AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE OF PAGES
J	1 of 3

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO.(If applicable)
0002	14-Feb-2003	W68MD9-2309-1321	

6. ISSUED BY	CODE	7. ADMINISTERED BY (If other than item 6)	CODE
USA ENGINEER DISTRICT, SEATTLE ATTN: CENWS-CT P.O. BOX 3755 SEATTLE WA 98124-3755	DACA67	**See Item 6**	

8. NAME AND ADDRESS OF CONTRACTOR (No., Street, County, State and Zip Code)		
	X	9A. AMENDMENT OF SOLICITATION NO. DACA67-03-R-0205
	X	9B. DATED (SEE ITEM 11) 14-Jan-2003
		10A. MOD. OF CONTRACT/ORDER NO.
		10B. DATED (SEE ITEM 13)
CODE / FACILITY CODE		

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 Offer [X] is extended, [ ] is not extended.

Offer 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 _____ 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.)

Change closing date and update/correct drawings and specifications.

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) TEL: EMAIL:	
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 14-Feb-2003

SECTION SF 30 BLOCK 14 CONTINUATION PAGE

The following items are applicable to this modification:

CONT. SHEET

A. This amendment is issued to provide the following revisions to this solicitation:

1. Revisions to the Bid Schedule.

2. Revisions to Drawings (E101, E103, E104, E106, E607, E609, E611 and E302) by Notation see Special Clauses, Section 00800, pages 43 & 44.

3. Revisions to Drawings

   a. Volume 1 Sheets C128, C505A, C505B, C505C, C505D, C505E, C505F, G101, G102, and L501

   b. Volume 2, drawing Sheets S004, S101, S107, S113, S119, S125, S131, T603 and T606

   c. Volume 3 Sheet G001

   d. Volume 4, Sheets G001 and S101.

4. Revisions to technical specifications Sections 01451, 02726 and 15895.

B. The time and due date for submission of the technical and price proposal **is changed** to: 2:00 PM (PST), **25 February 2003**.

C. Offerors must acknowledge receipt of this amendment by number and date on Standard Form 1442 BACK, in block 19, or by telegram.

Enclosures:
Revisions to Bid Schedule
Revisions to Drawings, Volume 1
Sheet C128,
Sheet C505A,
Sheet C505B,
Sheet C505C,
Sheet C505D,
Sheet C505E,
Sheet C505F,
Sheet G101,
Sheet G102
Sheet L501
Revisions to Drawings, Volume 2
Sheet S004,

Sheet S101,
Sheet S107,
Sheet S113,
Sheet S119,
Sheet S125,
Sheet S131,
Sheet T603
Sheet T606
Revisions to Drawings, Volume 3
Sheet G001
Revisions to Drawings, Volume 4
Sheet G001
Sheet S101
Section 00800 Special Clauses
Section 01451, Contractor Quality Control
Section 02726, Portland Cement Pervious Pavement
Section 15895, Air Supply, Distribution, Ventilation, and Exhaust System

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SCHEDULE

Item No.	Description of Item	Quantity	Unit	Unit Price	Amount
0001	All Work for FY 03 Whole Barracks Renewal, Except for Items 0002 through 0015	1	JOB	L.S.	$_____
0002	All Work for Two Barrack A Buildings	1	JOB	L.S.	$_____
0003	All Work for Two Barrack B Buildings	1	JOB	L.S.	$_____
0004	All Work for Two Barrack C Buildings	1	JOB	L.S.	$_____
0005	All Work for Two Soldier Community Buildings	1	JOB	L.S.	$_____
0006	All Work for the Large Battalion Headquarters Building	1	JOB	L.S.	$_____
0007	All Work for Two Medium Company Operations Buildings	1	JOB	L.S.	$_____
0008	All Work for Five Lawnmower Storage Buildings	1	JOB	L.S.	$_____
0009	All Landscape and Irrigation Work for Echo Block, Except for Item 0011	1	JOB	L.S.	$_____
0010	All Landscape Work for 41st Division Drive and Related Areas, Except for Items 0011 and 0012	1	JOB	L.S.	$_____
0011	All Work for Removal and Offsite Disposal of Scot's (Scotch) Broom (Cytisus scoparius) at 41st Division Drive Project				
0011AA	First 15,600 Square Meters	15,600	M^2	$____	$_____
0011AB	All Over 15,600 Square Meters	2,000	M^2	$____	$_____
0012	All Work to Provide Landscape Maintenance and Irrigation Maintenance for One-Year Plant Establishment Period (see Specification 02935).	1	JOB	L.S.	$_____
0013	All Work for As-Built Drawings as Specified in Section 01702 from Preparation to Final Approval	1	JOB	L.S.	$30,000.00
0014	All Work for O&M Manuals as Specified in	1	JOB	L.S.	$75,000.00

Item No.	Description of Item	Quantity	Unit	Unit Price	Amount
	Section 01701 from Peparation to Final Approval				
0015	All Work for Form 1354 Checklist and Equipment in Place List as Specified in Sections 01704 and 01705 from Preparation to Final Approval	1	JOB	L.S.	$15,000.00
				TOTAL	$_____

NOTE: The dollar amounts established in Items No. 0013, 0014, and 0015 shall not be revised by bidders.

TABLE OF CONTENTS

SPECIAL CLAUSES

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SPECIAL CLAUSES

SC-1. COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK (APR 1984) (FAR 52.211-10).

The Contractor shall be required to (a) commence work under this Contract within 10 calendar days after the date the Contractor receives the notice to proceed, (b) prosecute the work diligently, and (c) complete the entire work ready for use not later than 720 calendar days after date of receipt by Contractor of notice to proceed. The time stated for completion shall include final cleanup of the premises.

SC-1.1 DELETED

SC-1.2 Exception to Completion Period(s): In case the Contracting Officer determines that completion of seeding, sodding, and planting, and establishment of same is not feasible within the completion period(s) stated above, the Contractor shall accomplish such work in the first planting period following the contract completion period and shall complete such work as specified, unless other planting periods are directed or approved by the Contracting Officer.

SC-2. LIQUIDATED DAMAGES - CONSTRUCTION (APR 1984) (FAR 52.211-12)

(a) If the Contractor fails to complete the work within the time specified in the Contract, or any extension, the Contractor shall pay to the Government as liquidated damages, the sum of $2,830.00 for each day of delay.

(b) If the Government terminates the Contractor's right to proceed, the resulting damage will consist of liquidated damages until such reasonable time as may be required for final completion of the work together with any increased costs occasioned the Government in completing the work.

(c) If the Government does not terminate the Contractor's right to proceed, the resulting damage will consist of liquidated damages until the work is completed or accepted.

(d) Exception to Liquidated Damage: In case the Contracting Officer determines that completion of work stated above in paragraph Exception to Completion Period(s) is not feasible during the completion period(s) stated in SC-1, such work will be exempted from liquidated damages.

SC-3 DELETED.

SC-4. VARIATIONS IN ESTIMATED QUANTITIES - SUBDIVIDED ITEMS (MAR 1995) (EFARS 52.211-5001): This variation in estimated quantities clause is applicable only to Item No. 0011.

(a) Variation from the estimated quantity in the actual work performed under any second or subsequent sub-item or elimination of all work under such a second or subsequent sub-item will not be the basis for an adjustment in contract unit price.

(b) Where the actual quantity of work performed for Items No. 0011 is less than 85 ? of the quantity of the first sub-item listed under such item, the Contractor will be paid at the contract unit price for that sub-item for the actual quantity of work performed and, in addition, an equitable adjustment shall be made in accordance with the clause FAR 52.211-18, Variation in Estimated Quantities.

(c) If the actual quantity of work performed under Items No. 0011 exceeds 115 percent or is less than 85 percent of the total estimated quantity of the sub-item under that item and/or if the quantity of the work performed under the second sub-item or any subsequent sub-item under Items No. 0011 exceeds 115 ? or is less than 85 ? of the estimated quantity of any such sub-item, and if such variation causes an increase or a decrease in the time required for performance of this contract the contract completion time will be adjusted in accordance with the clause FAR 52.211-18, Variation in Estimated Quantities.

SC-5. INSURANCE - WORK ON A GOVERNMENT INSTALLATION (SEP 1989) (FAR 52.228-5)

(a) The Contractor shall, at its own expense, provide and maintain during the entire performance period of this Contract at least the kinds and minimum amounts of insurance required in the Insurance Liability Schedule or elsewhere in the Contract.

(b) Before commencing work under this Contract, the Contractor shall certify to the Contracting Officer in writing that the required insurance has been obtained. The policies evidencing required insurance shall contain an endorsement to the effect that any cancellation or any material change adversely affecting the Government's interest shall not be effective:

(1) for such period as the laws of the State in which this Contract is to be performed prescribe; or

(2) until 30 days after the insurer or the Contractor gives written notice to the Contracting Officer, whichever period is longer.

(c) The Contractor shall insert the substance of this clause, including this paragraph (c), in subcontracts under this Contract that require work on a Government installation and shall require subcontractors to provide and maintain the insurance required in the Schedule or elsewhere in the Contract. The Contractor shall maintain a copy of all subcontractors' proofs of required insurance, and shall make copies available to the Contracting Officer upon request.

(d) Insurance Liability Schedule (FAR 28.307-2)

(1) Workers' compensation and employer's liability. Contractors are required to comply with applicable Federal and State workers' compensation and occupational disease statutes. If occupational diseases are not compensable under those statutes, they shall be covered under the employer's liability section of the insurance policy, except when Contract operations are so commingled with a Contractor's commercial operation that it would not be practical to require this coverage. Employer's liability coverage of at least $100,000 shall be required, except in states with exclusive or monopolistic funds that do not permit workers' compensation to be written by private carriers.

(2) General Liability.

(a) The Contracting Officer shall require bodily injury liability insurance coverage written on the comprehensive form of policy of at least $500,000 per occurrence.

(b) Property damage liability insurance shall be required only in special circumstances as determined by the agency.

(3) Automobile liability. The Contracting Officer shall require automobile liability insurance written on the comprehensive form of policy. The policy shall provide for bodily injury and property damage liability covering the operation of all automobiles used in connection with performing the Contract. Policies covering automobiles operated in the United States shall provide coverage of at least $200,000 per person and $500,000 per occurrence for bodily injury and $20,000 per occurrence for property damage. The amount of liability coverage on other policies shall be commensurate with any legal requirements of the locality and sufficient to meet normal and customary claims.

(4) Aircraft public and passenger liability. When aircraft are used in connection with performing the Contract, the Contracting Officer shall require aircraft public and passenger liability insurance. Coverage shall be at least $200,000 per person and $500,000 per occurrence for bodily injury, other than passenger liability, and $200,000 per occurrence for property damage. Coverage for passenger liability bodily injury shall be at least $200,000 multiplied by the number of seats or passengers, whichever is greater.

(5) Environmental Liability If this contract includes the transport, treatment, storage, or disposal of hazardous material waste the following coverage is required.

The Contractor shall ensure the transporter and disposal facility have liability insurance if effect for claims arising out of the death or bodily injury and property damage from hazardous material/waste transport, treatment, storage and disposal, including vehicle liability and legal defense costs in the amount of $1,000,000.00 as evidenced by a certificate of insurance for General, Automobile, and Environmental Liability Coverage. Proof of this insurance shall be provided to the Contracting Officer.

SC-6 DELETED.

SC-7. PERFORMANCE OF WORK BY THE CONTRACTOR (APR 1984) (FAR 52.236-1): The Contractor shall perform on the site, and with its own organization, work equivalent to at least fifteen percent (15%) of the total amount of work to be performed under the Contract. The percentage may be reduced by a supplemental agreement to this Contract if, during performing the work, the Contractor requests a reduction and the Contracting Officer determines that the reduction would be to the advantage of the Government.

SC-8. PHYSICAL DATA (APR 1984) (FAR 52.236-4): Data and information furnished or referred to below is for the Contractor's information. The Government will not be responsible for any interpretation of or conclusion drawn from the data or information by the Contractor.

(a) Physical Conditions: The indications of physical conditions on the drawings and in the specifications are the result of site investigations by test holes shown on the drawings.

(b) Weather Conditions: Each bidder shall be satisfied before submitting his bid as to the hazards likely to arise from weather conditions. Complete weather records and reports may be obtained from any National Weather Service Office.

(c) Transportation Facilities: Each bidder, before submitting his bid, shall make an investigation of the conditions of existing public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress at the jobsite. The unavailability of transportation facilities or limitations thereon shall not become a basis for claims for damages or extension of time for completion of the work.

SC-9 DELETED.

SC-10. LAYOUT OF WORK (APR 1984) (FAR 52.236-17): The Contractor shall lay out its work from Government-established base lines and bench marks indicated on the drawings, and shall be responsible for all measurements in connection with the layout. The Contractor shall furnish, at its own expense, all stakes, templates, platforms, equipment, tools, materials, and labor required to lay out any part of the work. The Contractor shall be responsible for executing the work to the lines and grades that may be established or indicated by the Contracting Officer. The Contractor shall also be responsible for maintaining and preserving all stakes and other marks established by the Contracting Officer until authorized to remove them. If such marks are destroyed by the Contractor or through its negligence before their removal is authorized, the Contracting Officer may replace them and deduct the expense of the replacement from any amounts due, or to become due, to the Contractor.

SC-11 THROUGH SC-12 DELETED.

SC-13. IDENTIFICATION OF GOVERNMENT-FURNISHED PROPERTY (APR 1984) (FAR 52.245-3): The Government will furnish to the Contractor the property identified in the schedule to be incorporated or installed into the work or used in performing the contract. The listed property will be furnished to the Contractor at the place designated by the Contracting Officer. The Contractor is required to accept delivery, pay any demurrage or detention charges, and unload and transport the property to the jobsite at its own expense. When the property is delivered, the Contractor shall verify its quantity and condition and acknowledge receipt in writing to the Contracting Officer. The Contractor shall also report in writing to the Contracting Officer within 24 hours of delivery any damage to or shortage of the property as received. All such property shall be installed or incorporated into the work at the expense of the Contractor, unless otherwise indicated in this contract.

For purposes of calculating the amount of Washington State Use Tax to be included in his bid; the Contractor shall use an estimated value of $43,500.00 for Government-furnished Contractor-installed (GF/CI) equipment/property. Ultimately the actual cost of equipment furnished will be used to adjust the final contract amount by modification to reflect the user tax excluding Contractor markups, actually paid by the Contractor for GF/CI equipment schedule.

SCHEDULE

QUANTITY	ITEM	DESCRIPTION	EST. VALUE (TOTAL)
24	Washing Machines		$24, 000
5	Heavy Duty Washing Machines		$7,500
24	Clothes Dryers		$12,000

SC-14. EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE (MAR 1995)-(EFARS 52.231-5000)

(a) This clause does not apply to terminations. See 52.249-5000, Basis for Settlement of Proposals and FAR Part 49.

(b) Allowable cost for construction and marine plant and equipment in sound workable condition owned or controlled and furnished by a contractor or subcontractor at any tier shall be based on actual cost data for each piece of equipment or groups of similar serial and series for which the Government can determine both ownership and operating costs from the contractor's accounting records. When both ownership and operating costs cannot be determined for any piece of equipment or groups of similar serial or series equipment from the contractor's accounting records, costs for that equipment shall be based upon the applicable provisions of EP 1110-1-8, Construction Equipment Ownership and Operating Expense Schedule, Region VIII. Working conditions shall be considered to be average for determining equipment rates using the schedule unless specified otherwise by the contracting officer. For equipment not included in the schedule, rates for comparable pieces of equipment may be used or a rate may be developed using the formula provided in the schedule. For forward pricing, the schedule in effect at the time of negotiations shall apply. For retroactive pricing, the schedule in effect at the time the work was performed shall apply.

(c) Equipment rental costs are allowable, subject to the provisions of FAR 31.105(d)(ii) and FAR 31.205-36. Rates for equipment rented from an organization under common control, lease-purchase arrangements, and sale-leaseback arrangements, will be determined using the schedule, except that actual rates will be used for equipment leased from an organization under common control that has an established practice of leasing the same or similar equipment to unaffiliated lessees.

(d) When actual equipment costs are proposed and the total amount of the pricing action exceeds the small purchase threshold, the contracting officer shall request the contractor to submit either certified cost or pricing data, or partial/limited data, as appropriate. The data shall be submitted on Standard Form 1411, Contract Pricing Proposal Cover Sheet.

(e) Copies of EP1110-1-8 “Construction Equipment Ownership and Operating Expense Schedule” Volumes 1 through 12 are available in Portable Document Format (PDF) and can be viewed or downloaded at http://www.usace.army.mil/inet/usace-docs/eng-pamplets/cecw.htm. A CD-ROM containing (Volumes 1-12) is available through either the Superintendent of

Documents or Government bookstores. For additional information telephone 202-512-2250, or access on the Internet at http://www.access.gpo.gov/su_docs.

SC-15. PAYMENT FOR MATERIALS DELIVERED OFF-SITE (MAR 1995)-(EFARS 52.232-5000)

(a) Pursuant to FAR clause 52.232-5, Payments Under Fixed Priced Construction Contracts, materials delivered to the contractor at locations other than the site of the work may be taken into consideration in making payments if included in payment estimates and if all the conditions of the General Provisions are fulfilled. Payment for items delivered to locations other than the work site will be limited to: (1) materials required by the technical provisions; or (2) materials that have been fabricated to the point where they are identifiable to an item of work required under this contract.

(b) Such payment will be made only after receipt of paid or receipted invoices or invoices with canceled check showing title to the items in the prime contractor and including the value of material and labor incorporated into the item. In addition to petroleum products, payment for materials delivered off-site is limited to the following items: Any other construction material stored offsite may be considered in determining the amount of a progress payment.

SC-16 AND SC-17 DELETED.

SC-18. CONTRACT DRAWINGS, MAPS, AND SPECIFICATIONS (OCT 1996) (52.0236-4001 EBS)

(a) The Government--

(1) Will provide the Contractor, without charge, one set of contract drawings and one set of specifications in electronic format on a compact disk. The Government will not give the Contractor any hard copy paper drawings or specifications for any contract resulting from this solicitation.

(b) The Contractor shall--

(1) check all drawings furnished immediately upon receipt;

(2) Compare all drawings and verify the figures before laying out the work;

(3) Promptly notify the Contracting Officer of any discrepancies; and

(4) Be responsible for any errors which might have been avoided by complying with this paragraph (b).

(c) Large scale drawings shall, in general, govern small scale drawings. Figures marked on drawings shall, in general, be followed in preference to scale measurements.

(d) Omissions from the drawings or specifications or the misdescription of details of work which are manifestly necessary to carry out the intent of the drawings and specifications, or which are customarily performed, shall not relieve the Contractor from performing such

omitted or misdescribed details of the work, but shall be performed as if fully and correctly set forth and described in the drawings and specifications.

(e) The work shall conform to the specifications and the contract drawings identified in the index of drawings attached at the end of the Special Clauses.

SC-19 THROUGH SC-21 DELETED.

SC-22. EPA ENERGY STAR: The Government requires that certain equipment be Energy Star compliant. Initially, the sole Energy Star requirement shall be the self certification by the bidder that the specified equipment is Energy Star compliant. Within 3 months of the availability of an EPA sanctioned test for Energy Star compliance, the Contractor shall submit all equipment upgrades and additions for testing and provide proof of compliance to the Government upon completion of testing. Testing shall be at the Contractor's expense.

SC-23. RECOVERED MATERIALS: The Corps of Engineers encourages all bidders to utilize recovered materials to the maximum extent practicable. The attached APPENDIX R contains procurement guidelines for products containing recovered materials.

APPENDIX R

PART 247 - COMPREHENSIVE PROCUREMENT GUIDELINE FOR PRODUCTS CONTAINING RECOVERED MATERIALS

40 CFR Ch. 1 (9-1-99 Edition)

Subpart B-Item Designations

§ 247.10 Paper and paper products.

Paper and paper products, excluding building and construction paper grades.

§ 247.11 Vehicular products.

(a) Lubricating oils containing re-refined oil, including engine lubricating oils, hydraulic fluids, and gear oils, excluding marine and aviation oils.
(b) Tires, excluding airplane tire
(e) Reclaimed engine coolants, excluding coolants used in non-vehicular applications.

247.12 Construction products.

(a) Building insulation product including the following items:
(1) Loose-fill insulation, including but not limited to cellulose fiber, mineral fibers (fiberglass and rock vermiculite, and perlite;
(2) Blanket and batt insulation, including but not limited to mineral fibers (fiberglass and rock wool).
(3) Board (sheathing, roof decking wall panel) insulation, including but not limited to structural fiberboard and laminated paperboard products perlite composite board, polyurethane, polyisocyanurate, polystyrene, phenolics, and composites; and
(4) Spray-in-place insulation, including but not limited to foam-in-place polyurethane and polyisocyanurate and spray-on cellulose.
(b) Structural fiberboard and laminated paperboard products for applications other than building insulation, including building board, sheathing shingle backer, sound deadening board, roof insulating board, insulating wallboard, acoustical and non-acoustical ceiling tile, acoustical and non-acoustical lay-in panels, floor underlayments, and roof overlay (cover board).
(c) Cement and concrete, including concrete products such as pipe and block, containing coal fly as ground granulated blast furnace (GGBF) slag.
(d) Carpet made of polyester fiber use in low- and medium-wear applications.
(e) Floor tiles and patio block containing recovered rubber or plastic.
(f) Shower and restroom dividers/partitions containing recovered plastic or steel.
(g) (1) Consolidated latex paint used for covering graffiti; and
(2) Reprocessed latex paint used for interior and exterior architectural applications such as wallboard, ceilings, and trim; gutter boards; and concrete, stucco, masonry, wood and metal surfaces.

§247.13 Transportation products.

(a) Traffic barricades and traffic cones used in controlling or restricting vehicular traffic.

(b) Parking stops made from concrete or containing recovered plastic or rubber.
(c) Channelizers containing recovered plastic or rubber.
(d) Delineators containing recovered plastic, rubber, or steel.
(e) Flexible delineators containing recovered plastic.

§ 247.14 Park and recreation products

(a) Playground surfaces and running tracks containing recovered rubber or plastic.
(b) Plastic fencing containing recovered plastic for use in controlling snow or sand drifting and as a warning/safety barrier in construction or other applications.

247.15 Landscaping products.

(a) Hydraulic mulch products containing recovered paper or recovered wood used for hydroseeding and as an over-spray for straw mulch in landscaping, erosion control, and soil reclamation.
(b) Compost made from yard trimmings, leaves, and/or grass clippings for use in landscaping, seeding of grass or other plants on roadsides and embankments, as a nutritious mulch under trees and shrubs, and in erosion control and soil reclamation.
(c) Garden and soaker hoses containing recovered plastic or rubber.
(d) Lawn and garden edging containing recovered plastic or rubber.

§ 247.16 Non-paper office product.

(a) Office recycling containers and office waste receptacles.
(b) Plastic desktop accessories.
(c) Toner cartridges.
(d) Binders.
(e) Plastic trash bags.
(f) Printer ribbons.
(g) Plastic envelopes.

§ 247.17 Miscellaneous products.

Pallets containing recovered wood, plastic, or paperboard.

INDEX OF DRAWINGS

FY 03 WHOLE BARRACKS RENEWAL
FORT LEWIS, WASHINGTON
PN 41884
22s/721-12-14

NOTE: Some drawing sheets in this solicitation may be half size. A correct, full size sheet is 841 x 594 mm. Scale accordingly.

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
		VOLUME 1 – SITE AND UTILITIES 41ST DIVISION DRIVE LANDSCAPING		
		General		
1	G101	Title and Area Maps	A	14FEB03
2	G102	Drawing Index	A	14FEB03
		Geotechnical		
3	B001	Exploration Logs		03JAN03
4	B002	Exploration Logs		03JAN03
5	B003	Exploration Logs		03JAN03
6	B004	Exploration Logs		03JAN03
7	B005	Exploration Logs		03JAN03
8	B006	Exploration Logs		03JAN03
9	B007	Exploration Logs		03JAN03
10	B008	Exploration Logs		03JAN03
11	B101	Location Of Explorations Plan I		03JAN03
12	B102	Location Of Explorations Plan 2		03JAN03
13	B103	Location Of Explorations Plan 3		03JAN03
14	B104	Locations Of Explorations Plan 4		03JAN03
15	B105	Locations Of Explorations Plan 5		03JAN03
16	B106	Locations Of Explorations Plan 6		03JAN03
17	B107	Locations Of Explorations Plan 7		03JAN03
18	B108	Locations Of Explorations Plan 8		03JAN03
19	B109	Locations Of Explorations Plan 9		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
20	B110	Locations Of Explorations Plan 10		03JAN03
21	B111	Locations Of Explorations Plan 11	A	6 FEB 03
22	B112	Locations Of Explorations Plan 12		03JAN03
		Civil		
23	C001	Legend And Abbreviations		03JAN03
24	C002	General Site Plan		03JAN03
25	C101	Site Plan 1		03JAN03
26	C102	Site Plan 2		03JAN03
27	C103	Site Plan 3		03JAN03
28	C104	Site Plan 4		03JAN03
29	C105	Site Plan 5		03JAN03
30	C106	Site Plan 6		03JAN03
31	C107	Site Plan 7		03JAN03
32	C108	Site Plan 8		03JAN03
33	C109	Site Plan 9		03JAN03
34	C110	Site Plan 10		03JAN03
35	C111	Site Plan 11		03JAN03
36	C112	Site Plan 12		03JAN03
37	C113	Grading And Demolition Plan 1		03JAN03
38	C114	Grading And Demolition Plan 2		03JAN03
39	C115	Grading And Demolition Plan 3		03JAN03
40	C116	Grading Plan 4		03JAN03
41	C117	Grading And Demolition Plan 5		03JAN03
42	C118	Grading Plan 6		03JAN03
43	C119	Grading And Demolition Plan 7		03JAN03
44	C120	Grading And Demolition Plan 8		03JAN03
45	C121	Grading Plan 9		03JAN03
46	C122	Grading And Demolition Plan 10		03JAN03
47	C123	Grading And Demolition Plan 11		03JAN03
48	C124	Grading Plan 12		03JAN03
49	C125	Utility Plan 1		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
50	C126	Utility Plan 2		03JAN03
51	C127	Utility Plan 3		03JAN03
52	C128	Utility Plan 4		14FEB03
53	C129	Utility Plan 5		03JAN03
54	C130	Utility Plan 6		03JAN03
55	C501	Sections 1		03JAN03
56	C502	Sections 2		03JAN03
57	C503	Sections 3		03JAN03
58	C504	Sections 4		03JAN03
59	C505	Driveable Sidewalk Pavement Section And Joint Details		03JAN03
59A	C505A	Site Plan 7 Joint Layout	A	14FEB03
59B	C505B	Site Plan 8 Joint Layout	A	14FEB03
59C	C505C	Site Plan 9 Joint Layout	A	14FEB03
59D	C505D	Site Plan 10 Joint Layout	A	14FEB03
59E	C505E	Site Plan 11 Joint Layout	A	14FEB03
59F	C505F	Site Plan 12 Joint Layout	A	14FEB03
60	C506	Utility Details 1		03JAN03
61	C507	Utility Details 2		03JAN03
62	C508	Utility Details 3		03JAN03
63	C509	19,000 Liter Oil/Water Separator		03JAN03
64	C510	Miscellaneous Details 1		03JAN03
65	C511	Miscellaneous Details 2		03JAN03
66	C701	Sanitary Sewer Profile 5		03JAN03
67	C702	Sanitary Sewer Profiles 6 And 7		03JAN03
68	C703	Storm Sewer Profiles 12, 13, 14, 15, And 16		03JAN03
69	C704	Storm Sewer Profiles 17 And 18		03JAN03
		Landscape		
70	L001	Legend And General Notes		03JAN03
71	L002	Plant Material List (Summary)		03JAN03
72	L101	Landscape Plan 1		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
73	L102	Landscape Plan 2		03JAN03
74	L103	Landscape Plan 3		03JAN03
75	L104	Landscape Plan 4		03JAN03
76	L105	Landscape Plan 5		03JAN03
77	L106	Landscape Plan 6		03JAN03
78	L501	Landscape Details 1	A	14FEB03
79	L502	Landscape Details 2		03JAN03
80	L503	Landscape Details 3		03JAN03
81	L504	Landscape Details 4		03JAN03
82	L505	Landscape Details 5		03JAN03
83	L506	Landscape Details 6		03JAN03
84	L701	Irrigation Plan 1		03JAN03
85	L702	Irrigation Plan 2		03JAN03
86	L703	Irrigation Plan 3		03JAN03
87	L704	Irrigation Plan 4		03JAN03
88	L705	Irrigation Plan 5		03JAN03
89	L706	Irrigation Plan 6		03JAN03
90	L801	Irrigation Details 1		03JAN03
91	L802	Irrigation Details 2		03JAN03
		41st Division Drive		
92	L901	General Landscape Plan		03JAN03
93	L902	General Landscape Notes, Legend, And Plant List		03JAN03
94	L903	Landscape Plan A		03JAN03
95	L904	Landscape Plan B		03JAN03
96	L905	Landscape Plan C		03JAN03
97	L906	Landscape Plan D		03JAN03
98	L907	Landscape Plan E		03JAN03
99	L908	Landscape Plan F		03JAN03
100	L909	Landscape Plan G		03JAN03
101	L910	Landscape Plan H		03JAN03
102	L911	Landscape Plan I		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
103	L912	Landscape Plan J		03JAN03
104	L913	Landscape Plan K		03JAN03
105	L914	Landscape Plan L		03JAN03
106	L915	Landscape Plan M		03JAN03
107	L916	Landscape Details A		03JAN03
		Mechanical		
108	M101	Natural Gas Plan		03JAN03
		Electrical		
109	E001	Legend And Abbreviations		03JAN03
		Plans		
110	E101	Site Plan 1 Electrical		03JAN03
111	E102	Site Plan 2 Electrical		03JAN03
112	E103	Site Plan 3 Electrical		03JAN03
113	E104	Site Plan 4 Electrical		03JAN03
114	E105	Site Plan 5 Electrical		03JAN03
115	E106	Site Plan 6 Electrical		03JAN03
116	E107	Site Plan 7 Electrical	A	6 FEB 03
117	E108	Site Plan 8 Electrical	A	6 FEB 03
118	E109	Site Plan 9 Electrical	A	6 FEB 03
119	E110	Site Plan 10 Electrical	A	6 FEB 03
120	E111	Site Plan 11 Electrical	A	6 FEB 03
121	E112	Site Plan 12 Electrical	A	6 FEB 03
122	E113	Grounding Plan – Barracks North Site		03JAN03
123	E114	Grounding Plan – Barracks South Site		03JAN03
124	E115	Grounding Plan Medium Company Operations Facility		03JAN03
125	E116	Grounding Plan Large Battalion		03JAN03
		Details		
126	E501	Detail I		03JAN03
127	E502	Detail II		03JAN03
128	E503	Detail III		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
129	E504	Detail IV		03JAN03
130	E505	Detail V		03JAN03
131	E506	Detail VI		03JAN03
132	E507	Detail VII		03JAN03
133	E508	Detail VIII	A	6 FEB 03
		Schedules And Diagrams		
134	E601	Power One-Line Diagram	A	6 FEB 03
135	E602	Site Communication Riser Diagram	A	6 FEB 03
136	E603	Site Lighting Schedule		03JAN03
137	E604	Ductbank Schedule	A	6 FEB 03

Reference Drawings

DRAWING NUMBER	REF. NO.	PLATE NUMBER	TITLE	REVISION NUMBER	Date
22s/721-12-14	1	M101	Natural Gas Line And LPG Standby System Site Plan Layout		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE

VOLUME 2 – BARRACKS AND SOLDIER COMMUNITY BUILDINGS

General

1	G001	Title and Area Maps	03JAN03
2	G002	Drawing Index I	03JAN03
3	G003	Drawing Index II	03JAN03

Architectural

4	A001	Abbreviations and Notes	03JAN03
5	A002	Life Safety Summary	03JAN03
6	A101	Composite First Floor Plan North	03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
7	A102	Composite First Floor Plan South		03JAN03
8	A103	Barrack A (North) First Floor Plan		03JAN03
9	A104	Barrack A (North) Second Floor Plan		03JAN03
10	A105	Barrack A (North) Third Floor Plan		03JAN03
11	A106	Barrack A (North) Attic Plan		03JAN03
12	A107	Barrack A (North) Roof Plan		03JAN03
13	A108	Barrack A (North) Reflected Ceiling Plan First Floor		03JAN03
14	A109	Barrack A (North) Reflected Ceiling Plan Second Floor		03JAN03
15	A110	Barrack A (North) Reflected Ceiling Plan Third Floor		03JAN03
16	A111	Barrack B (North) First Floor Plan		03JAN03
17	A112	Barrack B (North) Second Floor Plan		03JAN03
18	A113	Barrack B (North) Third Floor Plan		03JAN03
19	A114	Barrack B (North) Attic Plan		03JAN03
20	A115	Barrack B (North) Roof Plan		03JAN03
21	A116	Barrack B (North) Reflected Ceiling Plan First Floor		03JAN03
22	A117	Barrack B (North) Reflected Ceiling Plan Second Floor		03JAN03
23	A118	Barrack B (North) Reflected Ceiling Plan Third Floor		03JAN03
24	A119	Barrack C (North) First Floor Plan		03JAN03
25	A120	Barrack C (North) Second Floor Plan		03JAN03
26	A121	Barrack C (North) Third Floor Plan		03JAN03
27	A122	Barrack C (North) Attic Plan		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
28	A123	Barrack C (North) Roof Plan		03JAN03
29	A124	Barrack C (North) Reflected Ceiling Plan First Floor		03JAN03
30	A125	Barrack C (North) Reflected Ceiling Plan		03JAN03
31	A126	Barrack C (North) Reflected Ceiling Plan Third Floor		03JAN03
32	A127	Barrack A (South) First Floor Plan		03JAN03
33	A128	Barrack A (South) Second Floor Plan		03JAN03
34	A129	Barrack A (South) Third Floor Plan		03JAN03
35	A130	Barrack A (South) Attic Plan		03JAN03
36	A131	Barrack A (South) Roof Plan		03JAN03
37	A132	Barrack A (South) Reflected Ceiling Plan First Floor		03JAN03
38	A133	Barrack A (South) Reflected Ceiling Plan Second Floor		03JAN03
39	A134	Barrack A (South) Reflected Ceiling Plan Third Floor		03JAN03
40	A135	Barrack B (South) First Floor Plan		03JAN03
41	A136	Barrack B (South) Second Floor Plan		03JAN03
42	A137	Barrack B (South) Third Floor Plan		03JAN03
43	A138	Barrack B (South) Attic Plan		03JAN03
44	A139	Barrack B (South) Roof Plan		03JAN03
45	A140	Barrack B (South) Reflected Ceiling Plan First Floor		03JAN03
46	A141	Barrack B (South) Reflected Ceiling Plan Second Floor		03JAN03
47	A142	Barrack B (South) Reflected Ceiling Plan Third Floor		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
48	A143	Barrack C (South) First Floor Plan		03JAN03
49	A144	Barrack C (South) Second Floor Plan		03JAN03
50	A145	Barrack C (South) Third Floor Plan		03JAN03
51	A146	Barrack C (South) Attic Plan		03JAN03
52	A147	Barrack C (South) Roof Plan		03JAN03
53	A148	Barrack C (South) Reflected Ceiling Plan First Floor		03JAN03
54	A149	Barrack C (South) Reflected Ceiling Plan Second Floor		03JAN03
55	A150	Barrack C (South) Reflected Ceiling Plan Third Floor		03JAN03
56	A151	SCB (North) Floor Plan		03JAN03
57	A152	SCB (North) Attic Plan		03JAN03
58	A153	SCB (North) Roof Plan		03JAN03
59	A154	SCB (North) Reflected Ceiling Plan		03JAN03
60	A155	SCB (South) Floor Plan		03JAN03
61	A156	SCB (South) Attic Plan		03JAN03
62	A157	SCB (South) Roof Plan		03JAN03
63	A158	SCB (South) Reflected Ceiling Plan		03JAN03
64	A201	Barrack A (North) East Elevation		03JAN03
65	A202	Barrack A (North) West Elevation		03JAN03
66	A203	Barrack A (North) North and South Elevations	A	6 FEB 03
67	A204	Barrack B (North) North and South Elevations		03JAN03
68	A205	Barrack B (North) East and West Elevations		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
69	A206	Barrack C (North) North and South Elevations		03JAN03
70	A207	Barrack C (North) East and West Elevations	A	6 FEB 03
71	A208	Barrack A (South) East Elevation		03JAN03
72	A209	Barrack A (South) West Elevation		03JAN03
73	A210	Barrack A (South) North and South Elevations		03JAN03
74	A211	Barrack B (South) North and South Elevations		03JAN03
75	A212	Barrack B (South) East and West Elevations		03JAN03
76	A213	Barrack C (South) North And South Elevations		03JAN03
77	A214	Barrack C (South) East and West Elevations		03JAN03
78	A215	SCB (North) Elevations		03JAN03
79	A216	SCB (South) Elevations		03JAN03
80	A301	Barracks Building Sections		03JAN03
81	A302	SCB Building Sections		03JAN03
82	A303	Barracks Building Wall Sections I		03JAN03
83	A304	Barracks Building Wall Sections II		03JAN03
84	A305	Barracks Building Wall Sections III		03JAN03
85	A306	SCB Wall Sections I		03JAN03
86	A307	SCB Wall Sections II		03JAN03
87	A401	Enlarged Plans Module Clusters		03JAN03
88	A402	Enlarged Plans Room Modules		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
89	A403	Enlarged Plans SCB		03JAN03
90	A404	Enlarged Plans – Stairs	A	6 FEB 03
91	A405	Enlarged Sections – Stairs	A	6 FEB 03
92	A406	Enlarged Elevations I	A	6 FEB 03
93	A407	Enlarged Elevations II	A	6 FEB 03
94	A408	Lawnmower Storage		03JAN03
95	A501	Roof Details		03JAN03
96	A502	Column Details I		03JAN03
97	A503	Column Details II		03JAN03
98	A504	Ceiling Details		03JAN03
99	A505	Miscellaneous Details I	A	6 FEB 03
100	A506	Miscellaneous Details II		03JAN03
101	A507	Door, Window and Louver Details		03JAN03
102	A508	Stair Details		03JAN03
103	A509	Exterior Details		03JAN03
104	A510	Portico Details	A	6 FEB 03
105	A511	Casework Details I	A	6 FEB 03
106	A512	Casework Details II	A	6 FEB 03
107	A513	Louver and Misc. Details	A	6 FEB 03
108	A601	Room Finish Schedule (North)	A	6 FEB 03
109	A602	Room Finish Schedule (South)	A	6 FEB 03
110	A603	Door Schedule (North)	A	6 FEB 03
111	A604	Door Schedule (South)	A	6 FEB 03
112	A605	Window/Louver/Misc. Schedules	A	6 FEB 03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
113	A606	Wall Types Schedule Details		03JAN03
114	A701	Interior Elevations I	A	6 FEB 03
115	A702	Interior Elevations II		03JAN03
116	A703	Interior Elevations III		03JAN03
117	A704	Signage		03JAN03
		Structural		
118	S001	General Structural Notes		03JAN03
119	S002	Slab Joint Details	A	6 FEB 03
120	S003	Base Plate And Anchor Bolt Details		03JAN03
121	S004	Typical Details I	A	14FEB03
122	S005	Typical Details II		03JAN03
123	S101	Barrack A (North) Foundation Plan	B	14FEB03
124	S102	Barrack A (North) Floor Slab Joint Layout Plan		03JAN03
125	S103	Barrack A (North) Second Floor Framing Plan		03JAN03
126	S104	Barrack A (North) Third Floor Framing Plan		03JAN03
127	S105	Barrack A (North) Attic Framing Plan		03JAN03
128	S106	Barrack A (North) Roof Framing Plan		03JAN03
129	S107	Barrack B (North) Foundation Plan	A	14FEB03
130	S108	Barrack B (North) Floor Slab Joint Layout Plan		03JAN03
131	S109	Barrack B (North) Second Floor Framing Plan		03JAN03
132	S110	Barrack B (North) Third Floor Framing Plan		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
133	S111	Barrack B (North) Attic Framing Plan		03JAN03
134	S112	Barrack B (North) Roof Framing Plan		03JAN03
135	S113	Barrack C (North) Foundation Plan	A	14FEB03
136	S114	Barrack C (North) Floor Slab Joint Layout Plan		03JAN03
137	S115	Barrack C (North) Second Floor Framing Plan		03JAN03
138	S116	Barrack C (North) Third Floor Framing Plan		03JAN03
139	S117	Barrack C (North) Attic Framing Plan		03JAN03
140	S118	Barrack C (North) Roof Framing Plan		03JAN03
141	S119	Barrack A (South) Foundation Plan	B	14FEB03
142	S120	Barrack A (South) Floor Slab Joint Layout Plan		03JAN03
143	S121	Barrack A (South) Second Floor Framing Plan		03JAN03
144	S122	Barrack A (South) Third Floor Framing Plan		03JAN03
145	S123	Barrack A (South) Attic Framing Plan		03JAN03
146	S124	Barrack A (South) Roof Framing Plan		03JAN03
147	S125	Barrack B (South) Foundation Plan	A	14FEB03
148	S126	Barrack B (South) Floor Slab Joint Layout Plan		03JAN03
149	S127	Barrack B (South) Second Floor Framing Plan		03JAN03
150	S128	Barrack B (South) Third Floor Framing Plan		03JAN03
151	S129	Barrack B (South) Attic Framing Plan		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
152	S130	Barrack B (South) Roof Framing Plan		03JAN03
153	S131	Barrack C (South) Foundation Plan	A	14FEB03
154	S132	Barrack C (South) Floor Slab Joint Layout Plan		03JAN03
155	S133	Barrack C (South) Second Floor Framing Plan		03JAN03
156	S134	Barrack C (South) Third Floor Framing Plan		03JAN03
157	S135	Barrack C (South) Attic Framing Plan		03JAN03
158	S136	Barrack C (South) Roof Framing Plan		03JAN03
159	S137	SCB (North) Foundation Plan		03JAN03
160	S138	SCB (North) Floor Slab Joint Layout Plan	A	6 FEB 03
161	S139	SCB (North) Roof Framing Plan	A	6 FEB 03
162	S140	SCB (South) Foundation Plan		03JAN03
163	S141	SCB (South) Floor Slab Joint Layout Plan	A	6 FEB 03
164	S142	SCB (South) Roof Framing Plan		03JAN03
165	S201	Braced Frame Elevations		03JAN03
166	S202	Braced Frame Connection Details		03JAN03
167	S203	Braced Frame Connection And Typical Details		03JAN03
168	S301	SCB Joist Bearing Details I		03JAN03
169	S302	SCB Joist Bearing Details II		03JAN03
170	S401	SCB Mechanical Platform Framing Plan and Details I		03JAN03
171	S402	SCB Mechanical Platform Framing Plan and Details II		03JAN03
172	S403	SCB Skylight Framing Plan Sections and Details		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
		Details		
173	S404	SCB Gable End Wall Framing		03JAN03
174	S405	SCB Miscellaneous Sections		03JAN03
175	S406	SCB Portico Framing		03JAN03
176	S501	Barracks Foundation Sections and Details		03JAN03
177	S502	SCB Foundation Sections and Details		03JAN03
178	S503	Foundation Sections At Entryways		03JAN03
179	S504	Miscellaneous Foundation Sections		03JAN03
180	S505	Miscellaneous Roof Framing Details I		03JAN03
181	S506	Miscellaneous Roof Framing Details II		03JAN03
182	S507	Miscellaneous Roof Framing Details III		03JAN03
183	S508	Roof Anchor Section and Details		03JAN03
184	S601	Moment Frame Connection Schedule		03JAN03
185	S701	Stair Framing Plan		03JAN03
186	S702	Stair Sections And Details I		03JAN03
187	S703	Stair Sections And Details II		03JAN03
188	S801	Lawn Mower Storage Plan And Sections		03JAN03
		Fire Protection		
189	F101	Composite (North) First Floor Sprinkler Layout		03JAN03
190	F102	Barrack A (North) First Floor Sprinkler Plan		03JAN03
191	F103	Barrack A (North) Second Floor Sprinkler Plan		03JAN03
192	F104	Barrack A (North) Third Floor Sprinkler Plan		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
		Plan		
193	F105	Barrack B (North) First Floor Sprinkler Plan		03JAN03
194	F106	Barrack B (North) Second Floor Sprinkler Plan		03JAN03
195	F107	Barrack B (North) Third Floor Sprinkler Plan		03JAN03
196	F108	Barrack C (North) First Floor Sprinkler Plan		03JAN03
197	F109	Barrack C (North) Second Floor Sprinkler Plan		03JAN03
198	F110	Barrack C (North) Third Floor Sprinkler Plan		03JAN03
199	F111	Composite (South) First Floor Sprinkler Layout		03JAN03
200	F112	Barrack A (South) First Floor Sprinkler Plan		03JAN03
201	F113	Barrack A (South) Second Floor Sprinkler Plan		03JAN03
202	F114	Barrack A (South) Third Floor Sprinkler Plan		03JAN03
203	F115	Barrack B (South) First Floor Sprinkler Plan		03JAN03
204	F116	Barrack B (South) Second Floor Sprinkler Plan		03JAN03
205	F117	Barrack C (South) Third Floor Sprinkler Plan		03JAN03
206	F118	Barrack C (South) First Floor Sprinkler Plan		03JAN03
207	F119	Barrack C (South) Second Floor Sprinkler Plan		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
208	F120	Barrack C (South) Third Floor Sprinkler Plan		03JAN03
209	F121	SCB (North) Fire Protection Plan		03JAN03
210	F122	SCB (South) Fire Protection Plan		03JAN03
211	F501	Detail I		03JAN03
		Plumbing		
212	P001	Legends & Abbreviations		03JAN03
213	P101	Barrack A (North) First Floor Plumbing Plan		03JAN03
214	P102	Barrack A (North) Second Floor Plumbing Plan		03JAN03
215	P103	Barrack A (North) Third Floor Plumbing Plan		03JAN03
216	P104	Barrack B (North) First Floor Plumbing Plan		03JAN03
217	P105	Barrack B (North) Second Floor Plumbing Plan		03JAN03
218	P106	Barrack B (North) Third Floor Plumbing Plan		03JAN03
219	P107	Barrack C (North) First Floor Plumbing Plan		03JAN03
220	P108	Barrack C (North) Second Floor Plumbing Plan		03JAN03
221	P109	Barrack C (North) Third Floor Plumbing Plan		03JAN03
222	P110	Barrack A (North) First Floor Foundation Sanitary Sewer		03JAN03
223	P111	Barrack B (North) First Floor Foundation Sanitary Sewer		03JAN03
224	P112	Barrack C (North) First Floor Foundation Sanitary Sewer		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
		Sanitary Sewer		
225	P113	Barrack C (North) Third Floor Attic Sanitary Sewer Vent		03JAN03
226	P114	Barrack B (North) Third Floor Attic Sanitary Sewer Vent		03JAN03
227	P115	Barrack C (North) Second Floor Attic Sanitary Sewer Vent		03JAN03
228	P116	Barrack C (North) Third Floor Attic Sanitary Sewer Vent		03JAN03
229	P117	Barrack A (South) First Floor Plumbing Plan		03JAN03
230	P118	Barrack A (South) Second Floor Plumbing Plan		03JAN03
231	P119	Barrack A (South) Third Floor Plumbing Plan		03JAN03
232	P120	Barrack B (South) First Floor Plumbing Plan		03JAN03
233	P121	Barrack B (South) Second Floor Plumbing Plan		03JAN03
234	P122	Barrack B (South) Third Floor Plumbing Plan		03JAN03
235	P123	Barrack C (South) First Floor Plumbing Plan		03JAN03
236	P124	Barrack C (South) Second Floor Plumbing Plan		03JAN03
237	P125	Barrack C (South) Third Floor Plumbing Plan		03JAN03
238	P126	Barrack A (South) First Floor Foundation Sanitary Sewer		03JAN03
239	P127	Barrack B (South) First Floor Foundation Sanitary Sewer		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
240	P128	Barrack C (South) First Floor Foundation Sanitary Sewer		03JAN03
241	P129	Barrack A (South) Third Floor Attic Sanitary Sewer Vent		03JAN03
242	P130	Barrack B (South) Third Floor Attic Sanitary Sewer Vent		03JAN03
243	P131	Barrack C (South) Second Floor Attic Sanitary Sewer Vent		03JAN03
244	P132	Barrack C (South) Third Floor Attic Sanitary Sewer Vent		03JAN03
245	P133	SCB (North) Plumbing Plan		03JAN03
246	P134	SCB (North) foundation Sanitary Sewer Plan		03JAN03
247	P135	SCB (North) Attic Space Sanitary Sewer Vent		03JAN03
248	P136	SCB (South) Plumbing Plan		03JAN03
249	P137	SCB (South) Foundation Sanitary Sewer		03JAN03
250	P138	SCB (South) Attic Space Sanitary Sewer Vent		03JAN03
251	P201	SCB Mech. Rm Elevation		03JAN03
252	P401	Enlarged Plan I Barracks A Typical Mech. Rm		03JAN03
253	P402	Enlarged Plan II Barracks B & C Typical Mech. Rm		03JAN03
254	P403	Enlarged Plan III SCB (North) Mech. Rm		03JAN03
255	P501	Typical Barracks Mech. Rm Schematic		03JAN03
256	P502	Detail I		03JAN03
257	P503	Detail II		03JAN03
258	P504	Detail III		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
259	P601	Schedule		03JAN03
260	P701	Sequence of Operations		03JAN03
261	P901	Isometric I Typical Barracks Plumbing Riser Diagram		03JAN03
262	P902	Isometric II Typical Barracks Sanitary Riser Diagram		03JAN03
263	P903	Isometric III Typical SCB Domestic Riser Diagram		03JAN03
264	P904	Isometric IV Typical SCB Sanitary Sewer Riser Diagram		03JAN03
		Mechanical		
265	M001	Legends & Abbreviations		03JAN03
266	M101	Composite (North) Hydronic Piping Plan		03JAN03
267	M102	Barrack A (North) First Floor HVAC Plan		03JAN03
268	M103	Barrack A (North) Second Floor HVAC Plan		03JAN03
269	M104	Barrack A (North) Third Floor HVAC Plan		03JAN03
270	M105	Barrack A (North) Attic Space HVAC Plan		03JAN03
271	M106	Barrack B (North) First Floor HVAC Plan		03JAN03
272	M107	Barrack B (North) Second Floor HVAC Plan		03JAN03
273	M108	Barrack B (North) Third Floor HVAC Plan		03JAN03
274	M109	Barrack B (North) Attic Space HVAC Plan		03JAN03
275	M110	Barrack C (North) First Floor HVAC Plan		03JAN03
276	M111	Barrack C (North) Second Floor HVAC Plan		03JAN03
277	M112	Barrack C (North) Third Floor HVAC Plan		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
278	M113	Barrack C (North) Attic Space HVAC Plan		03JAN03
279	M114	Composite (South) Hydronic Piping Plan		03JAN03
280	M115	Barrack A (South) First Floor HVAC Plan		03JAN03
281	M116	Barrack A (South) Second Floor HVAC Plan		03JAN03
282	M117	Barrack A (South) Third Floor HVAC Plan		03JAN03
283	M118	Barrack A (South) Attic Space HVAC Plan		03JAN03
284	M119	Barrack B (South) First Floor HVAC Plan		03JAN03
285	M120	Barrack B (South) Second Floor HVAC Plan		03JAN03
286	M121	Barrack B (South) Third Floor HVAC Plan		03JAN03
287	M122	Barrack B (South) Attic Space HVAC Plan		03JAN03
288	M123	Barrack C (South) First Floor HVAC Plan		03JAN03
289	M124	Barrack C (South) Second Floor HVAC Plan		03JAN03
290	M125	Barrack C (South) Third Floor HVAC Plan		03JAN03
291	M126	Barrack C (South) Attic Space HVAC Plan		03JAN03
292	M127	SCB (North) HVAC Plan		03JAN03
293	M128	SCB (North) HVAC Supply Plan		03JAN03
294	M129	SCB (North) HVAC Return and Exhaust Plan		03JAN03
295	M130	SCB (North) HVAC Laundry		03JAN03
296	M131	SCB (South) HVAC Plan		03JAN03
297	M132	SCB (South) HVAC Supply Plan		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
298	M133	SCB (South) HVAC Return and Exhaust Plan		03JAN03
299	M134	SCB (South) HVAC Laundry Plan		03JAN03
300	M201	SCB Mech. Rm Elevation		03JAN03
301	M202	Laundry Equipment & Equipment Platform Elevation I		03JAN03
302	M203	Laundry Equipment & Equipment Platform Elevation II		03JAN03
303	M301	Sections I		03JAN03
304	M302	Sections II		03JAN03
305	M401	Enlarged Plan I Room Module		03JAN03
306	M402	Enlarged Plan II Individual Room		03JAN03
307	M403	Enlarged Plan III Typical Barracks Mech Rm		03JAN03
308	M404	Enlarged Plan V SCB (North) Mech. Rm		03JAN03
309	M501	Hydronic Piping Schematic		03JAN03
310	M502	SCB Sequence of Operations & Schematic		03JAN03
311	M503	Barracks Sequence of Operations & Schematic		03JAN03
312	M504	Detail I		03JAN03
313	M505	Detail II		03JAN03
314	M506	Detail III		03JAN03
315	M601	Schedule I		03JAN03
316	M602	Schedule II		03JAN03
		Electrical		
317	E001	Legend		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
318	E101	Barrack A (North) First Floor Power		03JAN03
319	E102	Barrack A (North) Second Floor Power		03JAN03
320	E103	Barrack A (North) Third Floor Power		03JAN03
321	E104	Barrack A (North) Attic Power		03JAN03
322	E105	Barrack B (North) First Floor Power		03JAN03
323	E106	Barrack B (North) Second Floor Power		03JAN03
324	E107	Barrack B (North) Third Floor Power		03JAN03
325	E108	Barrack B (North) Attic Power		03JAN03
326	E109	Barrack C (North) First Floor Power		03JAN03
327	E110	Barrack C (North) Second Floor Power		03JAN03
328	E111	Barrack C (North) Third Floor Power		03JAN03
329	E112	Barrack C (North) Attic Power		03JAN03
330	E113	SCB (North) Power Plan		03JAN03
331	E114	Barrack A (South) First Floor Power		03JAN03
332	E115	Barrack A (South) Second Floor Power		03JAN03
333	E116	Barrack A (South) Third Floor Power		03JAN03
334	E117	Barrack A (South) Attic Power		03JAN03
335	E118	Barrack B (South) First Floor Power		03JAN03
336	E119	Barrack B (South) Second Floor Power		03JAN03
337	E120	Barrack B (South) Third Floor Power		03JAN03
338	E121	Barrack B (South) Attic Power		03JAN03
339	E122	Barrack C (South) First Floor Power		03JAN03
340	E123	Barrack C (South) Second Floor Power		03JAN03
341	E124	Barrack C (South) Third Floor Power		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
342	E125	Barrack C (South) Attic Power		03JAN03
343	E126	SCB (South) Power Plan		03JAN03
344	E127	Barrack A (North) First Floor Lighting		03JAN03
345	E128	Barrack A (North) Second Floor Lighting		03JAN03
346	E129	Barrack A (North) Third Floor Lighting		03JAN03
347	E130	Barrack A (North) Attic Lighting		03JAN03
348	E131	Barrack B (North) First Floor Lighting		03JAN03
349	E132	Barrack B (North) Second Floor Lighting		03JAN03
350	E133	Barrack B (North) Third Floor Lighting		03JAN03
351	E134	Barrack B (North) Attic Lighting		03JAN03
352	E135	Barrack C (North) First Floor Lighting		03JAN03
353	E136	Barrack C (North) Second Floor Lighting		03JAN03
354	E137	Barrack C (North) Third Floor Lighting		03JAN03
355	E138	Barrack C (North) Attic Lighting		03JAN03
356	E139	SCB (North) Lighting Plan		03JAN03
357	E140	Barrack A (South) First Floor Lighting		03JAN03
358	E141	Barrack A (South) Second Floor Lighting		03JAN03
359	E142	Barrack A (South) Third Floor Lighting		03JAN03
360	E143	Barrack A (South) Attic Lighting		03JAN03
361	E144	Barrack B (South) First Floor Lighting		03JAN03
362	E145	Barrack B (South) Second Floor Lighting		03JAN03
363	E146	Barrack B (South) Third Floor Lighting		03JAN03
364	E147	Barrack B (South) Attic Lighting		03JAN03
365	E148	Barrack C (South) First Floor Lighting		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
366	E149	Barrack C (South) Second Floor Lighting		03JAN03
367	E150	Barrack C (South) Third Floor Lighting		03JAN03
368	E151	Barrack C (South) Attic Lighting		03JAN03
369	E152	SCB (South) Lighting Plan		03JAN03
370	E401	Enlarged Module Power & Lighting		03JAN03
371	E402	Enlarged Service Rooms		03JAN03
372	E403	Enlarged Sections		03JAN03
373	E501	Details I		03JAN03
374	E502	Details II		03JAN03
375	E503	Lighting Details I		03JAN03
376	E504	Lighting Details II		03JAN03
377	E505	Lighting Details III		03JAN03
378	E601	One Line Diagram Bldg A		03JAN03
379	E602	One Line Diagram Bldg B		03JAN03
380	E603	One Line Diagram Bldg C		03JAN03
381	E604	One Line Diagram SCB		03JAN03
382	E605	Module Panel (LA)		03JAN03
383	E606	Main Distribution Panel (MDP) and Panel D – Bldg A		03JAN03
384	E607	Wing Panels Bldg A		03JAN03
385	E608	Misc. Panels Bldg A		03JAN03
386	E609	Main Distribution Panel (MDP) and Wing Panel – Bldg B		03JAN03
387	E610	Misc. Panels Bldg B		03JAN03
388	E611	Main Distribution Panel (MDP) and Wing Panel – Bldg C		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
		Panel – Bldg C		
389	E612	Misc. Panels Bldg C		03JAN03
390	E613	Main Distribution Panel (MDP)		03JAN03
391	E614	Misc. Panels I SCB		03JAN03
392	E615	Misc. Panels II SCB		03JAN03
393	E616	Misc. Panels III SCB		03JAN03
		Electrical (Telecommunications)		
394	T101	Barrack A (North) First Floor Communications		03JAN03
395	T102	Barrack A (North) Second Floor Communications		03JAN03
396	T103	Barrack A (North) Third Floor Communications		03JAN03
397	T104	Barrack A (North) Attic Communications		03JAN03
398	T105	Barrack B (North) First Floor Communications		03JAN03
399	T106	Barrack B (North) Second Floor Communications		03JAN03
400	T107	Barrack B (North) Third Floor Communications		03JAN03
401	T108	Barrack B (North) Attic Communications		03JAN03
402	T109	Barrack C (North) First Floor Communications		03JAN03
403	T110	Barrack C (North) Second Floor Communications		03JAN03
404	T111	Barrack C (North) Third Floor Communications		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
405	T112	SCB (North) Communications Plan		03JAN03
406	T113	Barrack C (North) Attic Communications		03JAN03
407	T114	Barrack A (South) First Floor Communications		03JAN03
408	T115	Barrack A (South) Second Floor Communications		03JAN03
409	T116	Barrack A (South) Third Floor Communications		03JAN03
410	T117	Barrack A (South) Attic Communications		03JAN03
411	T118	Barrack B (South) First Floor Communications		03JAN03
412	T119	Barrack B (South) Second Floor Communications		03JAN03
413	T120	Barrack B (South) Third Floor Communications		03JAN03
414	T121	Barrack B (South) Attic Communications		03JAN03
415	T122	Barrack C (South) First Floor Communications		03JAN03
416	T123	Barrack C (South) Second Floor Communications		03JAN03
417	T124	Barrack C (South) Third Floor Communications		03JAN03
418	T125	Barrack C (South) Attic Communications		03JAN03
419	T126	SCB (South) Communications Plan		03JAN03
420	T501	Telephone Details		03JAN03
421	T502	Fire Alarm Details		03JAN03
422	T601	Telephone Riser Bldg A		03JAN03
423	T602	Telephone Riser Bldg B		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
424	T603	Telephone Riser Bldg C	A	14FEB03
425	T604	Cable TV Riser Bldg A		03JAN03
426	T605	Cable TV Riser Bldg B		03JAN03
427	T606	Cable TV Riser Bldg C	A	14FEB03
428	T607	Fire Alarm Riser Bldg A		03JAN03
429	T608	Fire Alarm Riser Bldg B		03JAN03
430	T609	Fire Alarm Riser Bldg C		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE

VOLUME 3 – MEDIUM COMPANY OPERATIONS FACILITY (FLWM)

1	G001	Title And Area Maps	A	14FEB03
2	G002	Index of Drawings		03JAN03
3	A001	Architectural General Notes		03JAN03
4	A101	First Floor Plan		03JAN03
5	A102	Second Floor Plan		03JAN03
6	A103	AHU Platform Plan and Ceiling Plan		03JAN03
7	A104	Roof Plan		03JAN03
8	A105	First Floor Reflected Ceiling Plan		03JAN03
9	A106	Second Floor Reflected Ceiling Plan		03JAN03
10	A201	Exterior Elevations: North and South		03JAN03
11	A202	Exterior Elevations: East/West & Details		03JAN03
12	A301	Building Sections		03JAN03
13	A302	Wall Sections		03JAN03
14	A303	Wall Sections		03JAN03
15	A401	Enlarged Floor Plans		03JAN03
16	A402	Interior Elevations		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
17	A403	Interior Elevations		03JAN03
18	A405	Stair Plans And Sections		03JAN03
19	A501	Site Details		03JAN03
20	A502	Exterior Details		03JAN03
21	A503	Roof Details		03JAN03
22	A504	Interior Details		03JAN03
23	A505	Interior Details		03JAN03
24	A506	Details		03JAN03
25	A601	Door And Window Schedules	A	6 FEB 03
26	A602	Finish Schedule		03JAN03
27	A603	Exterior Finishes And Wall Types		03JAN03
28	A604	Signage Schedule And Details		03JAN03
29	S001	Structural General Notes		03JAN03
30	S002	Abbreviations & Symbols		03JAN03
31	S003	Live Load Diagrams		03JAN03
32	S101	Foundation Plan		03JAN03
33	S102	Second Floor Framing Plan		03JAN03
34	S103	Mechanical Platform Framing Plan		03JAN03
35	S104	Roof Framing Plan		03JAN03
36	S201	Frame Elevations		03JAN03
37	S202	Frame Elevations		03JAN03
38	S301	Wall Sections		03JAN03
39	S302	Wall Sections		03JAN03
40	S303	Wall Sections		03JAN03
41	S304	Wall Sections		03JAN03
42	S401	Elevated Slab Reinforcing Plan		03JAN03
43	S501	Foundation Details		03JAN03
44	S502	Foundation Details	A	6 FEB 03
45	S503	Foundation Details		03JAN03
46	S504	Foundation Details		03JAN03
47	S521	Steel Details		03JAN03
48	S522	Steel Details		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
49	S523	Steel Details		03JAN03
50	S524	Steel Details		03JAN03
51	S525	Steel Details		03JAN03
52	S526	Steel Details		03JAN03
53	S527	Steel Details	A	6 FEB 03
54	S528	Steel Details	A	6 FEB 03
55	S701	Stair Framing Plan		03JAN03
56	S702	Stair Details		03JAN03
57	M00.1	Abbreviations And Symbols		03JAN03
58	M00.2	Control Abbreviations And Symbols		03JAN03
59	M2.1.1	Heat & Vent Plan 1st Floor		03JAN03
60	M2.1.2	Heat & Vent Plan 2nd Floor & Platform		03JAN03
61	M2.2.1	Hydronics Plan 1st Floor & Mech Rm.		03JAN03
62	M2.2.2	Hydronics Plan 2nd Floor & Platform		03JAN03
63	MO4.1	Diagrams & Elevations		03JAN03
64	MO7.1	Ventilation Control Schematic & Schedule		03JAN03
65	MO7.2	Hydronic Heating System Schematic & Schedule		03JAN03
66	MO7.4	Control Ladder Diagram		03JAN03
67	M10.1	Heat And Vent Schedules		03JAN03
68	M11.1	Sections		03JAN03
69	M12.1	Heat & Vent Details		03JAN03
70	M12.2	Heat & Vent Details		03JAN03
70.1	F13.1	Fire Protection Plan		03JAN03
71	PO2.1	Plumbing Plan 1st Floor		03JAN03
72	PO2.2	Plumbing Plan 2nd Floor & Platform		03JAN03
73	P10.1.1	Enlarged Plumbing Plan		03JAN03
74	P10.1.2	Enlarged Plumbing Plan		03JAN03
75	P10.2	Plumbing Schedules		03JAN03
76	P12.1	Plumbing Details		03JAN03
77	E001	Electrical Legend		03JAN03
78	E002	Abbreviation List		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
79	E201	First Floor Lighting Plan		03JAN03
80	E202	Second Floor Lighting Plan		03JAN03
81	E203	AHU Platform Electrical Plans		03JAN03
82	E301	First Floor Power Plan		03JAN03
83	E302	Second Floor Power Plan		03JAN03
84	E401	First Floor Systems Plan		03JAN03
85	E402	Second Floor Systems Plan		03JAN03
86	E501	One Line Distribution System		03JAN03
87	E502	Signal Riser Diagrams		03JAN03
88	E601	Light Fixture Schedule		03JAN03
89	E602	“Lighting Details 1, Schedule”		03JAN03
90	E603	“Lighting Details 2, Schedule”		03JAN03
91	E604	“Lighting Details 3, Schedule”		03JAN03
92	E605	Panel Schedules		03JAN03
93	E606	Panel Schedules		03JAN03
94	E607	“Partial Floor Plan, Elevations”		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE

VOLUME 4 – LARGE BATTALION HEADQUARTERS (FLWL)

1	G001	Title & Area Maps	A	14FEB03
2	G002	Drawing Index		03JAN03
3	A001	Abbreviations, Symbols & General Notes		03JAN03
4	A101	First Floor Plan		03JAN03
5	A102	Second Floor Plan		03JAN03
6	A103	Roof Plan		03JAN03
7	A104	First Floor Reflected Ceiling Plan		03JAN03
8	A105	Second Floor Reflected Ceiling Plan		03JAN03
9	A201	Exterior Elevations		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
10	A202	Interior Elevations		03JAN03
11	A203	Interior Elevations		03JAN03
12	A204	Interior Elevations		03JAN03
13	A301	Building Sections		03JAN03
14	A302	Building Sections		03JAN03
15	A303	Wall Sections		03JAN03
16	A304	Wall Sections		03JAN03
17	A305	Wall Sections		03JAN03
18	A306	Wall Sections		03JAN03
19	A307	Wall Sections		03JAN03
20	A308	Wall Sections		03JAN03
21	A401	Enlarged Floor Plans		03JAN03
22	A402	Stair Plans & Sections		03JAN03
23	A403	Stair & Elevator Details		03JAN03
24	A501	Exterior Details		03JAN03
25	A502	Exterior Details		03JAN03
26	A503	Exterior Details		03JAN03
27	A504	Exterior Details		03JAN03
28	A505	Door & Window Details		03JAN03
29	A506	Exterior Details		03JAN03
30	A507	Interior Details		03JAN03
31	A508	Interior Casework Details		03JAN03
32	A509	Interior Details		03JAN03
33	A601	Wall Type Schedule		03JAN03
34	A602	Schedules		03JAN03
35	A603	Interior finish Schedule		03JAN03
36	A604	Exterior finish Key & Sign Schedule		03JAN03
37	S001	General Notes & Abbreviations		03JAN03
38	S002	General Notes & Abbreviations		03JAN03
39	S101	Foundation Plan	B	14FEB03
40	S102	Second Floor Framing Plan		03JAN03
41	S103	Roof Framing Plan	A	6 FEB 03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
42	S104	Stair Framing Plan		03JAN03
43	S201	Steel Frame Elevations		03JAN03
44	S202	Steel Frame Elevations		03JAN03
45	S203	Steel Frame Elevations		03JAN03
46	S501	Foundation Details		03JAN03
47	S502	Foundation Details		03JAN03
48	S503	Foundation Details		03JAN03
49	S504	Steel Details		03JAN03
50	S505	Steel Details		03JAN03
51	S506	Steel Details	A	6 FEB 03
52	S507	Steel Details		03JAN03
53	S508	Steel Details		03JAN03
54	S509	Steel Details	A	6 FEB 03
55	S701	Stair Framing Details		03JAN03
56	M001	Mechanical Legend & General Notes		03JAN03
57	M002	Control Abbreviations & Symbols		03JAN03
58	M003	Schedules		03JAN03
59	M004	Schedules		03JAN03
60	M201	Plumbing Foundation Plan		03JAN03
61	M301	Plumbing First Floor Plan		03JAN03
62	M302	Plumbing Second Floor Plan		03JAN03
63	M303	Enlarged Plumbing Floor Plans		03JAN03
64	M304	Plumbing Details		03JAN03
65	M401	Hydronic First Floor Plan		03JAN03
66	M402	Hydronic Second Floor Plan		03JAN03
67	M403	Boiler Schematic		03JAN03
68	M404	Hydronic Details		03JAN03
69	M501	Heating & Ventilating First Floor Plan		03JAN03
70	M502	Heating & Ventilating Second Floor Plan		03JAN03
71	M503	Enlarged HVAC Floor Plans		03JAN03
72	M504	Sections		03JAN03
73	M505	HVAC Details		03JAN03

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
74	M601	Control Schematics		03JAN03
75	M602	Control Schematics		03JAN03
76	F701	Fire Protection Plan		03JAN03
77	E001	“Legends, Notes”		03JAN03
78	E002	“Legend, Abbreviation List”		03JAN03
79	E201	First Floor Lighting Plan	A	6 FEB 03
80	E202	Second Floor Lighting Plan	A	6 FEB 03
81	E301	First Floor Power Plan	A	6 FEB 03
82	E302	Second Floor Power Plan	A	6 FEB 03
83	E401	First Floor Signal Plan	A	6 FEB 03
84	E402	Second Floor Signal Plan	A	6 FEB 03
85	E501	Building Riser Diagrams	A	6 FEB 03
86	E502	Building Riser Diagrams	A	6 FEB 03
87	E601	Light Fixture Schedule	A	6 FEB 03
88	E602	Lighting Details 1		03JAN03
89	E603	Lighting Details 2		03JAN03
90	E604	Panel Schedules	A	6 FEB 03
91	E605	Panel Schedules	A	6 FEB 03
92	E701	Details		03JAN03
93	E702	Building Enlarged Plans	A	6 FEB 03

STANDARD DETAILS BOUND IN THE SPECIFICATIONS

DRAWING NUMBER	SHEET NUMBER	TITLE	DATE
SECTION 01501 - CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS			
	1 & 2	U.S. Army Project Construction Sign	84JUN20
	1	Hard Hat Sign	10SEP90

REVISIONS TO DRAWINGS BY NOTATION

Drawings, Volume 1, Sheet E101: Add Note 7, to read, "Extend walkway lighting circuit to lawnmower storage building for power to the exterior fixture and one suspended fluorescent fixture with one 32W/T8 lamp. Interior fixture shall be switched. Exterior fixture shall be controlled with the walkway lights."

Drawings, Volume 1, Sheet E103: Add Note 9, to read, "Extend walkway lighting circuit to lawnmower storage building for power to the exterior fixture and one suspended fluorescent fixture with one 32W/T8 lamp. Interior fixture shall be switched. Exterior fixture shall be controlled with the walkway lights."

Drawings, Volume 1, Sheet E104: Add Note 10, to read, "Extend walkway lighting circuit to lawnmower storage building for power to the exterior fixture and one suspended fluorescent fixture with one 32W/T8 lamp. Interior fixture shall be switched. Exterior fixture shall be controlled with the walkway lights."

Drawings, Volume 1, Sheet E106: Add Note 7, to read, "Extend walkway lighting circuit to lawnmower storage building for power to the exterior fixture and one suspended fluorescent fixture with one 32W/T8 lamp. Interior fixture shall be switched. Exterior fixture shall be controlled with the walkway lights."

Drawings, Volume 2, Sheet E607: For Panels WPA and WPB, change all 100A, 3-pole breakers to 110A, 3-pole breakers.

Drawings, Volume 2, Sheet E609: For Panel WPA, change all 100A, 3-pole breakers to 110A, 3-pole breakers.

Drawings, Volume 2, Sheet E611: For Panel WPA, change all 100A, 3-pole breakers to 110A, 3-pole breakers.

Drawings, Volume 3, Sheet E302: Revise the sheet issued as part of Amendment 0001 to show the entire Second Floor Power Plan and all notes enclosed by brackets, with revision symbol "A." Add "R0001" in large characters to the lower right corner of the drawing sheet. Add notation to the revision block as follows:

Symbol	Description	Date	Appr.
A	REVISED SHEET	06FEB03	CM

END OF SECTION

SECTION 01451

CONTRACTOR QUALITY CONTROL

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.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3740	(2001) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM E 329	(2000b) Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

1.2 PAYMENT

Separate payment will not be made for providing and maintaining an effective Quality Control program, and all costs associated therewith shall be included in the applicable unit prices or lump-sum prices contained in the Bidding Schedule.

1.3 LABORATORY VALIDATION

The testing laboratory shall be validated by Corps of Engineers Material Testing Center (MTC) for all tests required by contract. See paragraph 3.7 TESTS.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

The Contractor is responsible for quality control and shall establish and maintain an effective quality control system in compliance with the Contract Clause titled "Inspection of Construction." The quality control system shall consist of plans, procedures, and organization necessary to produce an end product which complies with the contract requirements. The system shall cover all construction operations, both onsite and offsite, and shall be keyed to the proposed construction sequence. The site project superintendent will be held responsible for the quality of work on the job and is subject to removal by the Contracting Officer for non-compliance with quality requirements specified in the contract. The site project superintendent in this context shall be the highest level manager responsible for overall construction activities at the site, including quality and production. The site project superintendent shall maintain a physical presence at the site at all times, except as otherwise acceptable to the Contracting

Officer, and shall be responsible for all construction and construction related activities at the site.

3.2 QUALITY CONTROL PLAN

3.2.1 General

The Contractor shall furnish for review by the Government, not later than 10 days after receipt of notice to proceed, the Contractor Quality Control (CQC) Plan proposed to implement the requirements of the Contract Clause titled "Inspection of Construction." The plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used. The Government will consider an interim plan for the first 60 days of operation. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of work to be started. Work outside of the features of work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of work to be started.

3.2.2 Content of the CQC Plan

The CQC Plan shall include, as a minimum, the following to cover all construction operations, both onsite and offsite, including work by subcontractors, fabricators, suppliers, and purchasing agents:

a. A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff shall implement the three phase control system for all aspects of the work specified. The staff shall include a CQC System Manager who shall report to the project manager. If the project manager and project superintendent is the same person, the CQC System Manager shall report to someone higher in the Contractor's organization than the project manager.

b. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function.

c. A copy of the letter to the CQC System Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop work which is not in compliance with the contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Copies of these letters shall also be furnished to the Government.

d. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with Section 01330 SUBMITTAL PROCEDURES.

e. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. Laboratory facilities will

be validated by the Corps of Engineers Material Testing Center and approved by the Contracting Officer.

f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.

g. Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures shall establish verification that identified deficiencies have been corrected.

h. Reporting procedures, including proposed reporting formats.

i. A list of the definable features of work. A definable feature of work is a task which is separate and distinct from other tasks, has separate control requirements, and may be identified by different trades or disciplines, or it may be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable features under a particular section. This list will be agreed upon during the coordination meeting.

3.2.3 Acceptance of Plan

Acceptance of the Contractor's plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Government reserves the right to require the Contractor to make changes in his CQC Plan and operations including removal of personnel, as necessary, to obtain the quality specified.

3.2.4 Notification of Changes

After acceptance of the CQC Plan, the Contractor shall notify the Contracting Officer in writing of any proposed change. Proposed changes are subject to acceptance by the Contracting Officer.

3.3 COORDINATION MEETING

After the Preconstruction Conference, before start of construction, and prior to acceptance by the Government of the CQC Plan, the Contractor shall meet with the Contracting Officer or Authorized Representative and discuss the Contractor's quality control system. The CQC Plan shall be submitted for review a minimum of 5 calendar days prior to the Coordination Meeting. During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting shall be prepared by the Government and signed by both the Contractor and the Contracting Officer. The minutes shall become a part of the contract file. There may be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures which may require corrective action by the Contractor.

3.4 QUALITY CONTROL ORGANIZATION

3.4.1 Personnel Requirements

The requirements for the CQC organization are a CQC System Manager and sufficient number of additional qualified personnel to ensure safety and contract compliance. Personnel identified in technical provisions as requiring specialized skills to assure the required work is being performed properly will also be included as part of the CQC organization. The Contractor shall provide a CQC organization which shall be at the site at all times during progress of the work and with complete authority to take any action necessary to ensure compliance with the contract. All CQC staff members shall be subject to acceptance by the Contracting Officer. The Contractor shall provide adequate office space, filing systems and other resources as necessary to maintain an effective and fully functional CQC organization. Complete records of all letters, material submittals, shop drawings submittals, schedules and all other project documentation shall be promptly furnished to the CQC organization by the Contractor. The CQC organization shall be responsible to maintain these documents and records at the site at all times, except as otherwise acceptable to the Contracting Officer.

3.4.2 CQC System Manager

The Contractor shall identify as CQC System Manager an individual within the onsite work organization who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the Contractor. The CQC System Manager shall be a graduate engineer, graduate architect, or a graduate of construction management, with a minimum of 5 years construction experience on construction similar to this contract or a construction person with a minimum of 10 years in related work. This CQC System Manager shall be on the site at all times during construction and shall be employed by the prime Contractor. The CQC System Manager shall be assigned no other duties. An alternate for the CQC System Manager shall be identified in the plan to serve in the event of the System Manager's absence. The requirements for the alternate shall be the same as for the designated CQC System Manager.

3.4.3 CQC Personnel

In addition to CQC personnel specified elsewhere in the contract, the Contractor shall provide one (1) additional full time quality control individual to assist the CQC System Manager in daily CQC work requirements. This individual shall have the same qualifications as the CQC Systems Manager. Personnel directly assisting the CQC Systems Manager shall not be production supervisors in the company. The Contractor shall provide as part of the CQC organization specialized personnel to assist the CQC System Manager for the following areas: mechanical. These individuals may be employees of the prime or subcontractor; be responsible to the CQC System Manager; be physically present at the construction site during work on their areas of responsibility; have the necessary education and/or experience in accordance with the experience matrix listed herein. These individuals shall have no other duties other than quality control.

	Experience Matrix	
	Area	**Qualifications**
	Mechanical	Graduate Mechanical Engineer with 2 years experience or person with 5 years related experience

3.4.4 Additional Requirement

In addition to the above experience and/or education requirements the CQC System Manager shall have completed the course entitled "Construction Quality Management For Contractors". This course is periodically offered at AGC offices throughout the state of Washington and Oregon.

3.4.5 Organizational Changes

The Contractor shall maintain the CQC staff at full strength at all times. When it is necessary to make changes to the CQC staff, the Contractor shall revise the CQC Plan to reflect the changes and submit the changes to the Contracting Officer for acceptance.

3.5 SUBMITTALS AND DELIVERABLES

Submittals, if needed, shall be made as specified in Section 01330 SUBMITTAL PROCEDURES. The CQC organization shall be responsible for certifying that all submittals are in compliance with the contract requirements. When Section 15950A HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS, 15951A DIRECT DIGITAL CONTROL FOR HVAC; 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS; or 15995A COMMISSIONING OF HVAC SYSTEMS are included in the contract, the submittals required by these sections shall be coordinated with Section 01330 SUBMITTAL PROCEDURES to ensure adequate time is allowed for each type of submittal required. All Contractor forms for submitting test results are subject to Contracting Officer approval.

3.6 CONTROL

Contractor Quality Control is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. At least three phases of control shall be conducted by the CQC System Manager for each definable feature of work as follows:

3.6.1 Preparatory Phase

This phase shall be performed prior to beginning work on each definable feature of work, after all required plans/documents/materials are approved/accepted, and after copies are at the work site. This phase shall include:

a. A review of each paragraph of applicable specifications, reference codes, and standards. A copy of those sections of referenced codes and standards applicable to that portion of the work to be accomplished in the field shall be made available by the Contractor at the preparatory inspection. These copies shall be maintained in

the field and available for use by Government personnel until final acceptance of the work.

b. A review of the contract drawings.

c. A check to assure that all materials and/or equipment have been tested, submitted, and approved.

d. Review of provisions that have been made to provide required control inspection and testing.

e. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the contract.

f. A physical examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.

g. A review of the appropriate activity hazard analysis to assure safety requirements are met.

h. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of work.

i. A check to ensure that the portion of the plan for the work to be performed has been accepted by the Contracting Officer.

j. Discussion of the initial control phase.

k. The Government shall be notified at least 48 hours in advance of beginning the preparatory control phase. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The results of the preparatory phase actions shall be documented by separate minutes prepared by the CQC System Manager and attached to the daily CQC report. The Contractor shall instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

3.6.2 Initial Phase

This phase shall be accomplished at the beginning of a definable feature of work. The following shall be accomplished:

a. A check of work to ensure that it is in full compliance with contract requirements. Review minutes of the preparatory meeting.

b. Verify adequacy of controls to ensure full contract compliance. Verify required control inspection and testing.

c. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with required sample panels as appropriate.

d. Resolve all differences.

e. Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.

f. The Government shall be notified at least 24 hours in advance of beginning the initial phase. Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the daily CQC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.

g. The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.

3.6.3 Follow-up Phase

Daily checks shall be performed to assure control activities, including control testing, are providing continued compliance with contract requirements, until completion of the particular feature of work. The checks shall be made a matter of record in the CQC documentation. Final follow-up checks shall be conducted and all deficiencies corrected prior to the start of additional features of work which may be affected by the deficient work. The Contractor shall not build upon nor conceal non-conforming work.

3.6.4 Additional Preparatory and Initial Phases

Additional preparatory and initial phases shall be conducted on the same definable features of work if the quality of on-going work is unacceptable, if there are changes in the applicable CQC staff, onsite production supervision or work crew, if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.7 TESTS

3.7.1 Testing Procedure

The Contractor shall perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements, see Table 1 – Minimum Testing, attached at the end of this specification section. Contractor shall submit all materials test reports on forms standard to industry standards such as ACI, ASTM and AASHTO or with laboratory accreditation forms such as AALA, NIST or NVLAP. Upon request, the Contractor shall furnish to the Government duplicate samples of test specimens for possible testing by the Government. Testing includes operation and/or acceptance tests when specified. The Contractor shall procure the services of a Corps of Engineers validated testing laboratory or establish a testing laboratory at the project site which can be validated by the Corps of Engineers in advance of any and all required testing; and in addition, submit proof of validation for approval. The Contractor shall perform the following activities and record and provide the following data:

a. Verify that testing procedures comply with contract requirements.

b. Verify that facilities and testing equipment are available and comply with testing standards.

c. Check test instrument calibration data against certified standards.

d. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.

e. Results of all tests taken, both passing and failing tests, shall be recorded on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test shall be given. If approved by the Contracting Officer, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an offsite or commercial test facility shall be provided directly to the Contracting Officer. Failure to submit timely test reports as stated may result in nonpayment for related work performed and disapproval of the test facility for this contract.

3.7.2 Testing Laboratories

a. Validation

The testing laboratory shall be validated by the Corps of Engineers Materials Testing Center (MTC) for all tests required by the contract prior to the performance of any such testing. The validation of a laboratory is site specific and cannot be transferred or carried over to a facility at a different location. Any and all costs associated with this Government laboratory validation shall be borne by the laboratory and/or the Contractor. Validation of a laboratory is not granted for the entire laboratory activity, but only for the specific procedures requested by the inspected laboratory. The inspected laboratory has full choice of the procedures to be inspected except that the Quality Assurance portion of ASTM E 329 is mandatory to be inspected.

(1) Validation Procedures

Validation of a laboratory may consist of either an inspection or audit as defined herein. Validation of all material testing laboratories shall be performed by the MTC. Validation may be accomplished by one of the following processes:

(a) Inspection. Inspection shall be performed by the MTC in accordance with American Society for Testing and Materials (ASTM) standards E329 and D3740.

(b) Audit. A laboratory may be validated by auditing if it has been accredited by the Concrete and Cement Reference Laboratory (CCRL) or AASHTO Materials Reference Laboratory (AMRL) within the past two years in accordance with ASTM E329. Audit shall be performed by the MTC. Inspection by MTC may be required after auditing if one or more of the critical testing procedures required in the project specification were not included in the CCRL or AMRL inspection report or if there is any concern that the laboratory may not be able to provide required services.

b. Standards of Acceptability

(1) Aggregate, concrete, bituminous materials, soil, and rock. Laboratories for testing aggregate, concrete, bituminous materials, soil, and rock shall be validated for compliance with ASTM E 329, Engineer Manual (EM) 1110-2-1906, or project specifications, as applicable.

(2) Water, sediment, and other samples. Laboratories engaged in analysis of water, sediment, and other samples for chemical analysis shah be inspected to assure that they have the capability to perform analyses and quality control procedures described in references in Appendix A as appropriate. The use of analytical methods for procedures not addressed in these references will be evaluated by the CQAB for conformance with project or program requirements.

(3) Steel and other construction materials, Laboratories testing steel and other construction materials shall be validated for capabilities to perform tests required by project requirements and for compliance with ASTM E329.

c. Validation Schedule

(1) For all contracted laboratories and project Quality Assurance (QA) laboratories testing aggregate, concrete, bituminous materials, soils, rock, and other construction materials, an initial validation shall be performed prior to performance of testing and at least every two (2) years thereafter.

(2) Laboratories performing water quality, wastewater, sludge, and sediment testing shall be approved at an interval not to exceed eighteen (18) months.

(3) All laboratories shall be revalidated at any time at the discretion of the Corps of Engineers when conditions are judged to differ substantially from the conditions when last validated.

d. Validation Process

If a validated laboratory is unavailable or the Contractor selects to use a laboratory which has not been previously validated, Contractor shall coordinate with Corps of Engineers Material Testing Center (MTC) to obtain validation and pay all associated costs. Point of contact at MTC is Daniel Leavell, telephone (601) 634-2496, fax (601) 634-4656, email daniel.a.leavell@erdc.usace.army.mil, at the following address:

U.S. Army Corps of Engineers
Materials Testing Center
Waterways Experiment Station
3909 Hall Ferry Road
Vicksburg, MS 39180-6199

Procedure for Corps of Engineers validation, including qualifications and inspection/audit request forms are available at the MTC web site:

http://www.wes.army.mil/SL/MTC/mtc.htm

Contractor shall coordinate directly with the MTC to obtain validation. Contractor is cautioned the validation process is complicated and lengthy, may require an onsite inspection by MTC staff, correction of identified deficiencies, and the submittal and approval of significant documentation. Estimate a minimum of 60 days to schedule an inspection/submittal and receive a validation. Cost of onsite inspections is $4500 plus travel time and cost from Vicksburg MS. Cost of audits is $2500. If an onsite inspection is required following an audit, the cost of the inspection shall be $2500 plus travel time and cost. The Contractor will be invoiced for actual travel costs and shall submit payment direct to the MTC made payable to the ERDC Finance and Accounting Officer prior to the scheduling of the inspection and/or audit. The Contractor shall copy the Contracting Officer of all correspondence and submittals to the MTC for purposes of laboratory validation.

3.7.3 Onsite Laboratory

The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

3.7.4 Furnishing or Transportation of Samples for Testing

Costs incidental to the transportation of samples or materials will be borne by the Contractor. Samples of materials for test verification and acceptance testing by the Government shall be delivered to the Corps of Engineers Division Laboratory, f.o.b., at the following address:

U.S. Army Corps of Engineers
Materials Testing Center
Waterways Experiment Station
3909 Hall Ferry Road
Vicksburg, MS 39180-6199
Phone: (601) 634-2496 or (601) 634-3261

ATTN: Project _____, Contract Number _____

Coordination for each specific test, exact delivery location and dates will be made through the Area Office. If samples are scheduled to arrive at the laboratory on a weekend (after 1700 Friday through Sunday) notify the laboratory at least 24 hours in advance at (601) 634-2496 to arrange for delivery.

3.8 COMPLETION INSPECTION

3.8.1 Punch-Out Inspection

Near the completion of all work or any increment thereof established by a completion time stated in the Special Clause entitled "Commencement, Prosecution, and Completion of Work," or stated elsewhere in the specifications, the CQC System Manager shall conduct an inspection of the work and develop a punch list of items which do not conform to the approved drawings and specifications. Such a list of deficiencies shall be included in the CQC

documentation, as required by paragraph DOCUMENTATION below, and shall include the estimated date by which the deficiencies will be corrected. The CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected. Once this is accomplished, the Contractor shall notify the Government that the facility is ready for the Government Pre-Final inspection.

3.8.2 Pre-Final Inspection

The Government will perform this inspection to verify that the facility is complete and ready to be occupied. A Government Pre-Final Punch List may be developed as a result of this inspection. The Contractor's CQC System Manager shall ensure that all items on this list have been corrected before notifying the Government so that a Final inspection with the customer can be scheduled. Any items noted on the Pre-Final inspection shall be corrected in a timely manner. These inspections and any deficiency corrections required by this paragraph shall be accomplished within the time slated for completion of the entire work or any particular increment thereof if the project is divided into increments by separate completion dates.

3.8.3 Final Acceptance Inspection

The Contractor's Quality Control Inspection personnel, plus the superintendent or other primary management person, and the Contracting Officer's Representative shall be in attendance at this inspection. Additional Government personnel including, but not limited to, those from Base/Post Civil Facility Engineer user groups, and major commands may also be in attendance. The final acceptance inspection will be formally scheduled by the Contracting Officer based upon results of the Pre-Final inspection. Notice shall be given to the Contracting Officer at least 14 days prior to the final acceptance inspection and shall include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final acceptance inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with the contract clause titled "Inspection of Construction".

3.9 DOCUMENTATION

The Contractor shall maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the work of subcontractors and suppliers and shall be on an acceptable form that includes, as a minimum, the following information:

a. Contractor/subcontractor and their area of responsibility.

b. Operating plant/equipment with hours worked, idle, or down for repair.

c. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.

d. Test and/or control activities performed with results and references to specifications/drawings requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.

e. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications/drawings requirements.

f. Submittals reviewed, with contract reference, by whom, and action taken.

g. Off-site surveillance activities, including actions taken.

h. Job safety evaluations stating what was checked, results, and instructions or corrective actions.

i. Instructions given/received and conflicts in plans and/or specifications.

j. Contractor's verification statement.

These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. The original and one copy of these records in report form shall be furnished to the Government daily within 24 hours after the date covered by the report, except that reports need not be submitted for days on which no work is performed. As a minimum, one report shall be prepared and submitted for every 7 days of no work and on the last day of a no work period. All calendar days shall be accounted for throughout the life of the contract. The first report following a day of no work shall be for that day only. Reports shall be signed and dated by the CQC System Manager. The report from the CQC System Manager shall include copies of test reports and copies of reports prepared by all subordinate quality control personnel.

3.10 SAMPLE FORMS

Sample forms are attached at the end of this specification section.

3.11 NOTIFICATION OF NONCOMPLIANCE

The Contracting Officer will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

TABLE 1

MINIMUM SAMPLING AND TESTING FREQUENCY

Materials	Test	Minimum Sampling and Testing Frequency
Fills, Embankments, Backfills, Subgrade, Subbase, and Base Course Material		
Fill and Embankment	Field Density 2/12/	Two tests per lift for each increment or fraction of 1,672 square meters (2000 sy) and any time material type changes.
	Lab Density 3/	One test initially per each type of materials or blended material and any time material type changes, and one every 10 field density tests.
	Gradation 1/	One test every 153 cubic meters (200 cubic yards) of fill for each type of materials or blended material and any time material type changes.
Subgrade	Field Density 2/12/	One test per each increment or fraction of 84 square meters (100 s.y.)
	Lab Density 3/	One test every 10 field density tests.
Backfill for Culverts, Trenches, Buildings and Walls, Pavements, and Other Structures	Field Density 2/12/	Culverts: One test per each lift.
		Trenches: One test per lift for each increment or fraction of 152 lineal meters (500 linear feet) for backfill. Under pavements, one test every lift and at every crossing.
		Walls and Buildings Perimeters, Including Footings: One test per lift for each increment or fraction of 61 lineal meters (200 linear feet) of backfill.

Materials	Test	Minimum Sampling and Testing Frequency
		Buildings Slabs on Grade: One test per lift for each increment or faction of 93 square meters (1000 s.f.) Areas enclosed by grade beams, compacted with power driven hand operated compactors: One test per lift for each increment or fraction of 46 square meters (500 s.f.) Pavements: Two tests per lift for each increment or fraction of 1,672 square meters (2000 s.y.) Other Structures: One test per lift for each increment or fraction of 61 lineal meters (200 linear feet) of backfill.
	Lab Density3/	One test initially per each type of material or blended material and one every 10 field density tests.
	Gradation1/	One test per each type of material or blended material and one every 10 field density tests.
Subbase and Base	Gradation1/(including .02 mm particles size limits.	1 sample for every 3,345 square meters (4,000 sy.)
	In-Place Density2/ 12/	1 sample every 1,672 square meters (2,000 sy.)
	Moisture-Density Relationship3/	1 initially and every 20 density tests.
	Asphaltic Concrete and Pavements (Non airfield)	
Asphaltic concrete	Marshall method Test	1 test per day minimum and 1 per 907,200 kilograms (1,000 tons) thereafter.
	Specific Gravity	per each Marshall Test.
	Extraction	1 test for each Marshall Method.
	Gradation5/	1 per each extraction test.
	Fracture faces5/	1 per each extraction test.

Materials	Test	Minimum Sampling and Testing Frequency
Cored or sawed specimens	Perform complete test (thickness, in-place density and bulk specific gravity) on each cored or sawed sample.12/	Take 1 set of 3 cored sawed specimens for each 836 square meters (1,000 square yards) or fraction thereof. One specimen shall be taken from longitudinal joint or from transverse joint.
	Portland Cement Concrete (Non airfield)	
Coarse and Fine Aggregate7/	Moisture, specific gravity and absorption8/	1 initially.
	Gradation and fineness modules	1 every 191 cubic meters (250 cy) of concrete.
	Moisture, specific gravity and absorption8/	(same as coarse aggregate).
Concrete	Slump	Conduct test every day of placement and for every 19 cubic meters (25 cy) and more frequently if batching appears inconsistent. Conduct with strength tests.
	Entrained Air	Conduct with slump test.
	Ambient and concrete temperatures	Conduct with slump tests.
	Unit weight, yield, and water cement ratio	Conduct with strength tests. Check unit weight and adjust aggregate weights to ensure proper yield.
	Flexural strength and evaluation	When specified for slabs on grade or for concrete pavements, take one set of 6 beams every 76 cubic meters (100 cy) of concrete with a minimum of 1 set per day. Two beams shall be tested at 7 days, two at 28 days, and two at 90 days.

Materials	Test	Minimum Sampling and Testing Frequency
	Compressive strength	One set of 3 cylinders per day and every 76 cubic meters (100 cy) for each class of structural concrete. Test one cylinder at 7 days and two at 28 days. Additional field cure cylinders shall be made when insitu strengths are required to be known.
Vibrators	Frequency and amplitude	Check frequency and amplitude initially and any time vibration is questionable.
	Masonry	
Concrete Masonry Units[9/]	Dry shrinkage[10/]	1 set of 3 per 10,000 units and manufacturers certification and test report.
	Airdry condition[11/]	Same as dry shrinkage.
	Absorption	" " " "
	Compressive strength	" " " "
	Unit Weight	" " " "
Mortar and grout	Compressive Strength	1 set of 3, every 2,000 units (1 test at 7 days and 2 tests at 28 days).

NOTES:

1/All acceptance tests shall be conducted from in-place samples.
2/Additional tests shall be conducted when variations occur due to the contractors operations, weather conditions, site conditions, etc.
3/Classification (ASTM D-2487), moisture contents, Atterberg limits and specific gravity tests shall be conducted for each compaction test if applicable.
4/Materials to be submitted only upon request by the Contracting Officer.
5/Tests can substitute for same tests required under "Aggregates" (from bins or source), although gradations will be required when blending aggregates.
6/Increase quantities by 50 percent for Paving mixes and by 100 percent for Government testing of admixtures. Include standard deviation for similar mixes from the intended batch plant and data from a minimum of 30 tests, if available. Refer to ACI 214.
7/A petrographic report for aggregate is required with the sample for source approval. If the total amount of all types of concrete is less than 153 cubic meters (200 c.y.) service records from three separate structures in similar environments which used the aggregates may substitute for the petrographic report.
8/Aggregate moisture tests are to be conducted in conjunction with concrete strength tests for w/c calculations.
9/For less than 1,000 units, the above test may be waived at the discretion of the Contracting Officer and acceptance based on manufacturers certification and test report.
10/Additional tests shall be performed when changes are made either in the manufacturing processes or in materials used in the production of the masonry units.
11/If adequate storage protection is not provided at the jobsite, additional tests shall be made to determine that the allowable moisture condition has not been exceeded before the blocks can be placed in the structure.
12/The nuclear densometer, if properly calibrated, may be used but only in addition to the required testing frequency and procedures using sandcones. The densometer shall be calibrated and is recommended for use when the time for complete results becomes critical.

(sample of typical Contractor's Daily Report)
DAILY CONSTRUCTION QUALITY CONTROL REPORT

Contract Number: _____ Date: _____ Rpt. No._____

Contract Title: _____ Location: _____

Weather: Clear __ P. Cloudy __ Cloudy __ Rainfall __ (__% of workday)

Temperature during workday: High ____ degrees F. Low ___ degrees F.

1. WORK PERFORMED BY CONTRACTOR/SUBCONTRACTOR(S):

Contractor Name	No. of Workers	Crafts/Hours	Work performed

2. EQUIPMENT DATA:

Type, Size, Etc.	Owned/Rented	Hours Used	Hours Standby

3. QUALITY CONTROL INSPECTIONS AND RESULTS: (Include a description of preparatory, initial, and/or follow up inspections or meetings; check of subcontractors work and materials delivered to the site compared to submittals and/or specifications; comments on the proper storage of materials; include comments on corrective actions to be taken):

_____

_____

_____

_____

4. QUALITY CONTROL TESTING AND RESULTS (comment on tests and attach test reports):

_____

_____

_____

5. DAILY SAFETY INSPECTIONS (Include comments on new hazards to be added to the Hazard Analysis and corrective action of any safety issues):

_____

_____

6. REMARKS (Include conversations with or instructions from the Government representatives; delays of any kind that are impacting the job; conflicts in the contract documents; comments on change orders; environmental considerations; etc.):

_____

_____

_____

_____

_____

CONTRACTOR'S VERIFICATION: The above report is complete and correct. All material, equipment used, and work performed during this reporting period are in compliance with the contract documents except as noted above.

_____
CONTRACTOR QC REPRESENTATIVE

(Sample of Typical Contractor's Test Report)

TEST REPORT

STRUCTURE OR BUILDING _____

CONTRACT NO. _____

DESCRIPTION OF ITEM, SYSTEM, OR PART OF SYSTEM TESTED:
_____

_____

DESCRIPTION OF TEST: _____

_____

_____
NAME AND TITLE OF PERSON IN CHARGE OF PERFORMING TESTS FOR THE CONTRACTOR:

NAME_____

TITLE_____

SIGNATURE_____

I HEREBY CERTIFY THAT THE ABOVE DESCRIBED ITEM, SYSTEM, OR PART OF SYSTEM HAS BEEN TESTED AS INDICATED ABOVE AND FOUND TO BE ENTIRELY SATISFACTORY AS REQUIRED IN THE CONTRACT SPECIFICATIONS.

SIGNATURE OF CONTRACTOR
QUALITY CONTROL INSPECTOR_____

DATE_____

REMARKS
_____

_____

_____

END OF SECTION

SECTION 02726

PORTLAND CEMENT PERVIOUS PAVEMENT

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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(1997) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457 mm (18-in) Drop
AASHTO T 224	(1996) Correction for Coarse Particles in the Soil Compaction Test

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 29/C 29M	(1997) Bulk Density ("Unit Weight") and Voids in Aggregates
ASTM C 33	(1999a) Concrete Aggregates
ASTM C 42	(1999) Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 150	(1999a) Portland Cement
ASTM C 172	(1999) Sampling Freshly Mixed Concrete
ASTM C 494	(1999) Chemical Admixtures for Concrete
ASTM C 642	Test Method for Specific Gravity, Absorption, and Voids Hardened Concrete.
ASTM C 1077	(1998) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM D 448	(1998) Standard Sizes of Coarse Aggregate for Highway Construction

ASTM E 329	(2002) Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction
ASTM C 1116	(2000) Fiber-Reinforced Concrete and Shotcrete.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment

a. Details and data on the batching and mixing plant prior to plant assembly including manufacturer's literature showing that the equipment meets all requirements specified herein.

b. A description of the equipment proposed for transporting concrete mixture from the central mixing plant to the paving equipment at least 7 days prior to start of paving unless otherwise specified.

c. At the time the materials are furnished for the mixture proportioning study, a description of the equipment proposed for the placing of the concrete mixture, method of control, and manufacturer's literature on the paver and finisher, together with the manufacturer's written instructions on adjustments and operating procedures necessary to assure a tight, smooth surface on the concrete pavement, free of tears and other surface imperfections, including excessive paste on the surface. The literature shall show that the equipment meets all details of these specifications.

Proposed Techniques; G

a. A description of the placing and protection methods proposed prior to construction of the test section, if concrete is to be placed in or exposed to hot or cold weather conditions.

b. A detailed plan of the proposed paving pattern showing all planned construction joints. No deviation from the jointing pattern shown on the drawings shall be made without written approval of the Seattle District, Design Branch, Civil/Soils Section.

c. Data on the curing media and methods to be used.

Samples for Mixture Proportioning Studies; G

The results of the Contractor's mixture proportioning studies along with a statement giving the maximum nominal coarse aggregate size and the proportions of all ingredients that will be used in the manufacture of concrete at least 30 days prior to commencing concrete placing operations. Aggregate quantities shall be based on the mass in a saturated surface dry condition. The statement shall be accompanied by test results from an independent commercial testing laboratory, inspected by the Government, and approved in writing, showing that mixture proportioning studies have been made with materials proposed for the project and that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the mixture proportions without additional tests to show that the quality of the concrete is satisfactory.

SD-06 Test Reports

Sampling and Testing; G

Certified copies of laboratory test reports, including all test data, for cement, pozzolan, aggregate, admixtures, and curing compound proposed for use on this project. These tests shall be made by an approved independent commercial testing laboratory or by a laboratory maintained by the manufacturers of the materials. No material shall be used until notice of acceptance has been given. Materials may be subjected to check testing by the Government from samples obtained at the manufacturer, at transfer points, or at the project site.

SD-0X Contractor Qualifications

Qualifications; G

The use of an ACI Concrete Flatwork Certified Finisher is required. Prior to award of the contract, the placing contractor shall furnish the Contracting Officer a statement attesting to the following qualifications and experience:

A minimum of 2 successfully completed projects with addresses, including each project’s unit weight acceptance data, in-situ pavement test results including void content and unit weight, and sample of product (i.e. core of test panel).

If the placing Contractor and concrete producer have insufficient experience with portland cement pervious concrete pavement, the placing Contractor shall retain an experienced consultant (as qualified above) to monitor production, handling, and placement operations at the Contractor’s expense.

1.5 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by a testing laboratory approved in accordance with Section 01451 CONTRACTOR QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements; testing shall be performed at the specified frequency. The Contracting Officer may specify the time and location of the tests. Copies of test results shall be furnished to the Contracting Officer within 24 hours of completion of the tests.

1.5.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.5.2 Tests

The following tests shall be performed, in conformance with the applicable standards listed, as indicated in paragraph: PORTLAND CEMENT PERVIOUS PAVEMENT CONCRETE TESTING INSPECTION AND ACCEPTANCE.

1.5.4 Approval of Material

The source of the material shall be selected 30 days prior to the time the material will be required in the work. Tentative approval of material will be based on initial test results. Final approval of the materials will be based on sieve analysis, liquid limit, and plasticity index tests performed on samples taken from the completed and fully compacted ABC.

1.6 WEATHER LIMITATIONS

Portland cement pervious pavement construction shall be done when the atmospheric temperature is between 40 degrees F and 80 degrees F, unless specifically approved by the Contracting Officer. When the temperature falls below 40 degrees F, the Contractor shall protect all completed areas by approved methods against detrimental effects of freezing. Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

1.7 PLANT, EQUIPMENT, AND TOOLS

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

1.8 TEST PANEL

The Contractor shall place, joint and cure two test panels, each to be a minimum of 225 sq. ft. at the required project thickness to demonstrate, to the satisfaction of the Contracting Officer, that in-place unit weights can be achieved and a satisfactory pavement can be installed at the site location.

1.8.1 Test Panel Location

Test panels may be placed at any of the specified portland cement pervious pavement locations.

1.8.2 Test Panel Testing Requirements and Tolerances

Test panels shall be tested for the following:

Thickness: Thickness shall be accordance with ASTM C 42; Compacted thickness no less than 1/4-inch of specified thickness.

Void Structure: Void Structure shall be tested in accordance with ASTM C 138; 12% minimum to 21% maximum.

Core Unit Weight: The core unit weight shall be in accordance with ASTM C 140, paragraph 6.3, and shall be within plus or minus 5 pcf of the design unit weight.

1.8.3 Test Panel Acceptance

If measured void structure falls below 15%, if measured thickness is greater than 1/4" less than the specified thickness or measured weight falls less than 5 pcf below unit weight, the test panel shall be rejected and removed and disposed of at the Contractor's expense. If the test panel meets the above-mentioned requirements, it can be left in-place and included in the completed work.

PART 2 PRODUCTS

2.1 CONCRETE MIX DESIGN

Contractor shall furnish a proposed mix design with proportions of materials to the Contracting Officer 30 days prior to commencement of work. The data shall include rodded unit weights determined in accordance with ASTM C 29 Paragraph 11, Rodded Unit Weight.

2.1.1 Proportions

2.1.1.1 Aggregate and Cement Content

The volume of aggregate, cement, water, and admixture per cu. yd. shall be equal to 27 cu. ft. when calculated as a function of the unit weight determined in accordance with ASTM C 29 rodding procedure. Fine aggregate, if used, should not exceed 3 cu. ft. and shall be included in the total aggregate volume.

2.1.1.2 Admixtures

Shall be used in accordance with the manufacturer's instructions and recommendations.

2.1.1.3 Mix Water

Mix water shall be such that the cement paste displays a wet metallic sheen without causing the paste to flow from the aggregate. (Mix water yielding a cement paste with a dull-dry appearance has insufficient water for hydration).

2.1.1.4 Water Cement Ratio

Water cement ratio shall range from 0.27 to 0.35.

a. Insufficient water results in inconsistency in the mix and poor bond strength.

b. High water content results in the paste sealing the void system primarily at the bottom and poor surface bond.

2.2 MATERIALS

Locally available material having a record of satisfactory performance shall be used.

2.3 PORTLAND CEMENT PERVIOUS CONCRETE

2.3.1 Cement

Portland Cement Type I or II conforming to ASTM C 150 or Portland Cement Type IP or IS conforming to ASTM C 595.

2.3.2 Aggregate

Aggregate for Portland cement pervious concrete shall be crushed gravel, stone or hydraulic cement concrete or combination there of meeting No 8 coarse aggregate (3/8 to No. 16) per ASTM C 33 or No. 89 coarse aggregate (3/8 to No. 50) per ASTM D 448. If other gradation of aggregate is to be used, submit data on proposed material ~~to owner~~ for approval by Contracting Officer.

2.3.3 Admixtures

The following admixtures shall be used:

2.3.3.1 Water Reducing/Retarding Admixture

Water reducing/retarding shall be in conformance with ASTM C 494, Type D.

2.3.3.2 Hydration Stabilizer

A hydration stabilizer that also meets the requirements of ASTM C 494, Type B Retarding or Type D Water Reducing/Retarding admixtures. This stabilizer suspends cement hydration by forming a protective barrier around the cementitious particles, which delays the particles from achieving initial set.

2.3.3.3. Fiber Reinforcement.

Reinforcement shall be 1-1/2 inch fibrillated fiber at 1.5 pounds per cubic yard. Synthetic fibers shall conform to ASTM C 1116, Type III, Synthetic Fiber, and as follows. Fibers shall be 100 percent virgin polypropylene fibrillated fibers containing no reprocessed olefin materials. Fibers shall have a specific gravity of 0.9, a minimum tensile strength of 70 ksi graded per manufacturer, and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement.

2.3.4 Water

Potable water shall be used. Mix water shall be such that the cement paste displays a wet metallic sheen without causing the paste to flow from the aggregate. (Mix water yielding a

cement paste with a dull-dry appearance has insufficient water for hydration). Water cement ratios can range from 0.27 to 0.35.

2.3.5 Proportions – Aggregate and Cement Content

The volume of aggregate, cement, water, and admixture per cubic yard shall be equal to 27 cubic feet when calculated as a function of the unit weight determined in accordance with ASTM C 29 rodding procedure. Fine aggregate, if used, should not exceed 3 cubic feet and shall be included in the total aggregate volume. Admixtures shall be used in accordance with the manufacturer's instructions and recommendations. Insufficient mix water results in inconsistency in the mix and poor bond strength. High water content results in the paste sealing the void system primarily at the bottom and poor surface bond.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

~~a. Existing subgrade under bed areas shall~~ NOT ~~be compacted or subject to excessive construction equipment traffic prior to filter fabric and stone bed placement~~.

a~~b~~. Where erosion of subgrade has caused accumulation of fine materials and/or surface ponding, this material shall be removed with light equipment and the underlying soils scarified to a minimum depth of 6 inches with a York rake or equivalent and light tractor.

~~c. Bring subgrade of stone recharge bed to line, grade, and elevations indicated. Fill and lightly regrade any areas damaged by erosion, ponding, or traffic compaction before the placing of stone.~~

3.2 RECHARGE BED INSTALLATION (NOT APPLICABLE)

~~a. Upon completion of subgrade work, the Engineer shall be notified and shall inspect at his discretion before proceeding with recharge bed installation.~~

~~b. Filter fabric, pipe, and recharge bed aggregate shall be placed immediately after approval of subgrade preparation. Any accumulation of debris or sediment which has taken place after approval of subgrade shall be removed prior to installation of filter fabric at no extra cost to the Owner.~~

~~c. Place filter fabric in accordance with manufacturer's standards and recommendations. Adjacent strips of filter fabric shall overlap a minimum of sixteen inches (16"). Secure fabric at least two feet (2') outside of bed and take steps necessary to prevent any runoff or sediment from entering the storage bed. Place impervious liner over geo-textile extending 6' beyond toe of slope face at building face, secure as recommended by manufacturer.~~

~~d. Install coarse aggregate in 8-inch maximum lifts. Lightly compact each layer with equipment, keeping equipment movement over storage bed subgrades to a minimum. Install aggregate to grades indicated on the drawings.~~

~~e. Install 1" thick choker base course size No. 57 (AASHTO) aggregate evenly over surface of stone bed, sufficient to allow placement of pavement, and notify Engineer for approval.~~

~~f. Following placement of bed aggregate, the filter fabric shall be folded back along all bed edges to protect from sediment washout along bed edges. At least a two foot edge strip shall be used to protect beds from adjacent bare soil. This edge strip shall remain in place until all bare soils contiguous to beds are stabilized and vegetated. In addition, hay bales shall be placed at the toe of slopes which may be adjacent to beds to further prevent sediment from washing into beds during site development. As the site is fully stabilized, excess filter fabric along bed edges can be cut back to gravel edge.~~

3.3 PORTLAND CEMENT PERVIOUS PAVEMENT CONCRETE MIXING, HAULING AND PLACING

3.3.1 Mix Time

Truck mixers shall be operated at the speed designated as mixing speed by the manufacturer for 75 to 100 revolutions of the drum.

3.3.2 Transportation

The portland cement pervious pavement aggregate mixture may be transported or mixed on site and should be used within one (1) hour of the introduction of mix water, unless otherwise approved by an engineer. This time can be increased to 90 minutes when utilizing the hydration stabilizer specified as long as the temperature of the concrete does not exceed 90 degrees Fahrenheit. Under no circumstance will retempering of concrete be allowed after any water adjustments have been made to delivered concrete at jobsite. Trucks used to transport the porous concrete shall have not more than 3 consecutive loads of material without hauling conventional concrete or rinsing.

3.3.3 Base Course

Prior to placing concrete, the base course material shall be moistened and in a wet condition.

3.3.4 Discharge

Each mixer truck will be inspected for appearance of concrete uniformity. Water may be added to obtain the required mix consistency. Any water adjustments made at the jobsite shall be made by the Contractor's Quality Control representatives, only upon approval by the on-site Contracting Officer's Representative. A minimum of 20 revolutions at the manufacturer's designated mixing speed shall be required following any addition of water to the mix. Discharge shall be a continuous operation and shall be completed as quickly as possible. Concrete shall be deposited as close to its final position as practicable and such that fresh concrete enters the mass of previously placed concrete. The practice of discharging onto subgrade and pulling or shoveling to final placement is not allowed.

3.3.5 Placing and Finishing Equipment

The Contractor shall provide mechanical equipment of either slipform or form riding with a following compactive unit that will provide a minimum of 10 psi vertical force, unless otherwise approved by the Contracting Officer in writing. The pervious concrete pavement will be placed to the required cross section and shall not deviate more than +/- 3/8-inch in 10 feet from profile grade. If placing equipment does not provide the minimum specified vertical force, a full width roller or other full width compaction device that provides sufficient

compactive effort shall be used immediately following the strike-off operation. After mechanical or other approved strike-off and compaction operation, no other finishing operation will be allowed. If vibration, internal or surface applied, is used, it shall be shut off immediately when forward progress is halted for any reason. The Contractor will be restricted to pavement placement widths of a maximum of fifteen (15-ft) feet unless the Contractor can demonstrate competence to provide pavement placement widths greater than the maximum specified to the satisfaction of the Engineer.

3.3.6 Curing

Curing procedures shall begin within 20 minutes after the final placement operations. The pavement surface shall be covered with a minimum six (6) mil thick polyethylene sheet or other approved covering material. Prior to covering, a fog or light mist shall be sprayed above the surface when required due to ambient conditions (high temperature, high wind, and low humidity). The cover shall overlap all exposed edges and shall be secured (without using dirt or stone) to prevent dislocation due to winds or adjacent traffic conditions.

3.3.6.1 Cure Time

Portland Cement Type I, II: 7 days minimum. No truck traffic shall be allowed for 10 days (no passenger car/light trucks for 7 days).

3.3.7 Jointing

Control (contraction) joints shall be installed as indicated ~~by landscape architect~~on the ~~-~~plans. They shall be installed at a depth of 1/4 the thickness of the pavement and 1/8 inch to 3/16 inch wide. These joints can be installed in the plastic concrete or saw cut. If saw cut, the procedure should begin as soon as the pavement has hardened sufficiently to prevent raveling and uncontrolled cracking (normally after curing). Transverse constructions joints shall be installed whenever placing is suspended a sufficient length of time that concrete may begin to harden. In order to assure aggregate bond at construction joints, a bonding agent suitable for bonding fresh concrete shall be brushed, rolled, or sprayed on the existing pavement surface edge. Isolation (expansion) joints will not be used except when pavement is abutting slabs or other adjoining structures.

3.4 PORTLAND CEMENT PERVIOUS PAVEMENT CONCRETE TESTING, INSPECTION, AND ACCEPTANCE

3.4.1 Laboratory Testing

Testing will be conducted by an approved independent commercial testing laboratory.

3.4.2 Testing and Acceptance

3.4.2.1 Unit Weight

A minimum of one test for each day's placement of pervious concrete in accordance with ASTM C 172 and ASTM C 29 to verify unit weight shall be conducted. Delivered unit weights are to be determined in accordance with ASTM C 29 using a 0.25 cubic foot cylindrical metal measure. The measure is to be filled and compacted in accordance with ASTM C 29

paragraph 11, rodding procedure. The unit weight of the delivered concrete shall be +/- 5 pcf of the design unit weight. Infiltration rate shall be +/- 15% of accepted core samples.

3.4.2.2 Cores

The paving contractor shall provide two cores taken from each panel in accordance with ASTM C 42 at a minimum of seven (7) days after placement of the pervious concrete. The cores shall be measured for thickness, void structure, and unit weight. Untrimmed, hardened core samples shall be used to determine placement thickness. The average of all production cores shall not be less than the specified thickness with no individual core being more than 1/2-inch less than the specified thickness. After thickness determination, the cores shall be trimmed and measured for unit weight per ASTM C 642. Ranges of satisfactory unit weight values are +/- 5 pcf of the design unit weight. Core holes shall be filled with concrete meeting the pervious mix design per ASTM C 642.

END OF SECTION

SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

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 350	(1986) Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
ARI 410	(1991) Forced-Circulation Air-Cooling and Air-Heating Coils
ARI 430	(1989) Central-Station Air-Handling Units
ARI 440	(1998) Room Fan-Coil and Unit Ventilator
ARI 445	(1987; R 1993) Room Air-Induction Units
ARI 880	(1998) Air Terminals
ARI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

AIR CONDITIONING CONTRACTORS OF AMERICA (ACCA)

ACCA Manual 4	(1990) Installation Techniques for Perimeter Heating & Cooling; 11th Edition

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 210	(1985) Laboratory Methods of Testing Fans for Rating
AMCA 300	(1996) Reverberant Room Method for Sound Testing of Fans

AMERICAN BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA Std 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
AFBMA Std 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S12.32	(1990; R 1996) Precision Methods for the Determination of Sound Power Levels of Discrete-Frequency and Narrow-Band Noise Sources in Reverberation Rooms

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 47/A 47M	(1999) Ferritic Malleable Iron Castings
ASTM A 53/A 53M	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 106	(1999el) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 123/A 123M	(1997ael) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 181/A 181M	(1995b) Carbon Steel, Forgings for General-Purpose Piping
ASTM A 183	(1983; R 1998) Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	(1999a) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 234/A 234M	(1999) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A 536	(1999el) Ductile Iron Castings
ASTM A 733	(1999) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 924/A 924M	(1999) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings
ASTM B 75	(1999) Seamless Copper Tube
ASTM B 75M	(1999) Seamless Copper Tube (Metric)
ASTM B 88	(1999) Seamless Copper Water Tube
ASTM B 88M	(1999) Seamless Copper Water Tube (Metric)
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM B 650	(1995) Electrodeposited Engineering Chromium Coatings on Ferrous Substrates
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications for Copper and Copper Alloy Tube
ASTM C 916	(1985; R 1996el) Adhesives for Duct Thermal Insulation

ASTM C 1071	(1998) Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)
ASTM D 520	(1984; R 1995el) Zinc Dust Pigment
ASTM D 1384	(1997a) Corrosion Test for Engine Coolants in Glassware
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 1785	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2000	(1999) Rubber Products in Automotive Applications
ASTM D 2466	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM E 437	(1992; R 1997) Industrial Wire Cloth and Screens (Square Opening Series)
ASTM F 872	(1984; R 1990) Filter Units, Air-Conditioning: Viscous-Impingement Type, Cleanable
ASTM F 1199	(1988; R 1998) Cast (All Temperature and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)

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

ASHRAE 15	(1994) Safety Code for Mechanical Refrigeration
ASHRAE 52.1	(1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
ASHRAE 68	(1986) Laboratory Method of Testing In-Duct Sound Power Measurement Procedures for Fans
ASHRAE 70	(1991) Method of Testing for Rating the Performance of Air Outlets and Inlets
ASHRAE 84	(1991) Method of Testing Air-to-Air Heat Exchangers

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
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	(1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(1998) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.1	(1998) Power Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(1997) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(2000) Structural Welding Code - Steel

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1419	(Rev D; Canc. Notice 1) Filter Element, Air Conditioning (Viscous-Impingement and Dry Types, Replaceable)

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(1998; 7th Edition) EJMA Standards

INSTITUTE OF ENVIRONMENTAL SCIENCES (IES)

IES RP-CC-001.3	(1993) HEPA and ULPA Filters

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

MSS SP-25	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Cast Iron Swing Check Valves, Flanges and Threaded Ends
MSS SP-72	(1999) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(1994) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends
MSS SP-110	(1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1998) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
NFPA 90A	(1999) Installation of Air Conditioning and Ventilating Systems
NFPA 96	(1998) Ventilation Control and Fire Protection of Commercial Cooking Equipment

NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION (NAIMA)

NAIMA AH115	(1993) Fibrous Glass Duct Construction Standards

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

SMACNA HVAC Duct Const Stds	(1995; Addenda Nov 1997) HVAC Duct Construction Standards - Metal and Flexible
SMACNA Industry Practice	(1975) Accepted Industry Practice for Industrial Duct Construction

SMACNA Install Fire Damp HVAC	(1992) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
SMACNA Leakage Test Mnl	(1985) HVAC Air Duct Leakage Test Manual

UNDERWRITERS LABORATORIES (UL)

UL 94	(1996; Rev through Jul 1998) Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 181	(1996; Rev Dec 1998) Factory-Made Air Ducts and Air Connectors
UL 214	(1997) Tests for Flame-Propagation of Fabrics and Films
UL 555	(1999) Fire Dampers
UL 586	(1996; Rev through Aug 1999) High-Efficiency, Particulate, Air Filter Units
UL 705	(1994; Rev through Feb 1999) Power Ventilators
UL 723	(1996; Rev through Dec 1998) Test for Surface Burning Characteristics of Building Materials
UL 900	(1994; Rev through Nov 1999) Test Performance of Air Filter Units
UL 1995	(1995; Rev through Aug 1999) Heating and Cooling Equipment
UL Bld Mat Dir	(1999) Building Materials Directory
UL Elec Const Dir	(1999) Electrical Construction Equipment Directory
UL Fire Resist Dir	(1999) Fire Resistance Directory (2 Vol.)

1.2 COORDINATION OF TRADES

Ductwork, piping offsets, fittings, and accessories shall be furnished as required to provide a complete installation and to eliminate interference with other construction.

1.3 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings; G
Installation; G

Drawings shall consist of equipment layout including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of all guides and anchors, the load imposed on each support or anchor, and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

SD-03 Product Data

Components and Equipment; G

Manufacturer's catalog data shall be included with the detail drawings for the following items. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:

a. Piping Components

b. Ductwork Components

c. Air Systems Equipment

d. Air Handling Units

e. Energy Recovery Devices

f. Terminal Units

Test Procedures;

Proposed test procedures for piping hydrostatic test, ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

Welding Procedures;

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

System Diagrams; G

Proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

Similar Services;

Statement demonstrating successful completion of similar services on at least 5 projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section.

Welding Joints;

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

Testing, Adjusting and Balancing; G

Proposed test schedules for hydrostatic test of piping, ductwork leak test, and performance tests, at least 2 weeks prior to the start of related testing.

Field Training;

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

SD-06 Test Reports

Performance Tests;

Test reports for the piping hydrostatic test, ductwork leak test, and performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

SD-07 Certificates

Bolts;

Written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, and the number of each type of bolt to be furnished.

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; GA

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 8 hour onsite response to a service call on an emergency basis.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Components and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years before bid opening.

The 2-year experience shall include applications of components and equipment under similar circumstances and of similar size. The 2 years must 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 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization.

2.2 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.

2.3 NAMEPLATES

Equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.4 EQUIPMENT GUARDS AND ACCESS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified. Catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed according to Section 05500 MISCELLANEOUS METAL.

2.5 PIPING COMPONENTS

2.5.1 Steel Pipe

Steel pipe shall conform to ASTM A 53/A 53M, Schedule 40, Grade A or B, Type E or S.

2.5.2 Joints and Fittings For Steel Pipe

Joints shall be welded, flanged, threaded, or grooved as indicated. If not otherwise indicated, piping 25 mm (1 inch) and smaller shall be threaded; piping larger than 25 mm (1 inch) and smaller than 80 mm (3 inches) shall be either threaded, grooved, or welded; and piping 80 mm (3 inches) and larger shall be grooved, welded, or flanged. Rigid grooved mechanical joints and fittings may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 110 degrees C (230 degrees F). Flexible grooved joints shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein. The manufacturer of each fitting shall be permanently identified on the body of the fitting according to MSS SP-25.

2.5.2.1 Welded Joints and Fittings

Welded fittings shall conform to ASTM A 234/A 234M, and shall be identified with the appropriate grade and marking symbol. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11.

2.5.2.2 Flanged Joints and Fittings

Flanges shall conform to ASTM A 181/A 181M and ASME B16.5, Class 150. Gaskets shall be nonasbestos compressed material according to ASME B16.21, 2.0 mm (1/16 inch) thickness, full face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene

rubber (SBR) or nitrile butadiene rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.5. Bolts shall be high or intermediate strength material conforming to ASTM A 193/A 193M.

2.5.2.3 Threaded Joints and Fittings

Threads shall conform to ASME B1.20.1. Unions shall conform to ASME B16.39, Class 150. Nipples shall conform to ASTM A 733. Malleable iron fittings shall conform to ASME B16.3, type as required to match piping.

2.5.2.4 Dielectric Unions and Flanges

Dielectric unions shall have the tensile strength and dimensional requirements specified. Unions shall have metal connections on both ends threaded to match adjacent piping. Metal parts of dielectric unions shall be separated with a nylon insulator to prevent current flow between dissimilar metals. Unions shall be suitable for the required operating pressures and temperatures. Dielectric flanges shall provide the same pressure ratings as standard flanges and provide complete electrical isolation.

2.5.2.5 Grooved Mechanical Joints and Fittings

Joints and fittings shall be designed for not less than 862 kPa (125 psig) service and shall be the product of the same manufacturer. Fitting and coupling houses shall be malleable iron conforming to ASTM A 47/A 47M, Grade 32510; ductile iron conforming to ASTM A 536, Grade 65-45-12; or steel conforming to ASTM A 106, Grade B or ASTM A 53/A 53M. Gaskets shall be molded synthetic rubber with central cavity, pressure responsive configuration and shall conform to ASTM D 2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 110 degrees C (230 degrees F) or Grade No. M3BA610A15B44Z for circulating medium up to 93 degrees C (200 degrees F). Grooved joints shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A 183.

2.5.3 Copper Tube

Copper tube shall conform to ASTM B 88, and ASTM B 88M, Type K or L.

2.5.4 Joints and Fittings For Copper Tube

Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75M. ASTM B 75. Cast copper alloy solder-joint pressure fittings shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used.

2.5.5 Valves

Valves shall be Class 125 and shall be suitable for the intended application. Valves shall meet the material, fabrication and operating requirements of ASME B31.1. Chain operators shall be provided for valves located 3 meters (10 feet) or higher above the floor. Valves in sizes larger than 25 mm (1 inch) and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be provided by the same manufacturer as the grooved pipe joint and fitting system.

2.5.5.1 Gate Valves

Gate valves 65 mm (2-1/2 inches) and smaller shall conform to MSS SP-80 and shall be bronze with rising stem and threaded, solder, or flanged ends. Gate valves 80 mm (3 inches) and larger shall conform to MSS SP-70 and shall be cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.5.5.2 Globe Valves

Globe valves 65 mm (2-1/2 inches) and smaller shall conform to MSS SP-80, bronze, threaded, soldered, or flanged ends. Globe valves 80 mm (3 inches) and larger shall conform to MSS SP-85 and shall be cast iron with bronze trim and flanged, or threaded ends.

2.5.5.3 Check Valves

Check valves 65 mm (2-1/2 inches) and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Check valves 80 mm (3 inches) and larger shall conform to MSS SP-71and shall be cast iron with bronze trim and flanged or threaded ends.

2.5.5.4 Angle Valves

Angle valves 65 mm (2-1/2 inches) and smaller shall conform to MSS SP-80 and shall be bronze with threaded, soldered, or flanged ends. Angle valves 80 mm (3 inches) and larger shall conform to MSS SP-85 and shall be cast iron with bronze trim and flanged, or threaded ends.

2.5.5.5 Ball Valves

Ball valves 15 mm (1/2 inch) and larger shall conform to MSS SP-72 or MSS SP-110, and shall be ductile iron or bronze with threaded, soldered, or flanged ends.

2.5.5.6 Butterfly Valves

Butterfly valves shall be 2 flange or lug wafer type, and shall be bubble-tight at 1.03 MPa (150 psig). Valve bodies shall be cast iron, malleable iron, or steel. ASTM A 167, Type 404 or Type 316, corrosion resisting steel stems, bronze or corrosion resisting steel discs, and synthetic rubber seats shall be provided. Valves smaller than 200 mm (8 inches) shall have throttling handles with a minimum of seven locking positions. Valves 200 mm (8 inches) and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators. Valves in insulated lines shall have extended neck to accommodate insulation thickness.

2.5.5.7 Balancing Valves

Balancing valves 50 mm (2 inches) or smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valves 25 mm (1 inch) or larger may be all iron with threaded or flanged ends. The valves shall have a square head or similar device and an indicator arc and shall be designed for 120 degrees C (250 degrees F). Iron valves shall be lubricated, nonlubricated, or tetrafluoroethylene resin-coated plug valves. In lieu of plug valves, ball valves may be used. Plug valves and ball valves 200 mm (8 inches) or larger shall be provided with manual gear operators with position indicators. Where indicated, automatic flow control valves shall be provided to maintain constant flow, and shall be designed to be sensitive to pressure differential across the valve to provide the required opening. Valves shall be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Valves shall control the flow within 5 percent of the tag rating. Valves shall be suitable for the maximum operating pressure of 862 kPa (125 psig) or 150 percent of the system operating pressure, whichever is the greater. Where flow readings are provided by remote or portable meters, valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable meter to measure the pressure differential across the automatic flow control valve. A portable meter furnished with accessory kit as recommended by the automatic valve manufacturer shall be provided.

2.5.5.8 Air Vents

Manual air vents shall be brass or bronze valves or cocks suitable for pressure rating of piping system and furnished with threaded plugs or caps. Automatic air vents shall be float type, cast iron, stainless steel, or forged steel construction, suitable for pressure rating of piping system.

2.5.6 Strainers

Strainer shall be in accordance with ASTM F 1199, except as modified herein. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. The strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. The bodies shall have arrows clearly cast on the sides indicating the direction of flow. Each strainer shall be equipped with removable cover and sediment screen. The screen shall be made of minimum 0.8 mm (22 gauge) brass sheet, monel, or corrosion-resistant steel, with small perforations numbering not less than 60 per square centimeter (400 per square inch) to provide a net free area through the basket of at least 3.3 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.5.7 Water or Steam Heating System Accessories

Water heating accessories such as expansion tanks shall be as specified in Section 15569A WATER HEATING; GAS ; UP TO 20 MBTUH.

2.5.8 Glycol

The glycol shall be tested according to ASTM D 1384 and shall cause less than 0.0125 mm (0.5 mils) penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicon based inhibitors shall not be used. The solution shall be compatible with all wetted items within the system.

2.5.9 Backflow Preventers

Backflow preventers shall be according to Section 15400 PLUMBING, GENERAL PURPOSE.

2.5.10 Flexible Pipe Connectors

Flexible pipe connectors shall be designed for 862 kPa (125 psi) or 1034 kPa (150 psi) service as appropriate for the static head plus the system head, and 120 degrees C, (250 degrees F), 110 degrees C (230 degrees F) for grooved end flexible connectors. The flexible section shall be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. The flexible section shall be suitable for intended service with end connections to match adjacent piping. Flanged assemblies shall be equipped with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Covers to protect the bellows shall be provided where indicated.

2.5.11 Pressure Gauges

Gauges shall conform to ASME B40.1 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 85 mm (3-1/2 inches) in diameter and shall have a range from 0 kPa (0 psig) to approximately 1.5 times the maximum system working pressure. Pressure gauges shall be oil or glycerin filled.

2.5.12 Thermometers

Thermometers 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 225 mm (9 inch) scale, and shall have rigid stems with straight, angular, or inclined pattern.

2.5.13 Escutcheons

Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or setscrews.

2.5.14 Pipe Hangers, Inserts, and Supports

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

2.5.15 Expansion Joints

2.5.15.1 Slip Joints

Expansion joints shall provide for either single or double slip of the connected pipes, as required or indicated, and for not less than the traverse indicated. The joints shall be designed for working temperature and pressure suitable for the application, but not less than 1034 kPa (150 psig), and shall be according to applicable requirements of EJMA Stds and ASME B31.1. End connections shall be flanged or beveled for welding as indicated. Joint shall be provided with an anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip shall be seamless steel plated with a minimum of 0.058 mm (2 mils) of hard chrome according to ASTM B 650. All joint components shall be suitable for the intended service. Initial setting shall be made according to the manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer, but in any case shall be not more than 1.5 (4 inches) or smaller, guides shall be installed not more than 600 mm (2 feet) from the joint. Service outlets shall be provided where indicated.

2.5.15.2 Flexible Ball Joints

Flexible ball joints shall conform to EJMA Stds and ASME B31.1 and be constructed of alloys as appropriate for the service intended. Where so indicated, the ball joint shall be designed for packing injection under full line pressure to contain leakage. The joint ends shall be threaded to 50 mm (2 inches) only, grooved, flanged, or beveled for welding as indicated or required and shall be capable of absorbing a minimum of 15-degree angular flex and 360 degree rotation. Balls and sockets shall be suitable for the intended service. The exterior spherical surface of carbon steel balls shall be plated with mils of hard chrome according to ASTM B 650. The ball type joints shall be designed and constructed according to EJMA Stds and ASME B31.1 where applicable. Where required, flanges shall conform to ASME B16.5.

2.5.15.3 Bellows Type Joints

Bellows type joints shall be flexible, guided expansion joints. The expansion element shall be stabilized corrosion resistant steel. Bellows type expansion joints shall conform to the applicable requirements of EJMA Stds with internal sleeves. Guiding of piping on both sides of expansion joint shall be according to the published recommendations of the manufacturer of the expansion joint. The joints shall be designed for the working temperature and pressure suitable for the application but not less than 1034 kPa (150 psig).

2.5.17 Insulation

Shop and field applied insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. All insulation materials, including jackets used in the attic spaces shall be non-combustible.

2.6 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be according to Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 745 W (1 hp) and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers shall be utilized for motors rated 7.45 kW (10 hp) or less. Adjustable frequency drives shall be used for larger motors.

2.7 CONTROLS

Controls shall be provided as specified in Section 15910 DIRECT DIGITAL CONTROL SYSTEMS.

2.8 DUCTWORK COMPONENTS

2.8.1 Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA HVAC Duct Const Stds unless otherwise specified. Elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure Class 125, 250, and 500 Pa (1/2, 1, and 2 inch w.g.) ductwork shall meet the requirements of Seal Class C. Class 750 through 2500 Pa (3 through 10 inch) shall meet the requirements of Seal Class A. Sealants shall conform to fire hazard classification specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA HVAC Duct Const Stds. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 50 mm (2 inch) band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar will not be acceptable. Outdoor air intake ducts and plenums shall be fabricated with watertight soldered or brazed joints and seams.

2.8.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

2.8.1.2 Metallic Flexible Duct

Metallic type duct shall be single-ply galvanized steel, Type 316 stainless steel, or two-ply aluminum, self supporting to 2.4 m (8 foot) spans. Duct shall be of corrugated/interlocked, folded and knurled type seam construction, bendable without damage through 180 degrees with a throat radius equal to 1/2 duct diameter. Duct shall conform to UL 181 and shall be rated for positive or negative working pressure of 3.75 kPa (15 inches water gauge) at 177 degrees C (350 degrees F) when duct is aluminum, and 343 degrees C (650 degrees F) when duct is galvanized steel or stainless steel.

2.8.1.3 Insulated Nonmetallic Flexible Duct Runouts

Flexible duct runouts shall be used only where indicated. Runout length shall be as shown on the drawings, but shall in no case exceed 3 m (10 feet). Runouts shall be preinsulated, factory fabricated, and shall comply with NFPA 90A and UL 181. Either field or factory applied vapor barrier shall be provided. Where coil induction or high velocity units are supplied with vertical air inlets, a streamlined and vaned and mitered elbow transition piece shall be provided for connection to the flexible duct or hose. The last elbow to these units, other than the vertical air inlet type, shall be a die-stamped elbow and not a flexible connector. Insulated flexible connectors may be used as runouts. The insulated material and vapor barrier shall conform to the requirements of Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation material surface shall not be exposed to the air stream.

2.8.1.4 General Service Duct Connectors

A flexible duct connector approximately 150 mm (6 inches) in width shall be provided where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL Bld Mat Dir.

2.8.1.5 High Temperature Service Duct Connections

Material shall be approximately 2.38 mm (3/32 inch) thick, 1.2 to 1.36 kg per square meter (35 to 40-ounce per square yard) weight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 650 degrees C (1200 degrees F).

2.8.2 Ductwork Accessories

2.8.2.1 Duct Access Doors

Access doors shall be provided in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown, shall conform to SMACNA HVAC Duct Const Stds. Access doors shall be provided upstream and downstream of air flow measuring primaries and heating and cooling coils. Doors shall be minimum 375 x 450 mm, (15 x 18 inches), unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Doors 600 x 600 mm (24 x 24 inches) or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be the insulated type.

2.8.2.2 Fire Dampers

Fire dampers shall be 1-1/2 hour fire rated unless otherwise indicated. Fire dampers shall conform to the requirements of NFPA 90A and UL 555. The Contractor shall perform the fire damper test as outlined in NFPA 90A. A pressure relief damper shall be provided upstream of the fire damper whenever the fan static pressure rating exceeds the duct pressure classification. If the ductwork

connected to the fire damper is to be insulated then this pressure relief damper shall be factory insulated. Fire dampers shall be automatic operating type and shall have a dynamic rating suitable for the maximum air velocity and pressure differential to which it will be subjected. Fire dampers shall be approved for the specific application, and shall be installed according to their listing. Fire dampers shall be equipped with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, will not impair the operation of the damper. Sleeves or frames shall be equipped with perimeter mounting angles attached on both sides of the wall or floor opening. Ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies shall be constructed in conformance with UL Fire Resist Dir. Fire dampers shall be curtain type with damper blades out of the air stream or multi-blade type. Dampers shall not reduce the duct or the air transfer opening cross-sectional area. Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.8.2.3 Splitters and Manual Balancing Dampers

Splitters and manual balancing dampers shall be furnished with accessible operating mechanisms. Where operators occur in finished portions of the building, operators shall be chromium plated with all exposed edges rounded. Splitters shall be operated by quadrant operators or 5 mm (3/16 inch) rod brought through the side of the duct with locking setscrew and bushing. Two rods are required on splitters over 200 mm (8 inches). Manual volume control dampers shall be operated by locking-type quadrant operators. Dampers and splitters shall be 2 gauges heavier than the duct in which installed. Unless otherwise indicated, multileaf dampers shall be opposed blade type with maximum blade width of 300 mm (12 inches). Access doors or panels shall be provided for all concealed damper operators and locking setscrews. Unless otherwise indicated, the locking-type quadrant operators for dampers, when installed on ducts to be thermally insulated, shall be provided with stand-off mounting brackets, bases, or adapters to provide clearance between the duct surface and the operator not less than the thickness of the insulation. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer. Volume dampers shall be provided where indicated.

2.8.2.4 Air Deflectors and Branch Connections

Air deflectors shall be provided at duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections may be used in lieu of deflectors or extractors for branch connections. All air deflectors, except those installed in 90 degree elbows, shall be provided with an approved means of adjustment. Adjustment shall be made from easily accessible means inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, external adjustments shall be provided with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Air deflectors shall be factory-fabricated units consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Air deflectors shall be factory or field assembled. Blade air deflectors, also called blade air extractors, shall be approved factory fabricated units consisting of equalizing grid and adjustable blade and lock. Adjustment shall be easily made from the face of the diffuser or by position adjustment and lock external to the duct. Stand-off brackets shall be provided on insulated ducts and are described herein. Fixed air deflectors, also called turning vanes, shall be provided in 90 degree elbows.

2.8.4 Duct Sleeves, Framed Prepared Openings, Closure Collars

2.8.4.1 Duct Sleeves

Duct sleeves shall be provided for round ducts 375 mm (15 inches) in diameter or less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round ducts larger than 375 mm (15 inches) in diameter and square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 1.0 mm (20 gauge) galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53/A 53M, Schedule 20 shall be used. Sleeve shall provide 25 mm (1 inch) clearance between the duct and the sleeve or 25 mm (1 inch) clearance between the insulation and the sleeve for insulated ducts.

2.8.4.2 Framed Prepared Openings

Openings shall have 25 mm (1 inch) clearance between the duct and the opening or 25 mm (1 inch) clearance between the insulation and the opening for insulated ducts.

2.8.4.3 Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 100 mm (4 inches) wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 375 mm (15 inches) in diameter or less shall be fabricated from 1.0 mm (20 gauge) galvanized steel. Collars for round ducts larger than 375 mm (15 inches) and square, and rectangular ducts shall be fabricated from 1.3 mm (18 gauge) galvanized steel. Collars shall be installed with fasteners on maximum 150 mm (6 inch) centers, except that not less than 4 fasteners shall be used.

2.8.5 Plenums and Casings for Field-Fabricated Units

2.8.5.1 Plenum and Casings

Plenums and casings shall be fabricated and erected as shown in SMACNA HVAC Duct Const Stds, as applicable. Unless otherwise indicated, system casing shall be constructed of not less than 1.6 mm (16 gauge) galvanized sheet steel. Cooling coil drain pans with 25 mm (1 inch) threaded outlet shall be provided to collect condensation from the cooling coils. Drain pans shall be fabricated of not lighter than 1.6 mm (16 gauge) steel, galvanized after fabrication or of 1.3 mm (18 gauge) corrosion-resisting sheet steel conforming to ASTM A 167, Type 304, welded and stiffened. Drain pans exposed to the atmosphere shall be thermally insulated to prevent condensation. Insulation shall be coated with a flame resistant waterproofing material. Separate drain pans shall be provided for each vertical coil section, and a separate drain line shall be provided for each pan. Pans shall be generously sized to ensure capture of entrained moisture on the downstream-air side of the coil. Openings in the casing, such as for piping connections, shall be sealed and covered to prevent air leakage. Water seal for the drain shall provide at least 500 Pa (2 inch) water gauge greater than the maximum negative pressure in the coil space.

2.8.5.2 Casing

Casings shall be terminated at the curb line and anchored by the use of galvanized angle iron sealed and bolted to the curb, as indicated in SMACNA HVAC Duct Const Stds.

2.8.5.3 Access Doors

Access doors shall be provided in each section of the casing. Door frames shall be welded in place, and each door shall be neoprene gasketed, hinged with minimum of two brass hinges, and fastened with a minimum of two brass tension fasteners operable from inside and outside of the casing. Where possible, doors shall be 900 x 450 mm (36 x 18 inches) located 450 mm (18 inches) above the floor. Where the space available will not accommodate doors of this size, doors as large as the space will accommodate shall be provided. Doors shall swing so that fan suction or pressure holds door in closed position, and shall be airtight. A push-button station to stop the supply fan shall be located inside the casing where indicated.

2.8.5.4 Factory-Fabricated Insulated Sheet Metal Panels

Factory-fabricated components may be used for field-assembled units, provided all requirements specified for field-fabricated plenums and casings are met. Panels shall be of modular design, pretested for structural strength, thermal control, condensation control, and acoustical control. Panel joints shall be sealed and insulated access doors shall be provided and gasketed to prevent air leakage. Panel construction shall be not less than 1.0 mm (20 gauge) galvanized sheet steel and shall be assembled with fasteners treated against corrosion. Standard length panels shall deflect not more than 13 mm (1/2 inch) under operation. Details of construction, including joint sealing, not specifically covered shall be as indicated in SMACNA HVAC Duct Const Stds. The plenums and casings shall be constructed to withstand the specified internal pressure of the air systems.

2.8.5.5 Duct Liner

Unless otherwise specified, duct liner shall conform to ASTM C 1071, Type I or II.

2.8.6 Sound Attenuation Equipment

a. Systems With Total Pressure Above 1 kPa (4 Inches Water Gauge):

Sound attenuators shall be provided on the discharge duct of each fan operating at a total pressure above 1 kPa (4 inch water gauge), and, when indicated, at the intake of each fan system. Sound attenuators shall be provided elsewhere as indicated. The sound attenuators shall be factory fabricated and shall be tested by an independent laboratory for sound and performance characteristics. Net sound reduction shall be as indicated. Maximum permissible pressure drop shall not exceed 157 Pa (0.63 inch water gauge). Traps shall be constructed to be airtight when operating under an internal static pressure of 2.5 kPa (10 inch water gauge). Air-side surface shall be capable of withstanding air velocity of 50 m/s (10,000 fpm). The Contractor shall certify that the sound reduction values specified will be obtained after the equipment is installed in the system and coordinated with the sound information of the system fan to be provided. Sound absorbing material shall conform to ASTM C 1071, Type I or II. Sound absorbing material shall meet the fire hazard rating requirements for insulation specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. A duct transition section shall be provided for connection to ductwork. Factory fabricated double-walled internally insulated spiral lock seam and round duct and fittings designed for high pressure air system may be provided in lieu of factory fabricated sound attenuators, and shall comply with requirements specified for factory fabricated sound attenuators. The double-walled duct and fittings shall be constructed of an outer metal pressure shell of zinc-coated steel sheet, 25 mm (1 inch) thick acoustical blanket insulation, and an internal perforated zinc-coated metal liner. Sufficient length of run shall be provided to obtain the noise reduction coefficient specified. The Contractor shall certify that the sound reduction value specified will be obtained within the length of duct run provided. The outer sheet metal of the double-walled duct shall have welded, or spiral lock, seams to prevent water vapor penetration. The outer sheet of the duct and fittings shall conform to the metal thickness of high pressure spiral and round ducts and fittings shown in SMACNA HVAC Duct Const Stds. The acoustical insulation shall have a thermal conductivity "k" of not more than 0.0389 W/m-K (0.27 Btu/inch/square foot/hour/degree F) at 24 degrees C (75 degrees F) mean temperature. The internal perforated zinc-coated metal liner

shall be not less than 0.7 mm (24 gauge) with perforations not larger than 6.35 mm (1/4 inch) in diameter providing a net open area not less than 10 percent of the surface.

a. System With Total Pressure of 1000 Pa (4 Inch Water Gauge) and Lower:

Sound attenuators shall be provided only where indicated, or in lieu of lined ducts. Factory fabricated sound attenuators shall be constructed of galvanized steel sheets. Outer casing shall be not less than 0.85 mm (22 gauge). Acoustical fill shall be fibrous glass. Net sound reduction shall be as indicated. Values shall be obtained on a test unit not less than 600 mm (24 inches) by 600 mm (24 inches) outside dimensions made by a certified nationally recognized independent acoustical laboratory. Air flow capacity shall be as indicated or required. Pressure drop through the attenuator shall not exceed the value indicated, or shall not be in excess of 15 percent of the total external static pressure of the air handling system, whichever is less. Sound attenuators shall be acoustically tested with metal duct inlet and outlet sections while under the rated air flow conditions. Noise reduction data shall include the effects of flanking paths and vibration transmission. Sound attenuators shall be constructed to be airtight when operating at the internal static pressure indicated or specified for the duct system, but in no case less than 500 Pa (2 inch water gauge).

a. Acoustical Duct Liner:

Acoustical duct lining shall be fibrous glass designed exclusively for lining ductwork and shall conform to the requirements of ASTM C 1071, Type I and II. Liner composition may be uniform density, graduated density, or dual density, as standard with the manufacturer. Lining shall be coated, not less than 25 mm (1 inch) thick. Where acoustical duct liner is used, liner or combination of liner and insulation applied to the exterior of the ductwork shall be the thermal equivalent of the insulation specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Duct sizes shown shall be increased to compensate for the thickness of the lining used. In lieu of sheet metal duct with field-applied acoustical lining, acoustically equivalent lengths of fibrous glass duct or factory fabricated double-walled internally insulated duct with perforated liner may be provided. Net insertion loss value, static pressure drop, and air flow velocity capacity data shall be certified by a nationally recognized independent acoustical laboratory.

2.8.7 Diffusers, Registers, and Grilles

Units shall be factory-fabricated of steel, corrosion-resistant steel, or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 0.25 m/s (50 fpm) in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified according to ASHRAE 70. Inlets and outlets shall be sound rated and certified according to ASHRAE 70. Sound power level shall be as indicated. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers, except linear slot diffusers. Linear slot diffusers shall be provided with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 2 m (7 feet) above the floor, they shall be protected by a grille or screen according to NFPA 90A.

2.8.7.1 Diffusers

Diffuser types shall be as indicated. Ceiling mounted units shall be furnished with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Diffusers shall be provided with air deflectors of the type indicated. Air handling troffers or combination light and ceiling diffusers shall conform to the requirements of UL Elec Const Dir for the interchangeable use as cooled or heated air supply diffusers or return air units. Ceiling mounted units shall be installed with rims tight against ceiling. Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers.

Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller. Return or exhaust units shall be similar to supply diffusers.

2.8.7.2 Registers and Grilles

Units shall be four-way directional-control type, except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 150 mm (6 inches) below the ceiling unless otherwise indicated. Return and exhaust registers shall be located 150 mm (6 inches) above the floor unless otherwise indicated. Four-way directional control may be achieved by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Grilles shall be as specified for registers, without volume control damper.

2.8.8 Louvers

Louvers for installation in exterior walls which are associated with the air supply and distribution system shall be as specified in Section 07600 SHEET METALWORK, GENERAL.

2.8.9 Air Vents, Penthouses, and Goosenecks

Air vents, penthouses, and goosenecks shall be fabricated from galvanized steel or aluminum sheets with galvanized or aluminum structural shapes. Sheet metal thickness, reinforcement, and fabrication shall conform to SMACNA HVAC Duct Const Stds. Louver blades shall be accurately fitted and secured to frames. Edges of louver blades shall be folded or beaded for rigidity and baffled to exclude driving rain. Air vents, penthouses, and goosenecks shall be provided with bird screen.

2.8.10 Bird Screens and Frames

Bird screens shall conform to ASTM E 437, No. 2 mesh, aluminum or stainless steel. Aluminum screens shall be rated "medium-light". Stainless steel screens shall be rated "light". Frames shall be removable type, or stainless steel or extruded aluminum.

2.8.11 Radon Exhaust Ductwork

Radon exhaust ductwork installed in or beneath slabs shall be fabricated from Schedule 40 PVC pipe that conforms to ASTM D 1785. Fittings shall conform to ASTM D 2466. Solvent cement used to make joints shall conform to ASTM D 2564. Otherwise radon exhaust ductwork shall be metal as specified herein.

2.9 AIR SYSTEMS EQUIPMENT

2.9.1 Fans

Fans shall be tested and rated according to AMCA 210. Fans may be connected to the motors either directly or indirectly with V-belt drive. V-belt drives shall be designed for not less than 150 percent of the connected driving capacity. Motor sheaves shall be variable pitch for 11 kW (15 hp) and below and fixed pitch as defined by ARI Guideline D. Variable pitch sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts. Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings as indicated. Vibration-isolation units shall be

standard products with published loading ratings. Each fan shall be selected to produce the capacity required at the fan static pressure indicated. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated.

2.9.1.1 Centrifugal Fans

Centrifugal fans shall be fully enclosed, single-width single-inlet, or double-width double-inlet, AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Impeller wheels shall be rigidly constructed, accurately balanced both statically and dynamically. Fan blades may be forward curved, backward-inclined or airfoil design in wheel sizes up to 750 mm (30 inches, or as indicated on the drawings. Fan blades for wheels over 750 mm (30 inches) in diameter shall be backward-inclined or airfoil design, or as indicated on the drawings. Booster fans for exhaust dryer systems shall be the open-wheel radial type. These fans shall be suitable for conveying lint and the temperatures encountered. The fan shaft shall be provided with a heat slinger to dissipate heat buildup along the shaft. An access (service) door to facilitate maintenance shall be supplied with these fans. Fan wheels over 900 mm (36 inches) in diameter shall have overhung pulleys and a bearing on each side of the wheel. Fan wheels 900 mm (36 inches) or less in diameter may have one or more extra long bearings between the fan wheel and the drive. Bearings shall be sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Fan shafts shall be steel, accurately finished, and shall be provided with key seats and keys for impeller hubs and fan pulleys. Each fan outlet shall be of ample proportions and shall be designed for the attachment of angles and bolts for attaching flexible connections. Manually or automatically operated outlet dampers shall be provided as indicated. Motors, unless otherwise indicated, shall not exceed 1800 rpm and shall have open, dripproof, or totally enclosed enclosures. Motor starters shall be magnetic across-the-line type with general-purpose enclosure. Remote manual switch with pilot indicating light shall be provided where indicated.

2.9.1.2 In-Line Centrifugal Fans

In-line fans shall have centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Fans shall be mounted in a welded tubular casing. Air shall enter and leave the fan axially. Inlets shall be streamlined with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt and shall be permanently lubricated, and shall be precision self aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Motors shall have open, dripproof, or totally enclosed enclosure. Motor starters shall be magnetic across-the-line with general-purpose enclosures. Remote manual switch with pilot indicating light shall be provided where indicated.

2.9.1.3 Axial Flow Fans

Axial flow fans shall be complete with drive components and belt guard, and shall have a steel housing, cast fan wheel, cast or welded steel diffusers, fan shaft, bearings, and mounting frame as a factory-assembled unit. Fan wheels shall have radially projecting blades of airfoil cross section and shall be dynamically balanced and keyed to the fan shaft. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt, shall be permanently lubricated or with accessible grease fittings, and shall be precision self-aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours of operation as defined by AFBMA Std 9 and AFBMA Std 11. Fan inlets shall be provided with an aerodynamically shaped bell and an inlet cone. Diffuser or straightening vanes shall be provided at the fan discharge to minimize turbulence and provide smooth discharge air flow. Fan unit shall be provided with inlet and outlet flanges, inlet screen, and automatic operation adjustable inlet vanes. Unless otherwise indicated, motors shall not

exceed 1800 rpm and shall have open, dripproof, or totally enclosed enclosure. Motor starters shall be magnetic across-the-line with general-purpose enclosure. Remote manual switch with pilot indicating light shall be provided where indicated.

2.9.1.4 Panel Type Power Wall Ventilators

Fans shall be propeller type, assembled on a reinforced metal panel with venturi opening spun into panel. Fans with wheels less than 600 mm (24 inches) diameter shall be direct or V-belt driven and fans with wheels 600 mm (24 inches) diameter and larger shall be V-belt drive type. Fans shall be furnished with wall mounting collar. Lubricated bearings shall be provided. Fans shall be fitted with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Motor enclosure shall be dripproof, or totally enclosed fan cooled type. Gravity, or motor operated backdraft dampers shall be provided where and as indicated.

2.9.1.5 Centrifugal Type Power Wall Ventilators

Fans shall be direct or V-belt driven centrifugal type with backward inclined, non-overloading wheel. Motor housing shall be removable and weatherproof. Unit housing shall be designed for sealing to building surface and for discharge and condensate drippage away from building surface. Housing shall be constructed of heavy gauge aluminum. Unit shall be fitted with an aluminum or plated steel wire discharge bird screen, anodized aluminum, or stainless steel wall grille, manufacturer's standard gravity or motor-operated damper, an airtight and liquid-tight metallic wall sleeve. Motor enclosure shall be totally enclosed fan cooled, or dripproof type. Lubricated bearings shall be provided.

2.9.1.6 Centrifugal Type Power Roof Ventilators

Fans shall be direct or V-belt driven with backward inclined, non-overloading wheel. Motor compartment housing shall be hinged or removable and weatherproof, constructed of heavy gauge aluminum. Fans shall be provided with bird screen, disconnect switch, gravity or motorized dampers, sound curb, roof curb, and extended base as indicated or required. Motors enclosure shall be dripproof type. Lubricated bearings shall be provided.

2.9.1.7 Propeller Type Power Roof Ventilators

Fans shall be direct or V-belt driven. Fan housing shall be hinged or removable weathertight, fitted with framed rectangular base constructed of aluminum or galvanized steel. Motors shall be totally enclosed fan cooled type. Motors shall be provided with nonfusible, horsepower rated, manual disconnect mount on unit. Fans shall be provided with gravity or motor operated dampers, bird screen, sound curb, roof curb. Lubricated bearings shall be provided.

2.9.1.8 Ceiling Exhaust Fans

Suspended cabinet-type ceiling exhaust fans shall be centrifugal type, direct-driven. Fans shall have acoustically insulated housing. Integral backdraft damper shall be chatter-proof. The integral face grille shall be of egg-crate design or louver design. Fan motors shall be mounted on vibration isolators. Unit shall be provided with mounting flange for hanging unit from above. Fans shall be UL listed.

2.9.2 Coils

Coils shall be fin-and-tube type constructed of seamless copper tubes and aluminum or copper fins mechanically bonded or soldered to the tubes. Copper tube wall thickness shall be a minimum of 0.508 mm (0.020 inches). Aluminum fins shall be 0.19 mm (0.0075 inch) minimum thickness. Copper fins shall be 0.114 mm (0.0045 inch) minimum thickness. Casing and tube support sheets shall be not lighter than 1.6 mm (16 gauge) galvanized steel, formed to provide structural strength. When required, multiple tube supports shall be provided to prevent tube sag. Each coil shall be tested at the factory under water at not less than 2.76 MPa (400 psi) air pressure and shall be suitable for 1.38 MPa (200

psi) 200 psi working pressure. Coils shall be mounted for counterflow service. Coils shall be rated and certified according to ARI 410.

2.9.2.1 Water Coils

Water coils shall be installed with a pitch of not less than 10 mm per meter 1/8 inch per foot of the tube length toward the drain end. Headers shall be constructed of cast iron, welded steel or copper. Each coil shall be provided with a plugged vent and drain connection extending through the unit casing.

2.9.3 Air Filters

Air filters shall be listed according to requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method shall be as listed under the Label Service and shall meet the requirements of UL 586.

2.9.3.1 Extended Surface Pleated Panel Filters

Filters shall be 50 mm (2 inch) depth, sectional, disposable type of the size indicated and shall have an average efficiency of 25 to 30 percent when tested according to ASHRAE 52.1. Initial resistance at 2.54 m/s (500 feet per minute) shall not exceed 9 mm (0.36 inches) water gauge. Filters shall be UL Class 2. Media shall be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. All four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

2.9.3.2 Extended Surface Nonsupported Pocket Filters

Filters shall be 750 (30 inch) depth, sectional, replaceable dry media type of the size indicated and shall have an average efficiency of 80 to 85 percent when tested according to ASHRAE 52.1. Initial resistance at 2.54 m/s (500 feet per minute) shall not exceed 11 mm (0.45 inches) water gauge. Filters shall be UL Class 1. Media shall be fibrous glass, supported in the air stream by a wire or non-woven synthetic backing and secured to a galvanized steel metal header. Pockets shall not sag or flap at anticipated air flows. Each filter shall be installed with an extended surface pleated panel filter as a prefilter in a factory preassembled, side access housing or a factory-made sectional frame bank, as indicated.

2.9.3.3 Sectional Cleanable Filters

Cleanable filters shall conform to ASTM F 872, and shall be 25 1 inches thick. Viscous adhesive shall be provided in 20 liter (5 gallon) containers in sufficient quantity for 12 cleaning operations and not less than one liter (one quart) for each filter section. One washing and charging tank shall be provided for every 100 filter sections or fraction thereof. Each washing and charging unit shall consist of a tank and double drain rack mounted on legs. Drain rack shall be provided with dividers and partitions to properly support the filters in the draining position. Initial pressure drop for clean filters shall not exceed the applicable values listed in ASTM F 872.

2.9.3.4 Replaceable Media Filters

Replaceable media filters shall be the dry-media type, of the size required to suit the application. Filtering media shall be not less than 50 mm (2 inches) thick fibrous glass media pad supported by a structural wire grid or woven wire mesh. Pad shall be enclosed in a holding frame of not less than 1.6 mm (16 gauge) galvanized steel, and equipped with quick-opening mechanism for changing filter media. The air flow capacity of the filter shall be based on net filter face velocity not exceeding 1.5 m/s (300 feet per minute), with initial resistance of 32 Pa (0.13 inches water gauge). Average efficiency shall be not less than 35 percent when tested according to ASHRAE 52.1.

2.9.3.5 Range and Griddle Hood Service

Filter shall be sectional, permanent, washable, all metallic media type, nominal 50 mm (2 inches) thick, with suitable metal frames, designed for extraction of grease from grease-laden air.

2.9.3.6 Holding Frames

Frames shall be fabricated from not lighter than 1.6 mm (16 gauge) sheet steel with rust-inhibitor coating. Each holding frame shall be equipped with suitable filter holding devices. Holding frame seats shall be gasketed. All joints shall be airtight.

2.9.3.7 Filter Gauges

Filter gauges shall be dial type, diaphragm actuated draft and shall be provided for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Gauges shall be at least 98 mm (3-7/8 inches) in diameter, shall have white dials with black figures, and shall be graduated in 0.0025 kPa mm (0.01 inch of water), and shall have a minimum range of 0.25 kPa (1 inch of water) beyond the specified final resistance for the filter bank on which each gauge is applied. Each gauge shall incorporate a screw operated zero adjustment and shall be furnished complete with two static pressure tips with integral compression fittings, two molded plastic vent valves, two 1.5 m (5 foot) minimum lengths of 6.35 mm (1/4 inch) diameter vinyl tubing, and all hardware and accessories for gauge mounting.

2.10 AIR HANDLING UNITS

2.10.1 Field-Fabricated Air Handling Units

Built-up units shall be as specified in paragraph DUCTWORK COMPONENTS. Fans, coils, and air filters shall be as specified in paragraph AIR SYSTEMS EQUIPMENT for types indicated.

2.10.2 Factory-Fabricated Air Handling Units

Units shall be single-zone draw-through type or single-zone blow-through type or multizone blow-through type as indicated. Units shall include fans, coils, airtight insulated casing, prefilters, secondary filter sections, air blender adjustable V-belt drives, belt guards for externally mounted motors, access sections where indicated, mixing box, combination sectional filter-mixing box, vibration-isolators, and appurtenances required for specified operation. Vibration isolators shall be as indicated. Each air handling unit shall have physical dimensions suitable to fit space allotted to the unit and shall have the capacity indicated. Air handling unit shall have published ratings based on tests performed according to ARI 430.

2.10.2.1 Casings

Casing sections shall be single wall type unless otherwise indicated, constructed of a minimum 18 gauge galvanized steel, or 18 gauge steel outer casing protected with a corrosion resistant paint finish according to paragraph FACTORY PAINTING. Inner casing of double-wall units shall be minimum 1.0 mm (20 gauge) solid galvanized steel. Casing shall be designed and constructed with an integral structural steel frame such that exterior panels are non-load bearing. Exterior panels shall be individually removable. Removal shall not affect the structural integrity of the unit. Casings shall be provided with inspection doors, access sections, and access doors as indicated. Inspection and access doors shall be insulated, fully gasketed, double-wall type, of a minimum 1.3 mm (18 gauge) outer and 1.0 mm (20 gauge) inner panels. Doors shall be rigid and provided with heavy duty hinges and latches. Inspection doors shall be a minimum 300 mm (12 inches) wide by 300 mm (12 inches) high. Access doors shall be minimum 600 mm (24 inches) wide and shall be the full height of the unit casing or a minimum of 1800 mm (6 ft), whichever is less. Access Sections shall be according to paragraph AIR HANDLING UNITS. Drain pan shall be double-bottom type constructed of 16 gauge

stainless steel, pitched to the drain connection. Drain pans shall be constructed water tight, treated to prevent corrosion, and designed for positive condensate drainage. When 2 or more heat exchange coils are used, with one stacked above the other, condensate from the upper coils shall not flow across the face of lower coils. Intermediate drain pans or condensate collection channels and downspouts shall be provided, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover. Each casing section handling conditioned air shall be insulated with not less than 25 mm (1 inch), 24 kg per cubic meter (1-1/2 pound density) coated fibrous glass material having a thermal conductivity not greater than 0.033 W/m-K (0.23 Btu/hr-sf-F). Factory applied fibrous glass insulation shall conform to ASTM C 1071, except that the minimum thickness and density requirements do not apply, and shall meet the requirements of NFPA 90A. Foam-type insulation is not acceptable. Foil-faced insulation shall not be an acceptable substitute for use on double-wall access doors and inspections doors and casing sections. Duct liner material, coating, and adhesive shall conform to fire-hazard requirements specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Exposed insulation edges and joints where insulation panels are butted together shall be protected with a metal nosing strip or shall be coated to conform to meet erosion resistance requirements of ASTM C 1071. A latched and hinged inspection door, shall be provided in the fan and coil sections. Additional inspection doors, access doors and access sections shall be provided where indicated.

2.10.2.2 Heating Coils

Coils shall be provided as specified in paragraph AIR SYSTEMS EQUIPMENT, for types indicated.

2.10.2.3 Air Filters

Air filters shall be as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

2.10.2.4 Fans

Fans shall be double-inlet, centrifugal type with each fan in a separate scroll. Fans and shafts shall be dynamically balanced prior to installation into air handling unit, then the entire fan assembly shall be statically and dynamically balanced at the factory after it has been installed in the air handling unit. Fans shall be mounted on steel shafts accurately ground and finished. Fan bearings shall be sealed against dust and dirt and shall be precision self-aligning ball or roller type. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Bearings shall be permanently lubricated or lubricated type with lubrication fittings readily accessible at the drive side of the unit. Bearings shall be supported by structural shapes, or die formed sheet structural members, or support plates securely attached to the unit casing. Bearings may not be fastened directly to the unit sheet metal casing. Fans and scrolls shall be furnished with coating indicated. Fans shall be driven by a unit-mounted or a floor-mounted motor connected to fans by V-belt drive complete with belt guard for externally mounted motors. Belt guards shall be the three sided enclosed type with solid or expanded metal face. Belt drives shall be designed for not less than a 1.3 service factor based on motor nameplate rating. Motor sheaves shall be variable pitch for 20 kW (25 hp) and below and fixed pitch above 20 kW (25 hp) as defined by ARI Guideline D. Where fixed sheaves are required, variable pitch sheaves may be used during air balance, but shall be replaced with an appropriate fixed sheave after air balance is completed. Variable pitch sheaves shall be selected to drive the fan at a speed that will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. Motors for V-belt drives shall be provided with adjustable bases. Fan motors shall have open enclosures. Motor starters shall be magnetic across-the-line type with general-purpose enclosure. Unit fan or fans shall be selected to produce the required capacity at the fan static pressure. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300 or ASHRAE 68.

2.10.2.5 Access Sections and Filter/Mixing Boxes

Access sections shall be provided where indicated and shall be furnished with access doors as shown. Access sections and filter/mixing boxes shall be constructed in a manner identical to the remainder of the unit casing and shall be equipped with access doors. Mixing boxes shall be designed to minimize air stratification and to promote thorough mixing of the air streams.

2.10.2.6 Dampers

Dampers shall be as specified in paragraph CONTROLS.

2.11 TERMINAL UNITS

2.11.1 Ducted and Room Fan-Coil Units

Base units shall include galvanized coil casing, coil assembly drain pan valve and piping package (external for ducted fan coil units), outside air damper, wall intake box (where indicated), air filter, fans, motor, fan drive, and motor switch, plus an enclosure for cabinet models and casing for concealed models. Leveling devices integral with the unit shall be provided for vertical type non-ducted units. Sound power levels shall be as indicated. Sound power level data or values for these units shall be obtained according to test procedures based on ARI 350. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles. Values obtained for the standard cabinet models will be acceptable for concealed models without separate test provided there is no variation between models as to the coil configuration, blowers, motor speeds, or relative arrangement of parts. Automatic valves and controls shall be provided as specified in paragraph CONTROLS. Each unit shall be fastened securely to the building structure. Capacity of the units shall be as indicated. Room fan-coil units shall be certified as complying with ARI 440, and shall meet the requirements of UL 1995.

2.11.1.1 Enclosures of Room Fan Coil Units

Enclosures shall be fabricated of not lighter than 1.3 mm (18 gauge) steel, reinforced and braced. Front panels of enclosures shall be removable and provided with 13 mm (1/2 inch) thick dual density fibrous glass insulation. The exposed side shall be high density, erosion-proof material suitable for use in air streams with velocities up to 23 m/s (4,500 fpm). Discharge grille shall be integrally stamped and shall be of such design as to properly distribute air throughout the conditioned space. Plastic discharge and return grilles are acceptable provided the plastic material is certified by the manufacturer to be classified as flame resistant according to UL 94 and the material shall comply with the heat deflection criteria specified in UL 1995. Ferrous metal surfaces shall be galvanized or factory finished with corrosion resistant enamel. Access doors or removable panels shall be provided for piping and control compartments. Duct discharge collar shall be provided for concealed models. Enclosures shall have easy access for filter replacement.

2.11.1.2 Enclosures of Ducted Fan Coil Units

Enclosures shall be fabricated of not lighter than 1.3 mm (18 gauge) steel, reinforced and braced. Front panels of enclosures shall be removable and provided with 13 mm (1/2 inch) thick dual density fibrous glass insulation. The exposed side shall be high density, erosion-proof material suitable for use in air streams with velocities up to 23 m/s (4,500 fpm). Ferrous metal surfaces shall be galvanized or factory finished with corrosion resistant enamel. Access doors or removable panels shall be provided for piping and control compartments. Duct discharge collar shall be provided for concealed models. Mixing box bases shall be provided with return and outside air dampers accessible for ease of balancing. Vertical units concealed in closets shall be upflow type with the combined return and fresh inlet at the bottom of the unit. Enclosures shall have easy access for filter. A filter section may be provided with the mixing box base for ease of access for filter replacement.

2.11.1.3 Fans

Fans shall be galvanized steel or aluminum, multiblade, centrifugal type. In lieu of metal, fans and scrolls may be non-metallic materials of suitably reinforced compounds. Fans shall be dynamically and statically balanced. Surfaces shall be smooth. Assemblies shall be accessible for maintenance. Disassembly and re-assembly shall be by means of mechanical fastening devices and not by epoxies or cements.

2.11.1.4 Coils

Coils shall be constructed of not less than 10 mm (3/8 inch) outside diameter seamless copper tubing, with copper or aluminum fins mechanically bonded or soldered to the tubes. Coils shall be provided with not less than 12 mm (1/2 inch) outside diameter flare or sweat connectors, accessory piping package with thermal connections suitable for connection to the type of control valve supplied, and manual air vent. Coils shall be tested hydrostatically at 2000 kPa (300 psi) or under water at 1700 kPa (250 psi) air pressure and suitable for 1400 kPa (200 psi) working pressure. Provisions shall be made for coil removal.

2.11.1.5 Drain Pans

Where condensation is possible, drain and drip pans shall be sized and located to collect all water condensed on and dripping from any item within the unit enclosure or casing. Drain pans shall be constructed of not lighter than 0.9 mm (21 gauge) steel, galvanized after fabrication, thermally insulated to prevent condensation. Insulation shall have a flame spread rating not over 25 without evidence of continued progressive combustion, a smoke developed rating no higher than 50, and shall be of a waterproof type or coated with a waterproofing material. In lieu of the above, drain pans may be constructed of die-formed 0.85 mm (22 gauge) steel, formed from a single sheet, galvanized after fabrication, insulated and coated as specified for the 0.9 mm (21 gauge) material or of die-formed 0.9 mm (21 gauge) type 304 stainless steel, insulated as specified above. Drain pans shall be pitched to drain. Minimum 20 mm (3/4 inch) NPT or 15 mm (5/8 inch) OD drain connection shall be provided in drain pan. Auxiliary drain pans to catch drips from control and piping packages, eliminating insulation of the packages, may be plastic; if metal, the auxiliary pans shall comply with the requirements specified above. Insulation at control and piping connections thereto shall extend 25 mm (1 inch) minimum over the auxiliary drain pan.

2.11.1.5 Manually Operated Outside Air Dampers

Manually operated outside air dampers shall be provided according to the arrangement indicated. Dampers shall be parallel airfoil type and of galvanized construction. Blades shall rotate on stainless steel or nylon sleeve bearings.

2.11.1.6 Filters

Filters shall be of the fiberglass disposable type, 25 mm (1 inch) thick, conforming to CID A-A-1419. Filters in each unit shall be removable without the use of tools.

2.11.1.7 Motors

Motors shall be of the permanent split-capacitor type with built-in thermal overload protection, directly connected to unit fans. Motor switch shall be two or three speeds and off, manually operated, and shall be mounted on an identified plate inside the unit below or behind an access door for room units or adjacent to the unit in the closet for ducted units, or if indicated, adjacent to the room thermostat. In lieu of the above fan speed control, a solid-state variable-speed controller having a minimum speed reduction of 50 percent may be provided. Motors shall have permanently-lubricated or oilable sleeve-type or combination ball and sleeve-type bearings with vibration isolating mountings suitable for

continuous duty. Motor power consumption, shown in watts, at the fan operating speed selected to meet the specified capacity shall not exceed the following values:

Free Discharge Motors

Unit Capacity (LS)	Maximum Power Consumption (Watts)		
	115V	230V	277V
94	70	110	90
142	100	110	110
189	170	150	150
283	180	210	220
378	240	240	230
472	310	250	270
566	440	400	440

Free Discharge Motors

Unit Capacity (cfm)	Maximum Power Consumption (Watts)		
	115V	230V	277V
200	70	110	90
300	100	110	110
400	170	150	150
600	180	210	220
800	240	240	230
1000	310	250	270
1200	440	400	440

High Static Motors

Unit Capacity (L/S)	Maximum Power Consumption (Watts)
94	145
142	145
189	210
283	320
378	320
472	530
566	530

High Static Motors

Unit Capacity (cfm)	Maximum Power Consumption (Watts)
200	145
300	145
400	210
600	320
800	320
1000	530
1200	530

2.11.2 Variable Air Volume (VAV) and Dual Duct Terminal Units

VAV and dual duct terminal units shall be the type, size, and capacity shown and shall be mounted in the ceiling or wall cavity and shall be suitable for single or dual duct system applications. Actuators and controls shall be as specified in paragraph CONTROLS. Unit enclosures shall be constructed of galvanized steel not lighter than 0.85 mm (22 gauge) or aluminum sheet not lighter than 1.3 mm (18 gauge). Single or multiple discharge outlets shall be provided as required. Units with flow limiters are not acceptable. Unit air volume shall be factory preset and readily field adjustable without special tools. Reheat coils shall be provided as indicated. A flow chart shall be attached to each unit. Acoustic performance of the terminal units shall be based upon units tested according to ARI 880. Sound power level shall be as indicated. Discharge sound power shall be shown for minimum and 375 Pa (1-1/2 inches water gauge) inches water gauge inlet static pressure. Acoustical lining shall be according to NFPA 90A.

2.11.2.1 Constant Volume, Single Duct

Constant volume, single duct, terminal units shall contain within the casing, a mechanical or pneumatic constant volume regulator. Volume regulators shall control air delivery to within plus or minus 5 percent of specified air flow subjected to inlet pressure from 200 to 1500 Pa (3/4 to 6 inch water gauge).

2.11.2.2 Variable Volume, Single Duct

Variable volume, single duct, terminal units shall be provided with a calibrated air volume sensing device, air valve or damper, actuator, and accessory relays. Units shall control air volume to within plus or minus 5 percent of each air set point volume as determined by the thermostat with variations in inlet pressures from 200 to 1500 Pa (3/4 to 6 inch water gauge). Internal resistance of units shall not exceed 100 Pa (0.4 inch water gauge) at maximum flow range. External differential pressure taps separate from the control pressure taps shall be provided for air flow measurement with a 0 to 250 Pa (0 to 1 inch water gauge) range. Unit volume controller shall be normally open upon loss of power.

2.11.2.3 Variable Volume, Single Duct, Fan-Powered

Variable volume, single duct, fan-powered terminal units shall be provided with a calibrated air volume sensing device, air valve or damper, actuator, fan and motor, and accessory relays. Units shall control primary air volume to within plus or minus 5 percent of each air set point as determined by the thermostat with variations in inlet pressure from 200 to 1500 Pa (3/4 to 6 inch water gauge). Unit fan shall be centrifugal, direct-driven, double-inlet type with forward curved blades. Fan motor shall be either single speed with speed controller or three-speed, permanently lubricated, permanent split-capacitor type. Fan/motor assembly shall be isolated from the casing to minimize vibration transmission. Fan control shall be factory furnished and wired into the unit control system. A factory-mounted pressure switch shall be furnished to operate the unit fan whenever pressure exists at the unit primary air inlet or when the control system fan operates.

2.11.2.6 Reheat Units

a. Hot Water Coils: Hot-water coils shall be fin-and-tube type constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to the tubes. Headers shall be constructed of cast iron, welded steel or copper. Casing and tube support sheets shall be 1.6 mm (16 gauge), galvanized steel, formed to provide structural strength. Tubes shall be correctly circuited for proper water velocity without excessive pressure drop and they shall be drainable where required or indicated. At the factory, each coil shall be tested at not less than 1700 kPa (250 psi) air pressure and shall be suitable for 1400 kPa (200 psi) working pressure. Drainable coils shall be installed in the air handling units with a pitch of not less than 10 mm per m (1/8 inch per foot) of tube length toward the drain end. Coils shall conform to the provisions of ARI 410.

2.11.4 Unit Ventilators

Unit ventilators shall include an enclosure, galvanized casing, or cold-rolled steel casing with corrosion resistant coating, coil assembly, valve and piping package, drain pan, air filters, fan assembly, fan drive, motor, motor controller, dampers, and damper operators. Sound power level shall be as indicated. Sound power level data or values for these units shall be obtained according to test procedures based on ARI 350. Sound power values apply to units provided with factory fabricated cabinet enclosures and standard grilles, when handling standard flow for which the unit air capacity is rated. Each unit shall be secured to the building structure. Capacity of the unit ventilators shall be as indicated. Unit ventilators shall be of the year-round classroom type with automatic controls arranged to properly heat and ventilate the room. Automatic valves and controls shall be provided as specified in paragraph CONTROLS. Sequence of control shall be any one of the standard ANSI cycles specified in paragraph CONTROLS.

2.11.4.1 Enclosures

Enclosures shall be fabricated of not lighter than 1.6 mm (16 gauge) galvanized steel, reinforced and braced, or all welded framework with panels to provide equivalent strength. The casing shall be acoustically and thermally insulated internally with not less than 13 mm (1/2 inch) thick dual density fibrous glass insulation. The exposed side shall be high density, erosion-proof material suitable for use in air streams with velocities up to 246 m/s (4500 fpm). The insulation shall be fastened with waterproof, fire-resistant adhesive. Front panel shall be designed for easy removal by one person. Discharge grilles shall have adjustable grilles or grilles with adjustable vanes and shall properly distribute air throughout the conditioned space. Return grilles shall be removable where front panel does not provide access to interior components. Plastic discharge or return grilles are not acceptable. Removable panels or access doors shall be provided for all piping and control compartments. Fan switch shall be key operated or accessible through a locked access panel. Gaskets shall be provided at the back and bottom of the unit for effective air seal, as required.

2.11.4.2 Fans

Fans shall be of the galvanized steel or aluminum, multiblade, centrifugal type, dynamically and statically balanced. Fan housings shall be provided with resilient mounted, self-aligning permanently lubricated ball bearings, sleeve bearings, or combination ball and sleeve bearings, capable of not less than 2000 hours of operation on one oiling. Fans shall be direct-connected.

2.11.4.3 Coils

Coils shall be circuited for a maximum water velocity of 2.4 m/s (8 fps) without excessive pressure drop and shall otherwise be as specified for hot water coils in paragraph TERMINAL UNITS.

2.11.4.4 Drain Pans

Drain and drip pans shall be sized and located to collect all condensed water dripping from any item within the unit enclosure. Drain pans shall be constructed of not lighter than 1.2 mm (18 gauge) steel, galvanized after fabrication, and thermally insulated to prevent condensation. Insulation shall be coated with a fire-resistant waterproofing material. In lieu of the above, drain pans may be constructed of die-formed 1.0 mm (20 gauge) steel, formed from a single sheet and galvanized after fabrication and insulated and coated as for the 1.2 mm (18 gauge) steel material, or of die-formed 1.3 mm (18 gauge) type 304 stainless steel insulated as specified above. Drain pans shall be pitched to drain. Drain connection shall be provided when a condensate drain system is indicated. Connection shall be minimum 20 mm (3/4 inch) NDT or 18 mm (5/8 inch) OD.

2.11.4.5 Filters

Fiberglass disposable type, 25 mm (1 inch) thick, conforming to CID A-A-1419, installed upstream of coil.

2.11.4.6 Dampers

An outside air proportioning damper shall be provided on each unit. In addition, a vane shall be provided to prevent excessive outside air from entering unit and to prevent blow-through of outside air through the return air grille under high wind pressures. Where outside air and recirculated air proportioning dampers are provided on the unit, an additional vane will not be required. Face and bypass dampers shall be provided for each unit to ensure constant air volume at all positions of the dampers. Each unit shall be provided with a factory installed control cam assembly, electric motor to operate the face and bypass dampers and outside air damper or outside air and recirculated air dampers in the sequence as specified in paragraph CONTROLS.

2.11.4.7 Motors

Motors shall be of the permanent split-capacitor type with built-in thermal overload protection and automatic reset. Motor shall be mounted on a resilient mounting, isolated from the casing and shall be suitable for operation on electric service available. A manually operated motor switch shall provide for 2 or 3 speeds and off and shall be mounted on an identified plate inside the unit below or behind an access door or adjacent to the room thermostat as indicated. In lieu of speed control, a solid state variable speed controller having minimum speed reduction of 50 percent may be provided.

2.11.4.8 Outside Air Intakes

Outside air intakes shall be the manufacturer's standard design and provided with 13 mm (1/2 inch) mesh bird screen or louvers on 13 mm (1/2 inch) centers.

2.12 ENERGY RECOVERY DEVICES

~~2.12.1 Rotary Wheel~~

~~Unit shall be a factory fabricated and tested assembly for air-to-air energy recovery by transfer of sensible heat from exhaust air to supply air stream. Device performance shall be according to ASHRAE 84. Device shall deliver an energy transfer effectiveness of not less than 70 percent with cross-contamination not in excess of 0.1 percent of exhaust airflow rate at system design differential pressure, including purging sector if provided with wheel. Exchange media shall be chemically inert, moisture-resistant, fire-retardant, laminated, nonmetallic material which complies with NFPA 90A. Exhaust and supply streams shall be isolated by seals which are static, field adjustable, and replaceable. Chain drive mechanisms shall be fitted with ratcheting torque limiter or slip-clutch protective device. Enclosure shall be fabricated from galvanized steel and shall include maintenance access provisions. Recovery control and rotation failure provisions shall be as indicated.~~

2.12.1 ~~2~~ Heat Pipe

Device shall be a factory fabricated, assembled and tested, counterflow arrangement, air-to-air heat exchanger for transfer of sensible heat between exhaust and supply streams. Device shall deliver an energy transfer effectiveness not less than that indicated without cross-contamination. Heat exchanger tube core shall be 15, 18, or 25 mm (1/2, 5/8, 1 inch) nominal diameter, seamless aluminum or copper tube with extended surfaces, utilizing wrought aluminum Alloy 3003 or Alloy 5052, temper to suit. Maximum fins per unit length and number of tube rows shall be as indicated. Tubes shall be fitted with internal capillary wick, filled with an ASHRAE 15, Group 1 refrigerant working fluid, selected for system design temperature range, and hermetically sealed. Heat exchanger frame shall be constructed of not less than 1.6 mm (16 gauge) galvanized steel and fitted with intermediate tube supports, and flange

connections. Tube end-covers and a partition of galvanized steel to separate exhaust and supply air streams without cross-contamination and in required area ratio shall be provided. A drain pan constructed of welded Type 300 series stainless steel shall be provided. Heat recovery regulation shall be provided by system face and bypass dampers and related control system as indicated. Coil shall be fitted with pleated flexible connectors.

2.12.2 ~~3~~ Drain Pans

Drain and drip pans shall be sized and located to collect all condensed water dripping from any item within the unit enclosure. Drain pans shall be constructed of not lighter than 1.3 mm (18 gauge) Type 304 series stainless steel, and thermally insulated to prevent condensation. Insulation in the attic space shall be non-combustible, and shall be covered with a non-combustible waterproofing material. Drain pans shall be pitched to drain. Drain connection shall be provided to the sanitary waste through the use of an indirect waste fitting. Connection shall be minimum 20 mm (3/4 inch) NDT or 18 mm (5/8 inch) OD.

2.13 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123/A 123M or ASTM A 924/A 924M shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphatized and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than 6, average creepage not greater than 3 mm (1/8 inch). Rating of the inscribed area shall not be less than 10, no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through from the interior shall receive a final shop docket of zinc-rich protective paint according to ASTM D 520 Type I.

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.

3.1.1 Piping

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers. Changes 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 centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Horizontal supply mains shall pitch down in the direction of flow as indicated. The grade shall be not less than 2 mm in 1 m (1 inch in 40 feet). Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the system. Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 65 mm (2-1/2 inches) or less in diameter, and with flanges for pipe 80 mm (3 inches) and larger. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric unions or flanges. All piping located in air plenums shall conform to NFPA 90A

requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded.

3.1.1.1 Joints

a. Threaded Joints: Threaded joints shall be made with tapered threads and made tight with a stiff mixture of graphite and oil or polytetrafluoroethylene tape or equivalent thread joint compound or material, applied to the male threads only.

b. Soldered Joints: Joints in copper tubing shall be cut square with ends reamed, and all filings and dust wiped from interior of pipe. Joints shall be soldered with 95/5 solder or brazed with silver solder applied and drawn through the full fitting length. Care shall be taken to prevent annealing of tube or fittings when making connections. Joints 65 mm (2-1/2 inches) and larger shall be made with heat uniformly around the entire circumference of the joint with a multi-flame torch. Connections in floor slabs shall be brazed. Excess solder shall be wiped from joint before solder hardens. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B 813.

c. Welded Joints: Welding shall be according to qualified procedures using qualified welders and welding operators. Procedures and welders shall be qualified according to ASME BPV IX. Welding procedures qualified by others and welders and welding operators qualified by another operator may be permitted by ASME B31.1. Structural members shall be welded according to Section 05090 WELDING, STRUCTURAL. All welds shall be permanently identified by imprinting the welder's or welding operator's assigned symbol adjacent to the weld. Welded joints shall be fusion welded unless otherwise required. 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 connections may be made with either welding tees or branch outlet fittings. Branch outlet fittings shall be forged, 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. Electrodes shall be stored and dried according to AWS D1.1 or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.1.2 Grooved Mechanical Joints

Grooves shall be prepared according to the coupling manufacturer's instructions. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall be measured using a "go/no-go" gauge, vernier or dial caliper, or narrow-land micrometer. Groove width and dimension of groove from end of pipe shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

3.1.1.3 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

3.1.2 Supports

3.1.2.1 General

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.

3.1.2.2 Seismic Requirements (Pipe Supports and Structural Bracing)

Piping and attached valves shall be supported and braced to resist seismic loads as specified under Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05210 STEEL JOISTS.

3.1.2.3 Pipe Hangers, Inserts and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Types 5, 12, and 26 shall not be used.

a. Hangers: Type 3 shall not be used on insulated piping.

b. Inserts: 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.

c. C-Clamps: Type 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.

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

e. Hangers: Type 24 may be used only on trapeze hanger systems or on fabricated frames.

f. Type 39 saddles shall be used on all insulated pipe 100 mm (4 inches) and larger when the temperature of the medium is above 15.5 degrees C (60 degrees F). Type 39 saddles shall be welded to the pipe.

g. Type 40 shields shall:

(1) be used on all insulated pipes less than 100 mm (4 inches).

(2) be used on all insulated pipes 100 mm (4 inches) and larger when the temperature of the medium is 15.5 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 when the insulation shows signs of being visibly compressed, or when the insulation or jacket shows visible signs of distortion at or near the type 40 shield. High density inserts shall have a density of 144 kg/cubic meter (9 pcf) or greater.

h. Horizontal Pipe Supports: 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 m (5 feet) apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 220 N (50 pounds) shall have the excess hanger loads suspended from panel points.

i. Vertical Pipe Supports: Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 5 m 15 feet, not more than 2.4 m (8 feet) from end of risers, and at vent terminations.

j. Pipe Guides: Type 35 guides using steel reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

k. Steel Slides: Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm (4 inches) and larger with medium 15.5 degrees C (60 degrees F) or greater, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 100 mm (4 inches), a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

l. High Temperature Guides with Cradles: 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.

m. Insulated Pipe: Insulation on horizontal pipe shall be continuous through hangers for hot and cold piping. Other requirements on insulated pipe are specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.3 Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline.

3.1.4 Pipe Sleeves

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. 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. Unless otherwise indicated, sleeves shall provide a minimum of 6 mm (1/4 inch) all-around clearance between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be steel pipe or cast iron pipe. Sleeves in non-bearing walls, floors, or ceilings may be steel pipe, cast iron pipe, galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated, or moisture resistant fiber or plastic. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve, in non-fire rated walls, shall be sealed as indicated and specified in Section 07900 JOINT SEALING. Pipes passing through wall waterproofing membrane shall be sleeved as specified above, and a waterproofing clamping flange shall be installed as indicated.

3.1.4.1 Roof and Floor Sleeves

Pipes passing through roof or floor waterproofing membrane shall be installed through a 17-ounce copper sleeve or a 0.8 mm (0.032 inch) thick aluminum sleeve, each within an integral skirt or flange. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 200 mm 8 inches from the pipe and shall be set over the roof or floor membrane in a trowelled coating of

bituminous cement. Unless otherwise shown, the flashing sleeve shall extend up the pipe a minimum of 50 mm (2 inches) above highest floor level or a minimum of 250 mm (10 inches) above the roof. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. 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. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess. In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. 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/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved.

3.1.4.2 Fire Seal

Where pipes pass through firewalls, fire partitions, or floors, a fire seal shall be provided as specified in Section 07840 FIRESTOPPING.

3.1.4.3 Escutcheons

Escutcheons shall be provided at finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings except in boiler, utility, or equipment rooms. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheons shall be secured to pipe or pipe covering.

3.1.5 Condensate Drain Lines

Water seals shall be provided in the condensate drain from all units. The depth of each seal shall be 50 mm (2 inches) plus 0.1 mm for each Pa, (the number of inches, measured in water gauge) of the total static pressure rating of the unit to which the drain is connected. Water seals shall be constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Pipe cap or plug cleanouts shall be provided where indicated. Drains indicated to connect to the sanitary waste system shall be connected by an indirect waste fitting. Air conditioner drain lines shall be insulated as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.6 Pipe-Alignment Guides

Pipe-alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 1.5 m 5 feet on each side of each expansion joint, and in lines 100 mm (4 inches) 4 inches or smaller not more than 600 mm (2 feet) on each side of the joint.

3.1.7 Air Vents and Drains

3.1.7.1 Vents

Air vents shall be provided at high points, on water coils, and where indicated to ensure adequate venting of the piping system.

3.1.7.2 Drains

Drains shall be provided at low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.8 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment such as pumps, heaters, heating or cooling coils, and other similar items, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purposes. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

3.1.9 Equipment and Installation

Frames and supports shall be provided for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Air handling units shall be mounted on the mezzanine deck as shown on the drawings. The method of anchoring and fastening shall be as recommended by the equipment manufacturer. Concrete foundations for circulating pumps shall be 100 mm (4 inch) or heavy enough to minimize the intensity of the vibrations transmitted to the piping and the surrounding structure, as recommended in writing by the pump manufacturer. In lieu of a concrete pad foundation, a concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. The concrete foundation or concrete pedestal block shall be of a mass not less than three times the weight of the components to be supported. Lines connected to the pump mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.1.10 Access Panels

Access panels shall be provided for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METALS.

3.1.11 Flexible Connectors

Pre-insulated flexible connectors and flexible duct shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

3.1.12 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct insulation shall be packed as specified in Section 07840 FIRESTOPPING for fire rated penetrations. For non-fire rated penetrations, the space shall be packed as specified in Section 07900 JOINT SEALING.

3.1.13 Metal Ductwork

Installation shall be according to SMACNA HVAC Duct Const Stds unless otherwise indicated. Duct supports for sheet metal ductwork shall be according to SMACNA HVAC Duct Const Stds, unless otherwise specified. Friction beam clamps indicated in SMACNA HVAC Duct Const Stds shall not be

used. Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion. Supports on the risers shall allow free vertical movement of the duct. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

3.1.15 FRP Ductwork

Fibrous glass reinforced plastic ducting and related structures shall conform to SMACNA Industry Practice. Flanged joints shall be provided where indicated. Crevice-free butt lay-up joints are acceptable where flanged joints are not indicated. When ambient temperatures are lower than 10 degrees C (50 degrees F), joints shall be heat cured by exothermic reaction heat packs.

3.1.16 Concealed Ducts Conveying Moisture Laden Air

Concealed ducts conveying moisture laden air shall be fabricated from minimum 1.3 mm (18 gauge), Type 300 series, stainless steel. Joints shall be continuously welded, brazed, or soldered to be liquid tight. Duct shall be pitched to drain at points indicated. Transitions to other metals shall be liquid tight, companion angle bolted and gasketed.

3.1.17 Acoustical Duct Lining

Lining shall be applied in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive conforming to ASTM C 916, Type I, NFPA 90A, UL 723, and ASTM E 84. Top and bottom pieces shall lap the side pieces and shall be secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed according to SMACNA HVAC Duct Const Stds. Welded pins, cup-head pins, or adhered clips shall not distort the duct, burn through, nor mar the finish or the surface of the duct. Pins and washers shall be flush with the surfaces of the duct liner and all breaks and punctures of the duct liner coating shall be sealed with the nonflammable, fire resistant adhesive. Exposed edges of the liner at the duct ends and at other joints where the lining will be subject to erosion shall be coated with a heavy brush coat of the nonflammable, fire resistant adhesive, to prevent delamination of glass fibers. Duct liner may be applied to flat sheet metal prior to forming duct through the sheet metal brake. Lining at the top and bottom surfaces of the duct shall be additionally secured by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in SMACNA HVAC Duct Const Stds to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, will be acceptable.

3.1.18 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection shall be provided. The distribution system (supply and return) shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.

3.1.19 Insulation

Thickness and application of insulation materials for ductwork, piping, and equipment shall be according to Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Outdoor air intake ducts and plenums shall be externally insulated up to the point where the outdoor air reaches the conditioning unit or up to the point where the outdoor air mixes with the outside air stream.

3.1.20 Duct Test Holes

Holes with closures or threaded holes with plugs shall be provided in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Extensions, complete with cap or plug, shall be provided where the ducts are insulated.

3.1.21 Power Roof Ventilator Mounting

Foamed 13 mm (1/2 inch) thick, closed-cell, flexible elastomer insulation shall cover width of roof curb mounting flange. Where wood nailers are used, holes shall be pre-drilled for fasteners.

3.1.22 Power Transmission Components Adjustment

V-belts and sheaves shall be tested for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Belts on drive side shall be uniformly loaded, not bouncing. Alignment of direct driven couplings shall be to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.2 FIELD PAINTING AND COLOR CODE MARKING

Finish painting of items only primed at the factory, surfaces not specifically noted otherwise, and color code marking for piping shall be as specified in Section 09900 PAINTING, GENERAL.

3.3 PIPING HYDROSTATIC TEST

After cleaning, water piping shall be hydrostatically tested at a pressure equal to 150 percent of the total system operating pressure for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Leaks shall be repaired and piping retested until test is successful. No loss of pressure will be allowed. Leaks shall be repaired by re-welding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before covering or concealing.

3.4 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of foreign matter. A temporary bypass shall be provided for water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Inside of room fan-coil units, air terminal units, unit ventilators, ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided prior to startup of all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.5 TESTING, ADJUSTING, AND BALANCING

Testing, adjusting, and balancing shall be as specified in Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS. Testing, adjusting, and balancing shall begin only when the air

supply and distribution, including controls, has been completed, with the exception of performance tests.

3.6 PERFORMANCE TESTS

After testing, adjusting, and balancing has been completed as specified, each system shall be tested as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by an experienced engineer. Tests shall cover a period of not less than 4 days for each system and shall demonstrate that the entire system is functioning according to the specifications.

3.7 FIELD TRAINING

The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 24 hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions.

3.8 INDOOR AIR QUALITY ASSURANCE

Initial Building Flush Out: Prior to any furniture being placed in the building, but after completion of all scheduled interior construction finishes (trim, carpeting, painting, etc. but not including minor finish work associated with punchlist checks) operate the building's HVAC systems on 100% outdoor air for a period of 14 days to completely flush the building's air. Systems shall operate 18 hours/day on 100% outdoor air, with thermostats set to maintain space temperatures between 15.5°C (60°F) and 26.7°C(80°F). Promptly change out all system filters after this flush out period, and reset all adjusted items for normal operation.

Final Building Flush Out: After all furniture has been installed (unpacked and located) or at another similar time (as determined by the Owner), operate the building's HVAC systems on 100% outdoor air for an additional period of 14 days. Systems shall operate at least 18 hours/day on 100% outdoor air, with thermostats set to maintain space temperatures between 15.5°C (60°F) and 26.7°C(80°F). Promptly change out all system filters after this flush out period, and reset all adjusted items for normal operation.

END OF SECTION