
USACE / NAVFAC / AFCEA / NASA UFGS-04 01 40 (November 2009)

Preparing Activity: USACE Superseding
UFGS-04 01 40 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2011

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DIVISION 04 - MASONRY

SECTION 04 01 40

RESTORATION AND CLEANING OF MASONRY IN HISTORIC STRUCTURES

11/09

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SECTION 04 01 40

RESTORATION AND CLEANING OF MASONRY IN HISTORIC STRUCTURES 11/09

NOTE: This guide specification covers the requirements for restoration and cleaning of masonry in historic structures.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

NOTE: Where the words "as indicated" are used, ensure that sizes, positions and other designated information are indicated on the design drawings.

The following publications, from the United States Department of the Interior - National Park Service, provide useful guidance in the restoration of historic masonry and may be included as addenda to the specifications.

The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings (1995).

Preservation Brief #1 - (1975) The Cleaning and Waterproof Coating of Masonry Buildings

Preservation Brief #2 - (1976) Repointing Mortar

Joins in Historic Brick Buildings

Preservation Brief #6 - (1979) Dangers of Abrasive
Cleaning to Historic Buildings

Preservation Brief #7 - (1979) The Preservation of
Historic Glazed Architectural Terra-Cotta

1.1 REFERENCES

NOTE: This paragraph is used to list the
publications cited in the text of the guide
specification. The publications are referred to in
the text by basic designation only and listed in
this paragraph by organization, designation, date,
and title.

Use the Reference Wizard's Check Reference feature
when you add a RID outside of the Section's
Reference Article to automatically place the
reference in the Reference Article. Also use the
Reference Wizard's Check Reference feature to update
the issue dates.

References not used in the text will automatically
be deleted from this section of the project
specification when you choose to reconcile
references in the publish print process.

The publications listed below form a part of this specification to the
extent referenced. The publications are referred to within the text by the
basic designation only.

ACI INTERNATIONAL (ACI)

ACI C-20 (1992) Repair and Rehabilitation II

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100Doc (2005) Documentation of the Threshold
Limit Values and Biological Exposure
Indices

ASTM INTERNATIONAL (ASTM)

ASTM A 36/A 36M (2008) Standard Specification for Carbon
Structural Steel

ASTM C 109/C 109M (2008) Standard Test Method for
Compressive Strength of Hydraulic Cement
Mortars (Using 2-in. or (50-mm) Cube
Specimens)

ASTM C 1324 (2005) Standard Test Method for
Examination and Analysis of Hardened
Masonry Mortar

ASTM C 150/C 150M	(2009) Standard Specification for Portland Cement
ASTM C 1515	(2009) Standard Guide for Cleaning of Exterior Dimension Stone, Vertical and Horizontal Surfaces, New or Existing
ASTM C 207	(2006) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C 881/C 881M	(2010) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

BRICK INDUSTRY ASSOCIATION (BIA)

BIA Tech Note 20	(1990; R 2000) Cleaning Brick Masonry
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1.2 SYSTEM DESCRIPTION

Perform work complying with applicable federal, state, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis, specified in the CONTRACT CLAUSES. The Activity Hazard Analysis shall include analyses of the potential impact of cleaning operations on personnel and on others involved in and adjacent to the work zone. Perform work in conformance with **ACI C-20**. Non-historic masonry work, including materials, procedures, and requirements shall conform to Section **04 20 00** MASONRY, except as otherwise specified herein.

1.2.1 Design Strength

Each class or mixture of mortar shall have a 28-day compressive strength matching the compressive strength of the original existing mortar in the structure as determined by **ASTM C 109/C 109M** for mortar. Take test specimens of existing mortar from a sound and intact representative portion of the structure, at locations indicated.

1.2.2 Special Properties

Mortar may contain admixtures, such as pigments, to match the characteristics of the original mortar. Use of all admixtures shall be subject to approval.

1.2.3 Cementitious Content of Mortar

Each class or mixture of mortar shall have a cement content matching the cement content of the original existing mortar in order to provide uniform strength, weathering characteristics, and appearance of repaired surfaces in relation to existing surfaces.

1.2.4 Environmental Protection

The work shall comply with the requirements of Sections **01 57 20.00 10** ENVIRONMENTAL PROTECTION and **02 83 19.00 10** LEAD BASED PAINT HAZARD ABATEMENT, TARGET HOUSING & CHILD OCCUPIED FACILITIES.

1.2.5 General Protection

Protect persons, motor vehicles, adjacent surfaces, surrounding buildings, equipment, and landscape materials from chemicals used and runoff from cleaning and paint removal operations. Erect temporary protection covers, which will remain in operation during the course of the work, over pedestrian walkways and at personnel and vehicular points of entrance and exit.

1.2.5.1 Interior Protection

Protect the interior of buildings from the weather, cleaning, and repair operations at all times.

1.2.5.2 Worker Exposures

Exposure of workers to chemical substances shall not exceed the limits established by [ACGIH 0100Doc](#), or those required by a more stringent applicable regulation.

1.2.5.3 Training

Inform workers, having access to an affected work area, of the contents of the applicable material safety data sheets, of potential health and safety hazard, and of protective controls associated with materials used on the project. An affected work area is one which may receive dust, mists, and odors from the surface preparation operations. Workers involved in masonry cleaning shall be trained in the safe handling and application, and the exposure limit, of each material to be used in the project. Personnel having a need to use respirators and masks shall be instructed in the use and maintenance of such equipment.

1.2.5.4 Coordination

Coordinate the work to minimize exposure of building occupants, other Contractor personnel, and visitors to mists and odors from surface preparation, cleaning, and repair operations.

1.2.6 Cleaning and Restoration Methods

Submit for approval the cleaning and restoration methods organized in sequence from preparation through completion of the work, and materials selected for a specific structure, before work starts, taking into account the total construction system of the building to be worked upon, including different masonry and mortar materials, as well as non-masonry elements which may be affected by the work. Include schedule showing estimated time, in calendar days, for completion of each phase of the work.

1.2.7 Ionic Cleaners

Use ionic chemical cleaners as specified, in accordance with the manufacturer's instructions, and only upon the direction of the Contracting Officer. Ionic cleaners shall be used only after gentler cleaning methods have been determined to be ineffective through the use of test panels.

1.3 SUBMITTALS

NOTE: Review submittal description (SD) definitions

in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Masonry[; G][; G, [_____]]

SD-03 Product Data

Cleaning and Restoration Methods[; G][; G, [_____]]
Qualifications

SD-04 Samples

Materials
Sample Masonry Panels[; G][; G, [_____]]

SD-07 Certificates

Materials

1.4 QUALITY ASSURANCE

Submit documentation showing Contractor's experience of 5 consecutive years in masonry restoration, plus a list of similar jobs to the one specified herein. Submit required [qualifications](#) for workers trained and experienced in restoration of masonry in historic structures, and furnish documentation of 5 consecutive years of work of this type. A list of similar jobs shall be provided identifying when, where, and for whom the work was done. Submit for approval [Sample Masonry Panels](#) of each procedure proposed for use in the work and samples of the materials listed below; indicating sizes, shapes, finishes, color, and pertinent accessories: [____]. No [masonry](#) or mortar shall be used in the work until the samples and the represented mixture have been approved. Submit drawings showing location of masonry elements in the work, building elevations, interface with adjacent materials, and special placing instructions, in sufficient detail to cover fabrication, placement, and finishing.

1.5 DELIVERY, STORAGE, AND HANDLING

Furnish cement in suitable bags used for packaging cements. Labeling of packages shall clearly define contents, manufacturer, and batch identification. Detergents, masonry cleaners, paint removers, solvents, epoxies and other chemicals used for masonry cleaning shall be in sealed containers that legibly show the designated name, formula or specification number, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer. Store materials in weathertight structures which will exclude moisture and contaminants. Accessories shall be stored avoiding contamination and deterioration. Admixtures which have been in storage onsite for six months or longer, or which have been subjected to freezing, shall not be used unless retested and proven to meet the specified requirements.

1.6 ENVIRONMENTAL REQUIREMENTS

Masonry, mortar, and epoxy adhesives shall not be placed when weather conditions detrimentally affect the quality of the finished product. No masonry or mortar shall be placed when the air temperature is below [5 degrees C 40 degrees F](#) in the shade. When air temperature is likely to exceed [35 degrees C 90 degrees F](#) masonry and mortar shall have a temperature not exceeding [35 degrees C 90 degrees F](#) when deposited. Materials to be used in the work shall be neither produced nor placed during periods of rain or other precipitation. Stop material placements, and protect all in-place material from exposure, during periods of rain or other precipitation. Masonry surfaces shall be cleaned only when air temperatures are above [5 degrees C 40 degrees F](#) and will remain so until masonry has dried out, but for not less than 7 days after completion of the work.

1.7 WARRANTIES

1.7.1 Cleaning Warranty

Cleaning procedures shall be warranted for a period of two years against harm to substrate (masonry and mortar) or to adjacent materials including, but not limited to, discoloration of substrate from improper procedures or usage, chemical damage from inadequate rinse procedures, and abrasive damage from improper procedures.

1.7.2 Repair Warranty

Repair procedures, including repointing, shall be warranted for a period of two years against: discoloration or mismatch of new mortar to adjacent original historic mortar, discoloration or damage to masonry from improper mortar clean-up, loss of bond between masonry and mortar, fracturing of masonry edges from improper mortar joint preparation procedures or improper mortar formulation, and occurrence of efflorescence.

PART 2 PRODUCTS

2.1 MATERIALS

Materials, physical and chemical properties, and composition of masonry and mortar used in renovation work shall match that of original existing masonry and mortar to be repaired, unless samples and testing determine that existing mixtures and materials are faulty or non-performing. Submit certificates of compliance attesting that the materials, equipment, and cleaning agents (chemicals, detergents, etc.) to be used in the work meet the specified requirements.

2.2 CLEANING AGENTS

2.2.1 Paint Removers

Provide chemical paint removers which are manufacturer's water soluble, low toxicity products, effective for removal of paint on masonry without altering, damaging, or discoloring the masonry surface.

2.2.2 Detergent Cleaners

Detergent cleaners shall be in accordance with [____].

2.2.3 Ionic Cleaners

2.2.3.1 Alkaline Prewash Cleaner

Alkaline prewash cleaners shall be as recommended by the manufacturer.

2.2.3.2 One-Part Masonry Cleaner

One-part masonry cleaners shall be the standard, acid formulation recommended by the manufacturer.

2.2.3.3 Two-Part Limestone Cleaner

Two-part limestone cleaners shall be manufacturer's standard, two-part masonry cleaning system consisting of an alkaline prewash cleaner followed by acidic afterwash rinse.

2.2.3.4 Standard Strength Acidic Cleaner

Acidic cleaners shall be manufacturer's standard strength, acidic masonry restoration cleaner composed of hydrofluoric acid blended with other acids and combined with special wetting systems and inhibitors.

2.2.3.5 Extra Strength Acidic Cleaner

Masonry restoration extra strength acidic cleaners shall be as recommended

by the manufacturer.

2.2.4 Liquid Strippable Masking Agent

Liquid strippable masking agent shall be manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, and polished stone surfaces from the damaging effect of acidic and alkaline masonry cleaners.

2.2.5 Cleaning Implements

Furnish brushes that have natural or nylon fiber bristles only. Wire brushes shall not be used. Scrapers and application paddles shall be made of wood with rounded edges. Metallic tools shall not be used.

2.2.6 Water

Obtain potable water from a local source and shall be filtered to remove minerals resulting in a neutral pH, prior to application. Provide backflow prevention devices at the point of connection to the water supply.

2.3 EQUIPMENT AND TECHNIQUES DEMONSTRATION

Demonstrate equipment and techniques of operation in an approved location and subject to approval. Dependable and sufficient equipment, appropriate and adequate to accomplish the work specified, shall be assembled at the work site in sufficient lead time before the start of the work to permit inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required. Maintain the equipment in good working condition throughout the project.

2.3.1 Cleaning Equipment

Cleaning equipment shall not cause staining, erosion, marring, or other damage or changes in the appearance of the surfaces to be cleaned.

2.3.1.1 Sandblasting

Sandblasting equipment will not be allowed for cleaning masonry surfaces.

2.3.1.2 Water Blasting

Provide water blasting equipment including a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water re-supply equipment. The equipment shall not be operated at a pressure which will cause etching or other damage to the masonry surface or mortar joints. Operate the equipment at a discharge capacity of 0.38 to 3.5 MPa 55 to 500 psi and 9.5 to 11.4 L/m 2.5 to 3 gpm for general surface cleaning operations. The water tank and auxiliary re-supply equipment shall be of sufficient capacity to permit continuous operations. Provide protective covers and barriers as required to prevent over-spray onto adjacent surfaces.

2.3.2 Spray Equipment

Spray equipment for chemical cleaners shall be low-pressure tanks or chemical pumps suitable for chemical cleaner indicated, and shall be equipped with stainless steel, cone-shaped spray-tip. Spray equipment for water shall disperse water through a fan-shaped spray tip at an angle of

not less than 15 degrees. Spray equipment shall deliver water at a pressure not greater than 3.5 MPa 500 psi and at a volume between 9.5 and 11.4 L/m 2.5 and 3 gpm. Spray equipment for heated water shall be capable of maintaining temperature, at flow rates indicated, between 60 and 82 degrees C 140 and 180 degrees F.

2.3.3 Drilling Equipment

Equipment used to drill holes in masonry, for patch anchors and other applications, shall be standard handheld masonry drills, commonly used for drilling small holes in concrete and masonry. The drill shall be a small, powered, handheld type, using rotary drilling mode only. Impact and rotary impact type drills will not be allowed.

2.3.4 Finishing and Texturing Equipment

Equipment and hand tools used for placing, finishing and texturing masonry and mortar shall be commercially available and commonly used in masonry construction and repair. Surface grinders, impact tools, and other equipment shall conform to the specified requirements, except as specifically required by the type of finish and texture.

2.3.5 Compressed Air Supplies

Compressed air equipment shall deliver clean, oil and moisture free compressed air at the surface to be cleaned. The compressed air line shall have at least two in-line air filters to remove oil and moisture from the air supply. Test the compressed air supply during each shift for the presence of oil and moisture.

2.3.6 Material Handling and Associated Equipment

2.3.6.1 Mixing, Transporting, and Placing Job Materials

Provide equipment used for mixing, transporting, placing, and confining masonry and mortar placements capable of satisfactorily mixing material and supporting placement operations in an uninterrupted manner. Defects and deficiencies in operation or capacity shall be resolved prior to use in the work. Equipment used for mixing, conveying, and placing of materials shall be clean, free of old materials and contaminants, and shall conform to the material manufacturer's recommendations.

2.3.6.2 Associated Equipment

Provide associated equipment, such as mixer timing equipment, valves, pressure gauges, pressure hoses, other hardware, and tools, as required to ensure a continuous supply of material and operation control.

2.4 REPAIR MATERIALS

2.4.1 Masonry and Mortar

Masonry and mortar materials used for repair and renovation shall match the original existing historic materials as closely as possible in composition, color, texture, strength, size, finishing and porosity.

2.4.2 Cementitious Materials

Cementitious materials shall be of one type and from one source, when used

in mortar which will have surfaces exposed in the finished structure. Cement composition shall match that of cement used in existing mortar to be repaired, as determined by samples and testing, and shall conform to the basic requirements of [ASTM C 150/C 150M](#), Type [I] [II] [low alkali].

2.4.3 Epoxy Anchor Adhesives

An epoxy-resin grout shall be used to bond steel anchors to masonry, and shall be a 100 percent solids, moisture insensitive, low creep, structural adhesive. The epoxy shall conform to [ASTM C 881/C 881M](#), Type IV; Grade and Class selected to conform to the manufacturer's recommendations for the application.

2.4.4 Metal attachments

Anchors for spall repairs shall be threaded stainless steel, size as indicated. Other plates, angles, anchors, and embedments shall conform to [ASTM A 36/A 36M](#), and shall be prime painted with inorganic zinc primer.

PART 3 EXECUTION

3.1 EVALUATION AND ANALYSIS

Evaluation and analysis shall conform to the requirements specified herein, and to [Section 01 45 00.00 10 QUALITY CONTROL](#). Masonry renovation shall be undertaken only after complete evaluation and analysis of the areas to be repaired are completed; including sampling and testing of the existing mortar to determine its composition and qualities. No repair work shall be undertaken until conditions that have caused masonry deterioration have been identified; such conditions shall be corrected, if possible, prior to start of the work.

3.2 MASONRY CLEANING

Historic materials shall not be damaged or marred in the process of cleaning. Cleaning shall conform to [ASTM C 1515](#) [BIA Tech Note 20](#). Temporarily caulk or otherwise protect open joints to prevent water and cleaner intrusion into the interior of the structure from pressure spraying. Protect non-masonry materials and severely deteriorated masonry by approved methods prior to initiation of cleaning operations. Masonry cleaning shall remove all organic and inorganic contaminants from the surface and pores of the substrate, returning the masonry to its natural color. Surfaces shall be evenly cleaned with no evidence of streaking or bleaching. The cleaning process shall not affect the density, porosity, or color of the masonry or mortar. Cleaned masonry shall have a neutral pH. Use the gentlest methods possible for cleaning historic masonry to achieve the desired results. Make test patches to determine a satisfactory cleaning result. Cleaning shall proceed in an orderly manner, working from top to bottom of each scaffold width and from one end of each elevation to the other. Perform cleaning in a manner which results in uniform coverage of all surfaces, including corners, moldings, interstices and which produces an even effect without streaking or damage to masonry. The cleaning materials, equipment, and methods shall not result in staining, erosion, marring, or other damage to the surfaces of the structure. Following an initial inspection and evaluation of the structure and surfaces, give the structure a surface cleaning which shall be completed prior to start of repair work, and sampling and testing of mortars. The work shall provide for the complete cleaning of all exterior masonry surfaces of the structures, removing all traces of moss, dirt, and other

contaminants to allow determination of the masonry's color and shades, finish and texture, and other properties. Following completion of the surface cleaning of the structure (or side of structure) the masonry shall be dried prior to the start of any repair work. The following sequence of methods shall be used to determine the least aggressive, effective cleaning method:

1. Water with brushes
2. Water with mild soap
3. Water with stronger soap
4. Water with stronger soap plus ammonia
5. Water with stronger soap plus vinegar (but not on calcareous masonry)
6. Stronger chemical cleaners, only when above methods are determined to be ineffective by the Contracting Officer

3.2.1 Chemical Cleaners

Acidic chemical cleaners shall not be used on limestone, marble, concrete and other calcareous (calcium containing) masonry materials. If chemical cleaners are used on such materials, they shall be alkaline based and utilized with neutralizing afterwashes.

3.2.2 Test Patches

The materials, equipment, and methods to be used in cleaning shall be demonstrated in a test section approximately 1 by 1 m 3 by 3 ft square. The location of the test section, and the completed test section shall be subject to approval. Adjust the cleaning process as required and the test section rerun until an acceptable process is obtained. Test patches shall be located in inconspicuous areas of the building. The areas tested shall exhibit soiling characteristics representative of those larger areas to be cleaned. Also conduct tests on areas to be stripped of paint. Tested areas shall be allowed to dry before a determination is made on the effectiveness of a particular treatment.

3.2.3 Paint Removal

Remove paint and other coatings from masonry surfaces in areas indicated prior to general cleaning. Masonry shall not be damaged or marred in the process of paint removal. Areas where paint is to be removed shall first be cleaned with water and detergent solution to remove surface dirt, rinsed, and allowed to dry. Apply chemical paint removers in accordance with manufacturer's instructions. Surrounding painted surfaces to remain intact shall be protected from exposure to chemical paint removers to avoid damage. Remove paint containing lead in accordance with Section 02 83 19.00 10 LEAD BASED PAINT HAZARD ABATEMENT, TARGET HOUSING & CHILD OCCUPIED FACILITIES.

3.2.4 Water Cleaning

3.2.4.1 Pressure Spraying

Spray apply water to masonry surfaces to comply with requirements indicated by test patches for location, purpose, water temperature, pressure, volume, and equipment. Unless otherwise indicated, the surface washing shall be done with clean, low pressure water (pressure of less than 0.38 MPa 55 psi and 9.5 to 11.4 L/m 2.5 to 3 gpm discharge) and the spray nozzle shall not be held less than 300 mm 12 inches from surface of masonry. Water shall be applied side to side in overlapping bands to produce uniform coverage.

3.2.4.2 Handscrubbing

Pre-wetted surfaces shall be scrubbed using hand-held natural bristle or nylon brushes. Wire brushes shall not be used. Surfaces to be cleaned shall be scrubbed to remove surface contaminants.

3.2.4.3 Rinsing

Scrubbed surfaces shall be rinsed clean of all contaminants and cleaning solutions with water in a low-to-moderate pressure spray, working upwards from bottom to top of each treated area. The rinsing cycle shall remove all traces of contaminants and cleaning solutions.

3.2.5 Chemical Cleaning

Chemical cleaning of historic masonry shall use the gentlest means possible to achieve the desired result as determined by test patches. Chemical cleaning shall be the use of any product in addition to water, including detergents, ammonia, vinegar, and bleach. Cleaning shall proceed in an orderly manner, working from top to bottom of each scaffold width and from one end of each elevation to the other. Cleaning shall result in uniform coverage of all surfaces, including corners, moldings, interstices and shall produce an even effect without streaking or damage to masonry. Chemical cleaners shall not be applied to the same masonry surfaces more than twice.

3.2.5.1 Surface Prewetting

Masonry surfaces to be cleaned with chemical cleaners shall be wetted with water using a low pressure spray before application of any cleaner.

3.2.5.2 Acidic Chemical Cleaning

Apply acidic chemical cleaners according to manufacturer's instructions. Acidic chemical cleaners shall not be applied to masonry with high calcium content (e.g. marble, limestone). Apply acidic cleaners to masonry surfaces by low pressure spray 0.35 MPa 50 psi max., roller, or brush. Cleaner shall remain on masonry surface for the time period recommended by manufacturer. Manual scrubbing by brushes shall be employed as indicated by test patches for the specific location. Cleaned surfaces shall be rinsed with a low-to-moderate pressure spray of water to remove all traces of chemical cleaner.

3.2.5.3 Alkaline Chemical Cleaning - Prewash Phase

Apply alkaline chemical cleaners to masonry surfaces according to manufacturer's instructions, by low pressure spray 0.35 MPa 50 psi max., roller, or brush. Cleaner shall remain on masonry surface for the time period recommended by the manufacturer. Manual scrubbing by brushes shall be employed as indicated by test patches for the specific location. Cleaned surfaces shall be rinsed with a low-to-moderate pressure spray of water.

3.2.5.4 Alkaline Chemical Cleaning - Afterwash Phase

Immediately after rinsing of alkaline cleaned surfaces, apply a neutralizing afterwash to the cleaned masonry areas. Neutralizing afterwash shall be applied according to manufacturer's instructions, by low

pressure spray 0.35 MPa 50 psi max., roller, or brush. Afterwash shall remain on masonry surface for the time period recommended by manufacturer. Cleaned surfaces shall be rinsed with a low-to-moderate pressure spray of water to remove all traces of chemical cleaners.

3.2.5.5 pH Testing

Masonry surfaces which have been chemically cleaned shall be pH tested using pH monitoring pencils or papers. Chemically cleaned masonry shall be rinsed of all chemical residues until a neutral pH (7) reading is obtained from the masonry surface.

3.3 MASONRY REPAIR

NOTE: Provide missing information; if a reference
is added, revise paragraph REFERENCES accordingly.

Repaired surfaces shall match adjacent existing surfaces in all respects. Masonry repair shall proceed only after the cause of deterioration has been identified and corrected. Masonry repair shall conform to ACI C-20. Repair of terra cotta masonry shall [be as directed] [conform to [____]]. Masonry repair shall proceed only after the area to be repaired has been cleaned. The materials, methods and equipment proposed for use in the repair work shall be demonstrated in test panels. The location, number, size and completed test panels shall be subject to approval. Use products in accordance with the manufacturer's instructions.

3.3.1 Repointing

NOTE: Provide missing information; if a reference
is added, revise paragraph REFERENCES accordingly.

Repointing work shall be [as directed] [in accordance with [____]]. Old caulking, grout, or mortar shall be removed from previously repaired cracks where it is failing. Remove loose particles from cracks. Cracks shall be cleaned, rinsed with water followed by blowing with filtered, dry, compressed air.

3.3.1.1 Mortar Analysis

Analyze existing original historic mortar before repointing in order to provide a match with the new repointing mortar. Historic mortars are usually softer than newer mortars, often using lime as a binder rather than cement. Lime for repointing mortar shall conform to ASTM C 207, Type S, unless otherwise specified. Full laboratory analysis of the existing mortar shall conform to ASTM C 1324. Field analysis of the existing mortar shall be as specified below.

3.3.1.2 Taking and Preparation of Samples

Take and analyze samples of unweathered original historic mortar and different type of mortar in the structure in order to match the new mortar to be used for repointing. Three or four samples of each type of mortar to be matched shall be removed with a hand chisel from several locations on the building. Set aside the largest sample for comparison with the

repointing mortar. The remaining samples shall be broken apart with a wooden mallet, powdering them into their constituent parts.

3.3.1.3 Binder Analysis

A part of the sample shall be stirred into diluted hydrochloric acid. If a vigorous chemical reaction (bubbling) occurs and most of the binder disappears, leaving clean aggregate, the binder was lime. A portland cement binder will result in a murky liquid and will dissolve very slowly over several days.

3.3.1.4 Aggregate Analysis

Separate aggregate of the mortar sample from the binder by taking the crushed mortar sample and either gently blowing away the fine binder material, placing the crushed sample in a centrifuge, or chemically separating the aggregate from the binder. The separated aggregate shall be rinsed clean with water and dried. Examine the aggregate with a magnifying glass, and record the component materials as to range of materials, sizes, colors, as well as the presence of other materials.

3.3.2 Mechanical Repair

Repair or replace original historic masonry materials only if surfaces are extensively deteriorated (surface missing to a depth of 100 mm 4 inches or more) or are threatening the safety of the structure or individuals. Deteriorated surfaces shall be removed and repaired or replaced only upon approval. Repairs and replacements shall match the materials, colors, and finish of the existing historic masonry as closely as possible.

3.3.2.1 Areas To Be Removed

Remove unsound, weak, or damaged masonry and mortar in areas as indicated. Loose particles, laitance, spalling, cracked, or debonded masonry and mortar and foreign materials shall be removed with hand tools unless otherwise noted. Surfaces prepared for repair shall be cleaned free of dust, dirt, masonry chips, oil or other contaminants, rinsed with water, and dried before repair work is begun. Protect surfaces of the structure, and surfaces adjacent to the work area from damage which may result from removal, cleaning, and repair operations.

3.3.2.2 Application of Masonry and Mortar

Place masonry and mortar to rebuild spalled or damaged areas to match the original surface finish, level, texture, and color. The finished appearance of the patch shall match the adjacent existing surface.

3.3.2.3 Patch Anchors

Provide patch anchors to ensure that the patch is tied to the existing masonry structure at a frequency of at least one patch anchor per 93 square mm square foot of patch plan surface area; specific locations for patch anchors shall be as indicated. Use small handheld, low-speed rotary masonry drills to produce holes in the existing masonry, within the limits for the patch anchor installation.

3.3.2.4 Holes

Drill holes into the existing substrate material of the masonry using

rotary (non-hammer) drills. Holes shall have a diameter of 3 mm 1/8 inch larger than the anchor diameter. The holes shall be drilled to a depth of 100 mm 4 inches, except as otherwise indicated or directed. Drill holes shall not penetrate completely through the masonry, and shall provide at least 25 mm 1 inch of cover around the drill hole. Holes shall be cleaned by water blasting to remove drill dust and other debris and then blown dry with filtered, dry, compressed air. Drill holes shall be conditioned in accordance with the epoxy adhesive manufacturer's recommendations.

3.3.2.5 Anchor Installation

Clean anchors to remove all contaminants which may hinder epoxy bond. Epoxy adhesive shall be pressure injected into the back of the drilled holes. The epoxy shall fill the holes without spilling excess epoxy when the anchors are inserted. Insert anchors immediately into the holes. The anchors shall be set back from the exterior face at least 25 mm 1 inch. Install anchors without breaking or chipping the exposed masonry surface.

3.3.2.6 Cleanup

Remove excess epoxy and spills from the surface of the masonry. The surface of the masonry shall be left in a clean and uncontaminated condition. Spills on adjacent surfaces shall also be removed and surfaces repaired as required.

3.3.2.7 Dutchman Repairs

The piecing-in of small patches of masonry to repair or replace damaged areas (Dutchman repair) shall be used in areas indicated. Repair pieces shall be held in place with epoxy with the joint between the new and old materials kept as narrow as possible to maintain the appearance of a continuous surface. Make repairs to blend in with the surrounding original materials as closely as possible.

3.4 EPOXY-RESIN GROUT

The epoxy adhesive shall be conditioned, proportioned, mixed, applied, protected, and cured in accordance with the manufacturer's recommendations, except as otherwise specified herein or indicated on the drawings. Maintain the adjacent surfaces and ambient conditions within the manufacturer's recommendations. The patch anchors and epoxy adhesive shall be protected from displacement and disturbances.

3.4.1 Mixing Epoxy-Resin Grout Components

Mix epoxy-resin grout components in the proportions recommended by the manufacturer. The components shall be conditioned within 20 to 30 degrees C 70 to 85 degrees F for 48 hours prior to mixing. Mix the two epoxy components with a power-driven, explosion-proof stirring device in a metal or polyethylene container having a hemispherical bottom. The polysulfide curing agent component shall be added gradually to the epoxy-resin component with constant stirring until a uniform mixture is obtained. The rate of stirring shall be such that the entrained air is at a minimum.

3.4.2 Tools and Equipment

Clean tools and equipment to be used again in the work before the epoxy-resin grout sets.

3.4.3 Health and Safety Precautions

Provide full-face shields for mixing, blending, and placing operations as required and protective coveralls and neoprene-coated gloves for workers engaged in the operations. Supply protective creams of a suitable nature for the operation. Adequate fire protection shall be maintained at mixing and placing operations. Smoking or the use of spark- or flame-producing devices shall be prohibited within 15 m 50 feet of mixing and placing operations. The mixing, placing, or storage of epoxy-resin grout or solvent shall be prohibited within 15 m 50 feet of any vehicle, equipment, aircraft, or machinery that could be damaged from fire or could ignite vapors from the material.

3.5 MASONRY REPLACEMENT

Replace masonry with material that matches the original in terms of composition, color, texture, strength, finishing, and porosity as closely as possible. If a few isolated masonry units are to be replaced, remove each without disturbing the surrounding masonry. Deteriorated masonry units and mortar requiring replacement shall be removed by hand chiseling. Adjoining masonry units shall not be damaged during the removal of deteriorated units and mortar. Test the new element for fitting into its space without mortar. If wedges are used to support and align the new unit, they shall be covered with at least 38 mm 1-1/2 inches of mortar when pointing is complete. Cover the four sides and back of the space with sufficient mortar to ensure that there will be no air spaces when the new unit is set. The new unit shall be lined up and set by tapping it into place with a wooden or rubber mallet. Align face of new unit with that of existing masonry. Joints shall be repointed to match the rest of the wall after new units have been properly installed and adjusted. Clean replacement areas with a non-metallic brush and water to remove excess mortar

3.6 MASONRY AND MORTAR FINISHES AND COLOR

The exposed surfaces of masonry and mortar repair shall match the finish, color, texture, and surface detail of the original surface. Mechanical finishing and texturing may be required to produce the required finish and appearance. The finishing and texturing shall conceal bond lines between the repaired area and adjacent surfaces. The texturing shall provide replication of all surface details, including tooling and machine marks. The equipment used in finishing and texturing shall be a low-impact energy type which will not weaken the patch or damage the patch bond and the adjacent concrete.

3.7 JOINT SEALING

Provide joint sealing as specified in Section 07 92 00 JOINT SEALANTS.

3.8 FINAL CLEANING

No sooner than 72 hours after completion of the repair work and after joints are sealed, faces and other exposed surfaces of masonry shall be washed down with water applied with a soft bristle brush, then rinsed with clean water. Discolorations which cannot be removed by these procedures, shall be considered defective work. Perform cleaning work when temperature and humidity conditions allow the surfaces to dry rapidly. Protect adjacent surfaces from damage during cleaning operations.

3.9 PROTECTION OF WORK

Protect work against damage from subsequent operations.

3.10 DEFECTIVE WORK

Defective work shall be repaired or replaced, as directed, using approved procedures.

3.11 FINAL INSPECTION

Following completion of the work, inspect the structure for damage, staining, and other distresses. The patches shall be inspected for cracking, crazing, delamination, unsoundness, staining and other defects. The finish, texture, color and shade, and surface tolerances of the patches shall be inspected to verify that all requirements have been met. Repair surfaces exhibiting defects as directed.

-- End of Section --