AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE	OF PAGES
	1	2

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. *(If applicable)*
0003	12 MAY 98		

6. ISSUED BY CODE

Department of the Army
Corps of Engineers
Fort Worth District

7. ADMINISTERED BY *(If other than Item 6)* CODE

8. NAME AND ADDRESS OF CONTRACTOR *(No., street, county, State and ZIP Code)*

CODE FACILITY CODE

(√)	9A. AMENDMENT OF SOLICITATION NO.
X	DACA63-98-B-0003
	9B. DATED *(SEE ITEM 11)* 9 APRIL 1998
	10A. MODIFICATION OF CONTRACTS/ORDER NO.
	10B. DATED *(SEE ITEM 13)*

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

[X] The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers [X] is extended, [ ] is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:

(a) By completing Items 8 and 15, and returning 1 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)*

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

(√)	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: *(Specify authority)* THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES *(such as changes in paying office, appropriation date, etc.)* SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
	D. OTHER *(Specify type of modification and authority)*

E. IMPORTANT: Contractor [ ] is not, [ ] is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION *(Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*

The Solicitation for BLOOD DONOR CENTER, LACKLAND AIR FORCE BASE, SAN ANTONIO, TEXAS, is amended as follows:

See Continuation Sheet.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER *(Type or print)*		16A. NAME AND TITLE OF CONTRACTING OFFICER *(Type or print)*	
15B. CONTRACTOR/OFFEROR *(Signature of person authorized to sign)*	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA BY *(Signature of Contracting Officer)*	16C. DATE SIGNED

Blood Donor Center, Lackland AFB, Texas

A. Standard Form 1442

Item 13.A.- In the second line, change the bid opening date from "19 May 1998" to "22 May 1998"
Bid opening time will be 2 p.m. local time.

B. Drawings

1. Drawing C4.01, Sequence 0013, CIVIL DETAILS - Add detail 9/A6.02/C4.01 juncture of new flexible and rigid service drive as indicated in Attachment 1.

2. Drawing L1.01, Sequence 0021, LANDSCAPE PLAN, - Add additional sodding(Common Bermuda) at culvert headwall locations as indicated in Attachment 2.

3. Drawing A6.02, Sequence 0042, WALL SECTIONS - Add detail reference 09/A6.02/C4.01 as indicated on Attachment 3.

C. Specifications

1. Replace the following sections with the accompanying new sections of the same title and number, each bearing the notation "ACCOMPANYING AMENDMENT NO. 0003 TO SOLICITATION NO. DACA63-98-B-0003":

Section No.	Title
15405	PLUMBING, HOSPITAL
15951	DIRECT DIGITAL CONTROL FOR HVAC
16721	FIRE DETECTION AND ALARM SYSTEM

D. Ref. Amendment No. 0001

Item C. Drawings,

(1) First line revise to read: Drawing C2.01 in lieu of C1.01

(2) First line revise to read: Drawing C1.04 in lieu of C1.01

End of Amendment

SECTION 15405

PLUMBING, HOSPITAL

PART 1 GENERAL

1.1 REFERENCES

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

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 1010	(1994) Drinking-Fountains and Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22	(1986; Z21.22a) Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems
ANSI Z358.1	(1990) Emergency Eyewash and Shower Equipment

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47	(1990) Ferritic Malleable Iron Castings
ASTM A 53	(1993a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 74	(1994) Cast Iron Soil Pipe and Fittings
ASTM A 105	(1996) Forgings, Carbon Steel, for Piping Components
ASTM A 183	(1983; R 1990) Carbon Steel Track Bolts and Nuts
ASTM A 516	(1990) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 888	(1994) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications
ASTM B 32	(1995) Solder Metal
ASTM B 42	(1993) Seamless Copper Pipe, Standard Sizes
ASTM B 75	(1993) Seamless Copper Tube

ASTM B 88	(1993a) Seamless Copper Water Tube
ASTM B 111	(1993) Copper and Copper-Alloy Seamless Condenser Tubes and Ferule Stock
ASTM B 117	(1994) Operating Salt Spray (Fog) Testing Apparatus
ASTM B 152	(1994) Copper Sheet, Strip, Plate, and Rolled Bar
ASTM B 306	(1992) Copper Drainage Tube (DWV)
ASTM B 370	(1992) Copper Sheet and Strip for Building Construction
ASTM B 584	(1993b) Copper Alloy Sand Castings for General Applications
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM B 828	(1992) Making Capillary Joints by Soldering of Copper and Copper-Alloy Tube and Fittings
ASTM C 564	(1995) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 920	(1994) Elastomeric Joint Sealants
ASTM D 609	(1990) Preparation of Clad-Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products
ASTM D 1527	(1994) Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
ASTM D 1784	(1992) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(1993) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2466	(1993) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2468	(1993) Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40
ASTM D 2564	(1993) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2661	(1994a) Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2665	(1994) Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

ASTM D 2672	(1993; R 1995) Joints for IPS PVC Pipe Using Solvent Cement
ASTM D 2855	(1993) Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3138	(1993) Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components
ASTM D 3308	(1991a) PTFE Resin Skived Tape
ASTM E 1	(1995) ASTM Thermometers
ASTM E 96	(1995) Water Vapor Transmission of Materials

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1	(1989; 90.1b; 90.1c; 90.1d; 90.1e; 90.1g; 90.1i) Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.1.2	(1991) Air Gaps in Plumbing Systems
ASME A112.6.1M	(1988) Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.18.1M	(1994; Errata Feb 1995) Plumbing Fixture Fittings
ASME A112.19.1M	(1994) Enameled Cast Iron Plumbing Fixtures
ASME A112.19.2M	(1990) Vitreous China Plumbing Fixtures
ASME A112.21.1M	(1991) Floor Drains
ASME A112.36.2M	(1991) Cleanouts
ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Cast Iron Threaded Fittings
ASME B16.5	(1988; Errata Oct 88; B16.5a) Pipe Flanges and Flanged Fittings
ASME B16.12	(1991) Cast Iron Threaded Drainage Fittings
ASME B16.15	(1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250

ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(1989) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(1992; Errata Jan 1994) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.29	(1994) Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.39	(1986; R 1994) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV IV	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IV, Heating Boilers
ASME BPV VIII Div 1	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1995; Addenda Dec 1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(1990) Pipe Applied Atmospheric Type Vacuum Breakers
ASSE 1003	(1981) Water Pressure Reducing Valves for Domestic Water Supply Systems
ASSE 1005	(1993) Water Heater Drain Valves - 3/4-Inch Iron Pipe Size
ASSE 1011	(1993) Hose Connection Vacuum Breakers
ASSE 1013	(1993) Reduced Pressure Principle Backflow Preventers
ASSE 1037	(1990) Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA-10062JU	(1992) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(1992) Hypochlorites
AWWA B301	(1992) Liquid Chlorine

AWWA M20	(1973) Manual: Water Chlorination Principles and Practices

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(1990) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI HSN	(1985) Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-238	(Rev B) Seat, Water Closet
CID A-A-240	(Basic) Shower Head, Ball Joint

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA 404/0-RR	(1993) Copper Tube for Plumbing, Heating, Air Conditioning and Refrigeration

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCHR)

FCCHR-01	(1993) Manual of Cross-Connection Control

HYDRAULIC INSTITUTE (HI)

HI-01	(1983) Standards for Centrifugal, Rotary & Reciprocating Pumps

IRON AND STEEL SOCIETY (ISS)

ISS-222	(1990) Steel Products Manual - Stainless and Heat Resisting Steels

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(1993) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-44	(1991) Steel Pipe Line Flanges
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(1995) Butterfly Valves

MSS SP-69	(1991) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1990) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1990) Cast Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-welding Ends for General Service
MSS SP-73	(1991) Brazing Joints for Copper and Copper Alloy Pressure Fittings
MSS SP-78	(1987; R 1992) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(1987) Bronze Gate, Globe, Angle and Check Valves
MSS SP-84	(1990) Valves - Socket Welding and Threaded Ends
MSS SP-85	(1994) Cast Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(1992) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ASSOCIATION OF PLUMBING-HEATING-COOLING CONTRACTORS (NAPHCC)

NAPHCC-01	(1993; Supple 1994) National Standard Plumbing Code (Non-Illustrated Edition)
NAPHCC-02	(1993) National Standard Plumbing Code (Illustrated Edition)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(1993; Rev 1-1993; Rev 2-1995) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(1992) National Fuel Gas Code
NFPA 99	(1993) Health Care Facilities
PPFA-01	(1991) Plastic Pipe in Fire Resistive Construction

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(1992) Water Hammer Arresters

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J1508 (1993) Hose Clamps

1.2 GENERAL REQUIREMENTS

1.2.1 Standard Products

Specified materials and equipment shall be standard items of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least 2 years prior to bid opening.

1.2.2 Performance Requirements

1.2.2.1 Welding

Structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL.] [Welding and nondestructive testing procedures are specified in Section 15052 WELDING PRESSURE PIPING.

1.2.2.2 Cathodic Protection and Pipe Joint Bonding

Cathodic protection and pipe joint bonding systems shall be in accordance with [Section 16640 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [and] [Section 16642 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)].

1.2.2.3 Electrical Work

Motors, motor controllers and motor efficiencies shall conform to the applicable requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Electric motor-driven equipment specified herein shall be provided complete with motors. Equipment shall be rated at 60 Hz, single phase, ac unless otherwise indicated. Motors shall be open, dripproof type unless otherwise indicated. Where a motor controller is not provided in a motor-control center on the electrical drawings, a motor controller shall be provided with the mechanical equipment. Electrical characteristics shall be as indicated. Motor controllers shall be provided complete with properly sized thermal-overload protection in each ungrounded conductor, auxiliary contact, and other equipment at the specified capacity including an allowable service factor, and other appurtenances necessary for the motor control specified. Manual or automatic control and protective or signal devices required for operation herein specified and any wiring required to such devices not shown on the electrical drawings shall be provided under this section. Complete electrical schematic lineless or full line interconnection and connection diagram for each piece of mechanical equipment having more than one automatic or manual electrical control device shall be submitted for approval. Manual or automatic control and protective or signal devices required for operation herein specified and any wiring required to such devices not shown on the electrical drawings shall be provided under this section.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL

PROCEDURES:

SD-01 Data

Welding; FI0.

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

Vibration-Absorbing Features; FI0.

Details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

SD-04 Drawings

Electrical Schematics; FI0.

Complete electrical schematic lineless or full line interconnection and connection diagrams for each piece of mechanical equipment having more than one automatic or manual electrical control device.

Plumbing System; GA.

Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operation of each system. Detail drawings for the complete plumbing system including piping layout and location of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams; and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support method. All mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

SD-06 Instructions

Framed Instructions; FI0.

Diagrams, instructions, and other sheets, prior to posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

SD-09 Reports

Tests; GA.

Test reports in booklet form showing field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

SD-13 Certificates

Outlets; FI0.

Proof that outlets as an assembly conform to the requirements of Underwriters Laboratories, Inc.

Materials and Equipment; FI0.

Where materials or equipment are specified to comply with requirements of AGA, or ASME, proof of such compliance shall be included. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, a written certificate may be submitted from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency. Where equipment is specified to conform to ASME requirements, the design, fabrication, and installation shall conform to the code.

Bolts; FI0.

Written certification from the bolt manufacturer that the bolts furnished comply with specified requirements. The certification shall include illustrations of product-required markings, date of manufacture, and number of each type of bolt to be furnished based on this certification.

SD-19 Operation and Maintenance Manuals

Plumbing System; GA.

Six copies of the operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six copies of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

1.4 REGULATORY REQUIREMENTS

Plumbing work shall be in accordance with NAPHCC-01, unless otherwise stated and installed in accordance with NAPHCC-02.

1.5 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

PART 2 PRODUCTS

2.1 MATERIALS

Materials for various services shall be in accordance with TABLES I and II. Pipe fittings shall be compatible with the applicable pipe materials. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Material or equipment containing lead shall not be used in any potable water system. Hubless cast-iron soil pipe shall not be installed under concrete floor

slabs.

2.1.1 Pipe Joint Materials

Joint and gasket materials shall conform to the following:

a. Coupling for Hubless Cast-Iron Pipe: ASTM A 74, AWWA C606.

b. Coupling for Steel Pipe: AWWA C606.

c. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1.6 mm (1/16 inch) thick, and contain aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.

d. Neoprene Gaskets for Hub and Spigot Cast-Iron Pipe and Fittings: CISPI HSN.

e. Brazing Material: Brazing material shall conform to AWS A5.8, BCup-5.

f. Brazing Flux: Flux shall be in paste or liquid form, be appropriate for use with brazing material, be lead free, have a 100 percent flushable residue, contain slightly acidic reagents, contain potassium bromides, and contain fluorides.

g. Solder Material: Solder metal shall conform to ASTM B 32, 95-5 tin-antimony.

h. Solder Flux: Flux shall be liquid form, non-corrosive, and shall conform to ASTM B 813, Standard Test 1.

i. Polytetrafluoroethylene Tape, for use with Threaded Metal or Plastic Pipe, and Distilled Water-Piping: ASTM D 3308.

j. Rubber Gaskets for Cast-Iron Soil Pipe and Fittings: ASTM C 564.

k. Solvent Cement for Transition Joints between ABS and PVC Nonpressure Piping Components: ASTM D 3138.

l. Plastic Solvent Cement for ABS Plastic Pipe: ASTM D 2235.

m. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D 2564 and ASTM D 2855.

n. Flanged Fittings: Flanged fittings including flanges, bolts, nuts, bolt patterns, etc. shall be in accordance with ASME B16.5 Class 150 and shall have the manufacturers trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105. Blind flange material shall conform to ASTM A 516 cold service and ASTM A 515 for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Water Hammer Arresters: PDI WH 201.

b. Copper, Sheet and Strip for Building Construction: ASTM B 370.

c. Asphalt Roof Cement: ASTM D 2822.

d. Hose Clamps: SAE J1508

e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

f. Metallic Cleanouts: ASME A112.36.2M.

g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile, nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.&\

h. Coal-Tar Protective Coating and Linings for Steel Water Pipelines: AWWA C203.

i. Hypochlorites: AWWA B300.

j. Liquid Chlorine: AWWA B301.

k. Gauges - Pressure and Vacuum Indicating Dial Type-Elastic Element: ASME B40.1.

l. Thermometers: ASTM E 1.

2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.1.4 Copper Pipe Erosion Test Assembly

Provide a copper test coupon and assembly with calibrated thickness in the combined domestic hot water supply pipe from the hot water heaters. Assembly shall be provided with a permanent label indicating initial coupon thickness.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves shall be gate valves, unless otherwise specified or indicated. Valves 50 mm (2-1/2 inches) and smaller shall be bronze, with threaded bodies for pipe and solder-type connections for tubing. Valves 65 mm (3 inches) and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged or Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Backwater Valves	ASME A112.14.1
Vacuum Relief Valves	ASSE 1001
Water Pressure Reducing Valves	ASSE 1003
Water Heater Drain Valves	ASSE 1005
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22, and ASME BPV IV

2.3.1 Wall Faucets

Wall faucets with vacuum breaker backflow preventer shall be brass with 20 mm (3/4 inch) male inlet threads, hexagon shoulder, and 20 mm (3/4 inch) hose connection. Faucet handle shall be securely attached to stem.

2.3.2 Wall Hydrants

Wall hydrants with vacuum breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 20 mm (3/4 inch) exposed hose thread on spout and 20 mm (3/4 inch) male pipe thread on inlet.

2.3.3 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves rated according to ASME BPV IV, or ASME CSD-1, shall have 25.0 mm (1 inch) minimum inlets, and 25.0 mm (1 inch) outlets for systems where the maximum rate of heat input is greater than 59 kW (200,000 Btuh). The discharge pipe from the (P&T) valve shall be the size of the valve outlet.

2.3.4 Thermostatic Mixing Valves

2.3.4.1 Mixing Valves

Mixing valves, thermostatic type, shall be line size and shall be constructed with rough or finish bodies with plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Mixing valves shall maintain water temperature within 2 degrees C (5 degrees F) of any setting.

2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with NAPHCC-01 and installed in accordance with NAPHCC-02. Fixtures for use by the physically handicapped shall be in accordance with CABO A117.1. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports. Pipe, valves, and fittings exposed to view shall be chromium plated. Fixtures and trim not covered by

MIL-STD 1691 shall be considered special, but shall be of equal quality and material. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 82 degree C (180 degree F) water temperature. Plumbing fixtures shall be as listed below. Shower heads, other than emergency showers, shall include a non-removable, tamperproof flow control device which shall limit water flow to .16 liters per second (2.5 gpm) when tested in accordance with ASME A112.18.1M.

2.4.1 Flushometer Valves

Flushometer valves shall have a non-hold-open feature with backcheck angle control stop and a vacuum breaker. Flushometer valves shall be large diaphragm type, having a minimum upper chamber inside diameter of not less than 66.7 mm (2-5/8 inches) at the point where the diaphragm is sealed between the upper and lower chambers. Flushometer valves shall conform to ASSE 1037.

2.4.2 Joint Schedule Fixtures

The following Joint Schedule Numbers (JSN) for plumbing fixture items are as shown in MIL-STD 1691. Description of the fixture may vary from that in MIL-STD 1691.

a. CS140: Drain and P-Trap. Provide with 9.5 mm angle supplies with loose key stops and reducers, and 40 mm cast-brass "P" trap with cleanout.

b. CS140A: Provide 9.5mm angle supplies with loose key stops and reducers.

c. Item P3100. Lavatory, clinic, 508.0 by 457.2 mm (20 by 18 inches), shall conform to ASME A112.19.2M. Fixture shall be equipped with elevated gooseneck spout and wrist action handle combination faucet, pop-up drain fitting, "P" trap, and angle or straight stop valves.

d. Item P4700. Basin, mop service; molded polyester/fiberglass product, 914.4 by 609.6 by 254.0 mm (36 by 24 by 10 inches), built under heat and pressure, resulting in a one-piece, homogeneous product. Service faucet, hose, hose racket, and mop hanger shall be provided.

e. Item P5210. Shower, ANSI Z358.1, deluge, safety, shall be a complete, maximum protection safety station consisting of a free-standing emergency shower and an aerated eye-face wash fixture.

f. Item P5040. Shower, wheel chair with floor drain, to include one 1524 mm (5 foot) flexible spray hose, one thermostatic water regulating valve, one floor drain, and two valve stops. Flow shall be limited to 1.57 liters per second (2.5 gpm) at a flowing water pressure of 549 kPa.

g. Item P8150 and P8150H. Urinal wall-hanging, siphon-jet with extended

shields shall conform to ASME A112.19.2M. Fixture shall be equipped with flushometer valve conforming to ASSE 1037, SPN 1a1.5. Flow shall be limited to 3.8 liters per flush at a flowing water pressure of 549 kPa. (80 psi.)

h. Item P9050 and P9050H. Water closet wall-hanging, siphon-jet, elongated bowl for direct flushometer valve, shall conform to ASME A112.19.2M.

Seat shall conform to CID A-A-238, SPN CEWX. Flushometer valve shall conform to ASSE 1037, SPN 1a3.5. The maximum water use allowed shall be 6 liters (1.6 gallons) per flush.

2.5 BACKFLOW PREVENTERS

Backflow preventers shall be approved and listed by the Foundation For Cross-Connection Control & Hydraulic Research. Reduced-pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with FCCHR-01. Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Air gaps in plumbing systems shall conform to ASME A112.1.2.

2.6 DRAINS

2.6.1 Floor and Shower Drains

Floor and shower drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron, except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drain pipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded or caulked connection. In lieu of a caulked joint between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C 564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor and shower drains shall conform to ASME A112.21.1M.

2.6.1.1 Metallic Shower Pan Drains

Where metallic shower pan membrane is installed, polyethylene drain with corrosion-resistant screws for securing the clamping device shall be provided. Polyethylene drains shall have fittings to adapt drain-to-waste piping. Polyethylene floor drains shall be constructed of polyethylene conforming to ASTM D 1248. Drains shall have separate cast-iron "P" trap, circular body, seepage pan, and chrome-plated strainer, unless otherwise indicated.

2.6.1.2 Drains and Backwater Valves

Drains and backwater valves installed in connection with waterproofed floors or shower pans shall be equipped with bolted-type device to securely clamp flashing.

2.6.2 Item FD-1

Mechanical room floor drain shall be cast iron with integral clamping collar, seepage openings, and adjustable 200 mm round ductile iron top.

2.6.3 Item FD-2

Floor drain in finish room shall have adjustable height 125 mm x 125 mm square polished nickel bronze strainer.

2.6.4 Item FD-3 Floor Sinks

Floor sinks shall be circular or square, with 300 mm (12 inch) nominal overall width or diameter and 250 mm (10 inch) nominal overall depth. Floor sink shall have an acid-resistant enamel interior finish with cast-iron body and aluminum sediment bucket, and perforated grate of cast iron in industrial areas and stainless steel in finished areas. The outlet pipe size shall be as indicated or of the same size as the connective pipe.

2.7 WATER COOLERS

Self-contained, wall hung, mechanically refrigerated drinking water coolers shall conform to ARI 1010, shall use one of the halogenated hydrocarbons as a refrigerant, and shall have a capacity to deliver a minimum of 20.3 liters per hour (8 gph) of 10 degree C (50 degree F) water when supplied with 27 degree C (80 degree F) inlet water and a 32 degree C room temperature.

2.7.1 Item R2201

Drinking fountain, Bi-level, shall consist of two stainless steel receptors (one with barrier free design for the handicapped and one standard for general public), chrome-plated bubbler with push lever, stainless steel wall panel with removable louvered front panel for servicing. Cooling component shall be recessed into wall. Unit shall be complete with fan-cooled condenser, hermetically sealed compressor, insulated cooling tank and adjustable thermostat for water temperature control. Capacity shall be based on ARI standard rating conditions and shall deliver a minimum capacity of 20 L/h.

2.8 TRAPS

Unless otherwise specified, traps shall be plastic in accordance with ASTM F 409 or copper alloy adjustable tube type with slip joint inlet and swivel. Traps shall be without a cleanout. Tubes shall be copper alloy with walls not less than 0.81 mm (0.032 inch) thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint

connections. The depth of the water seal shall be not less than 50 mm (2 inches). The interior diameter shall be not more than 6 mm (1/8 inch) over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. A plastic or copper-alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast-brass wall flange, shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.9 WATER HEATERS

Water heater types and capacities shall be as indicated. Each primary water heater shall have controls adjustable from 23 to 60 degrees C (90 to 120 degrees F). Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and stand by heat losses shall conform to Table III, for each type of water heater specified.

2.9.1 Automatic Storage Type

Heaters shall be complete with control system, temperature gauge, and pressure gauge, and shall have ASME rated combination pressure and temperature relief valve.

2.9.1.1 Gas Fired Type

Gas fired water heaters shall conform to ANSI Z21.10.3 for heaters with input greater than 22 kW (75,000 Btu per hour).

2.9.2 Conventional Breeching and Stacks

Individual stacks shall be 6.600m in height when assembled on the water heater and measured from the ground line. Stack section shall be stainless steel schedule 10S or a prefabricated double wall stack system UL listed for positive pressure. The inner stack shall be 304 stainless steel having a thickness of not less than 0.89 mm. (0.035 inch). The outer stack shall be sheet steel having a thickness of not less than 0.635 mm (0.025 inch). A method of maintaining concentricity between the inner and outer stacks shall be incorporated. The joints between the stack sections shall be sealed to prevent flue gas leakage. A 7.92 mm (0.3125 inch) diameter hole shall be provided in the stack not greater than 150 mm (6 inches) from the furnace flue outlet for sampling of the exit gases. A method shall be provided to seal the hole to prevent exhaust gases from entering the boiler room when samples are not being taken. Each stack shall be provided complete with rain hood.

2.10 PUMPS

2.10.1 Circulating Pumps

Domestic hot water circulating pumps shall be electrically driven, single stage, centrifugal, mechanical seals, suitable for the intended service. Pump capacities, motor sizes, speeds, and impeller types shall be as shown. Pump and motor shall be supported by the piping on which it is installed. The shaft shall be one piece, heat-treated, corrosion-resisting steel with impeller and smooth surfaced housing of bronze. Motor shall be totally enclosed, fan-cooled and shall have sufficient wattage (horsepower) for the service required. Pump shall be hydraulically balanced and shall conform to

HI-01. Pump motors smaller than 746 W shall have integral thermal overload protection in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Guards shall shield exposed moving parts.

2.11 WATER SOFTENING WATER TREATMENT SYSTEM

Water softening water treatment system shall be provided for the indicated continuous water flow capacity and for the indicated grains hardness to which water shall be softened.

AM#3 ### 2.11.1 Water Analysis

The water analysis of the water to be softened is as follows:

Constituent	ppm	Constituent	ppm
Total solids	290	Nitrates as NO(3)	4
Calcium as Ca	65	Alkalinity as CaCO(3):	198
Magnesium as Mg	23	Total hardness as CaCO(3) . . .	257
Sodium and potassium as Na	12	Carbonate hardness as CaCO(3)	163
Iron as Fe	<0.05	Noncarbonate hardness as CaCO(3)	94
Silica as SiO(2)	12	Free carbon dioxide as CO(2). .	0
Sulphate as SO(4).	20	Turbidity	1
ppm Chlorides as Cl.	17	pH	75
Hydrogen Sulfide as H(2)S	0		

2.11.2 System Requirements

The water softener assembly shall consist of two softener units, with each unit designed for the full-flow capacity indicated, and a brine-solution tank for regeneration of the softener exchanger material. Each unit shall be a fully automatic, downflow pressure type water softener. The assembly shall be provided with the alarm and controls necessary to provide a complete operable system. The softener tank shells shall be of electric welded, heavy gauge, low carbon steel hot-dipped galvanized construction and the brine-solution tank shall be of polyethylene construction. The exchange material shall not require dosing or the adding of any chemical mixture or solution, either to the water to be treated or the water used for backwashing or regeneration, other than common salt (NaCl). The brine-solution tank shall be provided with indicators for measuring the correct volume of brine for regeneration and shall be of adequate size to provide for necessary salt storage. A hydraulic ejector or motor-driven all-bronze pump with valves, piping, and connections shall be provided for delivering brine to the softeners. The softeners shall be designed for 100 psi working pressure, and shall be designed and constructed in

accordance with ASME BPV VIII Div 1. A display of the ASME seal on the softeners or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code shall be provided.

2.11.3 Automatic Operation and Controls

Operation shall be initiated automatically and regeneration of the unit shall continue automatically. Operational power shall be from a 120 volt, 60 Hz, single-phase ac motor or self-contained hydraulic system. Electrically operated units shall be provided with a 5 meter (15 foot) electrical cord and plug cap matching the electrical receptacle provided for service. Electrical control shall be designed to be operated manually in the event of failure of the electrical equipment. The necessary washing, brining, and rinsing operations shall be timed by suitable timing device and carried out without manual attention or supervision other than to keep the salt-storage tank filled. Following complete regeneration, the softening run shall start automatically. Each function of softener operation shall be controlled mechanically or electrically, or by both methods in combination to assure the highest degree of efficiency; and the controls shall be capable of convenient and accurate manual adjustment. An interlocking system shall be provided that prevents the regeneration of more than one unit at a time. The transfer of water and brine solution to and from the water softener shall be accomplished by a single-unit multiple-port valve or by a package-type valve nest for automatic operation.

2.11.3.1 Multiple-Port Valve

The multiple-port valve shall consist of an assembly of nonsticking, nonleaking, water-lubricated valve ports that connect to the hard-water inlet, soft-water outlet, backwash inlet and outlet, and brine inlet, all enclosed in a single casing. The design shall permit the various steps of operation service, backwash, brine flow, and rinse to be accomplished by the rotation of a shaft that drives the mechanism causing the opening and closing of ports in correct sequence. The design of the valve mechanism shall be such that gradually increasing flows will be attained as ports are opened and initial surges and sudden inrushes of water or brine solutions are avoided. A dial pointer shall indicate each step of the operation.

2.11.3.2 Package-Type Valve Nest

The package-type valve nest shall consist of a pilot valve connected with fittings as may be required to each one of a nest of valves hydraulically or electrically operated. The nest of valves shall have connections to hard-water inlet, soft-water outlet, backwash inlet and outlet, and brine inlet. A dial pointer shall indicate each step of the operation.

2.11.3.3 Backwash and Brine-Rinse Control

Adequate means shall be provided for automatically controlling the rate of backwashing and brine rinsing. Wash and rinse water shall discharge into an open sump or other suitable drain. The controls shall be entirely automatic in operation and shall accurately regulate the rate of backwash and brine rinse as recommended by the softener manufacturer.

2.11.4 Accessories

2.11.4.1 Pressure Gauges and Sampling Cocks

Each softener unit shall be provided with a duplex pressure gauge, or two single pressure gauges, connected to the hard-water inlet and the soft-water outlet, to indicate pressure loss through softener when in operation. The pressure loss through the softener, plus its pipe, valve, and fitting assembly when delivering the indicated amount of water per softener unit, shall not exceed 69 kPa. (10 psi). Sampling cocks shall be furnished for both the hard and soft water.

2.11.4.2 Automatic Hardness Tester

A device for automatically testing the hardness of the water shall be installed in the soft-water line leading from each softener unit. The automatic hardness tester shall be suitable for wall mounting and shall be capable of carrying out intermittent tests on the softener water and of giving visual warning that the residual hardness present exceeds a predetermined limit. The tester shall be equipped with necessary wiring and electrical controls to initiate automatic regeneration.

2.11.4.3 Water Meters

Each softener shall be provided with displacement-type water meter reading in liters and U.S. gallons. The meter shall be equipped with necessary wiring and electrical controls to initiate automatic regeneration when the softener unit has delivered the indicated amount of water. The meter contacts shall be adjustable to permit setting to suit actual hardness of the water being tested. The meter shall be installed in the soft-water line from the softener unit and shall be located so as to be readily accessible for reading and setting.

2.11.4.4 Water-Testing Equipment

A complete water-testing set furnished by the manufacturer shall be provided with the water softener assembly, with complete instructions for conducting either the American Public Health Association test or other suitable test for hardness. Two Baume hydrometers, calibrated for the range necessary for testing saturated brine solution, and three glass cylinders of heat-resistant glass to hold sufficient brine for testing shall be provided.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Hubless cast-iron pipe shall not be installed under concrete floor slabs. Hubless cast-iron soil pipe shall not be installed in crawl space below kitchen floors. Piping located in air plenums shall conform to NFPA 90A requirements. Plastic pipe shall not be installed in air plenum.

Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA-01. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and

accessories. Water and drainage piping shall be extended 1.5 meters (5 feet) outside the building, unless otherwise indicated. A gate or full port ball valve and drain on the water service line shall be installed inside the building approximately 150 mm (6 inches) above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged, if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches. Exterior underground utilities shall be at least 300 mm (12 inches) below the average local frost depth. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with handle horizontal to or above the valve body.

3.2 WATER PIPE, FITTINGS, AND CONNECTIONS

3.2.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot water and cold water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flushing devices, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the time for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

3.2.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting through construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3.2.3 Protection to Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

3.2.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 15 mm (1/2 inch) between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural

elements so as to transmit sound to the structure or prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Buried pipe shall be inspected, tested, and approved before backfilling. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific excepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 100 mm (4 inches) and smaller will be permitted provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.2.5 Pipe Drains

Pipe drains indicated shall consist of 20 mm (3/4 inch) hose bibb with renewable seat and full port ballvalve ahead of hose bibb. At other low points, 20 mm (3/4 inch) brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

3.2.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot water and hot water circulation riser shall have expansion loops where indicated and required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 15 meters in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.2.7 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters, conforming to PDI WH 201, shall be provided on hot and cold water supplies and shall be located as generally indicated, with precise location and sizing per PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Vertical capped pipe columns will not be permitted.

3.3 JOINTS

3.3.1 Unioned and Flanged

Unions and flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 65 mm (2-1/2 inches) and smaller; flanges shall be used on pipe sizes 80 mm (3 inches) and larger.

3.3.2 Cast Iron Pipe

Cast iron soil, waste and vent pipe joints shall be bell and spigot compression and hubless gasketed clamped joints installed per the manufacturer's recommendations.

3.3.3 Copper Tube and Pipe

Joints shall be made up with fittings of compatible material and made for the purpose intended. The tube or fittings shall not be annealed when making connections. Connections shall be made with a multiflame torch.

a. Brazed. Brazed joints shall conform to MSS SP-73 and CDA 404/0-RR, made with flux, and are acceptable for all lines sizes.

b. Soldered. Soldered joints shall be made with flux and are only acceptable for lines 50 mm (2 inches) and smaller. Soldered joints shall conform to ASME B31.5 and CDA 404/0-RR.

3.3.4 Plastic Pipe

ABS pipe shall have joints made with solvent cement. PVC pipe shall have joints made with solvent cement elastomeric, threading, or mated flanged. Threading of Schedule 80 pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 pipe is not allowed. Joints for plastic pipe materials shall be made in the following manner:

Pipe Material	Joint Method
ABS	Solvent Cement
PVC AND CPVC	Solvent Cement Elastomeric

3.3.5 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous pipe shall be made with dielectric unions, flanges or dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fittings for this specific purpose.

3.4 PIPE SLEEVES AND FLASHING

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.4.1 Sleeve Requirements

Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves will not be required for cast-iron soil pipe passing through concrete slab on grade, except where penetrating a membrane waterproof floor. A modular mechanical type sealing assembly with sleeves of proper diameter shall be installed. The seals shall consist of interlocking synthetic rubber links shaped to continuously

fill the annular space between the pipe and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 100 mm (4 inches) above the finished floor. Unless otherwise indicated, sleeves shall be of a size to provide a minimum of 6 mm (1/4 inch) clearances between bare pipe and inside of sleeve or between jacket over insulation and sleeves. Sleeves in bearing walls shall be steel pipe or cast-iron pipe. Sleeves for membrane waterproof floors shall be steel pipe, cast-iron pipe, or plastic pipe. Membrane clamping devices shall be provided on pipe sleeves for waterproof floors. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. Plastic sleeves shall not be used in nonbearing fire walls, roofs, or floor/ceilings. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with primer backstop material and surface preparation as specified in Section 07920 JOINT SEALING. Pipes passing through sleeves in concrete floors over crawl spaces shall be sealed as specified above. The annular space between pipe and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated.

3.4.2 Flashing Requirements

Pipes passing through floor waterproofing membrane shall be installed through a lead flashing or a 4.9 kg/sq meter (16 ounce) copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed; the skirt or flange shall extend not less than 200 mm from the pipe, and shall be set over the roof or floor membrane in a solid coating of bituminous cement. The flashing shall extend up the pipe a minimum of 250 mm (10 inches). For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using copper flashing, with an adjustable integral flange of adequate size to extend not less than 200 mm (8 inches) from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between flashing and bare pipe or between flashing and metal-jacket covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 250 mm (10 inches) in diameter, passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above.

A waterproofing clamping flange shall be installed.

3.4.3 Optional Counterflashing

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket covered insulation and flashing, counterflashing may be accomplished by utilizing the following:

a. A standard roof coupling for threaded pipe up to 150 mm (6 inches) in diameter.

b. A tack-welded or banded-metal rain shield around the pipe.

3.5 FIRE SEAL

Where pipes pass through fire walls, fire partitions, fire rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07270 FIRESTOPPING.

3.6 SUPPORTS

Hangers used to support piping 50 mm (2 inches) and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.6.1 Pipe Hangers, Inserts, and Supports

Pipe hanger, insert and support installation shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

d. Types 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on

fabricated frames.

g. Type 39 saddles shall be used on insulated pipe 100 mm (4 inches) and larger when the temperature of the medium is 16 degrees C (60 degrees F) or higher. Type 39 saddles shall be welded to the pipe.

h. Type 40 shields shall:

1) Be used on insulated pipe less than 100 mm (4 inches).

2) Be used on insulated pipe 100 mm (4 inches) and larger when the temperature of the medium is 16 degrees C (60 degrees F) or less.

3) Have a high density insert for pipe 50 mm (2 inches) and larger and for smaller pipe sizes when the insulation is suspected of being visibly compressed, or distorted at or near the shield/insulation interface. High-density inserts shall have a density of 144 kg per cu. meter (9 pcf) or greater.

i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm (1 foot) from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 meters (5 feet) apart at valves. Operating temperatures of 49 degrees C (120 degrees F) for PVC pipe shall be used in determining hanger spacing for PVC pipe. Horizontal pipe runs shall include allowances for expansion and contraction.

j. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 5 meters, (15 feet,) nor more than 2 meters (8 feet) from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.

k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint, the following may be used:

1) On pipe 100 mm (4 inches) and larger when the temperature of the medium is 16 degrees C (60 degrees F) or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

2) On pipe less than 100 mm (4 inches), a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

3) On pipe 100 mm (4 inches) and larger carrying medium less than 16 degrees C, (60 degrees F,) a Type 40 shield, attached to the pipe or insulation, may freely rest on steel plate.

l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.

m. Where there are high system temperatures and welding to piping

is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm (4 inches), or by an amount adequate for the insulation, whichever is greater.

3.7 WELDED INSTALLATION

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.8 PIPE CLEANOUTS

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 100 mm will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 100 mm Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction. Pipe cleanouts concealed in partitions shall be provided with chromium-plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the head cleanouts shall be provided with adjustable cast iron or plastic heads.

3.9 VALVES, OUTLETS, AND DISPENSERS

3.9.1 Thermostatic Mixing Valve

The assembly, when not installed in a cabinet, shall be mounted 1.372 meters above the floor. When a cabinet is used, bottom of cabinet shall be set approximately 1.2 meters above finished floor. Cabinet doors shall not offer any obstruction when opened. Anchors shall be provided for fastening cabinet in place. Valves located in pipe corridors for tempering water for neuropsychiatric patient showers shall have a maximum outlet temperature of 48 degrees C and valves for neuropsychiatric patient lavatories shall have a maximum outlet temperature of 41 degrees C (105 degrees F).

3.10 FIXTURES AND FIXTURE TRIMMINGS

Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, or sweat inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beaded tool shall be used to mechanically deform the tubing above the compression fittings. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown. Stops for water closet seats shall be installed on the wall.

3.10.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural-rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.10.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finish connection to top spud adjacent to valve, to the wall with approved metal bracket.

3.10.3 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 775 mm above finished floor. Wall-hung drinking fountains shall be installed with rim 1.05 meters above floor. Wall-hung service sinks shall be mounted with rim 700 mm above the floor. Installation of fixtures for use by the physically handicapped shall conform to CABO A117.1.

3.10.4 Fixture Supports

Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair carrier type. The carrier shall provide the necessary means of mounting

the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.10.4.1 Concrete or Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

3.10.4.2 Cellular-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the cellular wall using through bolts and a back-up plate.

3.10.4.3 Steel Stud Frame Partitions

Chair carriers shall be used. The anchor feet and tubular uprights shall be of the heavy duty design. Feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, may be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

3.10.4.4 Wall-Mounted Water Closet Gaskets

When wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair carrier manufacturer.

3.10.5 Backflow Prevention Devices

Plumbing fixtures, equipment, and pipe connections shall not cross connect or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with NAPHCC-01 at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

3.10.6 Access Panels

Access panels shall be provided for concealed valves and controls or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced. Access panels shall be as specified in Section

05500 MISCELLANEOUS METAL.

3.10.7 Sight Drains

Sight drains shall be installed so that the indirect waste will terminate 50 mm above the flood rim of the funnel to provide an acceptable air gap.

3.10.8 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps for acid-resisting waste shall be of the same material as the pipe.

3.11 VIBRATION-ABSORBING FEATURES

Mechanical equipment, including pumps, shall be isolated from the building structure by approved vibration-absorbing features unless otherwise shown. Each foundation shall include standard isolation units. Each unit shall consist of machine and floor or foundation fastening, together with intermediate isolation material, and shall be a standard product with printed loading rating. Piping connected to mechanical equipment shall be provided with flexible connectors. Isolation unit installation shall limit vibration to 5 percent of the lowest equipment rpm.

3.12 WATER HEATERS AND HOT WATER STORAGE TANKS

3.12.1 Relief Valves

Valves shall not be installed between a relief valve and its water heater or storage tank. The relief valves shall be installed where the valve actuator comes in contact with the hottest water in the heater or tank. Whenever possible, the valve shall be installed directly in a tapping in the tank or heater. When heaters are not provided with a relief valve tapping, the valve shall be installed in the hot water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the hot water storage tank or water heater and mounted above and within 150 mm (6 inches) of the tank or water heater.

3.12.2 Connections to Water Heaters

Connections to water heaters and metallic pipe shall be made with dielectric unions or flanges.

3.13 IDENTIFICATION SYSTEMS

3.13.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number, shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 35 mm minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.13.2 Color Coding

Color coding for piping identification shall be as specified in Section 09900 PAINTING, GENERAL.

3.14 ESCUTCHEONS

Escutcheons shall be provided to finished surfaces where bare or insulated piping exposed to view passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one piece or split-pattern, held in place by internal spring tension or setscrew.

3.15 PAINTING

Painting of pipes, hangers, supports, and other iron work, in concealed spaces or exposed, is specified in Section 09900 PAINTING, GENERAL.

3.16 TESTS, FLUSHING, AND STERILIZATION

3.16.1 Plumbing System

The plumbing system shall be tested in accordance with NAPHCC-01.

3.16.1.1 Shower Pans

After installation of the pan and finished floor, the drain shall be temporarily plugged below the weep holes. The floor area shall be flooded with water to a minimum depth of 25 mm (1 inch) for a period of 24 hours. Any drop in the water level during test, except for evaporation, shall be reason for rejection, repair, and retest.

3.17 DEFECTIVE WORK

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new material. No caulking or screwed joints or holes will be acceptable.

3.18 SYSTEM FLUSHING

After tests are completed, potable water piping shall be flushed. In general, sufficient water shall be used to produce minimum water velocity of 0.762 meters per second through piping being flushed. Flushing shall be continued until discharge water shows no discoloration. System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced in line. After flushing and cleaning, system shall be prepared for service by immediately filling water piping with clean, fresh potable or high-purity water as applicable to the system being flushed. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building, due to the Contractor's failure to properly clean the piping system, shall be repaired by the Contractor. When the work is complete, the hot-water system shall be adjusted for uniform circulation.

Flushing devices and automatic control systems shall be adjusted for proper operation.

3.18.1 Operational Test

Upon completion of and prior to acceptance of the installation, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Pump suction and discharge pressures.

f. Temperature of domestic hot water supply.

g. Operation of each floor and roof drain by flooding with water.

h. Operation of each vacuum breaker and backflow preventer.

i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.

j. Compressed air readings at each compressor and at each outlet. Each indicating instrument shall be read at 1/2 hour intervals. The report of the test shall be submitted in quadruplicate. The Contractor shall furnish instruments, equipment, and personnel required for the tests; the Government will furnish the necessary water and electricity.

k. Operational test and verification of purity of medical gas systems. Each outlet shall be tested and installation certified as to correctness of installation. The tests shall be performed by an independent testing company and a certification document provided stating that the entire medical gas system, for each individual gas, has been tested, found correctly installed, and the purity of the delivered gas has been verified.

3.18.2 Sterilization

After pressure tests have been made, the entire domestic hot-and-cold water distribution system to be sterilized shall be flushed with water until entrained dirt and other foreign material have been removed, before introducing chlorinating material. The chlorinating material shall be either liquid chlorine or hypochlorite. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be constantly fed into the water piping system at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected

into the main through a solution-feed chlorinator and booster pump, shall be used. The chlorine residual shall be checked at intervals to ensure that the proper level is maintained. Chlorine application shall continue until the entire main is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system being sterilized shall be opened and closed several times during the contact period to ensure its proper disinfection. Following the 24 hour period, no less than 25 ppm chlorine residual shall remain in the system. Water tanks shall be disinfected by the addition of chlorine directly to the filling water. Following a 6 hour period, no less than 50 ppm chlorine residual shall remain in the tank. The system, including the tanks, shall then be flushed with clean water until the residual chlorine is reduced to less than 1 ppm. During the flushing period each valve and faucet shall be opened and closed several times. From several points in the system, the Contracting Officer will take samples of water in properly sterilized containers for bacterial examination. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA-10062JU. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. The sterilizing shall be repeated until tests indicate the absence of coliform organisms (zero-mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

TABLE I
PIPE AND FITTING MATERIALS FOR
DRAINAGE, WASTE, AND VENT PIPING SYSTEMS

Item No.	Pipe and Fitting Material	SERVICE A	B	C	D	E	F
1	Cast-iron soil pipe and fittings, hub and spigot, ASTM A 74	X	X	X	X	X	
2	Cast-iron soil pipe and fittings, hubless, CISPI 301 and ASTM A 888	X	X	X	X		
3	Cast-iron drainage fittings, threaded, ASME B16.12 for use with Item 6	X	X	X			
4	Cast-iron screwed fittings, threaded, ASME B16.4 for use with Item 6	X	X	X			
5	Malleable-iron threaded fittings, galvanized, ASME B16.3 for use with Item 6	X	X				
6	Steel pipe, seamless galvanized ASTM A 53, Type S, Grade B	X	X	X	X		
7	Bronze flanged fittings, ASME B16.24 for use with Item 9		X	X			
8	Cast-copper alloy solder joint pressure fittings.		X	X			
9	Bronze and sand castings, grooved joint pressure fittings for Non-Ferrous Pipe, ASTM B 584 for Use with Item 5			X	X		
10	Seamless copper pipe, ASTM B 42		X	X			
11	Cast-bronze threaded fittings, ASME B16.15 for use with Item 9		X	X			
12	Copper drainage tube, (DWV), ASTM B 306	X*	X	X*	X	X	

13	Wrought copper and wrought copper alloy solder-joint drainage fittings, ASME B16.29 for use with Item 12	X	X	X	X	X	
14	Cast-copper alloy solder joint drainage fittings, (DWV), ASME B16.23 for use with Item 12		X	X	X	X	X
15	Acrylonitrile-butadiene-styrene (ABS) plastic drain, waste, and vent pipe and fittings, ASTM D 2661	X	X	X	X		
16	Polyvinyl chloride plastic drain, waste and vent pipe and fittings, ASTM D 2665		X	X	X	X	

A - Underground Building Soil, Waste and Storm Drain
B - Aboveground Soil, Waste, Drain In Buildings
C - Underground Vent
D - Aboveground Vent
E - Interior Rainwater Conductors Aboveground
F - Corrosive Waste And Vent Above And Belowground
* - Hard Temper

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Material	SERVICE A	SERVICE B
1	Malleable-iron threaded fittings, galvanized, ASME B16.3 for use with Item 4	X	X
2	Steel pipe:	X	X
	a. seamless galvanized, ASTM A 53, Type S, Grade B		
	b. seamless, black, ASTM A 53, Type S, Grade B	X	
3	Bronze flanged fittings, ASME B16.24 for use with Items 5 and 7	X	X
4	Seamless copper pipe, ASTM B 42	X	X
5	Seamless copper water tube, ASTM B 88	X*	X*
6	Seamless and welded copper distribution tube (Type D), ASTM B 641	X	
7	Bronze and sand castings grooved joint pressure fittings for non-ferrous pipe ASTM B 584 for use with Item 2	X	X
8	Wrought copper grooved joint pressure fittings for non-ferrous pipe, ASTM B 75, C12200; ASTM B 152, C11000; ASME B16.22 for Use with Item 2	X	X
9	Cast-bronze threaded fittings, ASME B16.15 for use with Items 5 and 7	X	X
10	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 8 and 9	X	X
11	Cast-copper alloy solder-joint pressure fittings, ASME B16.18 for use with Items 8 and 9	X	X

12	Wrought copper and bronze mechanical-joint 2" to 4" pressure fittings, ASTM B 75, C12200; ASME B16.22 for use with Item 3	X	X
13	Bronze and sand castings mechanical-joint 5" to 6" pressure fittings, ASTM B 584, for use with Item 3	X	X
14	Flanges, pipe line, steel, MSS SP-44	X	X
15	Unions, ASME B16.39; brass or bronze, fittings: ASME B16.15, ASME B16.18, and ASTM B 828, Composition B; carbon steel pipe unions socket welding and threaded, MSS SP-83; malleable-iron threaded union, ASME B16.39	X	X
16	Nipples, pipe, threaded, ASTM A 733	X	X
17	Gaskets, flange, fiber plastic or other synthetic material for use with Item 20 ASTM D 3139	X	X

A - Cold Water Aboveground or Belowground
B - Hot Water 180 degrees F Maximum Aboveground
Indicated types are minimum wall thicknesses.
* - Type L Hard

3.19 FRAMED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

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SECTION 15951

DIRECT DIGITAL CONTROL FOR HVAC

PART 1 GENERAL

1.1 REFERENCES

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

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 500	(1989) Test Methods for Louvers, Dampers and Shutters

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(1988) Code for Electricity Metering
ANSI X3.64	(1979; R 1990) Additional Controls for Use with American National Standard Code for Information Interchange
ANSI X3.154	(1988) Office Machines and Supplies - Alphanumeric Machines-Keyboard Arrangement

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 269	(1994a) Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM B 88	(1993a) Seamless Copper Water Tube
ASTM D 635	(1991) Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 1693	(1970; R 1988) Environmental Stress -Cracking of Ethylene Plastics

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE-03	(1993; Errata) Handbook, Fundamentals I-P Edition

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.34	(1988) Valves - Flanged, Threaded, and Welding End
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV VIII Div 1	(1992; Addenda Dec 1992, Dec 1993) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME PTC 19.3	(1974; R 1986) Instruments and Apparatus: Part 3 Temperature Measurement

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 15	Radio Frequency Devices
47 CFR 68	Connection of Terminal Equipment to the Telephone Network

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 142	(1991) IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

INSTRUMENT SOCIETY OF AMERICA (ISA)

ISA S7.3	(1975; R 1981) Quality Standard for Instrument Air

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(1993) Industrial Controls and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(1993) Installation of Air Conditioning and Ventilating Systems

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA-07	(1993) HVAC Systems - Testing, Adjusting and Balancing

UNDERWRITERS LABORATORIES (UL)

UL 94	(1991; Rev thru May 1994) Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 555S	(1993; Rev Sep 1994) Leakage Rated Dampers for Use in Smoke-Control Systems
UL 916	(1994; Rev Apr 1994) Energy Management Equipment

1.2 GENERAL REQUIREMENTS

The Direct Digital Control System (DDC) shall comprise all Remote Control Units (RCU), Data Termination Cabinets (DTC), Auxiliary Control Units (ACU), Unitary Control Units (UCU) and all input/output points shown in the Control Algorithms, Schematics and Diagrams that are required for a complete system.

The DDC system shall be a METASYS by Johnson Controls, Inc. and shall be fully compatible with the system presently installed in the Wilford Hall Air Force Medical Center. The DDC system shall be networked to the Wilford Hall system and all systems and functions desired herein shall be executed seamlessly with the existing control system in either direction. The Contractor shall provide with the submittal the name, location and contact

for a previous contract showing a successfully integrated DDC extension with a system similar to the Wilford Hall Air Force Medical Center system.

The work shall include but not limited to the following:

a. Air distribution systems including air handling units, return and exhaust fans, terminal box control room temperature and humidity.

b. All equipment operational control sequences, monitoring of boilers/chillers control system, monitoring and alarms of equipment listed in I/O Summary.

c. Interfacing with the existing DDC systems. (External Network connections shall be provided by others.)

d. Interface with Fire Alarm System including operation of supply, return and exhaust air system in compliance with code requirements and the requirements of Division 16 and this section.

e. Control wiring and piping in compliance with Division 16 of these specifications.

Am#3 f. All equipment shall be Year 2000 compliant and shall be able to accurately process date/time data (including, but not limited to, calculating, comparing, and sequencing) from, into, and between the twentieth and twenty-first centuries, including leap year calculations.

1.2.1 Nameplates, Lens Caps, and Tags

Nameplates and lens caps bearing legends as shown and tags bearing device-unique identifiers as shown shall have engraved or stamped characters. Nameplates shall be mechanically attached to RCU panel interior doors. A plastic or metal tag shall be mechanically attached directly to each device or attached by a metal chain or wire. Each airflow measurement station shall have a tag showing flow rate range for signal output range, duct size, and identifier as shown.

1.2.2 Verification of Dimensions

The Contractor shall become familiar with all details of the work, shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

1.2.3 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall furnish all work necessary to meet such conditions.

1.2.4 Power-Line Surge Protection

Equipment connected to ac circuits shall be protected from power-line surges. Equipment protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

1.2.5 Surge Protection for Transmitter and Control Wiring

DDC system control-panel equipment shall be protected against surges induced on control and transmitter wiring installed outside and as shown. The equipment protection shall be tested in the normal mode and in the common mode, using the following two waveforms:

a. A 10 microsecond by 1,000 microsecond waveform with a peak voltage of 1,500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1,000 volts and a peak current of 500 amperes.

1.2.6 Power-Line Conditioners (PLC)

PLCs shall be furnished for each RCU panel. The PLCs shall provide both voltage regulation and noise rejection. The PLCs shall be of the ferro-resonant design, with no moving parts and no tap switching while electrically isolating the secondary from the power-line side. The PLCs shall be sized for 125 percent of the actual connected kVA load. Characteristics of the PLC shall be as follows:

a. At 85 percent load, the output voltage shall not deviate by more than plus or minus 1 percent of nominal when the input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.

b. During load changes of zero to full load, the output voltage shall not deviate by more than plus or minus 3 percent of nominal. Full correction of load switching disturbances shall be accomplished within 5 cycles, and 95 percent correction shall be accomplished within two cycles of the onset of the disturbance.

c. Total harmonic distortion shall not exceed 3-1/2 percent at full load.

1.2.7 System Overall Reliability Requirement

The system shall be configured and installed to yield a mean time between failure (MTBF) of at least 40,000 hours. Each RCU shall be designed, configured, installed and programmed to provide for stand alone operation with minimal performance degradation on failure of other system components to which it is connected or with which it communicates.

1.2.8 System Accuracy and Display

The system shall maintain an end-to-end accuracy for 1 year from sensor to operator's console display for the applications specified and shall display the value as specified. Each temperature shall be displayed and printed to nearest 0.1 degree F.

1.2.8.1 Space Temperature

Space temperature with a range of 10 to 30 degrees C plus or minus 0.50 degree C for conditioned space; 0 to 55 degrees C plus or minus 0.50 degree C for unconditioned space.

1.2.8.2 Duct Temperature

Duct temperature with a range of 5 to 60 degrees C plus or minus 1 degree C.

1.2.8.3 Outside Air Temperature

Outside air (OA) temperature with a range of minus 35 to plus 55 degrees C plus or minus 1 degrees C; with a subrange of 0 to 40 degrees C plus or minus 0.5 degree C.

1.2.8.4 Water Temperature

Water temperature with a range of 0 to 40 degrees C plus or minus 0.5 degree C; the range of 40 to 120 degrees C plus or minus degrees C; and water temperatures for the purpose of performing Btu calculations using differential temperatures to plus or minus 0.25 degrees C using matched sensors.

1.2.8.5 Relative Humidity

Relative humidity with a range of 20 to 80 percent plus or minus 6.0 percent of range (display and print to nearest 1.0 percent).

1.2.8.6 Pressure

Pressure with a range for the specific application plus or minus 2.0 percent of range (display and print to nearest psi.

1.2.8.7 Flow

Flow with a range for the specific application plus or minus 3.0 percent of range, and flows for the purpose of thermal calculations to plus or minus 2.0 percent of actual flow (display and print to nearest unit, such as gallons per minute).

1.2.8.8 Analog Value Input

An analog value input to the system's equipment via an AI with a maximum error of 0.50 percent of range, not including the sensor or transmitter error. This accuracy shall be maintained over the specified environmental conditions.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FI0" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment Data; GA.

The equipment data shall be in booklet form, indexed to the unique identifiers, shall consist of data sheets that document compliance with the specification and shall include a copy of each HVAC control system bill of materials. Catalog cuts shall be in booklet form indexed by device type. Where multiple components are shown on a catalog cut, the application specific component shall be marked. Data shall include a list of qualified service organizations and their qualifications. Service organizations shall be reasonably convenient to the equipment on a regular and emergency basis, during the warranty period.

System Descriptions and Analyses; GA.

System descriptions, analyses, and calculations used in required sizing equipment. Descriptions and calculations shall show how the equipment will operate as a system to meet the specified performance. The data package shall include the following:

a. RCU memory size.

b. RCU automatic start up operations.

c. Database update procedure.

d. RCU expansion capability and method of implementation.

e. RCU operation.

f. Database entry forms or data listings.

Software; GA.

Descriptions of software, including the control algorithm for PID control and explanation as required.

Provide details (name of project, location, contacts, summary) of a successful integration of the proposed system with an EMC, system similar to that used at Wilford Hall Air Force Medical Center.

System Overall Reliability Calculations; FI0.

Manufacturer's reliability data and calculations required to show compliance with the specified reliability. Instrumentation and controls shall not be included in the calculations.

Training Data; GA.

A training course in the maintenance and operation of the HVAC control systems, approved 60 days prior to the start of training. Lesson plans and training manuals for the training, including type of training to be provided, with a list of reference material. The training shall be oriented to the specific systems being installed. One training manual shall be furnished for each trainee, plus two additional copies for archival storage at the project site. The manuals shall include the agenda, the defined objectives for each lesson, and a detailed description of the subject matter for each lesson. Two copies of audiovisual materials shall be included, for archival storage at the project site, either as a part of the printed training manuals or on the same media as that to be used during the training session.

Data Entry Forms; GA.

The completed data entry forms or data summaries, if data entry is done through interactive computer interfacing, utilizing all data required by the contract documents and other pertinent information required for complete installation of the database. Additional data to provide a complete and operational control system shall be identified and requested from the Government. The proposed forms shall be provided at least 90 days prior to the Contractor's scheduled need date.

SD-04 Drawings

System Drawings; GA.

The system drawings shall include the following:

a. A drawing index.

b. A list of symbols.

c. A series of drawings for each HVAC control system using abbreviations, symbols, nomenclature and identifiers as shown on the contract drawings. Each control-system element on a drawing shall have a unique identifier as shown.

Each series of drawings for an HVAC control system shall include a schematic as shown on the contract drawings, a wiring diagram, a list of equipment with manufacturer and model number, a RCU arrangement drawing and an HVAC control-system sequence of operation. The sequence of operation for each HVAC control system shall be in the language and format of this specification. No operational deviations from specified sequences will be permitted without prior written approval of the Contracting Officer. The sequence of operation shall refer to each device by its unique identifier.

The wiring diagram shall show the interconnection of wires and cables to RCU terminal blocks and to the identified terminals of starters and packaged equipment, with all necessary jumpers and ground connections. The wiring diagram shall show the labels of all conductors. All sources of power required for HVAC control systems and for packaged equipment control systems shall be identified back to the panelboard circuit breaker number, RCU, magnetic starter, or packaged control equipment circuit. Each power supply and transformer not integral to a starter or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown.

d. A system block diagram.

e. RCU DTC installation, block diagrams, and wiring diagrams.

f. RCU DTC physical layout and schematics.

g. Details of surge protection device installations.

h. Valve schedules.

The valve schedule shall include each valve's unique identifier, size, flow coefficient (Cv), pressure drop at specified flow rate, spring range, positive-positioned range, and actuator size, supported by close-off pressure data, dimensions, operation rate, and access and clearance requirements data.

i. Damper schedules.

The damper schedule shall contain each damper's and each actuator's identifier, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, spring ranges, operation rate, positive-positioner ranges, locations of actuators and damper end switches, arrangement of sections in multi section dampers, and methods of connecting

dampers, actuators, and linkages. The damper schedule shall include the maximum expected velocity through the damper at the intended location and the maximum leakage rate at the operating static-pressure differential. The damper schedule shall contain actuator selection data, supported by calculations of the torque required to move and seal the dampers; and access and clearance requirements.

SD-08 Statements

Site Testing; GA.

Six copies of the test procedures for the site testing. The site testing procedures shall identify each item to be tested and shall clearly describe each test. The test procedures shall include a list of the test equipment to be used for site testing, manufacturer and model number, and the date of calibration and accuracy of calibration, within 6 months of the test date.

Performance Verification Testing and Endurance Testing; GA.

Six copies of the test procedures for the performance verification test and the endurance test. The test procedures shall explain in detail, step-by-step actions and expected results to demonstrate compliance with the specified requirements. These procedures shall follow in detail the control algorithm steps and each step shall be tested for correct function. Written approval by the Government of the performance verification test procedures shall be one of the prerequisites for commencing the performance verification test.

Commissioning Procedures; FI0.

Commissioning procedures for each HVAC control system, and for each type of terminal unit control system. The procedures shall reflect the language and format of this specification. The commissioning procedures shall refer to the devices by their unique identifiers as shown and shall include step-by-step configuration procedures for each system. The configuration procedures shall include a configuration check sheet showing all configuration parameters.

Six copies of Commissioning Procedures, in booklet form and indexed, for each system, 60 days prior to system commissioning. Commissioning procedures shall include general instructions on how to set control parameters including setpoints; proportional, integral, and derivative mode constants; contact output settings for the specific devices provided. Commissioning procedures shall be specific to each HVAC system, shall detail the steps involved, and shall refer to the procedures in the booklet for specific devices.

SD-09 Reports

Test Reports; GA.

Six copies of the site testing data. Original copies of all data produced during site testing, including results of each test procedure, after approval of the site tests.

Performance Verification and Endurance Report; GA.

Six copies of the performance verification and endurance test report after completion of a successful test.

Documentation of test results for the entire HVAC control system complete, in booklet form and indexed, within 30 days after each test.

Control System Calibration, Adjustments, and Commissioning; GA.

Six copies of the calibration, adjustment and commissioning report which shall include setpoints and proportional, integral and derivative mode constant settings, calibration data for all instruments and controls, and all the data resulting from adjusting the control system devices and commissioning HVAC control system.

SD-19 Operation and Maintenance Manuals

Operation and Maintenance Manuals; GA.

Final copies of the manuals bound in hardback, loose leaf binders, within 30 days after completing the endurance test. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. Each manual's contents shall be identified on the cover. The manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and of the nearest service representatives for each item of equipment and each system. The draft copy used during site testing shall be updated with any changes required, prior to final submission of the manual. The final copies delivered after completion of the endurance test shall include modifications made during installation checkout and acceptance. Manuals shall include:

Functional Design Manual; GA.

Two copies of the functional design manual which shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes.

Hardware Manual; GA.

Two copies of the hardware manual which shall describe equipment furnished, including:

a. General description and specifications.

b. Installation and checkout procedures.

c. Equipment electrical schematics and layout drawings.

d. System schematics and I/O device wiring lists.

e. Alignment and calibration procedures.

f. Manufacturer's repair parts list indicating sources of supply.

Software Manual; GA.

Two copies of the software manual which shall describe the functions of all software, and shall include all other information necessary to enable proper loading, testing and operation including, but not limited to the following:

a. Definitions of terms and functions.

b. Operator commands.

c. System access requirements.

d. Data entry requirements.

e. Descriptions of application software.

f. Description of database structure and interface with programs.

g. Alarms.

Operator's Manual; GA.

Six copies of operation manuals for each HVAC control system, in booklet form and indexed, outlining the step-by-step procedures required for each HVAC control system's startup, operation, and shutdown. The manuals shall includeall detail drawings, equipment data, and manufacturer supplied operation manuals for all equipment.

Maintenance Manual; GA.

Six complete copies of maintenance manuals, indexed in booklet form listing maintenance procedures. The maintenance instructions shall include a maintenance check list for each HVAC control system. Maintenance manuals shall include spare parts data and recommended maintenance tool kits for all control devices. Maintenance instructions shall include recommended repair methods, either field repair, factory repair, or whole-item replacement. The manual shall contain a list of service organizations qualified to service the HVAC control system, including the service organization name and telephone number. If operation and maintenance manuals are provided in a common volume, they shall be clearly differentiated and separately indexed.

1.4 DELIVERY AND STORAGE

Products shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage-condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

1.5 TESTING

1.5.1 Site Testing

Personnel, equipment, instrumentation, and supplies shall be provided as necessary to perform site testing, adjusting, calibration and commissioning. The tests shall not be conducted during scheduled seasonal off periods of base heating and cooling systems. Wiring shall be tested for continuity and for ground, open, and short circuits. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. Written Government approval of the specific site testing procedures shall be obtained prior to any test. Written notification of any planned site testing, commissioning or tuning shall be given at least 14 calendar days prior to any test.

1.5.2 Control System Calibration, Adjustments, and Commissioning

Instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Mechanical control devices shall be adjusted to operate as specified. Control parameters and logic (virtual) points including control loop setpoints, gain constants, and integral constraints, shall be adjusted before the system is placed on line. Communications requirements shall be as indicated. Control system commissioning shall be performed for each HVAC system. The report describing results of functional tests, diagnostics, and calibrations, including written certification, shall state that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

1.5.3 Performance Verification Test

Compliance of the HVAC control system with the contract documents shall be demonstrated. Using test plans and procedures previously approved, physical and functional requirements of the project, including communication requirements shall be demonstrated. The performance verification test procedures shall explain, step-by-step, the actions and expected results that will demonstrate that the control systems perform in accordance with the sequences of operation. The performance verification test shall not be started until after receipt of written permission by the Government, based on the Contractor's written certification of successful completion of site testing and training.

1.5.4 Endurance Test

The endurance test shall be used to demonstrate the specified overall system reliability requirement of the completed system. The endurance test shall not be started until the Government notifies the Contractor in writing that the performance verification test is satisfactorily completed. The Government may terminate the testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. Upon successful completion of the endurance test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to acceptance of the system.

a. Phase I (Testing)

The test shall be conducted 24 hours per day, 7 days per week, for 15 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing.

b. Phase II (Assessment)

After the conclusion of Phase I, the Contractor shall identify failures, determine causes of failures, repair failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. After delivering the written report, the Contractor shall convene a test review meeting at the jobsite to present the results and recommendations to the Government. As a part of this test review meeting, the Contractor shall demonstrate that all failures have been corrected by performing appropriate portions of the performance verification test. Based on the Contractor's report and test

review meeting, the Government may require that the Phase I test be totally or partially rerun. After the conclusion of any retesting which the Government may require, the Phase II assessment shall be repeated as if Phase I had just been completed.

1.5.5 Coordination with HVAC System Balancing

The HVAC control system shall be tuned after all air-system and hydronic-system balancing has been completed, minimum damper positions set and a report issued. Commissioning may be performed prior to or simultaneous with HVAC system balancing.

1.5.6 Posted Instructions

Instructions on letter-size sheets and half-size plastic laminated drawings for each system, showing the final installed conditions, shall be placed in each HVAC control panel. The posted instructions shall include the control sequence, control schematic, ladder diagram, wiring diagram, valve schedules, damper schedules, commissioning procedures, and preventive maintenance instructions.

1.6 TRAINING

1.6.1 General

The training course shall be conducted for 4 operating staff members designated by the Contracting Officer in the maintenance and operation of the system, including specified hardware and software. A training day is defined as 8 hours of classroom instruction, including breaks and lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, the Contractor shall assume that the attendees will have a high school education or equivalent, and are familiar with HVAC systems. No training shall be scheduled until training manuals and O&M manuals have been approved by the Government.

1.6.2 Training Course Content

The course shall be taught at the project site for a period of 2 training days. The training course shall cover all the material contained in the Operating and Maintenance Instructions, the layout and location of each HVAC control panel, the layout of one of each type of unitary equipment and the locations of each, the location of each system-control device external to the panels, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the calibration, adjustment and commissioning report shall be presented as benchmarks of HVAC control-system performance by which to measure operation and maintenance effectiveness.

1.7 MAINTENANCE AND SERVICE

1.7.1 General Requirements

Services, materials and equipment shall be provided as necessary to maintain the entire system in an operational state as specified for a period of 1 year after successful completion and acceptance of the Performance Verification Test. Impacts on facility operations shall be minimized.

1.7.2 Description of Work

The adjustment and repair of the system shall include the manufacturer's required adjustments of computer equipment, software updates, transmission equipment and instrumentation and control devices.

1.7.3 Personnel

Service personnel shall be qualified to accomplish work promptly and satisfactorily. The Government shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

1.7.4 Scheduled Inspections

Two inspections shall be performed at 6 month intervals (or less if required by the manufacturer), and all work required shall be performed. Inspections shall be scheduled in June and December. These inspections shall include:

a. Visual checks and operational tests of all equipment.

b. Fan checks and filter changes for all control system equipment.

c. Clean all control system equipment including interior and exterior surfaces.

d. Check and calibrate each field device. Check and calibrate 50 percent of the total analog points during the first inspection. Check and calibrate the remaining 50 percent of the analog points during the second major inspection. Certify analog test instrumentation accuracy to be twice that of the device being calibrated. Randomly check at least 25 percent of all digital points for proper operation during the first inspection. Randomly check at least 25 percent of the remaining digital points during the second inspection.

e. Run all system software diagnostics and correct all diagnosed problems.

f. Resolve any previous outstanding problems.

1.7.5 Scheduled Work

This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays.

1.7.6 Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the system. A telephone number where the service supervisor can be reached at all times shall be provided. Service personnel shall be at the site within 24 hours after receiving a request for service. The control system shall be restored to proper operating condition within 3 calendar days after receiving a request for service.

1.7.7 Operation

Scheduled adjustments and repairs shall include verification of the control system operation as demonstrated by the applicable tests of the performance

verification test.

1.7.8 Records and Logs

Dated records and logs shall be kept of each task, with cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain all initial analog span and zero calibration values and all digital points. Complete logs shall be kept and shall be available for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

1.7.9 Work Requests

Each service call request shall be recorded as received and shall include the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. A record of the work performed shall be submitted within 5 days after work is accomplished.

1.7.10 System Modifications

Recommendations for system modification shall be submitted in writing. System modifications, including operating parameters and control settings, shall not be made without prior approval of the Government. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected.

1.7.11 Software

Updates to the software shall be provided for system; operating and application software shall be updated and operation in the system shall be verified. Updates shall be incorporated into operations and maintenance manuals, and software documentation. There shall be at least one scheduled update near the end of the first year's warranty period, at which time the latest released version of the Contractor's software shall be installed and validated.

PART 2 PRODUCTS

2.1 GENERAL EQUIPMENT REQUIREMENTS

Units of the same type of equipment shall be products of a single manufacturer. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in a satisfactory commercial or industrial use for 2 years prior to use on this project. The 2 years use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory

field operation, for not less than 6,000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. Items of the same type and purpose shall be identical, including equipment, assemblies, parts and components. Automatic temperature controls shall be direct digital controls that will provide the required sequence of operation. No pneumatics will be allowed except for valve or damper actuators.

2.1.1 Electrical and Electronic Devices

Electrical, electronic, and electropneumatic devices not located within an HVAC control panel shall have a NEMA ICS 1 enclosure in accordance with NEMA 250 unless otherwise shown.

2.1.2 Standard Signals

Except for air distribution terminal unit control equipment, the output of all analog transmitters and the analog input and output of all CU panels shall be 4-to-20 mAdc signals. The signal shall originate from current-sourcing devices and shall be received by current-sinking devices.

2.1.3 Ambient Temperature Limits

CU panels shall have ambient condition ratings of plus 2 to 50 degrees C and 10 to 95 percent relative humidity, noncondensing. Devices installed outdoors shall operate within limit ratings of minus 35 to 65 degrees C. Instrumentation and control elements shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

2.2 WIRING

2.2.1 Terminal Blocks

Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

2.2.2 Control Wiring for 24-Volt Circuits

Control wiring for 24-volt circuits shall be 18 AWG minimum and shall be rated for 300-volt service.

2.2.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 14 AWG minimum and shall be rated for 600-volt service.

2.2.4 Instrumentation Cable

Instrumentation cable shall be 18 AWG, stranded copper, single- or multiple-twisted, minimum 51 mm (2 inch) lay of twist, 100 percent shielded pairs, and shall have a 300-volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.3 ACTUATORS

2.3.1 General Requirements

Actuators shall be proportional electronic. Actuators shall utilize a stored energy device to return to the normal position on signal or power failure and shall have a visible position indicator. Actuators shall open or close the devices to which they are applied within 120 seconds after a full scale input signal change. Proportional electronic actuators shall be capable of stopping at any point of rotation. Actuators shall be provided with two (2) auxiliary and switches.

2.3.2 Damper Actuators

The actuators shall be provided with mounting and connecting hardware. Actuators shall smoothly operate the devices to which they are applied. Actuators shall fully open and close the devices to which they are applied and shall have a full stroke response time of 120 seconds or less. The actuator stroke shall be limited by an adjustable stop in the direction of power stroke. Damper actuators shall be selected to provide a minimum of 150 percent of the motor power necessary to operate the damper over the full range of movement but not less than 5 Nm of torque. Actuators for outside air and return air dampers shall be capable of opening the closed damper with a differential pressure across the damper equip to the schedule fan static pressure.

2.3.3 Valve Actuators

Valve actuators shall be selected to provide a minimum of 125 percent of the motive power necessary to operate the valve over its full range of operation but not less than 5 Nm of torque.

2.4 AUTOMATIC CONTROL VALVES

Valves shall have stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Valve bodies shall be designed for not less than 125 psig working pressure or 150 percent of the system operating pressure, whichever is greater. Valve leakage rating shall be 0.01 percent of rated Cv. Unless otherwise specified, bodies for valves 40 mm (1-1/2 inches) and smaller shall be brass or bronze, with threaded or union ends; bodies for 50 mm (2 inch) valves shall have threaded ends; and bodies for valves 50 to 80 mm (2 to 3 inches) shall be of brass, bronze or iron. Bodies for valves 65 mm (2-1/2 inches) and larger shall be provided with flanged-end connections. Valve Cv shall be within 100 to 125 percent of the Cv shown.

2.4.1 Two-Way Valves

Two-way modulating valves shall have equal-percentage characteristics.

2.4.2 Three-Way Valves

Three-way valves shall provide linear flow control with constant total flow throughout full plug travel.

2.4.3 Valves for Chilled Water Service

Internal valve trim shall be bronze except that valve stems may be type 316

stainless steel. Valve Cv shall be within 100 to 125 percent of the Cv shown.

2.4.4 Valves for Hot Water Service

Internal trim for valves controlling water 100 degrees C or less shall be brass or bronze. Nonmetallic parts of hot-water control valves shall be suitable for a minimum continuous operating temperature 120 degrees C or 10 degrees C above the system design temperature, whichever is higher. Butterfly valves may be used for on/off control.

2.5 DAMPERS

2.5.1 Damper Assembly

A single damper section shall have blades no longer than 1.2 meters (48 inches) and shall be no higher than 1.8 meters (72 inches). Maximum damper blade width shall be 203 mm (8 inches). Larger sizes shall be made from a combination of sections. Dampers shall be steel, or other materials where shown. Flat blades shall be made rigid by folding the edges. Blade-operating linkages shall be within the frame so that blade-connecting devices within the same damper section shall not be located directly in the air stream. Damper axles shall be 13 mm (0.5 inch) minimum, plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings. Pressure drop through dampers shall not exceed 10 Pa (0.04 inch water gauge) at 5.1 m/s (1,000 fpm in the wide-open position. Frames shall not be less than 50 mm (2 inches) in width. Dampers shall be tested in accordance with AMCA 500.

2.5.2 Operating Links

Operating links external to dampers, such as crank arms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, shall withstand a load equal to at least twice the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crank arms shall control the open and closed positions of dampers.

2.5.3 Damper Types

2.5.3.1 Control Dampers

Outside air, and recirculating air dampers shall be parallel blade type and shall be provided where shown. Discharge air, mixed air and relief air dampers shall be opposed blade type and shall be provided where shown. Blades shall have interlocking edges and shall be provided with compressible seals at points of contact. The channel frames of the dampers shall be provided with jamb seals to minimize air leakage. Dampers shall not leak in excess of 102 L/s per square meter (20 cfm per square foot) at 1000 Pa (4 inches water gauge) static pressure when closed. Seals shall be suitable for an operating temperature range of minus 40 degrees C to 94 degrees C (minus 40 degrees F to 200 degrees F). Dampers shall be rated at not less than 10 m/s (2000 fpm) air velocity.

2.5.3.2 Smoke Control Dampers

Smoke control damper and actuator assembly required per NFPA 90A shall meet

the Class II leakage requirements of UL 555S. Dampers shall be rated at not less than 10 m/s air velocity. This includes outside air, mixed air and discharge air dampers.

2.6 INSTRUMENTATION

2.6.1 Measurements

Each transmitter shall have offset and span adjustments. Transmitters shall be calibrated to provide the following measurements, over the indicated ranges, for a linear output of 4-to-20 mAdc:

a. Conditioned space temperature, from 10 to 30 degrees C.

b. Duct temperature, from 5 to 60 degrees C except that return air temperature for economizer operation shall be minus 30 to plus 130 degrees F.

c. Chilled water temperature, from 0 to 40 degrees C.

d. Heating hot water temperature, from 35 to plus 55 degrees C.

e. Outside air temperature, from minus 35 to plus 55 degrees C.

f. Relative humidity, 0 to 100 percent for high limit applications; from 20 to 80 percent for space applications.

g. Differential pressure for VAV supply duct static pressure from 0 to 500 Pa.

h. Electronic air flow measurement station and transmitter, from 0.6 to 12.5 m/s.

2.6.2 Temperature Instruments

2.6.2.1 Resistance Temperature Detectors (RTD)

Each RTD shall be platinum with a tolerance of plus or minus 0.1 percent at 0 degrees C, and shall be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper. Each RTD shall be furnished with an RTD transmitter as specified, integrally mounted unless otherwise shown.

2.6.2.2 Continuous Averaging RTD

Continuous averaging RTDs shall have a tolerance of plus or minus 0.5 degree C at the reference temperature, and shall be of sufficient length to ensure that the resistance represents an average over the cross section in which it is installed. The sensing element shall have a bendable copper sheath. Each averaging RTD shall be furnished with an RTD transmitter to match the resistance range of the averaging RTD.

2.6.2.3 RTD Transmitter

The RTD transmitter shall match the resistance range of the RTD. The transmitter shall be a 2-wire, loop powered device. The transmitter shall produce a linear 4-to-20 mAdc output corresponding to the required temperature measurement. The output error shall not exceed 0.1 percent of the calibrated measurement.

2.6.2.4 Air Distribution Terminal Unit Space Temperature Sensors

a. Space temperature sensors shall be 10k ohm thermistor with accuracy not less than 0.1 degree C over the range 12 - 35°C. Where required space sensors shall be furnished complete with occupant setpoint adjustment and setpoint indicator. The occupant adjustment shall be capable of being locked out, overridden, or limited as to time or temperature in software from the Central Operator's Station or a remote operator's terminal. Temperature setpoints for heating and cooling and night setback shall be independent of each other. Provide integral push-button to allow the occupant to signal an extended service request to the RCU. Sensors shall include a communications port for local connection of a portable test/terminal device.

b. Public space sensors shall not have a visible means of setpoint adjustment.

c. Private office space sensors shall have occupant setpoint adjustment, and setpoint indicator. Integral pushbutton override shall be provided.

2.6.3 Relative Humidity Instruments

Relative humidity sensing element shall have a relative humidity sensing range from 0-100 percent (condensing). The sensor shall be capable of, sensing a condensing air stream (100 percent RH) without affect to the sensors calibration or harm to the sensor. The sensor shall be wall mount type or duct mount type as appropriate and shall be provided with the required accessories. Duct sensors shall be provided with duct probe designed to protect the sensing element from dust accumulation and mechanical damage. Sensing elements shall have an accuracy of plus or minus 5 percent of full scale within the range of 20 to 80 percent relative humidity. A 2-wire, loop powered transmitter located at the sensing element shall be provided to convert the sensing element output to a linear 4-to-20 mAdc output corresponding to the required humidity measurement. The output error shall not exceed 0.1 percent of calibrated measurement.

2.6.4 Electronic Airflow Measurement Stations and Transmitters

2.6.4.1 Stations

Each station shall contain an array of velocity sensing elements and straightening vanes inside a flanged sheet metal casing. The velocity sensing elements shall be of the RTD or thermistor type, with linearizing means. The sensing elements shall be distributed across the duct cross section in the quantity and pattern set forth for measurements and instruments of ASHRAE-03 and SMACNA-07 for the traversing of ducted air flows. The resistance to air flow through the airflow measurement station shall not exceed 20 Pa at an airflow of 10 m/s. Station construction shall be suitable for operation at airflows of up to 25 m/s over a temperature range of 5 to 50 degrees C, and accuracy shall be plus or minus 3 percent over a range of 0.6 to 12.5 m/s scaled to air volume.

2.6.4.2 Transmitters

Each transmitter shall produce a linear, temperature compensated 4-to-20 mAdc, output corresponding to the required velocity pressure measurement. The transmitter shall be a 2-wire, loop powered device. The output error of the transmitter shall not exceed 0.5 percent of the calibrated measurement.

2.6.5 Static Pressure Measurement Stations and Transmitters

2.6.5.1 Stations

Each station shall contain an array of static pressure sensing elements and straightening vanes inside a flanged sheet-metal casing. The sensing elements shall be of the multiple static pressure type with averaging manifolds. The sensing elements shall be distributed across the duct cross-section I the quantity and pattern set forth for measurement and instruments of ASHRAE-03 or SMACNA-07 for the traversing of ducted air flows. The resistance to air flow through the static pressure measurement station shall not exceed 0.08 inch water gauge at an air flow of 2000 fpm. Station construction shall be suitable for operation at air flows of up to 5000 fpm over a temperature range of 40 to 120◦F.

2.6.5.2 Transmitters:

Each transmitter shall produce a linear 4 to 20 mAdc output corresponding to the required static pressure measurement. The transmitter shall be a 2-wire, loop-powered device. Sensing element accuracy shall be plus or minus 1 percent of full scale, and overall transmitter accuracy shall be plus or minus 0.5 percent of the calibrated measurement. Each transmitter shall have offset and span adjustments.

2.6.5.3. Static pressure measurement stations and transmitters shall be furnished under this Section.

2.6.6 Flow Instruments

2.6.6.1 Venturi Tubes

Venturi tubes shall be made of cast iron or cast steel and shall have an accuracy of plus or minus 1 percent of full flow. The throat section shall be lined with austenitic stainless steel. Thermal expansion characteristics of the lining shall be the same as that of the throat casting material. The surface of the throat lining shall be machined to a 50 micro inch finish, including the short curvature leading from the converging entrance section into the throat.

2.6.7 Differential Pressure Instruments

The instrument shall be a pressure transmitter with an integral sensing element. The instrument over pressure rating shall be 300 percent of the operating pressure. The sensor/transmitter assembly accuracy shall be plus or minus 2 percent of full scale. The transmitter shall be a 2-wire, loop powered device. The transmitter shall produce a linear 4-to-20 mAdc output corresponding to the required pressure measurement.

2.6.8 Thermowells

Thermowells shall be Series 300 stainless steel with threaded brass plug and chain, 50 mm (2 inch) lagging neck and extension type well. Inside diameter and insertion length shall be as required for the application.

2.7 THERMOSTATS

2.7.1 General

Thermostat ranges shall be selected so that the setpoint is adjustable without tools between plus or minus (10 degrees F) 6 degrees C of the setpoint shown. Thermostats shall be electric or low-voltage electronic.

2.7.2 Nonmodulating Room Thermostats

Contacts shall be single-pole double-throw (SPDT), hermetically sealed, and wired to identified terminals. Maximum differential shall be (5 degrees F.) 3 degrees C Room thermostats shall be enclosed with separate locking covers (guards).

2.7.3 Modulating Room Thermostats

Modulating room thermostats shall have either one output signal, two output signals operating in unison, or two output signals operating in sequence, as required for the application. Each thermostat shall have an adjustable throttling range of (4 to 8 degrees F) 2 to 5 degrees C for each output. Room thermostats shall be enclosed with separate locking covers (guards).

2.7.4 Freezestats

Freezestats shall be manual reset, low temperature safety thermostats, with NO and NC contacts and a 20 foot element which shall respond to the coldest 18 inch segment.

2.7.5 Fan Coil Unit Room Thermostats

2.7.5.1 Heating Thermostat

Fan coil unit heating thermostats shall be provided with fixed heat anticipation and shall have a single-pole, single-throw switch hermetically sealed and actuated by a bimetallic or bellows type element. Thermostats shall be provided with external temperature setting devices with a factory set maximum of 22 degrees .C. Heating thermostats shall have an adjustable range of at least 7 degrees C below the maximum setting.

2.7.5.2 Cooling Thermostat

Fan coil cooling thermostats shall be provided with fixed cooling anticipation heater and shall have a single-pole, single-throw switch hermetically sealed and actuated by a bimetallic or bellows type element. Thermostats shall be provided with external temperature setting devices with a factory set minimum of 25 degrees .C. Cooling thermostats shall have an adjustable range of at least 4 degrees C above the minimum setting.

2.8 PRESSURE SWITCHES

2.8.1 Pressure Switches

Each switch shall have an adjustable setpoint with visible setpoint scale. Range shall be as shown. Differential adjustment shall span 20 to 40 percent of the range of the device.

2.8.2 Differential Pressure Switches

Each switch shall be an adjustable diaphragm-operated device with two SPDT

contacts, with taps for sensing lines to be connected to duct pressure fittings designed to sense air pressure. These fittings shall be of the angled-tip type with tips pointing into the air stream. Range shall be. Differential shall be a maximum of 40 Pa 1.25 to 1.50 kPa at the low end of the range and 90 Pa at the high end of the range.

2.9 INDICATING DEVICES

2.9.1 Insertion Thermometers

Thermometers for insertion in ductwork and piping systems shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 230 mm (9 inch). (9 inch scale.) Thermometers for piping systems shall have rigid stems with straight, angular, or inclined pattern, and shall conform to ASME PTC 19.3.

2.9.2 Thermometer Stems

Thermometer stems shall have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem shall be filled with a heat-transfer medium.

2.9.3 Air Duct Thermometers

Air duct thermometers shall have perforated stem guards and 45 degree adjustable duct flanges with locking mechanism.

2.9.4 Averaging Thermometers

Averaging thermometers shall have 90 mm (3-1/2 inch) (nominal) dial, with black legend on white background, and pointer traveling through a 270 degree arc.

2.9.5 Accuracy

Thermometers shall have an accuracy of plus or minus 1 percent of scale range. Thermometers shall have the following ranges:

a. Mixed air, return air, cooling-coil discharge, chilled water, condenser water, and glycol cooling temperatures: -20 to 40 degrees C in 0.5 degree graduations.

b. Heating-coil discharge temperature: 0 to 80 degrees C in 1 degree graduations.

c. Hydronic heating systems below 100 degrees C: -15 TO 95 degrees C in 0.5 degree graduations.

2.9.6 Pressure Gauges

Gauges shall be 50 mm (2 inch) (nominal) size, back connected, suitable for field or panel mounting as required, shall have black legend on white background, and shall have a pointer traveling through a 270 degree arc. Accuracy shall be plus or minus 3 percent of scale range. Gauges shall meet requirements of ASME B40.1.

2.10 RELAYS

Control relay contacts shall have utilization category and ratings selected for the application, with a minimum of two sets of contacts (two normally open, two normally closed) enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage. Time delay relays shall be 2 PDT with 8-pin connectors, dust cover, and a matching rail mounted socket. Adjustable timing range shall be 0 to 3 minutes. Power consumption shall not be greater than 3 watts.

2.11 WIRE AND CABLE

2.11.1 Digital Functions

Control wiring for digital functions shall be 18 AWG minimum with 600-volt insulation. Multi conductor wire shall have an outer jacket of polyvinyl chloride (PVC).

2.11.2 Analog Functions

Control wiring for analog functions shall be 18 AWG minimum with 600-volt insulation, twisted and shielded, 2-, 3-, or 4-wire to match analog function hardware. Multiconductor wire shall have an outer jacket of PVC.

2.11.3 Sensor Wiring

Sensor wiring shall be 20 AWG minimum twisted and shielded, two-, three-, or four-wire to match analog function hardware. Multiconductor wire shall have an outer jacket of PVC.

2.11.4 Class 2 Low Energy Conductors

The conductor sizes specified for digital and analog functions shall take precedence over any requirements for Class 2 low energy remote-controlled and signal-circuit conductors specified elsewhere.

2.12 CONTROL UNIT (CU) HARDWARE

2.12.1 Remote control Unit (RCU)

RCU panels shall be microcomputer based with sufficient memory to perform specified DDC panel functions and operations. The panel shall not be dependent on logic or data from an external computer. The panel shall contain necessary I/O functions to connect to field sensors and control devices. The RCU panel shall include:

a. Main power switch.

b. Power on indicator.

c. Portable tester connector.

d. On-Off-Auto switches for each digital output. The status of these switches will be available to the RCU panel for further processing.

e. Minimum-Maximum-Auto switches, or Auto-Manual switches with manual

potentiometer, for each analog output. The status of these switches will be available to the DDC panel for further processing.

2.12.1.1 Sealed Battery Backup

A sealed battery backup for the RCU memory and real time clock function sufficient to maintain them for a minimum period of 8 hours shall be provided. Automatic charging of batteries shall be provided, or alternately, lithium batteries sized to provide a minimum of 30 days operation and a shelf life of 2 years shall be provided. A low battery alarm with indication for each RCU shall be provided. Alternatively, capacitors may be provided to maintain memory and clock function for a minimum of 8 hours.

2.12.1.2 Electrical Service Outlet for use with Test Equipment

A single phase, 120 Vac electrical service outlet for use with test equipment shall be furnished either inside or within 2 m (6 feet) of the RCU enclosure.

2.12.1.3 Locking Type Mounting Cabinets

Locking type mounting cabinets, with common keying and door switch wired to and RCU input for intrusion alarm annunciation, shall be furnished.

2.12.1.4 Failure Mode

Upon failure of the RCU, all connected points shall be forced to the failure mode shown in the I/O summary tables.

2.12.1.5 Portable Tester

Provisions for connection of a portable tester shall be furnished at each RCU location.

2.12.1.6 I/O Functions

I/O functions shall be provided as part of the RCU and shall be in accordance with the following:

a. The Analog Input (AI) function shall monitor each analog input, perform A-to-D conversion, and hold the digital value in a buffer for interrogation. The A-to-D conversion shall have a minimum resolution of 10 bits plus sign. Signal conditioning shall be provided for each analog input. Analog inputs shall be individually calibrated for zero and span, in hardware or in software. The AI shall incorporate common mode noise rejection of 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of 20 dB at 60 Hz from a source impedance of 10,000 ohms. Input ranges shall be within the range of 4-to-20 mAdc.

b. The Analog Output (AO) function shall accept digital data, perform D-to-A conversion, and output a signal within the range of 4-to-20 mAdc. D-to-A conversion shall have a minimum resolution of 8 bits plus sign. Analog outputs shall be individually calibrated for zero and span. Short circuit protection on voltage outputs and open circuit protection on current outputs shall be provided. An individual gradual switch for manual override of each analog output and means of physically securing access to these switches shall be provided. Each AO shall have a three-position switch for selection of the DDC control signal, no control, or a locally generated

control signal for connection to the controlled device. Feedback shall be provided to the system as to the status of the output (manual control or automatic). Switches for pneumatic control outputs shall provide a connection for an externally generated pneumatic signal. All switches shall be either of a key operated design with the same keying system used for other outputs or otherwise suitably protected from unauthorized access.

c. The Digital Input (DI) function shall accept on-off, open-close, or other change of state (two state data) indications. Isolation and protection against an applied steady-state voltage up to 180 Vac peak shall be provided.

d. The Digital Output (DO) function shall provide contact closures for momentary and maintained operation of output devices. Closures shall have a minimum duration of 0.1 second. DO relays shall have an initial breakdown voltage between contacts and coil of at least 500 V peak. Electromagnetic interference suppression shall be furnished on all output lines to limit transients to nondamaging levels. Protection against an applied steady-state voltage up to 180 Vac peak shall be provided. Minimum contact rating shall be 1 ampere at 24 Vac. Key locked HOA switches shall be provided for manual override of each digital output. Feedback shall be provided to the system as to the status of the output (manual control or automatic). All switches shall be common keyed.

e. The pulse accumulator function shall have the same characteristics as the DI. In addition, a buffer shall be provided to totalize pulses and allow for interrogation by the DDC panel. The pulse accumulator shall accept rates up to 20 pulses per second. The totalized value shall be reset to zero upon operator's command.

f. Signal conditioning for sensors shall be provided as specified.

2.12.2 Data Terminal Cabinet

a. The DTC shall serve as an interface between the DDC controller and associated instrumentation and controls. Instrumentation and control devices shall be located within the DTC unless required to be at the measuring location. Firealarm changeover controls shall be located in the DTC enclosure. The Contractor shall provide the number of DTC's required to accommodate the power supplies, power distribution, instrumentation and control devices. DTC shall be mounted adjacent to the RCU.

b. The DTC shall be an independent metallic enclosure not physically part of the RCU, ACU or I/O functions. The DTC shall be sized to accommodate the instruments, controls and the number of I/O functions required for each RCU or ACU including installed spares, plus 25 percent expansion for each type of I/O function provided.

c. For UCU's a mounting base to which all field wiring is terminated, from which the control logic board can be removed and replaced without disturbing the field connections, is acceptable.

d. The DTC shall be provided with double sided screw type terminal strips. One side of the terminal strip shall be used for termination of field wiring from instrumentation and controls. The other side shall be used to connect the DTC to the RCU or ACU. Terminal strips shall have individual terminal identification numbers, corresponding to the numbers shown on the approved control drawings.

e. The DTC shall be a locking type mounting cabinet with common keying and door switch wired to the RCU input for intrusion alarm annunciation. DTC keying shall be identical to RCU keying.

2.12.3 Auxiliary Control Unit (ACU): The ACU's shall be functionally a part of the RCU as specified, but may be remotely located from the RCU and communicate over a dedicated communication circuit. When remotely located, the I/O functions shall be subject to the same requirements as for the RCU hardware.

a. General: ACUs shall be used to connect remote inputs and outputs to a supervisory RCU and shall contain all necessary I/O functions to connect to field sensors and control devices. ACU operation shall be fully supervised by the RCU to detect failures. Each ACU shall have a minimum of 10 percent of its I/O functions as spare capacity. The type of spares shall be in the same proportion as the implemented I/O functions on the ACU, but in no case shall there be less than two spare points of each implemented I/O type. The ACU shall be furnished complete, with no changes or additions necessary to support implementation of spare functions. Output relays associated with digital signals shall be considered part of the I/O function, whether physically mounted in the enclosure or separately mounted. Implementation of spare points by others shall require only providing the additional field sensor or control, field wiring including connection to the system, and point definition assignment by the operator. The ACU shall either report the status of all connected points on each scan, or report the status of all points which have changed state or value since the previous scan.

b. Controls: The ACU controls shall include:

Main power switch.

Power on indicator.

On-off line switch - enables and disables network communications.

ACU output disable switch.

On-Off-Auto switches for each digital output.

Minimum-Maximum-Auto switches, or Auto-Manual switches with manual potentiometer, for each analog output.

c. Failure Mode: Upon failure of the Acu, including data transmission or ACU hardware failure, all connected points shall be forced to the failure mode shown in I/O summary tables.

2.12.4 Terminal Unit Controls

The air terminal units shall be as specified in Section 15895 - AIR SUPPLY, DISTRIBUTION, VENTILATION AND EXHAUST SYSTEM. Terminal unit controls shall consist of individual box controllers which shall be fully interfaced to the control system through dedicated controllers (ACU). Terminal box controllers (UCU) shall be interfaced to the system through the RCU panel that controls the AHU serving that box.

2.12.5 Unitary Control Unit (UCU) Hardware

The UCU shall be a controller fully compatible with the RCU control panel. The UCU shall be a microprocessor based, dedicated device designed and

programmed to accomplish all of the functions required by the control algorithms for each terminal box. Shared use of UCU controllers is not acceptable. Each UCU shall contain all necessary power supplies, transformers, memory, I/O functions and communications interfaces necessary to perform its required functions and to provide supervision and monitoring capability from the Operator Station.

a. Controls

The UCU controls shall include:

1) Main power switch.

2) On-off line switch - enables and disables communication.

b. Features and Requirements

Control of air distribution terminal units shall be accomplished by an individual UCU provided for each air distribution terminal unit and shall interface to the Wilford Hall DDC system through the RCU terminal unit UCU components for air distribution terminal units shall be furnished to the air distribution terminal unit manufacturer for factory mounting and calibration. All control wiring to terminal units shall be provided under this section. Each air distribution terminal unit UCU shall contain resident programs which are field selectable for a specific application. Resident programs shall be contained in nonvolatile memory using EEPROM, EPROM, or RAM. Systems that employ volatile (RAM) memory shall provide 72 hour battery back-up for each terminal UCU.

c. Accessibility and Interfaces

Each air distribution terminal unit UCU shall be accessible for purposes of control parameters and setpoint adjustment and monitoring from the UCS Central Operator station, and operator interface panel as specified herein. An operator's terminal connected to any RCU on the network, directly or via modem, shall have access to the air distribution terminal unit UCUs. Air distribution terminal unit UCUs shall also be accessible through a communications port located at the associated space sensor.

d. Air Distribution Terminal Unit Controls

Pressure Independent: Controls shall consist of a transducer for connection to the velocity-sensing device provided by the terminal unit supplier in the primary air entering the terminal unit, a room temperature sensor, a damper actuator, and an adjustable microprocessor-based UCU controller. The controller shall operate the damper for cooling and heating and provide control outputs for supplementary heating or airflow reset.

e. Air Distribution Terminal Unit Controls

1) Double Duct, Constant Volume (DD01):

Pressure-independent type controls shall consist of a velocity-sensing device in each hot and cold primary air nozzle, a room temperature sensor, electronic damper actuators in each hot and cold duct and an adjustable microprocessor-based UCU terminal unit controller. The controller shall operate the hot and cold air dampers to maintain room setpoint and maintain constant air flow volume requirements. The controller shall provide a supplemental heat control output signal to be used to reset the hot deck

supply air temperature. The controller on a fall of space temperature shall modulate to open the hot air damper and modulate closed the cold air damper, on a continued fall of space temperature the controller will provide a supplemental heat required digital output to reset upwards the hot supply air temperature. Damper actuator shall open or close the device to which it is connected within 2 minutes.

2) Double Duct, Variable Air Volume (DD02):

Pressure-independent type controls shall consist of a velocity-sensing device in each hot and cold primary air nozzle, a room temperature sensor, electronic damper actuators and an adjustable microprocessor-based UCU terminal unit controller.

On a fall of space temperature the controller shall modulate to close the cold air damper to the minimum airflow volume scheduled. On a continuing fall of space temperature the controller shall modulate to open the hot air damper and close the cold air damper to, maintain space temperature and minimum airflow volume.

The controller shall provide a supplemental heat control output that will be used to reset the hot deck supply air temperature.

Damper actuator shall open or close the device to which it is connected within 2 minutes.

2.12.6 Air Distribution Terminal Unit UCU Communication-and-Programming Device

Two hand-held communication and programming devices with instruction manual for air distribution terminal unit UCUs shall be provided. The communication and programming device shall connect to the controller directly and to a communications port at the space temperature sensor for readout of variables, override control, servicing, troubleshooting and adjustment of control parameters. The terminal shall communicate in English language for inquiry, reporting, and programming purposes. When used remotely or locally the terminal shall:

a. Indicate system status (heating, cooling, out of control range).

b. Display, set, and manually override minimum and maximum air flow in cfm.

c. Display space temperature.

d. Display, set, and manually override space temperature setpoint and setback.

e. Display auxiliary (duct, discharge) temperature.

f. Display, set and change heating/cooling temperature.

g. Display damper and valve position in percent open notation.

h. Command damper and valve position in percent open notation.

i. Select application mode.

2.12.7 Command Entry Device

A command entry device (lap top computer) shall be provided for use with. RCU. The command entry device shall include a keyboard and display for local programming and setup. A printer and disk system shall also be provided. The command entry device shall be provided with communications interfaces to each RCU, and shall:

a. Allow for entry of database information, including parameters and constraints from the keyboard.

b. Display any digital, analog, and pulse accumulator input.

c. Control any digital and analog output.

d. Provide operator interface in alphanumeric and decimal.

e. Disable/enable any . CU.

2.12.7.1 Communications

A port and proper cabling shall be provided to allow for communications between the command entry device and the CU.

2.12.7.2 Keyboard

A keyboard shall be furnished with the command entry device panel. The keyboard shall include a 64-character standard ASCII character set based on ANSI X3.64 and ANSI X3.154. The keyboard shall also include a 10-key numeric keypad and 10 programmable function keys, light pen, or mouse. The keyboard shall provide a means for the operator to interact with all command and applications software.

2.12.7.3 Printer

A printer shall be provided for use with the command entry device panel. The printer shall have a minimum 96 character standard ASCII character set. It shall have adjustable sprockets for paper width up to 241 mm (9.5 inches) and a friction feed for paper width up to 216 mm (8.5 inches), and shall print at least 80 columns per line. The printer shall have a minimum speed of 150 characters per second in utility mode (draft quality) and 32 characters per second in near-letter quality mode. Print mode shall be switch or software selectable. The minimum character spacing shall be 10 characters per inch and 3 to 8 lines per inch. The printer shall utilize standard form size, sprocket-fed fanfold paper. The unit shall have programmable control of top-of-form and variable line skip capability.

2.12.7.4 Hard Disk

The command entry device shall include a hard disk system having a maximum average access time no greater than 19 milliseconds, and a minimum of 65 megabytes of formatted storage. The device shall allow each CU database to be stored as a separate file suitable for transfer to floppy disk.

2.12.7.5 Floppy Disk

The command entry device shall include a 3.5 inch high density floppy disk system as part of the command entry device providing a minimum of 1.44

megabytes of formatted storage.

2.12.8 Communication Equipment

The RCU shall be equipped with hardware to allow for communication over Data Transmission Media (DTM) using the communication network as shown.

2.12.9 Dial Up Modem

A type V.32 Modem operating at 1,200 or 2,400 BPS with automatic/selectable fall back operation with automatic answer and automatic dial capability shall be connected to the control system and to the telephone system and shall be certified to meet the requirements of 47 CFR 68.

2.13 CONTROL UNIT (CU) SOFTWARE

Each CU, shall contain an operating system that controls and schedules that CU activities in real time. The CU shall maintain a point database in its RAM that includes all parameters, constraints, and the latest value or status of all points connected to that CU. The operating system shall include a real time clock function that maintains the seconds, minutes, hours, date and month, including day of the week. The operating system shall allow local loading of software and data files from the portable tester and from an operator interface panel.

2.13.1 Command Priorities

A scheme of priority levels shall be provided to prevent interaction of a command of low priority with a command of higher priority. The system shall require the latest highest priority command addressed to a single point to be stored for a period of time longer than the longest time constraint in the on and off states, ensuring that the correct command will be issued when the time constraint is no longer in effect or report the rejected command. Override command entered by the operator shall have higher priority than those emanating from application programs.

2.13.2 CU Startup

The CU shall have startup software that causes automatic commencement of operation without human intervention, including startup of all connected I/O functions. A CU restart program based on detection of power failure at the CU shall be included in the CU software. Upon restoration of power to the CU, the program shall restart all equipment and restore all loads to the state at time of power failure, or to the state as commanded by time programs or other overriding programs. The restart program shall include start time delays between successive commands to prevent demand surges or overload trips. The startup software shall initiate operation of self-test diagnostic routines. Upon failure of the CU and if the database and application software are no longer resident, or if the clock cannot be read, the CU shall not restart and systems shall remain in the failure mode until the necessary repairs are made. If the database and application programs are resident, the CU shall resume operation after an adjustable time delay of from 0 to 600 seconds. The startup sequence for each CU shall include a unique time delay setting when system operation is initiated .

2.13.3 DDC Panel Operating Mode

Each CU shall control and monitor all functions independent of communication

with any other source. The software shall perform CU functions and CU resident application programs using data obtained from I/O functions and based upon the CU real time clock function. CU panel software shall execute commands after performing constraint checks in the CU.

2.13.4 CU Failure Mode

Upon failure for any reason, the system shall perform an orderly shutdown and force all DDC panel outputs to a predetermined state, consistent with the failure modes defined in the I/O summary tables and the associated controlled devices.

2.13.5 DCU Functions

Software necessary to accomplish the following functions, as appropriate, fully implemented and operational, within the RCU, ACU and UCU as required:

a. Scanning of inputs.

b. Control of outputs.

c. Store alarms for reporting when requested.

d. Maintain real time.

e. Execute CU resident application programs.

f. Averaging or filtering of each analog input.

g. Constraint checks, prior to command issuance.

h. CU diagnostics.

i. CU portable tester operation.

2.13.6 Analog Monitoring

The system shall measure analog values and shall be capable of transmitting analog values for display. An analog change in value is defined as a change exceeding a preset differential value as specified. Displays and reports shall express analog values in proper engineering units with polarity sign. The system shall accommodate up to 255 different sets of engineering unit conversions. Each engineering unit conversion shall include range, span, and conversion equation.

2.13.7 Logic (Virtual) Points

Logic (virtual) points shall be software points entered in the point database which are not directly associated with a physical I/O function. This value shall be created by calculating it from any combination of digital and analog points, or other data. Logic points shall be analog or digital points having all the properties of real points, including alarms, without the associated hardware. Logic points shall be defined or calculated and entered into the database by the Contractor as required. The calculated analog point shall have point identification in the same format as any other analog point. The calculated point shall be used in any program where the real value is not obtainable directly. Calculated point values shall be current for use by the system within 30 seconds of the time any input value changes and shall

include:

a. Control loop setpoints.

b. Control loop gain constants.

c. Control loop integral constants.

d. Summer/winter operation.

e. Real time.

f. Scheduled on/off times.

g. Equipment run-time targets.

h. Calculated point values.

2.13.8 I/O Point Definition

Each I/O point shall be defined in a database in the CU. The definition shall include all physical parameters and constraints associated with each point.

2.13.9 Parameter Definition

Each I/O point shall be defined and entered into the database by the Contractor, including as applicable:

a. Name.

b. Device or sensor type (i.e., sensor, control, motors).

c. Point identifications number.

d. Area.

e. Sensor range.

f. Controller range.

g. Sensor span.

h. Controller span.

i. Engineering units conversion (scale factor).

j. High and low reasonableness value (analog).

k. High and low alarm limit (analog).

l. High and low alarm limit differential (return to normal).

m. Analog change differential (for reporting).

n. High accumulator limit (pulse).

o. Status description (digital inputs).

2.13.10 Alarm Processing

Each shall have alarm processing software for digital, analog, and pulse accumulator alarms for all input and virtual points connected to that

2.13.10.1 Digital Alarms Definition

Digital alarms are those abnormal conditions indicated by digital inputs as specified in the I/O Summary Tables and elsewhere.

2.13.10.2 Analog Alarms Definition

Analog alarms are those conditions higher or lower than a defined value, as measured by an analog input as specified in the I/O Summary Tables and elsewhere. Analog readings shall be compared to predefined high and low limits, and alarmed each time a value enters or returns from a limit condition. Unique high and low limits shall be assigned to each analog point in the system. Analog alarm limits shall be stored in the CU database. Each analog alarm limit shall have an associated unique limit differential specifying the amount by which a variable must return to the proper operating range before being declared as a return-to-normal state. Limits and differentials shall be entered on line by the operator in limits or the measured variable, without interruption or loss of monitoring of the point concerned.

2.13.10.3 Pulse Accumulator Alarms Definition

Pulse accumulator alarms are those conditions calculated from totalized values of accumulator inputs or pulse accumulator inputs rates that are outside defined limits as specified in the I/O Summary Tables and elsewhere. Pulse accumulator totalized values shall be compared to predefined limits and alarmed each time a value enters a limit condition. Unique limits shall be assigned to each pulse accumulator point in the system. Limits shall be stored in the DDC panel database.

2.13.10.4 Equipment Constraints Definitions

Each control point in the database shall have CU resident constraints defined and entered by the Contractor, including as applicable:

a. Minimum off time.

b. Minimum on time.

c. High limit (value in engineering units).

d. Low limit (value in engineering units).

2.13.10.5 Constraint Checks

Control devices connected to the system shall have the CU memory resident constraints checked before each command is issued to ensure that no equipment damage will result from improper operation. Each command shall be executed by the CU only after all constraint checks have been passed. Each command point shall have unique constraints assigned. High and low "reasonableness" values or one differential "rate-of-change" value shall be assigned to each analog input. Values outside the reasonableness limits shall be rejected and an alarm generated. Status changes and analog point values shall be

reported upon request, such as for reports, and application programs. Each individual point shall be capable of being selectively disabled by the operator. Disabling a point shall prohibit monitoring and automatic control of that point.

2.13.11 CU Diagnostics

Each CU shall have self-test diagnostic routines implemented in firmware. The tests shall include routines that exercise memory. Diagnostic software shall be provided for use in the portable tester. The software shall display messages in plain language to inform the tester's operator of diagnosed problems.

2.13.12 Control Sequences and Control Loops

Operator commands shall be used to create and execute control sequences and control loops for automated control of equipment based on operational parameters including times and events, defined in the database. Through the command entry device, the system shall prompt the operator for information necessary to create, modify, list, and delete control sequences and Proportional-plus-Integral-plus Derivative (PID) control loops. The system shall prompt the operator for confirmation that the control sequence and control loop addition/modification/deletion is correct, prior to placing it in operation. Mathematic functions required shall be available for use in creating the control sequences and control loops. Sufficient spare memory shall be provided to allow four control sequences and four control loops in addition to those necessary to implement the requirements specified for each RCU or ACU. Each control sequence shall accommodate up to eight terms or devices.

2.13.12.1 Control Functions

The CU shall provide the following control functions:

a. PID Control

The system shall provide for PID control. The control algorithm intended for use shall be submitted for approval with a full explanation of its functions and limitations. A determination shall be made of the antiwindup limit for the CU software (for example, an antiwindup limit of plus/minus one half of the actuator range).

b. Two Position Control

This function shall provide control for two state device control by comparing a setpoint against a process variable and an established deadband.

c. Floating Point Control

This function shall exercise control when an error signal exceeds a selected deadband, and shall maintain control until the error is within the deadband limits.

d. Signal Selection

This function shall allow the selection of the highest or lowest analog value from a group of analog values as the basis of control. The function shall include the ability to cascade analog values so that large numbers of inputs,

up to a maximum of 20, can be reduced to one or two outputs.

e. Reset Function

This function shall develop an analog output based on up to two analog inputs and one operator specified reset schedule.

f. Self Tuning

The controller shall provide self tuning operation to proportional, integral and derivative modes of control and shall modify the mode constants as required.

2.13.12.2 CU Resident Applications Software

Application software required to achieve the sequences of operation, parameters, constraints, and interlocks necessary to provide control of the systems connected to the DDC system shall be provided. Application software shall be resident and executing in the CU , and shall be coordinated to ensure that no conflicts or contentions remain unresolved.

2.13.13 Communication Programs

The RCU shall be equipped with software drivers and handlers which allow for communication with a base-wide EMCS. The software drivers shall allow for communications via modems, line drivers, transmitters/receivers over LAN, wirelines, fiber optic or coaxial cables. The software shall be structured to support communication over a network with star, ring, radial, or a combination of topologies. Each communication program module shall be functionally independent of other Contractor-furnished software, to allow for future upgrade or replacement of communication modules without affecting other application programs and other software modules. Communication protocol for communication shall conform to a standard communication protocol.

2.14 CENTRAL STATION EQUIPMENT

2.14.1 Systems Graphic Software

The system graphic software exits in the present central station EMCS system and shall be utilized by this Contractor to format the graphics packages required for this project.

2.14.2 System Graphics Implementation

System graphics displays shall include real time data integrated into the display. The schematics indicated in the contract drawings shall be used as a guide for preparing the displays. System graphics shall reflect actual system configuration. Each system schematic shall be included as a separate display keyed to the building in which it is installed. Displays of all systems and points shown in the I/O summary tables and elsewhere shall be included. Different colors shall be used for various components and real time data. Colors shall be uniform on all displays. When the display is active on the operator's console, the data associated with that display shall be updated within 10 seconds of the digital status change or the analog change in excess of the analog change differential. When a point is in alarm, the representation for that point shall be red blinking until acknowledged, and shall be steady red until the alarm condition no longer

exists. Colors shall be used to allow rapid recognition and ease of interaction. Any real time data which is not current, due to CU communications failure, CU failure, or point out of service, shall be highlighted.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION CRITERIA

3.1.1 HVAC Control System

The HVAC control system shall be completely installed and ready for operation. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be made watertight. The HVAC control system installation shall provide clearance for control system maintenance by maintaining access space between coils, access space to mixed-air plenums, and other access space required to calibrate, remove, repair, or replace control system devices. The control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.2 Software Installation

Software shall be loaded for an operational system, including databases for all points, operational parameters, and system, command, and application software. The Contractor shall provide original and backup copies of source, excluding the general purpose operating systems and utility programs furnished by computer manufacturers and the non-job-specific proprietary code furnished by the system manufacturer, and object modules for all software on each type of media utilized, within 30 days of formal Government acceptance. In addition, a copy of individual floppy disks of all software for each DDC panel shall be provided.

3.1.3 Device-Mounting Criteria

Devices mounted in or on piping or ductwork, on building surfaces, in mechanical/electrical spaces, or in occupied space ceilings shall be installed in accordance with manufacturer's recommendations and as shown. Control devices to be installed in piping and ductwork shall be provided with all required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used except as specified.

3.1.4 Wiring Criteria:

a. All wiring with voltage exceeding 50 volts shall be installed in metal conduits or enclosed in panels, boxes, etc.

b. All network communication (LAN) between RCU’s and from RCU’s to ACU's shall be installed in metal conduits.

c. All wiring that is exposed or is not in an accessible location shall be installed in metal conduits.

d. Communication wiring external to the RCU/DTC that is in accessible

locations may be run in plenum rated cabling or installed in metal conduits or raceways.

e. Wiring shall be installed without splices between control panel terminations and control devices. Instrumentation grounding shall be installed as necessary to prevent ground loops, noise and surges from adversely affecting operation of the system. Cables and conductors shall be tagged at both ends with the identified shown on the shop drawing.

f. Wiring shall comply with Division 16 of these specifications. The term wiring shall include furnishing of wire, conduit, miscellaneous material and labor to install a working system. Outdoor installations shall be NEMA 12 enclosures.

3.2 CONTROL-SYSTEM INSTALLATION

3.2.1 Damper Actuators

Actuators shall not be mounted in the air stream. Multiple actuators operating a common damper shall be connected to a common drive shaft. Actuators shall be installed so that their action shall seal the damper to the extent required to maintain leakage at or below the specified rate and shall move the blades smoothly.

3.2.2 Room-Instrument Mounting

Room instruments shall be mounted so that their sensing elements are 1.5m (5 feet) above the finished floor unless otherwise shown. Temperature setpoint device shall be recess mounted.

3.2.3 Freezestats

For each 2 square meters (20 square feet) of coil-face area, or fraction thereof, a freezestat shall be provided to sense the temperature at the location shown. Manual reset freezestats shall be installed in approved, accessible locations where they can be reset easily. The freezestat sensing element shall be installed in a serpentine pattern.

3.2.4 Averaging-Temperature Sensing Elements

Sensing elements shall have a total element minimum length equal to 3 m per square meter (1 linear foot per square foot) of duct cross-sectional area.

3.2.5 Foundations and Housekeeping Pads

Foundations and housekeeping pads shall be provided for the HVAC control system air compressors.

3.2.6 Duct Static-Pressure Sensing Elements and Transmitters

The duct static-pressure sensing element and transmitter sensing point shall be located approximately two-thirds of the distance from the supply fan to the end of the duct with the greatest pressure drop.

3.2.7 Indication Devices Installed in Piping and Liquid Systems

Gauges in piping systems subject to pulsation shall have snubbers. Gauges for steam service shall have pigtail fittings with cock. Thermometers an

temperature sensing elements installed in liquid systems shall be installed in thermowells.

3.3 CONTROL SEQUENCES OF OPERATION

3.3.1 General Requirements

These requirements with the control algorithms, schematics and diagrams shall apply to all primary HVAC systems. The sequences describe the actions of the control system for one direction of change in the HVAC process analog variable, such as temperature, humidity or pressure. The reverse sequence shall occur when the direction of change is reversed.

3.3.2 Scheduled Start-Stop Program

This program shall start and stop equipment based on a time of day schedule for each day of the week, and on a holiday schedule. To eliminate power surges, an operator adjustable time delay shall be provided between consecutive start commands.

3.3.2.1 Program Inputs

a. Day of week/holiday.

b. Time of day.

c. Summer and winter start-stop schedules.

d. Summer or winter operation.

e. Equipment status.

f. Equipment constraints.

3.3.2.2. Program Outputs (direct digital control)

a. Start/stop signal.

3.3.3 Optimum Start-Stop Program

This program shall start and stop equipment as specified for the scheduled start-stop program but shall include a sliding schedule based on indoor and outdoor conditions.

The program shall take into account the thermal characteristics of the structure, indoor and outdoor air conditions using prediction software to determine the minimum time of HVAC system operation needed to satisfy space environmental requirements at the start of the occupied cycle, and determine the earliest time for stopping equipment at the day’s end without allowing the space environmental conditions to drift out of the range specified for the occupied cycle before the start of the unoccupied cycle.

3.3.4 Auto/Cycle Program

This program shall enable the system to accept a local start command during the system off period and shall stop the equipment when the system temperature is within limits.

The software shall limit the drop of space temperature (or specified fluid temperature) during unoccupied hours. Whenever the space temperature (or specified fluid temperature) is below the operator assigned temperature limit, the system shall be cycled on until the temperature is above the assigned temperature limit.

3.3.4.1 Program Inputs:

a. Day of week.

b. Time of day.

c. Summer or winter operation.

d. Summer and winter occupancy schedules.

e. Equipment status.

f. Space temperature (or specified fluid temperature).

g. Minimum space temperature (or specified fluid temperature) during unoccupied periods.

h. Equipment constraints.

3.3.4.2 Program Output:

a. Start/stop signal (direct digital control).

3.3.5 Auto-On-Off Program

This program shall enable the operator to run equipment by manual selection. Returning this selection to auto will retain the equipment operation in the original program.

3.3.5.1 Program Input:

a. Equipment constraints.

b. Equipment status.

3.3.5.2 Program Output:

a. Start/stop signal.

3.3.6 Enable/Off: This program will enable the units to run under the direction of the local loop controller.

3.3.6.1 Program Input

a. Operation schedule.

b. Time of day, day of week/holiday.

3.3.6.2 Program Outputs

a. Enable signal to mechanically held relay.

b. Disable signal to unlatch mechanically held relay.

3.3.7 Boiler Program

This program shall monitor boiler plant operation.

3.3.7.1 Program Inputs:

a. Boiler status (2).

b. Pump status (2).

c. HW flow.

d. HW Supply Temperature.

e. HW Return Temperature.

3.3.7.2 Program Outputs

a. Boiler enable-off control signal.

b. Pump on-off control signal.

c. Building heating load.

d. Hot water temperature reset signal.

3.3.8 Chiller Program

This program shall monitor the chiller plant operation.

3.3.8.1 Program Inputs

a. Chiller status.

b. Pump status (2).

c. Chilled Water Flow.

d. Chilled Water Supply temperature.

e. Chilled Water Return temperature.

f. Chiller alarm.

3.3.8.2 Program Outputs

a. Chiller enable-off control signal.

b. Chilled Water Pump on-off control signal.

c. Building cooling load.

d. Chilled water temperature reset signal.

3.3.9 Preheat Coil Program

3.3.9.1 Program Input:

a. Leaving air temperature.

b. Schedule temperature.

3.3.9.2 Program Output:

a. Hot Water actuator control signal (direct digital control).

b. Fan shutdown.

c. O.A. damper actuator control signal.

3.3.10 Cooling Coil Program

This program shall maintain the leaving air temperature from the chilled water cooling coil in accordance with the System Operating Schedule and algorithm.

3.3.10.1 Program Input.

a. Leaving air temperature.

b. Scheduled temperature.

3.3.10.2 Program Output:

Chilled water control valve actuator control signal (direct digital control).

3.3.11 Heating Coil Control

This program shall maintain the leaving air temperature from the heating coil in accordance with the scheduled temperature and supplemental heat reset schedule.

3.3.11.1 Program Inputs

a. Leaving air temperature.

b. Maximum leaving air temperature.

c. Minimum leaving air temperature.

d. Outside air temperature.

e. Terminal unit supplemental heat reset.

3.3.11.2 Program Outputs

a. Hot water control valve actuator control signal.

3.3.12 Airflow Synchronization Control

This program shall maintain the minimum setpoint static pressure required in either the hot or cold supply ducts by modulating the speed of the supply air fan. A pressure sensor in the discharge duct from the fan will limit the speed of the fan so that the maximum discharge pressure will not be exceeded.

The program shall maintain a constant airflow volume difference between the supply air and return air volumes equal to the exhaust air volume. On systems with more than one major supply or return air branch additional air flow measuring stations each with a differential pressure transmitter shall be used. Signals from the multiple transmitters will be measured separately and the resulting air flow volumes added to provide the total air flow volume.

3.3.12.1 Program Inputs:

a. Static pressure stations.

b. Airflow measuring stations.

c. Equipment constraints.

d. Exhaust air flow volume

e. Discharge pressure.

3.3.12.2 Program Output:

a. Supply fan variable frequency drive unit speed control signal.

b. Return fan variable frequency drive unit speed control signal.

c. Air flow volumes.

3.3.13 Static Pressure Program

This program shall maintain the minimum setpoint status pressure required in the supply duct by modulating the speed of the supply air fan. A pressure sensor in the discharge duct from the fan will limit the speed of the fan so that the maximum discharge pressure will not be exceeded.

3.3.13.1 Program Inputs:

a. Static pressure stations.

b. Discharge pressure.

c. Terminal Unit Controller reset signal

d. Equipment constraints.

3.3.13.2 Program Output:

a. Supply fan variable frequency drive unit speed control signal.

b. Duct static pressure.

3.3.14 System Humidity Control

This program shall maintain the scheduled minimum return air relative humidity. A humidity sensor downstream of the humidifier will override and modulate closed the humidifier steam valve should the supply air humidity exceed 85% rh.

3.3.14.1 Program Input:

a. R.A. Relative Humidity.

b. Supply air relative humidity (downstream of humidifier).

c. Steam generator status (pressure).

3.3.14.2 Program Output:

a. Humidifier steam control valve actuator control signal (direct digital control).

3.3.15 Air Distribution Terminal Unit UCU Program

This program shall control the air distribution terminal units, monitoring, alarming and reporting of terminal unit parameters on an individual basis; and remote setpoint adjustment of terminal unit control parameters on an individual basis. Provide the following minimum functions at each air distribution terminal unit UCU.

Volume control in response to temperature.

Volume flow limits, minimum and maximum.

Occupied and unoccupied operation with associated temperature and volume limits.

Occupant temperature adjustment.

Temperature setpoint override.

Occupant override.

3.3.15.1 Program Inputs:

a. Space temperature.

b. Space temperature setpoint.

c. Space temperature setpoint limits.

d. Time of day.

e. Supply airflow volume

f. Supply airflow volume high and low limits.

g. Occupant override request.

3.3.15.2 Program Outputs (direct digital control):

a. Cold duct damper actuator control signal.

b. Hot duct damper actuator control signal.

c. Supply air pressure reset control.

d. Supply air temperature control reset.

3.3.16 Fire Alarm Interface

The RCUs shall interface with the fire alarm system through the use of fire alarm control relays. These relays will be provided and installed within 3 feet of the appropriate DTC. The controls contractor shall arrange the system to accomplish the required sequences as described herein in response to activation of these fire alarm relays and testing required for proper operation in response to the fire alarm control relays shall be provided as part of Section 15951. Fire alarm control sequences shall operate completely independently of the RCU and shall not rely on any CU logic or software components to accomplish the specified actions.

3.3.17 Domestic Hot Water Program

This program shall monitor the domestic hot water storage temperature and the domestic hot water distribution and return temperatures.

3.3.17.1 Program Inputs

a. Storage tank temperature (2).

b. Domestic hot water supply temperature.

c. Domestic hot water return temperature.

d. Storage tank scheduled temperature.

e. Storage tank limit temperature.

3.3.17.2 Program Outputs

a. Heating hot water control valve actuator control signal (2).

b. Storage tank temperature alarm.

3.4 COMMISSIONING PROCEDURES

3.4.1 Evaluations

The Contractor shall make the observations, adjustments, calibrations, measurements, and tests of the control systems, set the time schedule, and make any necessary control-system corrections to ensure that the systems function as described in the sequence of operation.

3.4.1.1 Item Check

Signal levels shall be recorded for the extreme positions of each controlled device. An item-by-item check of the sequence of operation requirement shall be performed using Steps 1 through 4 in the specified control system commissioning procedures. Steps 1, 2, and 3 shall be performed with the HVAC system shut down; Step 4 shall be performed after the HVAC systems have been started. External input signals to the CU panel (such as starter auxiliary contacts, and external systems) may be simulated in steps 1, 2, and 3. With each operational-mode signal change, CU panel output relay contacts shall be observed to ensure that they function.

3.4.1.2 Weather-Dependent Test Procedures

Weather-dependent test procedures that cannot be performed by simulation shall be performed in the appropriate climatic season. When simulation is used, the actual results shall be verified in the appropriate season.

3.4.1.3 Two-Point Accuracy Check

A two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter shall be performed by comparing the CU panel readout to the actual value of the variable measured at the sensing element and transmitter or airflow measurement station location. Digital indicating test instruments shall be used, such as digital thermometers, motor-driven psychrometers, and tachometers. The test instruments shall be at least twice as accurate as the specified sensing element-to-CU panel readout accuracy. The calibration of the test instruments shall be traceable to National Institute Of Standards And Technology standards. The first check point shall be with the HVAC system in the shutdown condition, and the second check point shall be with the HVAC system in an operational condition. Calibration checks shall verify that the sensing element-to- CU panel readout accuracies at two points are within the specified product accuracy tolerances. If not, the device shall be recalibrated or replaced and the calibration check repeated.

3.4.1.4 Insertion and Immersion Temperatures

Insertion temperature and immersion temperature sensing elements and transmitter-to-DDC panel readout calibration accuracy shall be checked at one physical location along the axis of the sensing element.

3.4.1.5 Averaging Temperature

Averaging-temperature sensing element and transmitter-to- CU panel readout calibration accuracy shall be checked every 600 mm (2 feet) along the axis of the sensing element in the proximity of the sensing element, for a maximum of 10 readings. These readings shall then be averaged.

3.4.2 Fan-Coil Unit

The dual-temperature hydronic system shall be set to heating. Each space thermostat temperature setting shall be turned up so that it makes contact and turns the fan-coil unit on. It shall be ensured that the fan coil unit fan starts and the valves open to flow through the coils. Each space thermostat temperature setting shall be turned down and it shall be ensured that the fan coil unit fans stop. It shall be ensured that the valves close to flow through the coils. The dual-temperature hydronic system shall be switched to cooling. Each space thermostat temperature setting shall be turned up and it shall be ensured that contact is broken and the fan coil unit fans stop. It shall be ensured that the valves close to flow through the coil. Each space thermostat temperature setting shall be turned down. It shall be ensured that the fan coil unit fans start and the valves open to flow through the coils. The thermostats shall be set at their temperature setpoints. The results of testing of one of each type of unit shall be logged.

3.5 FIELD TEST AND INSPECTIONS

3.5.1 System Equipment:

Upon completion of installation of each piece of equipment, field inspect and mechanically and electrically test equipment for proper function.

3.5.2 Signal Transmission System Equipment:

Ground Rod Tests: Before any wire is connected to the ground rods, use a portable ground testing instrument to test each ground or group of grounds.

3.5.3 Site Testing:

Perform tests as required in Part 1, Paragraph 1.5 - Site Testing.

3.5.4 Performance Tests:

Perform in accordance with Part 1, Paragraph 1.5 - Performance Verification Testing and Endurance Testing.

3.6 MAINTENANCE AND SERVICE

3.6.1 Provide in accordance with Part 1, Paragraph 1.7 - Maintenance and Service.

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SECTION 16721

FIRE DETECTION AND ALARM SYSTEM

PART 1 - GENERAL REQUIREMENTS

1.1 REFERENCES

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

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

\-FM p7825-\	(1994; Supple 1) Approval Guide

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

\-IEEE C62.41-\	(1991) Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

\-NFPA 70-\	(1996) National Electrical Code
\-NFPA 72-\	(1996) National Fire Alarm Code
\-NFPA 90A-\	(1996) Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

\-UL-04-\	(1994) Fire Protection Equipment Directory
\-UL 6-\	(1993) Rigid Metal Conduit
\-UL 38-\	(1994; Rev Jan 1994) Manually Actuated Signaling Boxes for Use with Fire Protective Signaling Systems
\-UL 268-\	(1989; Rev May 1989) Smoke Detectors for Fire Protective Signaling Systems
\-UL 464-\	(1990) Audible Signal Appliances
\-UL 467-\	(1993) Grounding and Bonding Equipment
\-UL 521-\	(1993) Heat Detectors for Fire Protective Signaling Systems
\-UL 797-|	(1993) Electrical Metallic Tubing
\-UL 864-\	(1991; Rev thru May 1994) Control Units for Fire-Protective Signaling Systems

\-UL 1242-\ (1993; Rev thru Jul 1993) Intermediate Metal Conduit

1.2 GENERAL REQUIREMENTS

1.2.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least two years prior to bid opening.

Am#3 **All equipment shall be Year 2000 compliant and shall be able to accurately process date/time data (including, but not limited to, calculating, comparing, and sequencing) from, into, and between the twentieth and twenty-first centuries, including leap year calculations.**

1.2.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

1.2.3 Keys and Locks shall be interchangeable

1.2.4 Furnish tags with stamped id number for keys and locks.

1.2.5 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.2.6 Compliance

The fire detection and internal alarm system and the central reporting system shall be configured in accordance with NFPA 72. The equipment furnished shall be compatible and be UL listed or FM approved or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

1.2.7 Manufacturer’s Services

Services of a manufacturer’s representative who is experienced in the installation, adjustment, testing, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

1.3 SYSTEM DESIGN

1.3.1 Operation

a. System shall be supervised, microprocessor based, auxiliary local protective signaling system with individually addressable initiating devices. System shall remain in the alarm mode until initiating device is reset and FACP is reset.

b. Strobes shall continue to flash after alarm silence signal is initiated.

c. A 2-loop conduit system shall be provided so that if any one conduit and all conductors contained in that conduit are severed, all initiating devices or indicating devices on that circuit shall remain functional. A 2-loop system is not applicable to the connection from the FACP to the base fire alarm system.

1.3.2 Operational Features

The system shall have the following operating features:

a. Complete field programmability using keyboard commands or dip switches.

b. Electrical supervision of alarm initiating circuits and alarm indicating circuits and audible and visual alarm indicating circuits. Smoke detectors shall have combined alarm initiating and power circuits.

c. Audible and visual trouble indication to activate upon a single break, ground fault, or open condition in any supervised circuit which prevents the normal operation of the system. The trouble alarm silence command shall be provided which silences the trouble alarm but will not restore the trouble condition. When the system returns to normal, the trouble alarm shall sound until the operator acknowledges that the system has been restored to normal.

d. Supervised switches to disconnect auxiliary functions such as transmitter connection circuit, air handling unit shutdown, etc.

e. Addressable communication modules to connect nonintelligent devices to FACP.

f. Provide connection from FACP to existing base fire alarm and reporting system. Connection shall transmit all alarm and trouble signals to the reporting system.

g. Install initiating device circuits so that each circuit has the capacity to add at least 20 percent additional devices without exceeding full circuit capacity.

1.3.3 Alarm Functions

a. An alarm condition at any initiating device shall cause the functions identified on the attached matrix to occur. The following additional functions shall be performed:

1 The FACP audible alarm device shall sound.

2 The English language description of the alarm point shall be displayed at the FACP.

3 Audible and visual devices shall sound in the building.

1.3.4 Supervisory Functions

a. A supervisory alarm for any device shall initiate functions listed on the matrix attached. The following additional functions shall be performed:

1 The English language description of the point shall be displayed at the FACP.

2 The FACP audible supervisory alarm shall sound

b. Supervisory alarms shall be displayed and printed as a lower priority alarm than any alarm conditions.

1.3.5 Primary Power

Operating power for the system shall be 120 volt AC, 1 phase, 60 Hz taken from the building emergency circuit distribution panel. Power supply circuit shall be dedicated to the system. Transfer from normal to emergency power or restoration of normal power shall be automatic.

1.3.6 Emergency Power

Emergency power for the FACP shall be through use of rechargeable, sealed-type storage batteries and battery charger.

1.4 SUBMITTALS

Government approval is required for submittals with a “GA” designation. Submittals having an “FIO” designation are for information only.

The contractor shall furnish the Owner and Engineer with the following in accordance with section \01300\ submittal procedures:

SD-01 Data\

Battery\ *GA*\

a. Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component. Battery recharging period. Detailed operating sequence.

b. Complete CRT English language description for each point that will be displayed. This detailed information shall be in a drawing format.

Voltage Drop\; *GA*\.

Voltage drop calculations for signaling appliance circuits to indicate that sufficient voltage is available for proper appliance operation.

Spare Parts\; *FIO*\

Spare parts data for each different item of material and equipment specified, not later than 2 months prior to the data of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 2 years of service.

Qualifications\; *FIO*\

Qualifications, with verification of experience and license number, of a Registered Professional Engineer with at least 4 years of current experience in the design of the fire protection and detection systems. This engineer must perform the various specification items required by this section to be

performed by a registered Professional Engineer.

SD-04 Drawings

***Fire Alarm Reporting System*; *GA*.**

Detail drawings, signed by the Registered Professional Engineer, consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical detectors. The contractor shall check the layout based on the actual detectors to be installed and make any necessary revisions in the detail drawings. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

Detailed point-to-point wiring diagram, signed by the Registered Professional Engineer, showing all points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and all equipment that is activated or controlled by the panel.

SD-06 Instructions

***Fire Alarm Reporting System*; *GA*.**

Six copies of operating instructions outlining step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The instructions shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. Instructions shall be approved prior to training.

***Training*; *FIO*.**

Lesson plans and training data, in manual format, for the training courses.

SD-08 Statements

***Test Procedures*; *FIO*.**

Detailed test procedures, signed by the Registered Professional Engineer, for the fire detection and alarm system 60 days prior to performing system tests.

SD-09 Reports

***Testing*; *FIO*.**

Test reports in booklet form showing all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document all readings, test results and indicate the final position of controls. Submit a certificate of completion after testing as required by NFPA 72, Section 1-7.2.

SD-13 Certificates\

Equipment\; *FIO*\.

Certified copies of current approvals or listings issued by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

Installer\; *FIO*\.

The Contractor shall provide documentation demonstrating that its fire detection and alarm system installer has been regularly engaged in the installation of fire detection and alarm systems meeting NFPA standards for a minimum of three years immediately preceding commencement of this contract. Such documentation shall specifically include proof of satisfactory performance on at least three projects similar to that required by these specification, including the names and telephone numbers of using agency points of contact for each of these projects. Documentation shall indicate the type of each system installed and include a written certificate that each system has performed satisfactorily in the manner specified for a period of not less than 12 months following completion. All such data shall be submitted 30 days prior to commencement of installation for approval of the Contracting Officer. Listing of the installer under “Proprietary Signaling Services - Local, Auxiliary, Remote Station Proprietary (UUJS)” of \-UL-04-\ shall be accepted as equivalent proof of compliance with the foregoing experience requirements.

As-Built (Record) Drawings\ *FIO*\

Furnish the Owner two sets of AUTOCAD 13 disks and two copies of as-built (record) detail drawings, record CRT English Language description and record battery calculations on 3 mil Mylar sepia. The record drawings shall be developed from a set of drawings maintained at the site with up-to-date mark-ups.

1.5 DELIVERY AND STORAGE

Deliver all materials to area of project designated by Owner's representative. Vehicles shall not block fire lanes or fire doors during delivery of materials.

PART 2 - PRODUCTS

2.1 EQUIPMENT CONFIGURATION

The microprocessor based system shall contain the following equipment:

1. FACP
2. Central Processing Unit (CPU)
3. Power Supplies
4. System Operating Terminal
5. Alarm Initiating Devices
6. Alarm Indicating Devices
7. Additional equipment, such as wiring, conduit, air handler shutdown, base alarm system connection, etc.

2.2 FACP

1. The FACP shall provide an interface between the system and the operator. It shall include the following indicators, controls, and features:

   A. Power on
   B. Alarm and trouble silence capability
   C. System reset capability
   D. Auxiliary function disconnect capability
   E. Programming, data storage and timing functions. Operating systems shall be stored in nonvolatile memory. Programming shall include:

      1 Basic Alarm processing programs.
      2 Control by event programs sequences.
      3 System point scanning programs and system point description.
      4 Password control routines.
      5 Emergency file display routines and statements.
      6 Capability to enable and disable each point in the system.
      7 Complete list of every point in the system and storage of historical alarm and trouble events.
      8 Walk test feature. This function shall make it possible to test groups of points without disabling the entire system. Operation of any alarm initiating device during the test shall override the test function. Operation of any alarm initiating device outside the test area shall function as normal.
      9 At least three program access levels with passwords required for all levels except the lowest level.
      10 Wall mount or floor mount capability.
      11 Ability to display English language messages of up to 40 characters.
      12 Multiple levels of alarm priority.
      13 Modular construction for easier maintenance.

2.3 CPU

a. CPU shall be a computer which is UL listed for fire alarm use. Memory system shall be adequately sized to provide display, printout and control of at least 150 percent of the points specified, including basic alarm and control software. CPU shall be completely field programmable. All data entered shall reside in the system.

b. The CPU shall be equipped with a nonvolatile main memory system of EPROM, battery protected RAM, bubble type, or EEPROM. The mass storage media for all English language messages, operators messages and associated data files shall be fully encapsulated disk media. The mass storage media shall be equipped with all necessary control hardware.

c. The data transmission system to the base alarm system shall be compatible with the Monaco Transmitter.

2.4 POWER SUPPLIES

a. Primary operating power for the FACP shall be 120 volt AC., 1 ph, 60 Hz.

b. Fire alarm system shall operate on 24 volt DC power provided by transformer and rectifier.

c. Power supply shall be sufficient to operate audible circuits, initiating circuits, and auxiliary circuits simultaneously.

d. Emergency power for the FACP shall be provided by sealed maintenance-free batteries and charges. They shall require no additional water. Batteries shall have capacity to operate for 24 hours in a standby condition and thereafter operate alarm and audible circuits for 5 minutes. Batteries shall be sized to provide 20 percent more capacity than calculations indicate is required. Batteries shall be installed in a separate enclosure or within a separate compartment of the FACP.

e. Battery charger shall be completely automatic with high\low charging rate, capable of restoring the batteries from discharge to full voltage in 24 hours. Charger shall visually indicate that high charge rate is operating. Charger shall be in the same location as the batteries.

2.5 SYSTEM OPERATING TERMINAL

The Operating Terminal shall include, at a minimum, control function keys, digital display window programming keys, key operated lock-out capability, and permanent time display. The operating terminal shall allow the operator (with proper password) to perform the following tasks:

A. Inquire point status
B. Start or stop equipment
C. Test and reset equipment
D. Bypass control points during manual system tests
E. Initiate control by event sequences
F. Manually request "logs" of system status
G. Acknowledge status changes
H. Silence audible signals

2.6 MCE SOFTWARE

Provide all executive system software to include, but not be limited, to the following:

A. Basic alarm processing programs
B. Control by event programs
C. System point scanning routines
D. Password control routines
E. Emergency file display routines

Prepare and install all data files including, but not limited to the following:

A. Point descriptions
B. Control by event sequence
C. Emergency file statements
D. Password installation

2.7 SENSITIVITY ADJUSTER

Provide means for adjusting the sensitivity of any or all analog intelligent detectors in the system. Sensitivity settings shall be within the allowed UL range and shall have at least 3 selections.

2.8 ALARM INITIATING DEVICES

Fire detecting devices shall comply with the applicable requirements of NFPA

72, 90A, UL268, UL268A, and UL 521.

2.8.1 Addressable Analog Smoke Detectors and Duct Detectors

A. Mount detectors as specified. Detector base shall have terminals for making connections. No solder connections will be allowed.

B. Detectors shall be photoelectric. Detectors shall contain a visible indicator lamp that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in-type in which the detector base contains terminals for making all wiring connections. Detector shall send data to the panel representing analog level of smoke density.

C. Operation of smoke detectors shall not be affected by RF interference or other exterior signals.

2.8.2 Addressable Manual Fire Alarm Stations

A. Manual fire alarm stations shall conform to the applicable requirements of UL38. Install stations on surface or semi flush-mounted outlet boxes. Stations shall be double action type. Stations shall be finished in a color to match surrounding finishes (see section 09915 for paint finishes), with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable; however, stations employing glass rods are acceptable. The use of a key or wrench shall be required to reset the station. Gravity or mercury switches are not acceptable. Stations shall have a separate screw terminal for each conductor. Surface mounted boxes shall be painted the same color as the fire alarm manual stations.

B. Provide manual fire alarm stations with address setting means and an internal identifying code used to identify the type of device.

2.8.3 Addressable Duct Smoke Detectors

Detectors shall have a duct housing, mounted exterior to the duct, with perforated sampling tubes. Detectors shall be rated for the air velocity to be expected. Detectors shall be mounted in readily accessible locations. The switches shall be provided with address setting means using rotary decimal switches and an internal identifying code to identify the type of device.

Duct smoke detectors shall be installed where they are accessible. Detectors which are not readily visible shall have remote led indicators.

Detectors shall be photoelectric. Detectors shall contain a visible indicator lamp that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in-type in which the detector base contains terminals for making all wiring connections. Detector shall send data to the panel representing analog level of smoke density.

2.9 NOTIFICATION APPLIANCES

Audible signal devices shall be heavy duty and conform to the applicable requirements of UL464.

2.9.1 Alarm Horns

Horns shall be surface mounted, with the matching mounting back box recessed double projector, grill and vibrating type suitable for use in an electrically supervised circuit. Horns shall produce a minimum sound rating of at least 85 dBA at \^3.048 m (10 feet). ^\ \~10 feet.~\ Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grills.

2.9.2 Chimes

Chimes shall be electrically operated, supervised, single stroke, heavy-duty type with tempered tone bar and resonator to sound fire alarm code signals. Chimes shall have a minimum sound rating of 85 dBA at \^3.048 m (10 feet).^\

2.9.3 Visual Notification Appliances

Visual notification appliances shall have high intensity optic lens and flash tubes. Strobes shall flash at approximately 1 flash per second and a minimum of 15 candela (8,000 peak candle power). Strobe shall be surface mounted.

2.9.4 Combination Audible/Visual Notification Appliances

Combination audible/visual notification appliances shall provide the same requirements as individual units except they shall mount as a unit in standard backboxes. All units shall be factory assembled. Any other audible indicating appliance employed in the fire alarm systems shall be approved by the authority having jurisdiction.

2.10 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

2.10.1 Conduit

All conduit, junction boxes and fittings shall conform to the following:

A. Conduit shall be ½ inch minimum and be EMT, except other types are required by NFPA 70.

B. Conduit exposed to weather shall be rigid steel or seal-tight, as required by NFPA 70.

C. All EMT conduit fittings shall be compression type.

D. All rigid conduit fittings shall be threaded with plastic inserts.

E. Junctions boxes shall be installed in accordance with NFPA 70 and shall be painted red.

F. Sectional boxes shall not be used.

G. Boxes exposed to weather, moisture, adjacent to water or steam connections, or at sprinkler water flow switches and tamper switches, shall be of the threaded hub type with gasketed weatherproof covers.

2.10.2 Wiring

A. Wiring for strobe light circuits shall be shielded No. 14 AWG minimum. Wiring for low voltage DC circuits shall be No. 16 AWG minimum. Power

wiring and control wiring shall be isolated. All wiring shall conform to NFPA 70. All conductors shall be color coded. Two different color codes shall be used for each alarm circuit; one for each loop. Wiring code color shall remain uniform throughout the circuit. Pigtail connections to alarm initiating and alarm indicating circuits are unacceptable. Wiring not installed in conduit shall be plenum rated fire alarm wiring.

B. Wiring for initiating circuits shall be tee-tapped at each floor so that maintenance on one floor does not require taking other floors out of service.

C. Initiating circuits shall be arranged so that each circuit has spare capacity sufficient to add 20 percent of the total number of devices to that circuit.

2.10.3 Special Tools and Spare Parts

Special tools necessary for the maintenance of the equipment shall be furnished. Two spare sets of fuses of each type and size required and five spare lamps and LED's of each type shall be furnished. Two percent of the total number of each detector, but no less than two each, shall be furnished.

PART 3 - EXECUTION

3.1 INSTALLATION

Install all work in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified.

3.1.1 Power Supply for System

Wiring for the fire alarm system shall be installed in conduit in all areas with no ceilings or dry wall ceilings. Plenum rated fire alarm wiring shall be used in all areas with lay in or spline ceilings. All conduit and plenum rated fire alarm wiring shall be installed tight to structure. The wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems.

A single dedicated circuit connection for supplying power to each building fire alarm system shall be provided. The primary power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked “FIRE ALARM CIRCUIT CONTROL”.

No more than one conductor shall be installed under any screw terminal. All circuit conductors entering or leaving any mounting box, outlet box enclosure or cabinet shall be connected to terminals with each terminal marked in accordance with the wiring diagram for identification. Connections shall be made with either crimp-on terminal spade lugs or with approved pressure type terminal blocks. All wiring within any control equipment shall be readily accessible without removing any component parts.

The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.

Wiring for the indicating circuits shall be Style Z as defined by NFPA 72.

Wiring for the initiating circuits shall be Style B as defined by NFPA 72.

3.1.3 Control Panel

Mount the control panel and its assorted components so that no part of the enclosing cabinet is less than 12 inches above the finished floor no more than 78 inches above the finished floor. All manually operable controls shall be at lest three feet and less than five feet above the finished floor. Install panel to comply with the requirements of UL864.

3.1.4 Detectors

Install detectors in accordance with NFPA 72. Locate detectors at least 12 inches from any part of any lighting fixture and at least three feet from diffusers of air handling systems. Provide each detector with appropriate mounting hardware as required by its mounting location. Detectors which mount in free space shall be mounted directly to the end of the stubbed down conduit drop. Secure conduit drops to minimize detector sway.

3.1.5 Notification Appliances

Mount signaling devices a minimum of 80 inches above the finished floor unless limited by ceiling height or otherwise indicated. Install devices in accordance with the ADA Guidelines and NFPA 72.

3.2 OVERVOLTAGE AND SURGE PROTECTION

All equipment connected to alternating current circuits shall be protected from surges per \-IEEE C62.41-\ and \-NFPA 70-\. All cables and conductors which serve as communications links, except fiber optics, shall have surge protection circuits installed at each end. Fuses shall not be used for surge protection.

3.3 GROUNDING

Grounding shall be provided to building ground. Maximum impedance to ground shall be 25 ohms.

3.4 ADDITIONAL FUNCTIONS

Connect the following items to the fire alarm systems:

1. Wiring from existing Monaco Transmitter to FACP.

2. Wiring from duct smoke detectors to air handling unit shutdown controls.

3.5 TRAINING

Conduct one four hour training course with the Owner's operating staff. The training period shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the operating and maintenance instructions.

3.6 TESTING

The Contractor shall notify the Owner 30 days before the performance tests are to be conducted. The tests shall be performed in the presence of the Owner and Engineer. The Contractor shall furnish all instruments and personnel required for the tests.

3.6.1 Preliminary Tests

Upon completion of the installation, the system shall be subjected to functional and operational performance tests including tests of each installed alarm initiating and signaling device. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional

3.6.2 Acceptance Test

The testing shall be in accordance with NFPA 72 and shall verify that all previous deficiencies have been corrected. The test shall include the following:

A. Ground fault, short circuit fault, stray voltage and loop resistance.
B. Test of each function of the FACP.
C. Test of each circuit in trouble and normal modes.
D. Test of alarm initiating devices in both normal and trouble conditions.
E. Tests of each control circuit and device.
F. Tests of each alarm indicating device.
G. Tests of the battery charger and batteries.
H. Complete operational tests under emergency power.
I. Visual inspection of all wiring.
J. Opening the circuit at each alarm initiating and indicating device to test the supervision.
K. Sound and visual tests throughout the building.

BLOOD DONOR CENTER
FIRE ALARM MATRIX

Device	Activate Visual Devices	Activate Audible Devices	Send Signal to FACP	Send Signal to Reporting System	Shut Down Corresponding AHU
Area Smoke Detector	X	X	X	X	
Manual Pull Station	X	X	X	X	
Duct Detector	X	X	X	X	X
Waterflow Switch	X	X	X	X	
Elevator Machine Room Heat Detector	X	X	X	X	
Tamper Switch			X	X	

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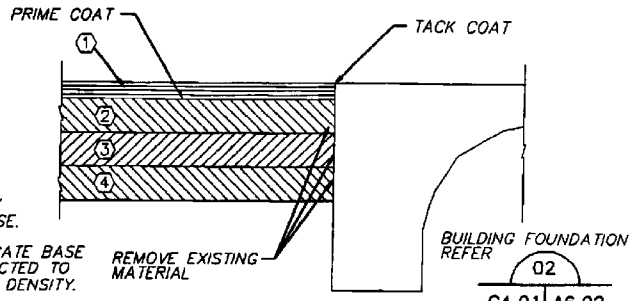

1. 40mm HOT-MIX SURFACE COURSE.
2. 150mm AGGREGATE BASE COURSE COMPACTED TO 100% MAX. LAB DENSITY.
3. 180mm LIME-STABILIZED SUBGRADE COMPACTED TO 95% MAX. LAB DENSITY.
4. 150mm RAW SUBGRADE COMPACTED TO 90% MAX. LAB DENSITY.

A' 9 **JUNCTURE OF NEW FLEXIBLE AND RIGID SERVICE DRIVE**

A6.02 | C4.01

NOT TO SCALE

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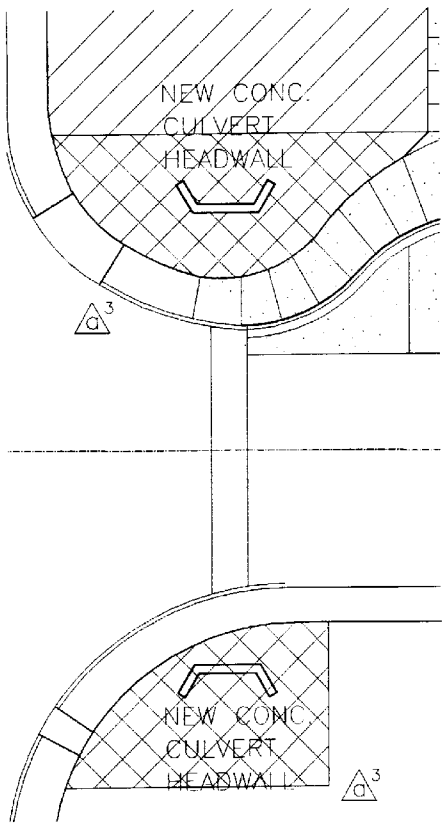
DATE
MAY 1998

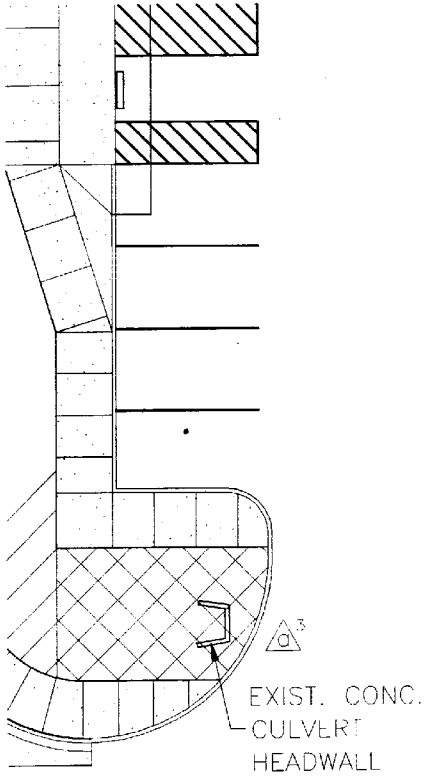
BLOOD DONOR CENTER
SAN ANTONIO, TEXAS

ATTACHMENT 001

AMENDMENT 003



@ LADD AND KENLEY



@ LADD AND PARKING

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MAY 1998

BLOOD DONOR CENTER
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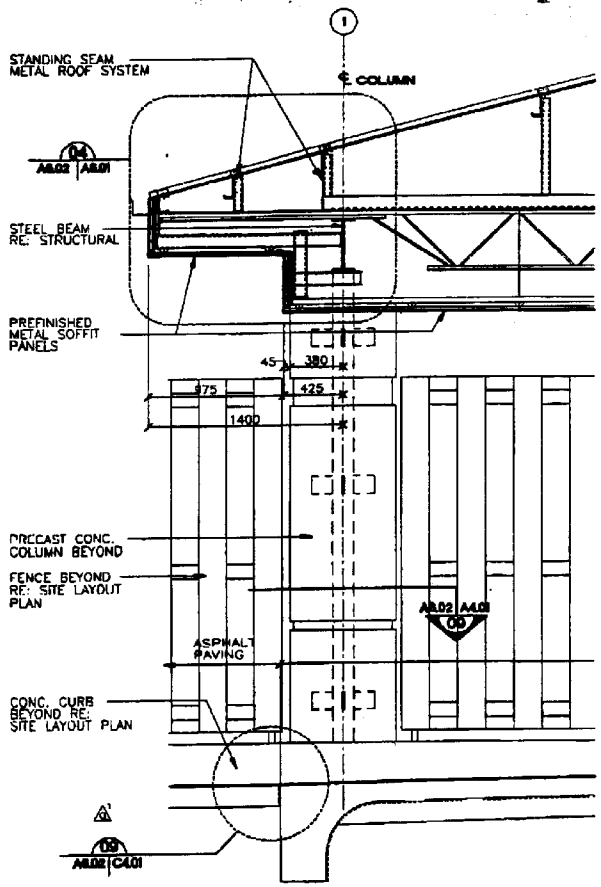
ATTACHMENT 002

AMENDMENT 003



02 WALL SECTION

A1.01 | A8.02 120
A1.02
A5.02
A9.02

WINGLER AND SHARP ARCHITECTS AND PLANNERS INC 1717 10TH STREET WICHITA FALLS TEXAS T: 940-322-3181 F: 940-322-3368 E: wa@winglerandsharp.com	DATE MAY 1998	BLOOD DONOR CENTER SAN ANTONIO, TEXAS ATTACHMENT 003 AMENDMENT 003