of their capability for satisfying the specifications. They may then bid on the basis of their own designs and some stated volume of work. Typically, designs of buildings in which the new products are to be used are not yet available. In fact, after a certain point, building design cannot proceed without knowledge of which product design is going to be developed. Thus, if performance bidding by manufacturers is to be utilized for a particular project, initiation must occur as early as possible to avoid conflict with the building design and construction schedule.

764.3.3 Performance specifications are normally neither feasible nor desirable as an integral part of a set of construction documents. This is not only because of the time and contingency factors discussed above, but also because such specifications are aimed primarily at manufacturers rather than construction contractors.

Modern conventional specifications are increasingly performance-oriented, and VA Master Construction Specifications are a case in point. Under most imaginable circumstances, the use of performance specifications in this context has no real advantage over direct subsystem design by the A/E, and it could have serious disadvantages, primarily large contingency factors in building contractor bidding and delays in the construction schedule.

764.3.4 The Prototype Design does, however, present one opportunity for some product development work, and that is in optimizing the detailed design of the ceiling system. If a carefully planned program could be started promptly after commitment of design funds, there is probably enough time available for a limited but useful manufacturer response to a request for performance design and bids, even within an accelerated design and construction schedule. Use of phased bidding and construction management would in fact improve feasibility. A format for a ceiling system performance specification is provided for this purpose (Section 770).

A discussion of how the specifications could be utilized within a single building project is presented in Section 764.4 below.

764.4 A DEVELOPMENT PROGRAM FOR A SPECIAL CEILING SYSTEM

764.4.1 Determine Feasibility

An initial study is made to determine if the scheduled time available before the ceiling system must be installed in a building for which design funds have been committed is adequate for a superimposed development program. Potential bidders are identified and interviewed to assess research and development capabilities. They are given all pertinent information such as the Prototype Design, performance requirements, preliminary cost targets, and delivery schedule. If these discussions indicate that there are capable manufacturers willing to invest development effort within the given constraints, and that this effort is more likely to lead to a cost-effective solution than direct design by the A/E utilizing products already available, the program is considered feasible.

764.4.2 Establish Scope

Preliminary analysis is conducted in cooperation with interested manufacturers to identify those components of the ceiling system most likely to benefit from research and development in terms of both cost and performance. The specifications in Section 770 have been prepared on the assumption that the hangers cannot be significantly affected and should therefore not be included in the scope. Work to be performed by bidders is delineated and includes installation as well as manufacture and delivery.

764.4.3 Encourage Alliances

There are few if any manufacturers presently prepared to accept single responsibility for all components or for installation as well as delivery. Alliances are therefore necessary among manufacturers and between manufacturers and installation sub-contractors. Partial bids are not acceptable, so each alliance presents itself as a single bidder called a “component contractor.” The VA and its consultants encourage and assist the formation of these groups. If viable groups cannot be quickly formed, project feasibility and scope are re-examined.

764.4.4 Publish Bid Documents

Using the format provided in Section 770, all performance parameters are quantified on the basis of appropriate standards, cost-benefit analyses, trade-offs, etc. The performance specifications and other required bidding documents, such as general and special conditions, are distributed to interested parties. This includes bid forms stating component quantities to be used as the basis for bidding. A conference is held shortly thereafter for verbal explanations and answering of questions. The A/E or other consultant is designated as the official interpreter of documents and arbiter of disputes.

764.4.5 Provide Design Assistance

Each bidder prepares his design in response to the performance specifications. The A/E provides design guidance to the bidders to a degree commensurate with their own internal capabilities and as required to assure responsive submissions. The A/E fee is adjusted accordingly by the VA.

Design proposal material is prepared in the form of shop drawings, material specifications, and any other sketches, models or text required to completely describe the design.

764.4.6 Evaluate Designs

At the termination of the design period established in the bid documents, all designs are submitted to the VA and its consultants for evaluation. Failure to submit a responsive design disqualifies a bidder. Designs judged probably capable of meeting all performance criteria if developed are officially accepted and considered equivalent for bidding purposes regardless of various features which may exceed minimum requirements. Bidders thus qualified are so notified and invited to submit sealed bids on the basis of their own designs. Until bid opening, all designs have their confidentiality guaranteed.

764.4.7 Evaluate Bids

Bid forms require application of certain weighting factors to the bidder's base cost calculations to reflect external cost implications of his design. The purpose is to approximate true owning cost in the adjusted total and thus render different designs more truly comparable. For example, a weighting factor of four cents per inch of thickness per square foot of ceiling is added to account for the cost effect on the total building of increased floor-to-floor height.

Bids are opened at the scheduled time and place and examined for responsiveness. If alternates have been requested, they are applied to the base bid in a predetermined manner. The overall low bidder is nominated Component Contractor and assigned a contract to develop, test, supply and install the required quantity of ceiling in accordance with his design. If all bids significantly exceed the target, the VA either rejects all bids or negotiates with the low bidder.

Unit prices are either required on the bid forms, or the contract requires their submission at some designated time during the development period.

If the VA has provided any direct financial aid to potential bidders to offset design costs, all designs are made public. Otherwise, only the designated Component Contractor's design is revealed; all others are kept confidential and design material returned to the unsuccessful bidders.

764.4.8 Provide Development Assistance

Development of the ceiling design into a manufactured product meeting all performance criteria is the responsibility of the Component Contractor. However, it is in the VA's own interest to provide the Contractor with technical, and perhaps financial, assistance to assure optimum cost-effectiveness.

Prototype components are subjected to a predetermined testing program and certification of test results submitted according to schedule. This work is performed either on the construction site with all components in their actual location or under suitable simulated conditions elsewhere. If possible, one service module is completed on a crash schedule to provide for mock-ups and testing while remaining construction proceeds at normal pace. Development and testing is supervised by the A/E, or by the construction manager if there is one.

The Component Contractor provides the VA and the A/E with unit prices (if not required in the bid) and an information manual completely describing the developed design.

764.4.9 Install the Developed Ceiling

Upon successful completion of all performance tests, the Component Contractor becomes a sub-contractor to the general construction contractor, or continues under direct contract with the VA if a construction manager is being used. The Component Contractor must install, and the VA buy, approximately the quantity of ceiling established as the basis of original bidding, at exactly the submitted unit prices, subject to appropriate escalation clauses. After completion of the contract, the Component Contractor is free to change his design and prices.

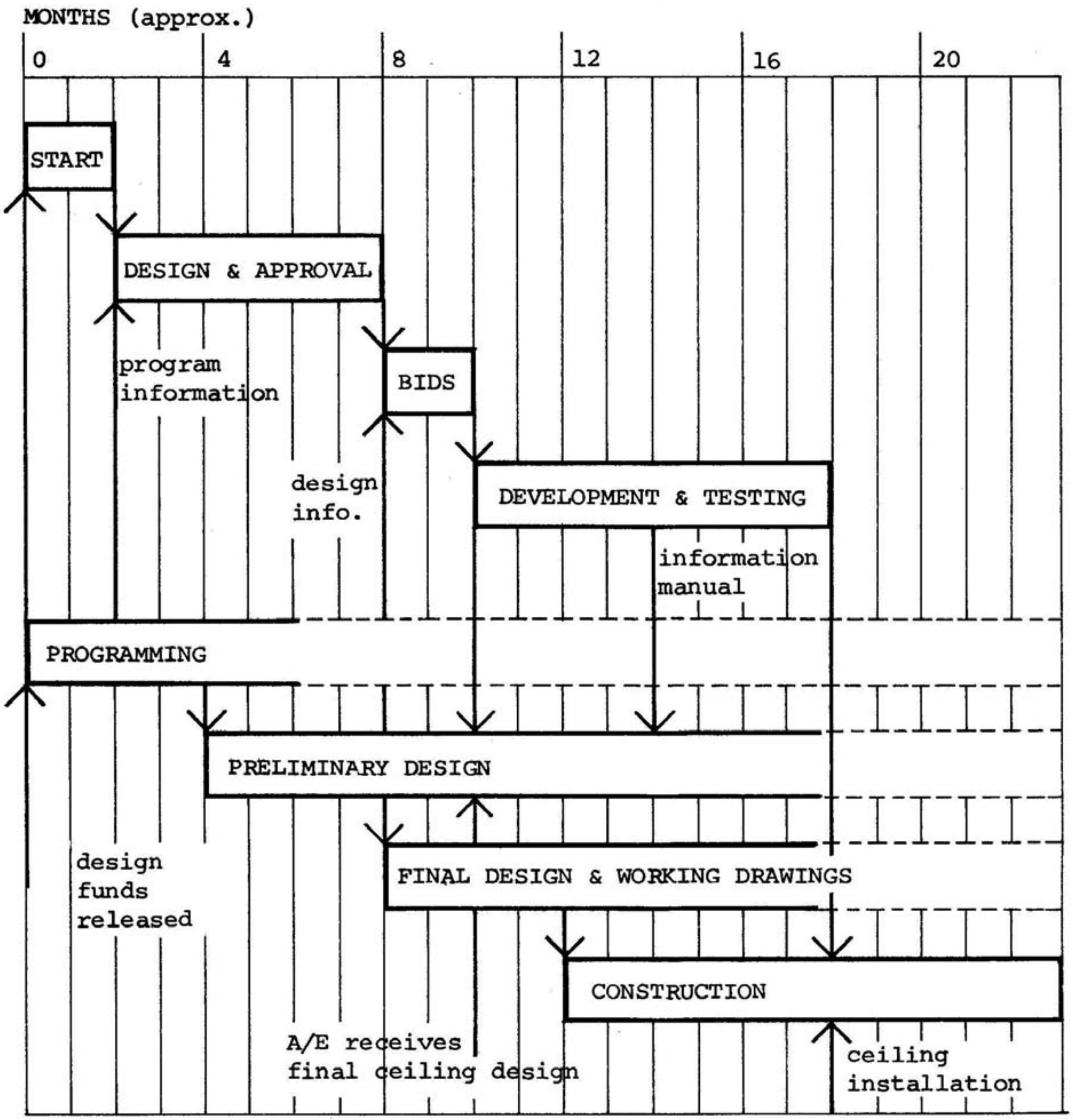
764.4.10 Expedite Decisions

The time available for the complete development program, assuming accelerated scheduling, is about eighteen months. The product development program is superimposed on the design and construction schedule as shown in Figure 760-2.

Bidders have about six months to qualify their designs, perhaps two months to prepare their bids, and some eight months to develop all components and pass performance tests.

This is rather tight considering the possibilities for unexpected delays in an innovative program, so every effort must be made by all parties to make necessary decisions promptly and submit fully responsive material at each deadline.

Figure 760-2. APPROXIMATE SCHEDULE FOR SPECIAL CEILING DEVELOPMENT PROGRAM



765 SYSTEM EVALUATION

765.1 MONITORING THE PROCESS

765.1.1 Objectives

The construction of a demonstration hospital utilizing the Prototype Design will constitute an example of the application of the principles of systems integration to the particular building problems of the VA.

765.1.2 Scope of Subject Material

The precise nature of the monitoring program will depend to a great extent on the degree to which the VA is involved in special funding, phased bidding, product development, subsystem innovation, construction management, etc., at the time. In any case, the scope of the program should cover the entire production process, from inception through occupancy, to provide full benefit. Limited monitoring should continue through the life of the building to determine long-range effects, particularly on adaptability.

765.1.3 Structuring the Experiment

From the point of view of overall building system research and development, the more innovations that can be tried out on a single project, the better, so long as their effects can be kept sufficiently separated to allow accurate assignment of each effect to a specific innovation. The general parameters are cost, time and performance, but appropriate specific parameters must be selected for each project, depending on what degree of emphasis has been placed on various subsystems and on particular aspects of design, construction, operations and alteration. Both innovations to be tried and parameters to be measured should be selected to maximize return of useful information within budget available for monitoring.

765.1.4 The Threat of Red Tape

Monitoring is a task requiring expenditure of considerable time and effort by all parties involved in administration, design and construction on a systems project. This effort is superimposed on all the usual as well as new tasks these parties will be responsible for just to build the building, and therefore can come into conflict with the demands of these tasks.

This problem is not untypical of scientific experiments in which the process of observation can have disturbing effects on the phenomena being observed. Thus, quality of information obtained depends not only on a level of cooperation and an appreciation of common objectives appropriate to a team effort, but also on highly efficient monitoring procedures which extract the desired data with minimum interruption of primary activity.

765.2 PROCESSING THE DATA

An effective monitoring program must be coupled to a broadly based data processing program if each successive systems project is to benefit fully from experience gained not only by the VA but by all agencies, public and private, engaged in parallel efforts. Eventual industrialization of general and special building systems will require ready access to all current information by owners, designers, manufacturers and construction contractors. Information presently available in a form directly applicable to systems design and development problems is fragmented and generally inadequate as the basis for commitments and decisions involving radical innovations. The data processing program should therefore accommodate pertinent material from external sources as well as from the monitoring process, and should organize information for the specialized demands of system development.

770 Ceiling Performance Specifications

771 INTRODUCTION

771.1 INTENT

771.1.1 These specifications provide the basis upon which the ceiling system to be incorporated in the Veterans Administration Hospital Facility to be built at (location) will be designed, evaluated, bid, developed, tested and installed.

771.1.2 Section 320 of the VA Design Manual, Hospital Building System, is an integral part of these specifications.

771.1.3 There is no intent to imply that any particular material or design is desired by the VA. Any detailed designs indicated in the Design Manual as possible approaches to meeting the requirements are for guidance only. Bidders are encouraged to apply their most advanced design concepts and materials to the problem described.

771.1.4 Specific minimum criteria are established in critical areas of performance where parameters can be quantified. Bidders are expected to exceed these if appropriate to the nature of their products, and to provide a performance level at least equal to normal industry standards in those areas not directly covered.

771.2 BASE OF CONTRACT AWARD

Priced proposals will be accepted only from qualified bidders on the basis of their approved designs. All such designs will be considered of equivalent value for purposes of bidding. The successful bidder will be selected on the basis of the lowest responsive lump sum bid submitted on the Bid Form provided by the Office of Construction. Approval of design, selection of the successful bidder, or award of a contract will not relieve the Component Contractor from meeting the performance requirements during the Development and Construction Phases.

771.3 GOVERNING REGULATIONS

All work and materials shall be in accordance with the following codes and standards unless specifically required or authorized to the contrary by the VA:

1. Federal Procurement Regulations

2. VA Construction Standards

3. VA Master Construction Specifications

4. NFPA Life Safety Code

5. National Building Code

6. Uniform Building Code

771.4 SCHEDULE

	Event	Date
771.4.1	Pre-design conference for interested bidders.	(2 months)
771.4.2	Letter of Intent due from interested bidders.	(4 months)
771.4.3	Design Proposal Due.	(7 months)
771.4.4	Design Evaluation returned to bidders, design approved or disapproved. Schematic design of hospital provided to qualified bidders.	(8 months)
771.4.5	Priced Proposal due.	(9 months)
771.4.6	Bid Evaluation complete, Component Contractor nominated, contract awarded.	(10 months)
771.4.7	Information Manual due. Unit Prices due (if not included in Priced Proposal).	(16 months)
771.4.8	Development complete. Test certifications due. Component Contractor signs sub-contract with General Construction Contractor. Commence production and installation.	(18 months)

772 SCOPE

772.1 INCLUDED

772.1.1 Development Phase

1. All necessary product research, development and testing.
2. Design coordination with the VA, A/E and General Construction Contractor (or Construction Manager if used).
3. Descriptive material and samples as required by VA, A/E and GCC (or CM).
4. Supply, installation and testing in mock-up and/or prototype as required.
5. Information Manual and unit prices.

772.1.2 Construction Phase

1. All equipment, materials, labor and supervision required for the manufacture, supply, storage, weather protection and installation of all ceilings in the hospital, except in service bays.
2. Construction coordination with VA, A/E and GCC (or CM).
3. Shop drawings.
4. Leveling devices.
5. Platform and walking surface.
6. Horizontal frame and bracing as required.
7. Ceiling base and finish.
8. Access doors through ceiling and platform.
9. All clips, anchors, spacers, edge trim and other attachments and accessories necessary for a complete finished installation.
10. Sealants, gaskets, etc., as required for sound and air tightness.

11. One year guarantee of materials, workmanship and performance.

772.2 NOT INCLUDED

1. Hangers and attachments to beams.
2. Lighting fixtures, HVC terminals, cubicle tracks, or any other ceiling-mounted equipment.
3. Attachments or support devices for service distribution elements.
4. Radiation or electrostatic shielding.

773 DESIGN PROPOSAL

773.1 GENERAL

Not later than the date specified in 771.4.3 above, each bidder shall submit a Design Proposal to the Office of Construction for evaluation and approval of his design solution. No additional material will be accepted after that date unless specifically requested by the O/C. Evaluations and notifications of approval or disapproval will be returned to all bidders by the date given in 771.4.4 above. Since disapproval shall constitute disqualification of the bidder, it is recommended that all bidders maintain liaison with the O/C and the A/E during the Design Phase to assure responsiveness of their submissions.

773.2 DESCRIPTION OF THE DESIGN

773.2.1 The Proposal shall be in the form of a written description of the bidder's design with appropriate visual material such as drawings, photographs or models. No verbal presentation will be permitted. The Proposal shall include specific statements describing how the design will meet each and every requirement established in these Specifications. Description must be in sufficient detail to permit an accurate assessment of the capabilities and limitations of the design. Include all available reports of tests by recognized testing agencies giving performance data for components already in production. Prices are not required. All submitted material will be kept confidential.

773.2.2 The Component Contractor shall be responsible for all work listed in 772.1. However, to ensure comparable bids with respect to services offered, bidders shall submit lists of the specific items they regard as being inclusive and exclusive of their designs. These lists will be used by the O/C to clarify this aspect of the program before priced proposals are submitted.

773.2.3 The description shall include all special requirements, such as clearances from other building, tolerances of other building, and items required to be supplied by others. The Proposal shall also describe the process of fabrication and installation of all ceiling components, including the relationship to other contractors and trades. Specific reference shall be made to:

1. Fabrication location and procedures.

2. Methods of achieving tolerance control in fabrication and installation.

3. Job site storage requirements.

4. Construction elevator and/or crane requirements.

5. Installation technique, including trades, equipment, etc.

6. Installation schedule, including time required for each step and average installation rates in square feet of platform and square feet of finished ceiling installed per week.

773.2.4 Extra features inherent in the design shall be described. Bidders wishing to offer components with characteristics not listed in the Specifications shall describe them so the O/C may provide guidance on their relative importance as an assistance to preparation of the Priced Proposal. Bidders intending to submit alternatives with their Priced Proposal shall submit complete descriptions of them for evaluation.

773.3 OTHER MATERIAL

773.3.1 The Proposal shall include suggestions for detailed test procedures during the Development Phase, stating which characteristics would be examined by testing laboratory, mock-up, field prototype, etc. Space will be provided by the O/C in the hospital under construction for final prototype testing. All other testing costs will be borne by the Component Contractor.

773.3.2 Bidders who wish to have criteria modified shall submit a description of any proposed changes not later than __(date)__. If in the opinion of the O/C the bidder can show that a change in criteria is justified, the change might be made. All bidders will be notified of all changes through addenda to the Specifications. Any modification of the Approved Design during the Development and Construction Phases will be allowed only by a written change order from the O/C.

773.3.3 The Proposal shall include a copy of the guarantee to be provided by the Component Contractor upon completion of his work.

774 PRICED PROPOSAL

774.1 GENERAL

Priced proposals shall be submitted in accordance with the Invitation for Bids. A certified copy of the bidder's Approved Design shall be included. Prices shall be based on quantities derived by the bidder from schematic drawings supplied by the O/C and any other information included with such drawings. The lump sum bid will be the total price quoted by the bidder for all required work, plus the weighting factors described in Section 774.2 below.

774.2 WEIGHTING FACTORS

774.2.1 A weighting factor of four cents ($0.04) per outside gross square foot of total hospital area will be added for each inch of thickness from the finished surface of the ceiling to the walking surface of the platform.

774.2.2 A weighting factor of one-fifth of a cent ($0.002) per pound of total ceiling weight will be added.

775 PERFORMANCE CRITERIA

775.1 ASSUMPTIONS

775.1.1 The basic structure of the hospital will be a steel or concrete frame with concrete floor slabs and shear walls. Girders will span columns in the short direction of the structural bays and beams will span girders in the long direction. The ceiling will be hung at a uniform height with its top (platform) surface about 6'6" below the underside of the floor slab and with its bottom finished surface 9'3" to 10'3" above the top of the structural floor slab.

775.1.2 Ceiling hangers, to be provided by others, will be ½" diameter steel rods with three inches of standard bolt thread at the lower end. Hangers will be attached by others along the center line of beams, 9'0" on center, minimum. In the direction of the girders, hangers will be spaced either 7'6" or 5'7-1/2" on center.

775.1.3 The Component Contractor will have access to each floor by stairway and construction elevator, and if required, by crane. The external wall will be in place at the time of ceiling installation, but sections may be temporarily omitted for delivery of large components. Interior two-hour partitions will be in place running from slab to slab and dividing each floor into areas of 5,000 to 20,000 square feet. The floor topping slab will not be in place and there will be no depressions in the structural slab. The floor structure will be designed for a 75 psf uniform live load.

775.1.4 Vertical shafts penetrating enclosed spaces will occur rarely, if at all. Interior columns will be spaced 22'6" in one direction and from 40'6" to 58'6" in the other direction. Trunk ducts and all main horizontal service lines will be in place, hung from the structural slab between ceiling hangers.

775.1.5 No other trades will be present in any space in which the ceiling is being installed.

775.1.6 Heavy ceiling-mounted equipment which would exceed design live load capability of 40 psf will be hung directly from the structure above, after completion of ceiling installation.

775.1.7 All partitions, except two-hour partitions, including door frames, will be installed after the ceiling is complete. No framing members of these partitions will penetrate the ceiling.

775.1.8 The ceiling, except for finishes, will be regarded as a more or less permanent part of the building shell, along with the structure, exterior walls and major service mains.

775.2 REQUIREMENTS

775.2.1 Vertical Loads

The ceiling shall provide a platform over its entire upper surface, capable of supporting some of the distribution components located in the service zone, HVC terminals, and workmen engaged in construction, maintenance, repairs and alterations. It must also provide support for ceiling-hung items such as cubicle tracks, TV consoles, etc. These shall be calculated as a uniform live load of 40 psf. The ceiling shall withstand upward point loads of at least 25 pounds over a six-inch square area without appreciable deformation. Deflection of ceiling base material shall be limited to 1/360 of the distance between supporting members under full live load.

775.2.2 Lateral Loads

The ceiling is not required to contribute to the lateral force resistance of the structure, but it shall transmit all lateral forces developed in partitions, as well as within the ceiling itself, to the structure.

775.2.3 Acoustics

1. The ceiling shall provide a sound barrier between the service zone and the functional zone of Sound Transmission Class (STC) 40.

2. Ceiling surface treatment shall have a minimum absorption capability of Noise Reduction Coefficient (NRC) 60.

775.2.4 Fire Safety

The ceiling shall be non-combustible and shall have a fire resistance rating of one hour. Maximum flame spread rating of surface materials is 25 and maximum smoke developed rating is 50. When burnt, surfaces shall not produce noxious or toxic fumes.

775.2.5 Surface Characteristics

The ceiling shall have a finished surface with the following characteristics:

1. A minimum reflectance of 80, and low gloss.

2. High resistance to abrasion, moisture, cleaning and disinfectant materials, staining, fading, and impact.

3. Easily repaired and patched.

The ceiling shall have the capability of supporting standard types of radiation and electrostatic shielding.

775.2.6 Framing and Leveling Devices

1. Ceiling framing, stiffening ribs and the like, if required by the design, shall not protrude above the walking surface of the platform more than one foot at any point. Such elements shall not place undue restrictions on the location of partitions; ideally, there would be no restrictions.

2. The ceiling shall be attached to the hangers by leveling devices capable of adjustment to provide a level lower surface during construction, and periodic readjustment throughout the life of the building.

775.2.7 Provision for Plenum

The ceiling shall be airtight under pressure differentials produced by utilizing the service zone as a return air plenum.

775.2.8 Adaptability

Adaptability of the ceiling is principally a question of access to, and variable support of, other building components.

1. Access to the service zone will be primarily horizontal and will be provided via building components other than the ceiling. Nevertheless, a reasonable degree of vertical access through the ceiling shall be provided for convenience of engineering personnel.

2. There will be no horizontal distribution of services within partitions; all such distribution will occur above the ceiling. Distribution to service containers within functional spaces will be routed vertically via ceiling penetrations. Ceiling materials shall allow rapid and convenient drilling, cutting and patching. Penetrations of distribution lines through the ceiling will be sealed (by others) to preserve acoustic qualities.

3. The ceiling shall provide support for a wide range of ceiling-mounted items such as cubicle tracks, I.V. hangers, TV consoles, etc., in a manner allowing simple cutting and drilling of holes as they are installed and patching when they are removed.

4. For purposes of relocating lighting fixtures, HVC terminals and the like, the ceiling shall provide for convenient introduction of new openings and closing off of unused openings.

5. Ceiling base and finish materials shall allow for simple partition head attachment, and for relocation of partitions without major damage of these materials.

6. The base ceiling surface shall provide substantial backing for commonly used ceiling finishes which can be applied, cleaned, repaired, removed or changed without significant damage to the base material.

775.2.9 Compatibility

1. The ceiling shall be fitted around and fastened to columns and shear walls in a manner allowing for construction tolerances of both ceiling and structure while transferring all lateral loads developed in the ceiling to the structure. Vertical loads will be transferred to the structure solely through the hangers provided.

2. The ceiling shall be fitted and fastened to the exterior wall and to the two-hour partitions in a manner allowing for construction tolerances of ceiling, walls and partitions. The joint at the exterior wall shall allow for reasonable deflection due to wind loads. All joints shall be sealed to prevent flanking paths for sound transmission.

3. To receive partitions within their vertical adjustment capability, the ceiling shall, under dead load conditions, be set at a uniform specified height above the finished floor within ¼" ± and shall not slope more than ¼" in 10'0".

780 Service Containers

781 INDENTIFICATION OF SUITABLE PRODUCTS

The extent to which services and partitions are able to be uncoupled on any particular project will be directly linked to the cost and availability of suitable products for containing the services.

Ideally, the service containers would comprise a whole system of easily movable appliances, ranging in complexity from the simplest electrical raceway or pole to the most complex, highly specialized medical equipment consoles. These would all be dimensionally and aesthetically coordinated, and several competing manufacturers would each fabricate the total range required for the whole hospital.

This ideal is far from the present state of fragmented, uncoordinated product development, however, and very few products can be described as “appliance-like”. Several manufacturers have indicated a willingness to modify their products or engage in new product development if a need could be demonstrated and/or specifications were made available. It also appears that more and more types of manufacturers are entering this field of development. These include manufacturers of hospital equipment such as monitors, nurse call systems, etc., who are beginning to realize the marketing possibilities of coordinating their own products into containers – or “consoles” – rather than leaving this function to others. The whole field of product development in the area of service containers appears to be very fluid at present, with a great deal of interest in the hospital market displayed by all types of manufacturers.

In order to identify the many manufacturers and products necessary to comprise a complete range of service containers for a total hospital, the word “container” was loosely defined as any product which would free the partitions of the function of containing services. Six broad categories emerged. A description of each category and a list of manufacturers is included below.

782 CATEGORIES AND MANUFACTURERS (Figures 780-1 and 780-2)

782.1 ELECTRICAL RACEWAYS AND DISTRIBUTION POLES

Surface-mounted electrical raceways are commonly used in conventional construction. In the majority of cases, they are mounted horizontally on walls, either at dado height or at the base. It is possible to mount them on the ceiling in appropriate situations (e.g. laboratories) or use them vertically as containers of telephone jacks, duplex outlets, switch boxes, thermostats and even small night lights.

To facilitate open planning in schools and offices, a comparatively new building component has appeared on the market which is designed to house telephone, power and other electrical outlets. It is essentially a floor-to-ceiling, free-standing pole, sometimes made up of standard back-to-back raceways (Wiremold) or of bent sheet metal (Luminous Ceilings, Inc.)

Manufacturers in this category include:

1. Electro-Link Systems Ltd., Ontario, Canada.

2. Luminous Ceilings, Inc., Chicago, Ill.

3. The Wiremold Company, Hartford, Conn.

782.2 LAVATORY CONSOLES

A number of manufacturers currently make a product which is essentially a cabinet containing a combination of various components such as a pre-plumbed lavatory, waste receptacle, mirror, overhead light, bed pan, etc., built into a unit and either recessed or surface-mounted on partitions. These consoles are already used in conventional hospital construction; typically they are recessed. Certain consoles would require modifications to conform with the system rules. For instance, the casing would have to extend to the finished ceiling to cover the service drops from the service zone above.

Manufacturers in this category include:

1. Accessory Specialties, Inc., New York, N.Y.

2. Anco Industries, Riverton, N.J.

3. Bobrick Dispensers Inc., Los Angeles, Ca.

4. Innerspacenetics, Inc., San Francisco, Ca.

5. Charles Parker Co., Meriden, Conn.

6. Watrous, Inc., Bensenville, Ill.

782.3 PREFABRICATED BATHROOM COMPONENTS

A number of large manufacturers of bathroom fixtures are making significant efforts in the direction of prefabricated bathroom components for various markets, including hospitals. Few of these new products are currently available, though plans exist for prefabricating plumbing walls and modular bathroom units.

Manufacturers interested in product development in this category include:

1. American Standard, New York, N.Y.

2. Eljer, Pittsburgh, Pa.

3. Kohler Co., Kohler, Wisc.

4. Meridian Modules Inc., St. Louis, Mo.

5. Moen, Division of Stanadyne, Elyria, Ohio.

6. Rohr Corp., Chula Vista, Ca.

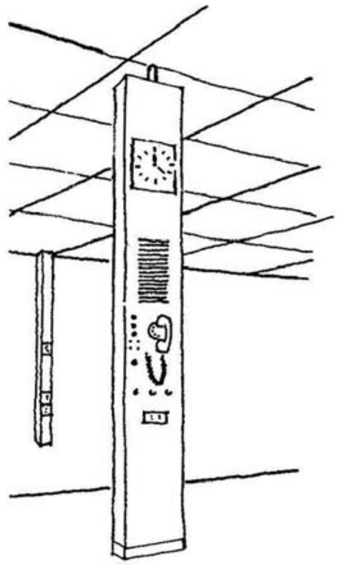
7. Stahl Industries, Inc., Youngstown, Ohio.

8. Symmons Engineering Co., Braintree, Mass.

782.4 WALL-HUNG INTEGRATED SERVICE CONTAINERS

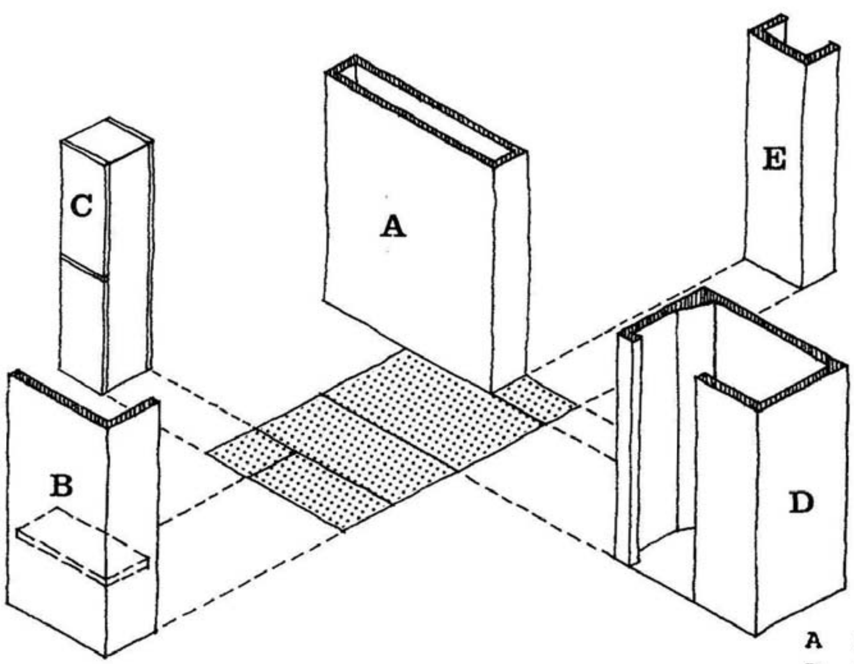
Several manufacturers are currently producing patient bedside units with multiple outlets for medical equipment and patient conveniences, including lighting, communications, terminals, medical gases, TV, etc. These service containers are currently designed for use in general patient rooms, intensive care units and recovery rooms. They range in complexity from a simple flush-mounted console containing a limited number of service outlets to large, modular, surface-mounted wall assemblies. Generally, the container manufacturer’s task is primarily one of coordination; he usually fabricates only the container which houses the equipment supplied by a variety of other manufacturers.

Figure 780-1. SERVICE CONTAINER CATEGORIES 1 – 3



1. Electrical Raceways and Distribution Poles

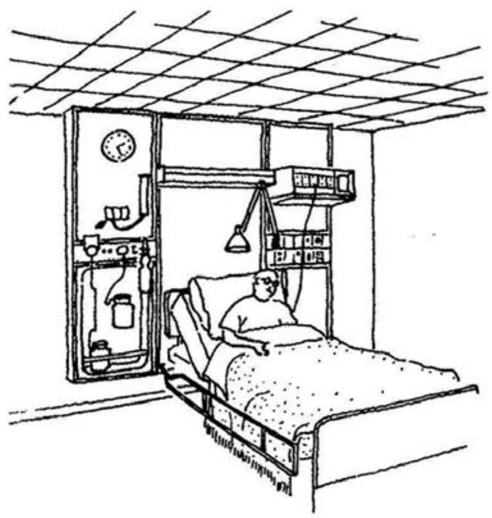
2. Lavatory Consoles



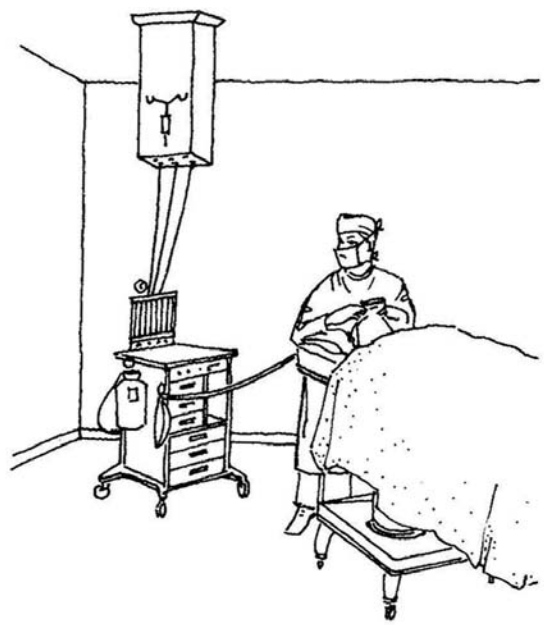
A Mechanical Chase
B Lavatory Center
C Nurserver
D Toilet-Shower
E Wardrobe Closet

3. Prefabricated Bathroom Components

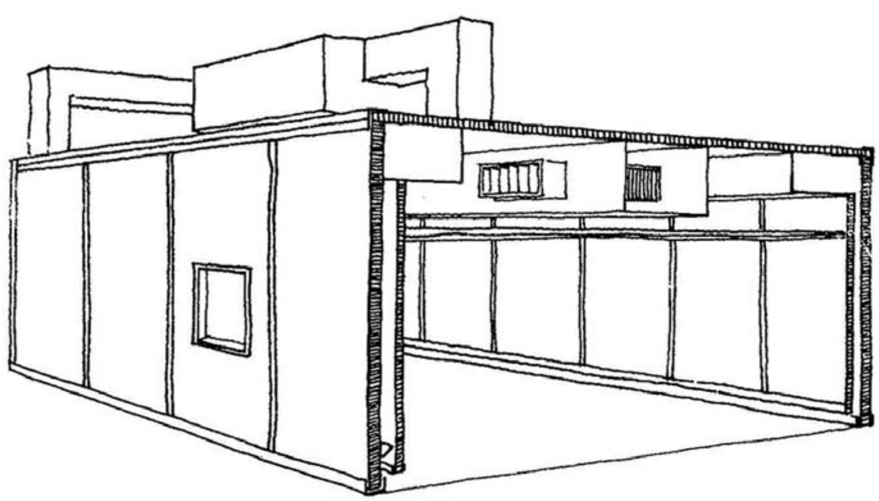
Figure 780-2. SERVICE CONTAINER CATEGORIES 4 – 6



4. Wall Hung Integrated Service Containers



5. Ceiling Hung Integrated Service Containers



6. Prefabricated Rooms for Specialized Environments

At least one manufacturer of bedside units (Post-Glover) also makes panels for more specialized areas such as surgeries. It seems quite likely that other manufacturers will extend their line of products as well.

Manufacturers in this category include:

1. Amsco, Patient/Power Products, Richmond, Ca.

2. Electro/Systems, Inc., Richmond, Ca.

3. Hill-Rom Co., Inc., Batesville, Indiana.

4. Hospital Systems Inc., Berkeley, Ca.

5. National Cylinder Gas (NCG) Division, Chemetron Corp., Chicago, Ill.

6. Pacific Associated Lighting Co., Inc., (Palco), San Francisco, Ca.

7. Post-Glover Division, ESB Inc., Erlanger, Kentucky.

8. Sunbeam Lighting Co., Los Angeles, Ca.

782.5 CEILING-HUNG INTEGRATED SERVICE CONTAINERS

Products in this category include retractable or rigid ceiling columns, overhead dispenser units, etc. Generally, the units are approximately 70-150 square inches in cross section and are hung from the ceiling so that they clear the floor by about 6'4". They typically provide medical gases in spaces such as surgery, emergency, recovery and intensive care areas, but the concept appears to be applicable in many other areas of the hospital for those units which can also furnish electrical and monitoring receptacles.

Manufacturers of products in this category include:

1. Logan Manufacturing Company, Manheim, Penn.

2. Ohio Medical Products, Madison, Wisc.

782.6 PREFABRICATED ROOMS FOR SPECIALIZED ENVIRONMENTS

If the term “container” is taken to describe those objects which enhance building adaptability by housing services more or less independently of the building elements, then prefabricated rooms for specialized purposes will fall into this category at one end of the scale, just as the electrical raceways fall in at the other end. An attempt was made to identify manufacturers not only of the more commonly used environmental, audiometric and clean rooms, but also of prefabricated surgeries and laboratories, etc. It appears that manufacturers of totally equipped prefabricated surgeries have not yet been able to market their product in the United States, though some progress has been made in Europe. Information was sought from the following manufacturers or their representatives:

1. American Air Filter (clean rooms) Berlin, Conn.

2. Bendix Corporation (laboratories) Dayton, Ohio.

3. Honeywell (surgeries) Minneapolis, Minn.

4. James Howarth & Co., Ltd., Bolton Lanes, England.

5. Industrial Acoustics Co., Inc., (audiometric and environmental rooms) Bronx, N.Y.

6. Liberty Industries, Inc. (clean rooms) Berlin, Conn.

7. Rayproof Corp. (shielded and audiometric rooms) Norwalk, Conn.

8. Thermatron (environmental rooms), Holland, Mich.

9. Tracor (audiometric rooms) Austin, Texas.

10. Veller (surgery) Gentilly, France.

11. Weber (clean rooms) Grand Rapids, Mich.

783 COST COMPARISON (EXAMPLE)

The cost of service containers in the same category will vary widely depending on the services contained, the materials and details of the container etc.

The comparison of these costs with costs of conventional methods of installing services in partitions, or enclosing them with furring, will also produce widely varying results depending on the location and quantity of services.

The following example is given to assist in estimating the range of costs involved in several alternatives.

783.1 BASIS OF COMPARISON

Figure 780-3 illustrates two back-to-back two-bed patient rooms, with clustered services in two locations in each room.

The costs include the labor, materials, overhead and profit for the service drops from the branches in the service zone to outlets in the functional zone, including connections to the branches and including the outlets.

The outlets to be provided are as follows:

1. The Bedside Location. Each bed will be provided with the following outlets:

    a. Three medical gas outlets,

    b. one nurse call outlet,

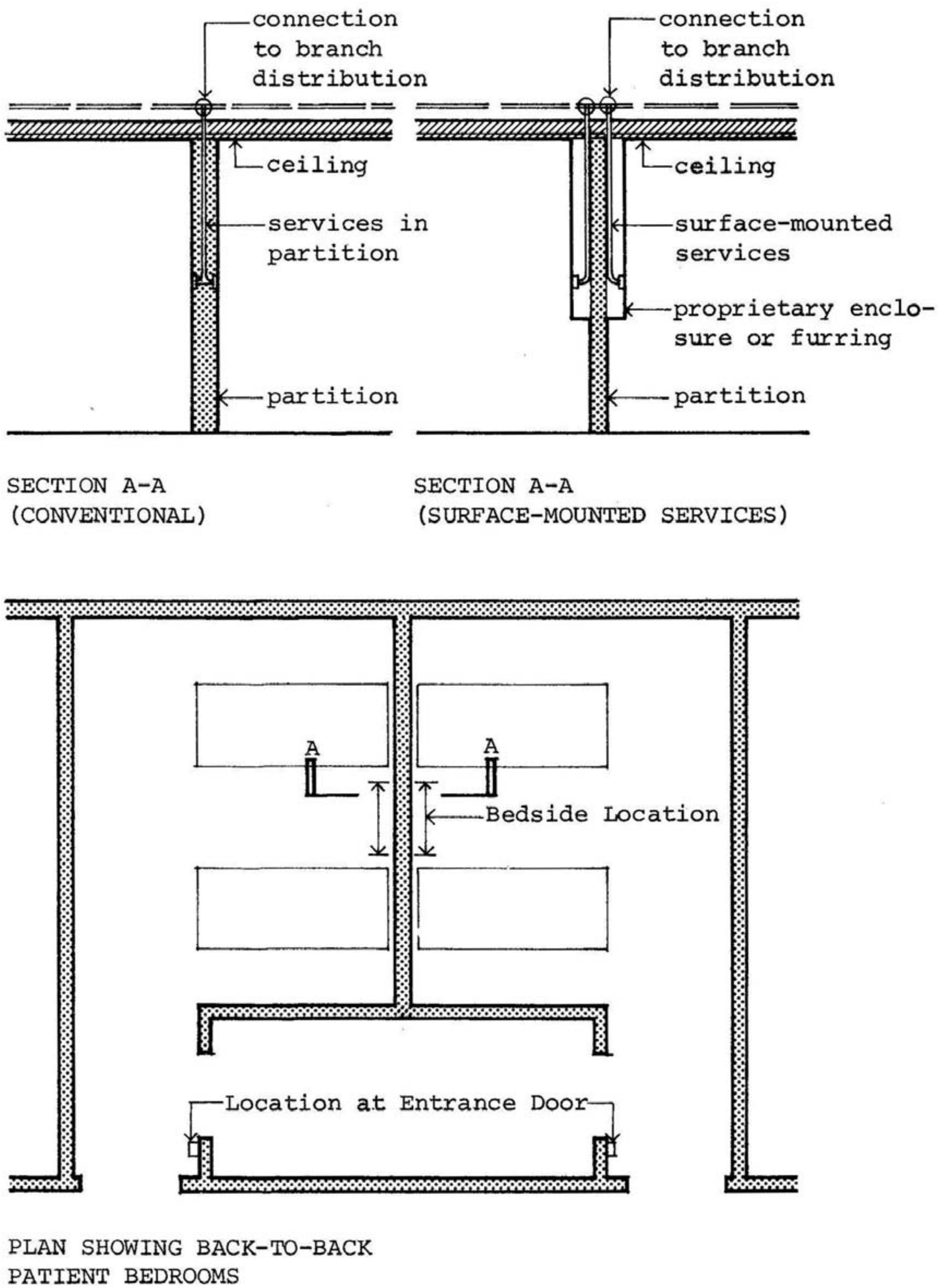
    c. one physiological monitoring outlet,

    d. one outlet for bed light,

    e. one telephone jack, and

    f. three power outlets.

Figure 780-3. BASIS OF COST COMPARISON



2. Location Near Entrance Door. At the entrance door to each room, the following outlets will be provided:

   a. One light switch,

   b. one thermostat (including the thermostat itself) and,

   c. one night light.

783.2 RESULTS OF COMPARISON

Provision of the outlets at the patient bedside as described above would cost an estimated $275 per patient using conventional construction, i.e. services within the partition.

Surface mounting services and enclosing them with furring would cost approximately 30% more, whereas the use of proprietary enclosures could cost 50-80% more.

If the comparison is made in a situation where patient beds are not back-to-back, the difference between the cost of conventional installation and the cost of furring out services will be no more than the cost of the furring. (This amounts to approximately $50 per unit, or $25 per patient.) In this case the proprietary enclosure would be only 30-50% more than the cost of conventional installation.

The difference in cost between conventional installation and surface mounting services is mostly due to the increased cost of outlets for medical gases and not to the electrical work. This is reflected in the cost comparison for electrical services near the entrance door.

At the location near the entrance door, the difference in cost between conventional construction and the use of a surface mounted raceway is approximately 20%. Conventional construction would cost approximately $80 and surface mounting would cost $100.

It must be emphasized that all percentages quoted will be greatly reduced when the cost comparisons are considered in relation to the total subsystem costs of the various subsystems involved.

The benefits of surface mounting services have been discussed in Section 723.

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