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USACE / NAVFAC / AFCEA / NASA UFGS-43 41 16.16 (August 2010)  
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Preparing Activity: NASA Superseding  
UFGS-43 41 13.19 (August 2008)

## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2010

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### SECTION TABLE OF CONTENTS

DIVISION 43 - PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE  
EQUIPMENT

SECTION 43 41 16.16

VERTICAL ATMOSPHERIC TANKS AND VESSELS

08/10

#### PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 ADMINISTRATIVE REQUIREMENTS
  - 1.2.1 Preconstruction Requirements
    - 1.2.1.1 Record Drawing of Existing Conditions
    - 1.2.1.2 Fabrication Drawings
    - 1.2.1.3 Equipment Room Drawings
    - 1.2.1.4 Installation Drawings
- 1.3 SUBMITTALS
- 1.4 QUALITY ASSURANCE
- 1.5 PRODUCT DELIVERY AND STORAGE

#### PART 2 PRODUCTS

- 2.1 LOADING CONDITIONS
- 2.2 CHEMICAL STORAGE REQUIREMENTS
- 2.3 CAPACITY AND DIMENSIONAL REQUIREMENTS
  - 2.3.1 Liquid Level Gauge
- 2.4 TANK CONSTRUCTION REQUIREMENTS
- 2.5 ACCESSORIES
  - 2.5.1 Flanged Nozzles
  - 2.5.2 Inlet Nozzles
  - 2.5.3 Outlet Nozzles
  - 2.5.4 Vent
  - 2.5.5 Flanged Manways
  - 2.5.6 Removable Cover
  - 2.5.7 Tiedown Lugs
  - 2.5.8 Tank Lifting Lugs
  - 2.5.9 Identification Plate
  - 2.5.10 Certification Plate

#### PART 3 EXECUTION

- 3.1 INSTALLATION

- 3.2 OPERATION AND MAINTENANCE MANUAL
- 3.3 HYDROSTATIC TEST
- 3.4 CLEANING
- 3.5 INSPECTION
- 3.6 RECORD DRAWINGS

-- End of Section Table of Contents --

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### SECTION 43 41 16.16

#### VERTICAL ATMOSPHERIC TANKS AND VESSELS

08/10

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NOTE: This specification covers the requirements for fiberglass-reinforced polyester storage tanks and accessories for use in aggressive chemical service at atmospheric pressures and is limited to flat-bottomed, aboveground, vertical, cylindrical tanks.

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 and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Submit recommended changes to a UFGS master text section as a Criteria Change Request (CCR).

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#### PART 1 GENERAL

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NOTE: This section does not cover vertical tanks with dished or conical bottoms, vertical tanks for buried service, pressure vessels, and horizontal tanks for both above ground and buried services.

Related work specified elsewhere includes:

Cast-in-place concrete

Anchor bolts (provide calculations that determine bolt types, sizes and quantities required.)

Plastic pipe

Acid-resistant pipe

Chemical valves

Liquid level gages

As a minimum, show on drawings:

The physical location of each tank

The location of all accessories to be furnished with each tank

Concrete-foundation details for each tank

Anchoring details for each tank to the foundation

A schedule with connections, size, quantity, and location of tanks.

Specify connection usage such as drain, vent, or overflow and location by top or side. Coordinate this schedule with all accessories and their locations shown on drawings.

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## 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.

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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.

ASME INTERNATIONAL (ASME)

ASME B16.5

(2009) Pipe Flanges and Flanged Fittings:  
NPS 1/2 Through NPS 24 Metric/Inch Standard

ASTM INTERNATIONAL (ASTM)

ASTM C 581 (2003; R 2008e1) Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures, Intended for Liquid Service

ASTM D 5948 (2005e1) Standard Specification for Molding Compounds, Thermosetting

BRITISH STANDARDS INSTITUTE (BSI)

BS 4994 (1973; R 1987; Amendment 1990) Specification for Design and Construction of Vessels and Tanks in Reinforced Plastics

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 7005-2 (1988) Metallic Flanges Part 2: Cast Iron Flanges

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA 2.63 (2004) Tank and Storage Tank Un-pressurized

RCBEA GUIDE (2004) NASA Reliability Centered Building and Equipment Acceptance Guide

1.2 ADMINISTRATIVE REQUIREMENTS

\*\*\*\*\*  
NOTE: If Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS is not included in the project specification, applicable requirements thereof should be inserted and the following paragraph deleted.  
\*\*\*\*\*

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

1.2.1 Preconstruction Requirements

1.2.1.1 Record Drawing of Existing Conditions

Submit [record drawing of existing conditions](#), including any underground utilities, [30] [\_\_\_\_\_] days prior to start of construction work.

1.2.1.2 Fabrication Drawings

Submit [fabrication drawings](#) for fiberglass-reinforced polyester storage tanks, including construction and anchorage details, [30] [\_\_\_\_\_] days prior to start of construction work.

Submit [manufacturer's standard color charts for laminates](#) for visual inspection of surface finish and color.

Submit manufacturer's catalog data for storage tanks including spare parts.

#### 1.2.1.3 Equipment Room Drawings

Show on drawings of [equipment room layout](#) structural and fenestration features, and items requiring installation that could reduce the available space. Detail all ductwork and piping.

#### 1.2.1.4 Installation Drawings

Submit [installation drawings](#) for fiberglass-reinforced polyester storage tanks including all foundation and anchorage details [30] [\_\_\_\_\_] days prior to start of construction work. Also submit equipment foundation data including equipment weight and operating loads, horizontal and vertical loads, seismic data, [wind loads][hurricane force windloads], location and projection of anchor bolts, horizontal and vertical clearances for installation, plan dimensions of foundations and relative elevations, and other installation requirements such as utility services.

Also include in submittal [coordination drawings](#) showing the processes, structural, and architectural elements of the work. Indicate where conflicts or clearance problems exist between the various functions. Clearly show on drawings:

- a. Manufacturer's certification that storage tanks are suitable for storage of specified chemicals,
- b. Signed statements providing confirmation that [Installers](#) have knowledge of the requirements of the applicable standards, [including NASA RCBEA GUIDE](#), and [specifically RCBEA 2.63](#), and installation practices to ensure installation in a sound, undamaged condition,
- c. [Material, equipment, and fixture lists](#) including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site,
- d. [Equipment and performance data](#) by the storage tank manufacturer indicating use life, safety features, and mechanical automated details.
- e. [Construction equipment lists](#) consisting of proposed construction equipment to be used in the project, including descriptive data.
- f. [Manufacturer's instructions](#) describing the installation of specified system, including special notices and material safety data sheets, special signage and data relating to impedances, hazards, and safety precautions.

#### 1.3 SUBMITTALS

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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.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for 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-01 Preconstruction Submittals

Record Drawing of Existing Conditions[; G][; G, [\_\_\_\_\_]]

Material, Equipment, and Fixture Lists[; G][; G, [\_\_\_\_\_]]

Construction Equipment Lists[; G][; G, [\_\_\_\_\_]]

Listing of Product Installation[; G][; G, [\_\_\_\_\_]]

#### SD-02 Shop Drawings

Coordination Drawings[; G][; G, [\_\_\_\_\_]]

Equipment Room Layout[; G][; G, [\_\_\_\_\_]]

Fabrication Drawings[; G][; G, [\_\_\_\_\_]]

Installation Drawings[; G][; G, [\_\_\_\_\_]]

#### SD-03 Product Data

Equipment and Performance Data[; G][; G, [\_\_\_\_\_]]

Equipment Foundation Data[; G][; G, [\_\_\_\_\_]]

Storage Tanks[; G][; G, [\_\_\_\_\_]]

Accessories[; G][; G, [\_\_\_\_\_]]

#### SD-04 Samples

Manufacturer's Standard Color Charts for Laminates[; G][; G, [\_\_\_\_\_]].

Flanged Nozzles[; G][; G, [\_\_\_\_\_]].

Inlet Nozzles[; G][; G, [\_\_\_\_\_]].

Outlet Nozzles[; G][; G, [\_\_\_\_\_]]

#### SD-05 Design Data

Design Analysis and Calculations[; G][; G, [\_\_\_\_\_]]

#### SD-06 Test Reports

Chemical Resistance Tests[; G][; G, [\_\_\_\_\_]]

Tank Integrity[; G][; G, [\_\_\_\_\_]]

Verification of Liquid Level Indication Results[; G][; G, [\_\_\_\_\_]]

Verification of Relief Device Results[; G][; G, [\_\_\_\_\_]]

Hydrostatic Tests[; G][; G, [\_\_\_\_\_]]

#### SD-07 Certificates

Certificates of Conformance[; G][; G, [\_\_\_\_\_]]

Installers

#### SD-08 Manufacturer's Instructions

Manufacturer's Instructions[; G][; G, [\_\_\_\_\_]]

#### SD-09 Manufacturer's Field Reports

Manufacturer's Field Reports[; G][; G, [\_\_\_\_\_]]

#### SD-10 Operation and Maintenance Data

Operation and Maintenance Manual[; G][; G, [\_\_\_\_\_]].

#### SD-11 Closeout Submittals

Record Drawings[; G][; G, [\_\_\_\_\_]].

### 1.4 QUALITY ASSURANCE

Submit listing of product installation for fiberglass-reinforced polyester storage tanks identifying at least five units, similar to those proposed for use, that have been in successful service for a minimum of five years. Identify purchaser, address of installation, service organization, and date of installation.



30 [\_\_\_\_\_] days prior to commencement of work, submit [certificates of conformance](#) verifying compliance with the standards and specifications for the following items:

- a. Storage tanks
- b. Installer

#### 1.5 PRODUCT DELIVERY AND STORAGE

Handle and store tanks per manufacturer's guidelines to prevent damage. Deliver each tank in compliance with specifications and provide verification of no damage, surface defects, or poor quality laminates.

All damaged or defective tanks or removable covers will be rejected. Remove immediately from the project site.

Concurrent with delivery of tanks, submit three copies of manufacturer's Operation and Maintenance Manual.

### PART 2 PRODUCTS

#### 2.1 LOADING CONDITIONS

\*\*\*\*\*  
**NOTE: Show equipment and accessory loads affecting tank shells and tops, if required. Show windload for exterior tanks and tank top design load when top manways are specified.**  
\*\*\*\*\*

Provide tanks conforming to loading conditions specified in project requirements.

#### 2.2 CHEMICAL STORAGE REQUIREMENTS

Provide [design analysis and calculations](#) for fiberglass-reinforced polyester storage tanks complying with [BS 4994](#).

\*\*\*\*\*  
**NOTE: Project Manager should review NASA RCBEA criteria under section 2.63 (2.63.1, 2.63.2, and 2.63.3 to determine the extent of required acceptance documentation.**  
\*\*\*\*\*

Submit test reports for [chemical resistance tests](#) in accordance with [ASTM C 581](#).

Submit test reports for the following:

[Tank integrity](#)

[Verification of liquid level indication results](#)

[Verification of relief device results](#)

Results of previous successful tests are acceptable provided laminates are representative of the tanks specified for this project.

## 2.3 CAPACITY AND DIMENSIONAL REQUIREMENTS

\*\*\*\*\*  
NOTE: Capacities vary from approximately 40 liter  
to 300 kiloliter 10 to 75,000 gallons.  
\*\*\*\*\*

Provide minimum capacity in liter gallons measured to the top of the  
straight shell or wall height as indicated.

\*\*\*\*\*  
NOTE: Diameters vary from approximately 0.6 to 5  
meter 2 to 16 feet. Wall heights vary from  
approximately 0.3 to 14 meter 1 to 47 feet.  
\*\*\*\*\*

Ensure approximate diameter and approximate straight shell or wall height  
are as specified.

### 2.3.1 Liquid Level Gauge

Provide tank with liquid level armored gauge glass sight tube [with  
flanges], indicating 10 to 90 percent of tank capacity.

## 2.4 TANK CONSTRUCTION REQUIREMENTS

\*\*\*\*\*  
NOTE: Select either filament-wound or  
contact-molded construction.

Filament winding is a process for tank fabrication  
in which continuous strands of fiberglass  
impregnated with resin are wound over the inner  
corrosion barrier in a predetermined geometric  
pattern.

Contact molding is a process for tank fabrication in  
which the structural reinforcement comprises  
sprayed, chopped-fiberglass supplemented with  
woven-glass roving fabric. This process is also  
known as hand layup, spray layup, pressure molding,  
or contact pressure molding. The pressure is seldom  
greater than that required to hold the materials  
together during fabrication.

Tanks up to 1.5 meter 5 feet are less expensive when  
fabricated by contact-molding methods. Strength  
requirements in larger tanks make filament-wound  
structures more economical. Filament winding offers  
equivalent strength with less shell thickness, and  
laminate quality is also improved.

\*\*\*\*\*  
[ Provide contact-molded tank, conforming to BS 4994 ASTM D 5948.  
][Provide filament-wound tank, conforming to BS 4994 ASTM D 5948.  
]  
\*\*\*\*\*

NOTE: Select one of the following for tank top.

\*\*\*\*\*

[ Provide tank with an open top, with reinforcing flange in compliance with  
ISO 7005-2 or rib [and removable cover].

][Provide tank with a closed top.

]

\*\*\*\*\*

NOTE: Select one of the following types if tank is  
to have closed top.

The end of a filament-wound cylindrical container  
normally appearing convex is called a domed top.

The end of a filament-wound or contact-molded tank  
normally appearing concave is called a dished top.

\*\*\*\*\*

[ Provide tank with a [dome] [dished] [flat] type closed top.

]

\*\*\*\*\*

NOTE: Select one of the following for top  
fabrication.

Separate fabrication of top and shell is most common.

\*\*\*\*\*

[ Provide closed top [integrally fabricated with shell] [separately  
fabricated and laminated to the shell].

]

\*\*\*\*\*

NOTE: Select one of the following two paragraphs  
for flat bottom fabrication.

Integral fabrication offers greater strength and  
does not rely on laminating procedures to join  
separate sections.

\*\*\*\*\*

Provide flat bottom tank fabricated [integrally with the shell] [separately  
and laminated to the shell].

\*\*\*\*\*

NOTE: Specify any additional special surfaces based  
on accessories and equipment required.

\*\*\*\*\*

Provide tank with bracketed flat surfaces for [identification plate]  
[certification plate] [liquid-level gage] [mounting lugs].

Submit manufacturer's catalog data for storage tanks including spare parts.

## 2.5 ACCESSORIES

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NOTE: Accessories specified are common items for  
general usage. Consult manufacturer's literature  
for other standard and special accessories.

```

*****

2.5.1    Flanged Nozzles

*****
        NOTE: Standard nozzles are suitable for most
        applications, but specify conically gusseted nozzles
        when vibratory or thermal stresses are anticipated.
*****

Provide [standard] [conically gusseted] nozzles.

Conform flange diameter and drilling to ISO 7005-2, 1050 kilopascal (150
psi) ASME B16.5, 150 pounds per square inch.

2.5.2    Inlet Nozzles

*****
        NOTE: Specify double-flanged inlet nozzles when
        interior pipe connections are desired.
*****

Provide [single] [double] flanged inlet connections.

2.5.3    Outlet Nozzles

*****
        NOTE: Specify double-flanged outlet nozzles when
        interior pipe connections are desired.
*****

Provide [single] [double] flanged outlet connections for side shell and
top, [side-bottom] [full] [siphon] [bottom] type drain[s], with bottom
elbow.

2.5.4    Vent

*****
        NOTE: Select one of the following types of vents
        for closed-top and removable-top tanks. Show vent
        size on drawings.
*****

Provide [v-vent][gooseneck][mushroom][ flanged nozzle
[breather][combination vacuum break/pressure relief]] vent for tank top.

2.5.5    Flanged Manways

[ Manway not required.][Provide [top-flanged] [side-flanged] manway.

][Conform flange diameter and drilling to ASME B16.5, ISO 7005-2, 1050
kilopascal 150 pounds per square inch.

][2.5.6    Removable Cover

[Cover not required.][Provide [domed] [dished] [flat] style cover, with[
lifting ring at center of cover][ three lifting lugs at 120 degrees apart
on cover]].

```

### 2.5.7 Tiedown Lugs

\*\*\*\*\*  
NOTE: Indicate quantity of lugs and angular spacing based on manufacturer's recommendations. Specify lugs on tanks subject to vibratory stresses and those erected outdoors. Three to six lugs evenly spaced are standard practice, depending upon tank size.  
\*\*\*\*\*

Provide tiedown lugs as indicated.

### 2.5.8 Tank Lifting Lugs

Provide [three lifting lugs spaced 120 degrees apart at top portion of straight shell][ one center top lug].

### 2.5.9 Identification Plate

Provide phenolic-plastic identification plate stating chemical to be stored, with letters at least 50 millimeter 2 inches high.

### 2.5.10 Certification Plate

Provide stainless-steel certification plate, stating tank is designed for chemical to be stored, concentration, specific gravity, and maximum temperature.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Install tank on foundation in accordance with recommended manufacturer's instructions. Submit equipment foundation data to the Contracting Officer prior to commencement of foundation work.

### 3.2 OPERATION AND MAINTENANCE MANUAL

Submit [\_\_\_\_\_] copies of the operation and maintenance manual [30][\_\_\_\_\_] calendar days prior to testing the system involved. Update and resubmit all data for final approval no later than [30][\_\_\_\_\_] calendar days prior to contract completion. Ensure manual includes information for:

- a. Storage Tanks
- b. Flanged Nozzles
- c. Inlet Nozzles
- d. Outlet Nozzles

### 3.3 HYDROSTATIC TEST

After tank has been installed, before piping connections are made and equipment attached, block outlets and fill straight-shell portion with chemically compatible fluid. Perform hydrostatic tests to determine if leak proof storage is provided, and correct deficiencies .

Submit written **manufacturer's field reports** of all test data made at the job site for review and final approval no later than [30][\_\_\_\_\_] calendar days prior to contract completion. Repair or replace unsatisfactory tanks and retest at no additional cost to the Government until leak proof systems are obtained.

#### 3.4 CLEANING

After installation has been completed and piping connections have been made, clean tank and nozzles in accordance with manufacturer's instructions.

#### 3.5 INSPECTION

Inspect installed tanks for indications of defective workmanship or improper installation practices. Repair or replace all faulty construction and damaged work at no additional cost to the Government.

#### 3.6 **RECORD DRAWINGS**

Submit record drawings of completed installation no later than [30][\_\_\_\_\_] days prior to final completion. Include in record drawings all civil site developments such as new facility and/or land modifications, external structural changes to aboveground structures, and changes to underground structures and utilities external to facilities located on lands owned by or held in leasehold interest of the federal government.

Acceptance of the completed drawings by the Contractor certifies accuracy and completeness of the documents. Nonconformity with any of the following requirements will result in withholding of vendor payments.

Mandatory information required in record drawings is, but not limited to:

- a. Location of all new lines, conduits, valves, fittings, fire hydrants, meters, terminal points using at least two ties to permanent points (manholes, power poles, curbs, or storm water inlets), or GPS coordinates with accuracy to at least 1 meter, or better if more stringent accuracy requirements are specified in other sections of this subcontract. An acceptable station and offset system may be used for service lines and fittings only.
- b. Location of new lines from property easement lines or edges of pavement at intervals of **90 meter 300 feet**.
- c. All utility routing and interface changes indicated clearly on the drawings to scale and defined with sufficient dimensions.

\*\*\*\*\*

**NOTE: Insert the appropriate form and jurisdictional authority for your respective agency within the appropriate blanks below if other than the Contracting Officer or Government.**

\*\*\*\*\*

- d. Provide support for obtaining surveyed coordinates for facility footprint corner and underground structures and utilities external to facilities by submitting [Form [\_\_\_\_\_] [\_\_\_\_]] to the [Contracting Officer] [\_\_\_\_\_] at least five (5) working days prior to foundation construction or open excavation as notification to the [Government] [\_\_\_\_\_].

- e. Prepare record drawing prints at a minimum scale of 1 cm equals 100 meters 1 inch equals 100 feet. Enlarge scale as necessary all areas requiring additional detail.
- f. Provide record drawings in digital format. Provide geospatially referenced files in ESRI GIS Geodatabase, ESRI GIS Shapefile, Microstation DGN, AutoCAD DWG or DXF file format. Provide information in separate layers/levels as specified by GIS in at least the same degree of separation as the design drawings provided. Contain in the same levels any new like items to permit easy conversion to GIS layers.
- g. Use spatial reference as:

\*\*\*\*\*  
**NOTE: Insert appropriate survey reference  
information, and date of most recent updated datum.**  
\*\*\*\*\*

Horizontal accuracy: Reference all surveys/drawings to  
[Regional][\_\_\_\_\_] Plane Coordinate System,[ East Zone] [\_\_\_\_\_] ,  
North American Datum [\_\_\_\_\_] adjustment based on Second Order  
Class II horizontal control monument.

Vertical accuracy: Reference all surveys to North American  
Vertical Datum (NAVD) [1988] [\_\_\_\_\_] . Include a description of  
the reference benchmarks from which the NAVD has been determined  
in the survey.

- h. Make all lines, letters, and details sharp, clean, and fully legible.
- i. Submit one reproducible print and one digital copy in an electronic storage media.

-- End of Section --