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SECTION 01312

RESIDENT MANAGEMENT SYSTEM (RMS)

PART 1 GENERAL

1.1 GENERAL

The Government will use the Resident Management System for Windows (RMS-W) to assist in its monitoring and administration of this contract. The Contractor shall use the Government-furnished Construction Contractor Module of RMS-Windows, referred to as RMS-QC (QC for Quality Control), to record, maintain, and submit various information throughout the contract period. This joint Government-Contractor use of RMS-W and RMS-QC will facilitate electronic exchange of information and overall management of the contract. RMS-QC provides the means for the Contractor to input, track, and electronically share information with the Government in the following areas:

- Administration
- Finances
- Quality Control
- Submittal Monitoring
- Scheduling
- Import/Export of Data

1.1.1 Correspondence and Electronic Communications

For ease and speed of communications, both Government and Contractor will, to the maximum extent feasible, exchange correspondence and other documents in electronic format. Correspondence, pay requests and other documents comprising the official contract record shall also be provided in paper format, with signatures and dates where necessary. Paper documents will govern, in the event of discrepancy with the electronic version.

1.1.2 Other Factors

Particular attention is directed to Contract Clause, "Schedules for Construction Contracts", Contract Clause, "Payments", Section 01320, "Project Schedule", Section 01330, SUBMITTAL PROCEDURES, and Section 01455, CONTRACTOR QUALITY CONTROL, which have a direct relationship to the reporting to be accomplished through RMS-QC. Also, there is no separate payment for establishing and maintaining the RMS-QC database; all costs associated therewith shall be included in the contract pricing for the work.

1.2 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.

ENGINEERING MANUALS (EM)

EM 385-1-1

U.S. Army Corps of Engineers Safety and

Health Requirement Manual

1.3 RMS-QC SOFTWARE

RMS-QC is a Windows-based program that can be run on a stand-alone personal computer or on a network. The Government will make available the RMS-QC software to the Contractor after award of the construction contract. Prior to the Pre-Construction Conference, the Contractor shall be responsible to download, install and use the latest version of the RMS-QC software from the Government's RMS Internet Website. Upon specific justification and request by the Contractor, the Government can provide RMS-QC on high-density diskettes or CD-ROM. Any program updates of RMS-QC will be made available to the Contractor via the Government RMS Website as they become available.

1.4 SYSTEM REQUIREMENTS

The following listed hardware and software is the minimum system configuration that the Contractor shall have to run RMS-QC:

Hardware

IBM-compatible PC with 200 MHz Pentium or higher processor
32+ MB RAM
4 GB hard drive disk space for sole use by the RMS-QC system
3 1/2 inch high-density floppy drive
Compact disk (CD) Reader
Color monitor
Laser printer compatible with HP LaserJet III or better, with minimum 4 MB installed memory.
Connection to the Internet, minimum 28 BPS

Software

Microsoft (MS) Access 97 or newer version database software
MS Windows 95 or newer version operating system (MS Windows NT 4.0 or newer is recommended)
Word Processing software compatible with MS Word 97 or newer
Internet browser
The Contractor's computer system shall be protected by virus protection software that is regularly upgraded with all issued manufacturer's updates throughout the life of the contract.
Electronic mail (E-mail) compatible with MS Outlook

1.5 RELATED INFORMATION

1.5.1 RMS-QC User Guide

After contract award, the Contractor shall download instructions for the installation and use of RMS-QC from the Government RMS Internet Website; the Contractor can obtain the current address from the Government. In case of justifiable difficulties, the Government will provide the Contractor with a CD-ROM containing these instructions.

1.5.2 Contractor Quality Control(CQC) Training

The use of RMS-QC will be discussed with the Contractor's QC System Manager during the mandatory CQC Training class.

1.5.3 Video Training for RMS-QC

After contract award, the Contractor will be provided with a CD containing a training video on the use of RMS-QC.

1.6 CONTRACT DATABASE

Prior to the pre-construction conference, the Government shall provide the Contractor with basic contract award data to use for RMS-QC. The Government will provide data updates to the Contractor as needed, generally by files attached to E-mail. These updates will generally consist of submittal reviews, correspondence status, QA comments, and other administrative and QA data.

1.7 DATABASE MAINTENANCE

Unless otherwise directed by the Contracting Officer the Contractor shall establish, maintain, and update data for the contract in the RMS-QC database throughout the duration of the contract. The Contractor shall establish and maintain the RMS-QC database. Data updates to the Government shall be submitted by E-mail with file attachments, e.g., daily reports, schedule updates, payment requests. If permitted by the Contracting Officer, a data diskette or CD-ROM may be used instead of E-mail (see Paragraph DATA SUBMISSION VIA COMPUTER DISKETTE OR CD-ROM). The RMS-QC database typically shall include current data on the following items:

1.7.1 Administration

1.7.1.1 Contractor Information

The database shall contain the Contractor's name, address, telephone numbers, management staff, and other required items. Within 14 calendar days of receipt of RMS-QC software from the Government, the Contractor shall deliver Contractor administrative data in electronic format via E-mail.

1.7.1.2 Subcontractor Information

The database shall contain the name, trade, address, phone numbers, and other required information for all subcontractors. A subcontractor must be listed separately for each trade to be performed. Each subcontractor/trade shall be assigned a unique Responsibility Code, provided in RMS-QC. Within 14 calendar days of receipt of RMS-QC software from the Government, the Contractor shall deliver subcontractor administrative data in electronic format via E-mail.

1.7.1.3 Correspondence

All Contractor correspondence to the Government shall be identified with a serial number. Correspondence initiated by the Contractor's site office shall be prefixed with "S". Letters initiated by the Contractor's home (main) office shall be prefixed with "H". Letters shall be numbered starting from 0001. (e.g., H-0001 or S-0001). The Government's letters to the Contractor will be prefixed with "C".

1.7.1.4 Requests for Information

RMS-QC includes a means for the Contractor to enter, log, and transmit requests for information (RFI) to the Government. RFIs can be exchanged electronically using the import/export functions of RMS-QC. The Contractor shall also provide the Government with a signed, printed copy of each RFI. All RFIs from the Contractor to the Government shall have the prefix "RFI" and shall be numbered sequentially beginning with RFI-0001.

1.7.1.5 Equipment

The Contractor's RMS-QC database shall contain a current list of equipment planned for use or being used on the jobsite, including the most recent and planned equipment inspection dates.

1.7.1.6 EM 385-1-1, Corps of Engineers Safety Manual and RMS Linkage

Upon request, the Contractor can obtain a copy of the current version of the Safety Manual, EM 385-1-1, on CD. Data on the CD will be accessible through RMS-QC, or in stand-alone mode.

1.7.1.7 Management Reporting

RMS-QC includes a number of reports that Contractor management can use to track the status of the project. The value of these reports is reflective of the quality of the data input, and is maintained in the various sections of RMS-QC. Among these reports are: Progress Payment Request worksheet, QA/QC comments, Submittal Register Status, Three-Phase Inspection checklists.

1.7.2 Finances

1.7.2.1 Pay Activity Data

The RMS-QC database shall include a list of pay activities that the Contractor shall develop in conjunction with the construction schedule. The sum of all pay activities shall be equal to the total contract amount, including modifications. Pay activities shall be grouped as directed by the Contracting Officer, and the sum of the activities shall equal the Contract Amount.

1.7.2.2 Payment Requests

All progress payment requests shall be prepared using RMS-QC. The Contractor shall complete the payment request worksheet and include it with the payment request. The work completed under the contract, measured as percent or as specific quantities, shall be updated at least monthly. After the update, the Contractor shall generate a payment request report using RMS-QC. The Contractor shall submit the payment requests with supporting data by E-mail with file attachment(s). If permitted by the Contracting Officer, a data diskette may be used instead of E-mail. A signed paper copy of the approved payment request is also required, which

shall govern in the event of discrepancy with the electronic version.

1.7.3 Quality Control (QC)

RMS-QC provides a means to track implementation of the 3-phase QC Control System, prepare daily reports, identify and track deficiencies, document progress of work, and support other contractor QC requirements. The Contractor shall maintain this data on a daily basis. Entered data will automatically output to the RMS-QC generated daily report. The Contractor shall provide the Government a Contractor Quality Control (CQC) Plan within the time required in Section 01455, CONTRACTOR QUALITY CONTROL. Within seven calendar days of Government acceptance, the Contractor shall submit a data diskette or CD-ROM reflecting the information contained in the accepted CQC Plan: schedule, pay activities, features of work, submittal register, QC requirements, and equipment list.

1.7.3.1 Daily Contractor Quality Control (CQC) Reports.

RMS-QC includes the means to produce the Daily CQC Report. The Contractor may use other formats to record basic QC data. However, the Daily CQC Report generated by RMS-QC shall be the Contractor's official report. Data from any supplemental reports by the Contractor shall be summarized and consolidated onto the RMS-QC-generated Daily CQC Report. Daily CQC Reports shall be submitted as required by Section 01455, CONTRACTOR QUALITY CONTROL. Reports shall be submitted electronically to the Government using E-mail or diskette within 24 hours after the date covered by the report. Use of either mode of submittal shall be coordinated with the government representative. The Contractor shall also provide the Government a signed, printed copy of the daily CQC report.

1.7.3.2 Deficiency Tracking.

The Contractor shall use RMS-QC to track deficiencies. Deficiencies identified by the Contractor will be numerically tracked using QC Comments. The contractor shall maintain a current log of its QC comments in the RMS-QC database. The Government will log the deficiencies it has identified using its QA comments. The Government's QA comments will be included in its export file to the Contractor. The Contractor shall regularly update the correction status of both QC and QA comments.

1.7.3.3 Three-Phase Control Meetings

The Contractor shall maintain scheduled and actual dates and times of preparatory and initial control meetings in RMS-QC.

1.7.3.4 Accident/Safety Tracking.

The Government will issue safety comments, directions, or guidance whenever safety deficiencies are observed. The Government's safety comments will be included in its export file to the Contractor. The Contractor shall regularly update the correction status of the safety comments. In addition, the Contractor shall utilize RMS-QC to advise the Government of any accidents occurring on the jobsite. This brief supplemental entry is not to be considered as a substitute for completion of mandatory reports, e.g., ENG Form 3394 and OSHA Form 200.

1.7.3.5 Features of Work

The Contractor shall include a complete list of the features of work in the

RMS-QC database. A feature of work may be associated with multiple pay activities. However, each pay activity (see subparagraph "Pay Activity Data" of paragraph "Finances") will only be linked to a single feature of work.

1.7.3.6 QC Requirements

The Contractor shall develop and maintain a complete list of QC testing, transferred and installed property, and user training requirements in RMS-QC. The Contractor shall update all data on these QC requirements as work progresses, and shall promptly provide this information to the Government via RMS-QC.

1.7.4 Submittal Management

The Government will provide the initial submittal register, ENG Form 4288, SUBMITTAL REGISTER, in electronic format. Thereafter, the Contractor shall maintain a complete list of all submittals, including completion of all data columns as described in Section 01330, SUBMITTAL PROCEDURES. Dates on which submittals are received and returned by the Government will be included in its export file to the Contractor. The Contractor shall use RMS-QC to track and transmit all submittals. ENG Form 4025, submittal transmittal form, and the submittal register update, ENG Form 4288, shall be produced using RMS-QC. RMS will be used to update, store and exchange submittal registers and transmittals, but will not be used for storage of actual submittals.

1.7.5 Schedule

The Contractor shall develop a construction schedule consisting of pay activities, in accordance with Contract Clause "Schedules for Construction Contracts", or Section 01320, PROJECT SCHEDULE, as applicable. This schedule shall be input and maintained in the RMS-QC database either manually or by using the Standard Data Exchange Format (SDEF) (see Section 01320 PROJECT SCHEDULE). The updated schedule data shall be included with each pay request submitted by the Contractor.

1.7.6 Import/Export of Data

RMS-QC includes the ability to export Contractor data to the Government and to import submittal register and other Government-provided data, and schedule data using SDEF.

1.8 IMPLEMENTATION

Contractor use of RMS-QC as described in the preceding paragraphs is mandatory. The Contractor shall ensure that sufficient resources are available to maintain its RMS-QC database, and to provide the Government with regular database updates. RMS-QC shall be an integral part of the Contractor's management of quality control.

1.9 DATA SUBMISSION VIA COMPUTER DISKETTE OR CD-ROM

The Government-preferred method for Contractor's submission of updates, payment requests, correspondence and other data is by E-mail with file attachment(s). For locations where this is not feasible, the Contracting Officer may permit use of computer diskettes or CD-ROM for data transfer. Data on the disks or CDs shall be exported using the RMS-QC built-in export function. If used, diskettes and CD-ROMs will be submitted in accordance

with the following:

1.9.1 File Medium

The Contractor shall submit required data on 3-1/2" double-sided high-density diskettes formatted to hold 1.44 MB of data, capable of running under Microsoft Windows 95 or newer. Alternatively, CD-ROMs may be used. They shall conform to industry standards used in the United States. All data shall be provided in English.

1.9.2 Disk or CD-ROM Labels

The Contractor shall affix a permanent exterior label to each diskette and CD-ROM submitted. The label shall indicate in English, the RMS-QC file name, full contract number, project name, project location, data date, name and telephone number of person responsible for the data.

1.9.3 File Names

The Government will provide the file names to be used by the Contractor with the RMS-QC software.

1.10 MONTHLY COORDINATION MEETING

The Contractor shall update the RMS-QC database each workday. At least monthly, the Contractor shall generate and submit an export file to the Government with schedule update and progress payment request. As required in Contract Clause "Payments", at least one week prior to submittal, the contractor shall meet with the Government representative to review the planned progress payment data submission for errors and omissions. The contractor shall make all required corrections prior to Government acceptance of the export file and progress payment request. Payment requests accompanied by incomplete or incorrect data submittals will be returned. The Government will not process progress payments until an acceptable RMS-QC export file is received.

1.11 NOTIFICATION OF NONCOMPLIANCE

The Contracting Officer will notify the Contractor of any detected noncompliance with the requirements of this specification. 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.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

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SECTION 01430

ENVIRONMENTAL PROTECTION

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.

STATE OF HAWAII DEPARTMENT OF HEALTH (HIDOH)

HIDOH, Chapter 46	Administrative Rules, Title 11, Community Noise Control
HIDOH, Chapter 59	Administrative Rules, Ambient Air Quality Standards
HIDOH, Chapter 60.1	Administrative Rules, Air Pollution Control

1.2 GENERAL REQUIREMENTS

This section covers prevention of environmental pollution and damage as the result of construction operations under this contract and for those measures set forth in the TECHNICAL REQUIREMENTS. For the purpose of this specification, environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of air, water, and land, and includes management of visual aesthetics, noise, solid waste, radiant energy and radioactive materials, as well as other pollutants.

1.2.1 Subcontractors

Assurance of compliance with this section by subcontractors will be the responsibility of the Contractor.

1.2.2 Notification

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with the aforementioned Federal, State or local laws or regulations, permits, and other elements of the Contractor's environmental protection plan. The Contractor shall, after receipt of such notice, inform the Contracting Officer of proposed corrective action and take such action as may be approved. If the Contractor fails 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 time extensions will be granted or costs or damages allowed to the Contractor for any such suspension.

1.3 SUBMITTALS

Government approval is required for submittals with "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-18 Records

Environmental Protection Plan; FIO.

Within 30 calendar days of receipt of Notice to Proceed, the Contractor shall submit in writing an environmental protection plan. Approval of the Contractor's plan will not relieve the Contractor of his responsibility for adequate and continuing control of pollutants and other environmental protection measures. The environmental protection plan shall include but not be limited to the following:

- a. A list of Federal, State, and local laws, regulations, and permits concerning environmental protection, pollution control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits.
- b. Methods for protection of features to be preserved within authorized work areas. The Contractor shall prepare a listing of methods to protect resources needing protection; i.e., trees, grasses and ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, archeological, and cultural resources.
- c. Procedures to be implemented to provide the required environmental protection and to comply with the applicable laws and regulations. The Contractor shall set out the procedures to be followed to correct pollution of the environment due to accident, natural causes, or failure to follow the procedures set out in accordance with the environmental protection plan.
- d. Location of the solid waste disposal area.
- e. **Drawings showing locations of any proposed temporary excavations or embankments for haul roads, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials.**
- f. Environmental monitoring plans for the job site, including land, water, air, and noise monitoring.
- g. Traffic control plan.
- h. Methods of protecting surface and ground water during construction activities.
- i. Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas.
- j. Training for his personnel during the construction period.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 PROTECTION OF ENVIRONMENTAL RESOURCES

The environmental resources within the project boundaries and those affected outside the limits of permanent work under this contract shall be protected during the entire period of this contract. The Contractor shall confine his activities to areas defined by the drawings and specifications.

3.1.1 Land Resources

Prior to the beginning of any construction, the Contractor shall identify all land resources to be preserved within the Contractor's work area. Except in areas indicated on the drawings or specified to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, grasses, topsoil, and land forms without special permission from the Contracting Officer. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. Where such special emergency use is permitted, the Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs.

3.1.1.1 Work Area Limits

Prior to any construction, the Contractor shall mark the areas that are not required to accomplish all work to be performed under this contract. Isolated areas within the general work area which are to be saved and protected shall also be marked or fenced. Monuments and markers shall be protected before construction operations commence. Where construction operations are to be conducted during darkness, the markers shall be visible. The Contractor shall convey to his personnel the purpose of marking and/or protection of all necessary objects.

3.1.1.2 Protection of Landscape

Trees, shrubs, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved shall be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques.

3.1.1.3 Reduction of Exposure of Unprotected Erodible Soils

Earthwork brought to final grade shall be finished as indicated and specified. Side slopes and back slopes shall be protected as soon as practicable upon completion of rough grading. All earthwork shall be planned and conducted to minimize the duration of exposure of unprotected soils. Except in instances where the constructed feature obscures waste material areas, these areas shall not initially be cleared in total. Clearing of such areas shall progress in reasonably sized increments as needed to use the areas developed as approved by the Contracting Officer.

3.1.1.4 Protection of Disturbed Areas

Such methods as necessary shall be utilized to effectively prevent erosion and control sedimentation, including but not limited to the following:

- a. Retardation and Control of Runoff: Runoff from the construction site shall be controlled by construction of diversion ditches,

benches, and berms to retard and divert runoff to protected drainage courses, and any measures required by areawide plans approved under Paragraph 208 of the Clean Water Act.

- b. Erosion and Sedimentation Control Devices: The Contractor shall construct or install all temporary and permanent erosion and sedimentation control features as indicated on the drawings. Temporary erosion and sediment control measures such as berms, dikes, drains, grassing, and mulching shall be maintained until permanent drainage and erosion control facilities are completed and operative.

3.1.1.5 Contractor Facilities and Work Areas

- a. Location of Field Offices, Storage, and Other Contractor Facilities: The Contractors' field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas designated on the drawings or as directed by the Contracting Officer. Temporary movement or relocation of Contractor facilities shall be made only on approval by the Contracting Officer.
- b. Spoil Areas on Government Property: Spoil areas shall be managed and controlled to limit spoil to areas designated on the drawings and prevent erosion of soil or sediment from entering nearby waters. Spoil areas shall be developed in accordance with the grading plan indicated on the drawings.
- c. Temporary Excavations and Embankments: Temporary excavations and embankments for work areas shall be controlled to protect adjacent areas from despoilment.

3.1.2 Disposal of Wastes

Disposal of wastes shall be as specified in Section 02220 DEMOLITION and as specified hereinafter.

3.1.2.1 Solid Wastes

Solid wastes (excluding clearing debris) shall be placed in containers which are emptied on a regular schedule. All handling and disposal shall be conducted to prevent contamination. Segregation measures shall be employed such that no hazardous or toxic waste will become commingled with solid waste. The Contractor shall transport all solid waste off Government property and dispose of it in compliance with Federal, State, and local requirements for solid waste disposal. The Contractor shall comply with site procedures and with Federal, State, and local laws and regulations pertaining to the use of landfill areas.

3.1.2.2 Chemical Wastes:

Chemical wastes shall be stored in corrosion resistant containers, removed from the work area and disposed of in accordance with Federal, State, and local laws and regulations.

3.1.2.3 Hazardous Wastes:

The Contractor shall take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing and shall collect waste in suitable containers observing compatibility. The Contractor shall transport all hazardous waste off Government property and dispose of it in compliance with Federal and local laws and regulations. Spills of hazardous or toxic materials shall be immediately reported to the Contracting Officer. Cleanup and cleanup costs due to spills shall be the responsibility of the Contractor.

3.1.3 Historical, Archeological, and Cultural Resources

If during excavation or other construction activities any unidentified or unanticipated resources are discovered or found, all activities that may damage or alter such resources shall be temporarily suspended. These resources or cultural remains (prehistoric or historic surface or subsurface) include but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rocks or coral alignments, paving, wall, or other constructed features; and any indication of agricultural or other uses. Upon such discovery or find, the Contractor shall immediately notify the Contracting Officer. When so notified, the Contracting Officer will initiate action so that prompt and proper data recovery can be accomplished. In the mean time, recording and preservation of historical and archeological finds during construction activities shall be reported in accordance with the SPECIAL CONTRACT REQUIREMENTS.

3.1.4 Water Resources

The Contractor shall keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters. All activities, equipment processes, and work operated or performed by the Contractor in accomplishing the specified construction shall be in strict conformance with the State of Hawaii Department of Health (HIDOH) Administrative Rules, Chapter 11-54 and HIDOH Administrative Rules, Chapter 11-55. **The Whole Barracks Renewal (WBR) Project has a National Pollution Discharge Elimination System (NPDES) General Permit pending with the NIDOH.**

The The government has prepared a DOH CWB-NOI Form C (Notice of Intent (NOI) for HAR Chapter 11-55 Appendix C- NPDES General Permit Coverage Authorizing Discharges of Storm Water Associated with Construction Activity) (1st submittal is attached) covering the general aspects of the entire Phase 2 project (FY00 to 05 projects). A general Best Management Practices (BMP) Plan (1st submittal is attached) (addressing general aspects of the overall project)(NOI Form C #16) has also been submitted to the DOH CWB. Contractor shall abide by all requirements set forth in the CWB-NOI Form C on file at the State DOH. Contractor is responsible for preparing and submitting all items required to satisfy DOH requirements pertaining to the FY00 WBR IJK, SB project NPDES permit application. Any variations to the CWB NOI Form C (attached) enlisted by the Contractor shall be submitted to the Contracting Officer or his representative for approval. Once approved, Contractor shall incorporate proposed changes in his site specific plans and submit them to the State DOH a minimum of 30 days prior to the start of construction operations to obtain permit coverage for this phase of the WBR project.

Required CWB-NOI Form C Item #:

3. General Contractor Information (see Guidelines for CWB-NOI Form C

- Note 3). (Note: If Contractor main office location is not a local address, Contractor shall also submit a local address, contact person & title, phone & fax nos.
15. **Project Site Maps (see Guidelines for CWB-NOI Form C - Note 15):**
1. Provide a phasing map identifying each phase of the FY00 Phase 2A project.
 2. Attach Site Maps (i.e., site plan, grading plan, drainage plan, erosion control plan, etc. folded to 8-1/2 x 11 inches) which shows the information requested in Item 15.2.1 through 15.2.8.
16. **Site-Specific Construction Best Management Practices (BMP) Plan (see Guidelines for CWB-NOI Form C - Note 16).** The site specific construction BMP plan shall be signed in accordance with HAR Section 11-55-34.08(e). The site-specific construction BMP plan shall be kept at the construction site.
18. **Additional Information (see Guidelines for CWB-NOI Form C - Note 18).**

All activities, equipment processes, and work operated or performed by the Contractor in accomplishing the specified construction shall be in strict conformance with the General & Site Specific Best Management Plans (BMP) for this project. Site Specific BMP shall be prepared by the Contractor after contract award.

Contractor shall obtain all required additional NPDES permits for construction activities (submitting a Notice of Intent (NOI) to be Covered Under General Permit, along with applicable HAR Chapter 11-55 Appendix/Appendices (B,C,D,E,F,G,H and/or I). Contractor is responsible for all applicable filing fees (if required) and for preparation of required supporting documents. As specified in Section 342D-11 Hawaii Revised Statutes, if the project has any storm water discharge before a Notice of General Permit Coverage (NGPC) is issued, the permittee could face penalties of up to \$25,000 per day per violation. Contractor shall be fully liable for the entire amount of any and all penalties imposed as a result of his actions (e.g. if work is begun prior to receiving NGPC and the state imposes penalties for storm water discharge to the Government, the Contractor shall be responsible for all penalties.

3.1.4.1 Monitoring of Water Areas:

Monitoring of water areas affected by construction activities shall be the responsibility of the Contractor. All water areas affected by construction activities shall be monitored by the Contractor.

3.1.5 Fish and Wildlife Resources

The Contractor shall keep construction activities under surveillance, management and control to minimize interference with, disturbance to and damage of fish and wildlife. Species that require specific attention along with measures for their protection will be listed by the Contractor prior to beginning of construction operations.

3.1.6 Air Resources

The Contractor shall keep construction activities under surveillance,

management and control to minimize pollution of air resources. All activities, equipment, processes, and work operated or performed by the Contractor in accomplishing the specified construction shall be in strict accordance with HIDOH, Chapter 59, HIDOH, Chapter 60.1, and all Federal emission and performance laws and standards. Ambient Air Quality Standards set by the Environmental Protection Agency shall be maintained for those construction operations and activities specified in this section. Special management techniques as set out below shall be implemented to control air pollution by the construction activities which are included in the contract. The Contractor shall be responsible for obtaining any necessary permits under HIDOH, Chapter 60.1, for contractor equipment.

3.1.6.1 Particulates

- a. Dust particles, aerosols, and gaseous by-products from all construction activities, processing and preparation of materials, such as from asphaltic batch plants, shall be controlled at all times, including weekends, holidays and hours when work is not in progress.
- b. The Contractor shall maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause the air pollution standards mentioned in paragraph Air Resources, herein before, to be exceeded or which would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated at such intervals as to keep the disturbed area damp at all times. The Contractor must have sufficient competent equipment available to accomplish this task. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs.

3.1.6.2 Hydrocarbons and Carbon Monoxide

Hydrocarbons and carbon monoxide emissions from equipment shall be controlled to Federal and State allowable limits at all times.

3.1.6.3 Odors

Odors shall be controlled at all times for all construction activities, processing and preparation of materials.

3.1.6.4 Monitoring of Air Quality

Monitoring of air quality shall be the responsibility of the Contractor. All air areas affected by the construction activities shall be monitored by the Contractor.

3.1.7 Sound Intrusions

The Contractor shall keep construction activities under surveillance, and control to minimize damage to the environment by noise. The Contractor shall comply with the provisions of HIDOH, Chapter 46.

3.2 POST CONSTRUCTION CLEANUP

The Contractor shall clean up area(s) used for construction.

3.3 RESTORATION OF LANDSCAPE DAMAGE

The Contractor shall restore all landscape features damaged or destroyed during construction operations outside the limits of the approved work areas. Such restoration shall be in accordance with the plan submitted for approval by the Contracting Officer. This work will be accomplished at the Contractor's expense.

3.4 MAINTENANCE OF POLLUTION CONTROL FACILITIES

The Contractor shall maintain all constructed facilities and portable pollution control devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

3.5 TRAINING OF CONTRACTOR PERSONNEL IN POLLUTION CONTROL

The Contractor shall train his personnel in all phases of environmental protection. The training shall include methods of detecting and avoiding pollution, familiarization with pollution standards, both statutory and contractual, and installation and care of facilities (vegetative covers, and instruments required for monitoring purposes) to ensure adequate and continuous environmental pollution control.

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SECTION 01455

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 (1996) 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 (1995b) 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.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 GENERAL

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 burden of proof of contract compliance is placed on the Contractor and not assumed by the Government. The Contractor's Quality Control (CQC) System shall not be accepted without question and the right to inspect or verify the work at any time is reserved by the Government. The 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 project superintendent in this context shall mean the individual with the responsibility for the overall management of the project including quality and production.

3.2 QUALITY CONTROL PLAN

3.2.1 General

The Contractor shall furnish for review by the Government, not later than 30 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 90 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 not identified in the features of work included in an accepted plan will not be permitted to begin until acceptance of a supplemental or amended CQC 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 superintendent.
- b. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function. Technicians responsible for sampling and testing of concrete shall be certified by the American Concrete Institute (ACI) or the Concrete Technicians Association of Hawaii (CTAH). Proof of certification shall be included in the CQC Plan. Personnel qualifications may be furnished incrementally as the work progresses, but in no case, less than fourteen (14) calendar days before personnel are required on the job.
- 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. A similar letter is required for the Assistant CQCSM. 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.

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.

3.2.5 Corrective Actions

Anytime it is determined by the Government that the Contractor's Quality Control system is not entirely satisfying the contract requirements, corrective action shall be taken by the Contractor to the satisfaction of the Contracting Officer. A portion of the payments to the Contractor shall be withheld for non-performance until an acceptable Quality Control system is established, implemented and enforced by the Contractor, including revisions to the organization due to deficient management. In addition, no work shall be performed on the contract or Government identified areas of work where the Government determines that the Quality Control system is ineffective. No time loss, due to issuance of the Government's stop work order, and/or any possible impact shall be made the subject of a claim for time extension or for additional costs or damages by the Contractor.

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 7 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 General

The Quality Control System shall be implemented by the prime Contractor utilizing not less than the following Quality Control staff at the jobsite.

The actual strength of the staff may vary during any specific work period to cover the needs of the work phases. However, the CQC organization shall be sufficient qualifications and size, satisfactory to the Contracting Officer, to insure contract compliance. Qualifications shall consider both experience and technical training to perform the assigned responsibilities.

Of primary consideration, whether an individual's qualifications are acceptable to the Contracting Officer, shall be the proposed individual's past experiences with projects of similar complexity, magnitude and type/scope of work. The requirements for CQC personnel described below are in addition to other specified technical representatives such as registered land surveyor, consultant, manufacturer's representatives, etc., that may be required under the other sections of the Technical Specifications.

3.4.2 CQC System Manager (CQCSM) and Assistant CQCSM

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 both a Registered Professional Engineer and a construction person with a minimum of 5 years in related work experience, i.e. - CQCSM or Superintendent on projects of similar complexity, magnitude and type/scope of work. (Note: The requirement for a registered professional engineer may be waived if the Assistant CQCSM is a registered professional engineer.) This CQC System manager shall be on the site at all time during construction and shall be employed by the prime Contractor. The CQC System Manger shall be assigned no other duties. A full time Assistant CQCSM shall also be identified. The qualifications for the Assistant CQCSM shall be the same as that for the CQCSM except as noted above. The Assistant CQCSM shall work directly for the CQCSM in managing the CQC system,, be on site at all times, be employed by the prime Contractore, be assigned no other duties, and shall act in behalf of the CQCSM in his absense.

3.4.3 Registered Mechanical Engineer and Registered Electrical Engineer

One each registered Mechanical Engineer and Registered Electrical Engineer shall be provided physically on the site for the duration of the contract from the date that mechanical or electrical submittals are available for review or from the date of commencement of any work activities related to mechanical or electrical systems as applicable to their respective profession; which ever occurs first. These engineers shall have specific responsibilities for submittal review (including O&M manuals and related training), verification of installations, check out, testing, verification

that support systems are adjusted and regulated properly, and inspection of mechanical and electrical systems. These engineers shall have a minimum of five years experience on installations of similar complexity, type and scope of work.

3.4.4 Engineering Technician

One full time Engineering Technician shall be provided physically on site for the duration of the contract to coordinate the prime Contractor's submittal system and monitor the effectiveness of the Contractor's system for handling Government-furnished property in accordance with the contract requirements. The Technician may also be utilized to assist and coordinate the preparation and submittal of O&M manuals, posted schematics/diagrams, etc., for systems operations, and preparation of training plans and testing plans.

3.4.5 Clerical Staff

Sufficient Clerical help, one minimum, shall be provided physically on site for the duration of the contract to insure the completion and/or submission in a timely manner of all reports, memoranda, charts, and other data required in accordance with the contract.

3.4.6 Quality Control Representatives

A minimum of two full type Quality Control Representative shall be provided physically on site for the duration of the contract, under the direct supervision of the CQCSM, to assist with submittal review, daily review of on-going construction, safety, and other related duties as assigned. These QC representatives shall have a minimum of 5 years relative experience on projects of similar complexity, type and scope of work. Additional QC representatives shall be provided as required to verify that the on-going construction is in full compliance with the contract requirements.

3.4.7 Required QC Specialist

Provide separate QC specialist(s) at the work site for each of the areas of responsibilities, specified below, who will assist and report to the CQCSM and who will have no other duties other than reviewing submittals, performing the three phases of control and preparing documentation required by this contract. QC Specialists shall perform these duties for each definable feature of work in their area of responsibility at the frequency specified below.

Qualifications/Experience in Area of Responsibility	Area of Responsibility	Frequency
Registered Structural Engineer, (P.E.)/5 years minimum as P.E.	Structural Steel	Minimum twice per week.
Certified Concrete/Masonry Inspector, 5 years minimum experience.	Formwork, Reinforcing Steel, Concrete and Masonry	Continuous while work is being performed.
Food Service Equipment Specialist, 5 years minimum experience and	Food Service Equipment	Continuous while work is being performed and until all food service

Qualifications/Experience in Area of Responsibility	Area of Responsibility	Frequency
work on min. 2 previous projects of similar size, complexity and scope.		equipment is accepted by the Government.

3.4.8 CQC Personnel

In addition to CQC personnel specified elsewhere in the contract, the Contractor shall provide as part of the CQC organization additional specialized personnel to assist the CQC System Manager as may be required. If it is subsequently determined by the Contracting Officer that the minimum contract CQC requirements are insufficient/ineffective, the Contractor may be required to provide additional staff personnel to the CQC organization at no cost to the Government.

3.4.9 Additional Requirement

The CQC System Manager and the Assistant CQCSM shall have completed the course entitled "Construction Quality Management For Contractors". This course is periodically offered at the General Contractors Association of Hawaii.

3.4.10 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

Submittals 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.

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.
- 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.
- l. The preparatory phase shall be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.

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 shall 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. 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 obtain the services of an industry recognized testing laboratory, or may establish a testing laboratory at the project site acceptable to the Contracting Officer. However, tests contractually required to be performed by an industry recognized testing laboratory shall not be accomplished by the Contractor established on-site laboratory. 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

3.7.2.1 Laboratory Accreditation

The testing laboratory performing the actual testing on the project shall be accredited by one of the following laboratory accreditation authorities:

American Association of State Highway and Transportation Officials
National Voluntary Laboratory Accreditation Program
American Association for Laboratory Accreditation
Washington Association of Building Officials

The testing laboratory shall submit an acknowledgement letter from one of the listed laboratory accreditation authorities indicating that the application for accreditation has been received and the accreditation process started.

3.7.2.2 Capability Check

The Government reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt, and steel shall meet criteria detailed in ASTM D 3740 and ASTM E 329.

3.7.2.3 Capability Recheck

If the selected laboratory fails the capability check, the Contractor shall reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the contract amount due the Contractor.

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 shall be borne by the Contractor. Samples of materials for test verification and acceptance testing by the Government shall be delivered to a testing laboratory on the Island of Oahu, State of Hawaii, designated by the Contracting Officer. Coordination for each specific test, exact delivery location, and dates will be made through the Government field office.

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. The QC Manager shall develop a punch list of items which do not conform to the contract documents. The Government will review the punch list and add to or correct the items listed. The QC Manager shall incorporate Government comments and provide a Pre-Final Punch List. 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. **Unless otherwise directed by the Contracting Officer.** 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 DEFECTIVE (NONCOMPLYING) WORK

The Contractor shall not build upon or conceal defective work. The effectiveness of the Quality Control system shall be judged on the basis of defective work being promptly recognized, the Contractor's production staff advised and immediate corrective action taken. If the Contractor's production staff builds directly upon or over defective work, without making prompt and necessary corrections; and in the process conceals the defective work, 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 any such stop orders or corrective action shall be made the subject of a claim for extension of time or additional costs or damages to the Contractor. No payments shall be made for defective work.

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.

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SECTION 01900

MISCELLANEOUS PROVISIONS

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having a "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment Data; FIO.

FOR DINING FACILITY ONLY.

A list of all equipment furnished under this contract. This list shall include, but not be limited to, each piece of equipment with a serial number, and shall include all information shown on the manufacturer's nameplate, so as to positively identify the piece of equipment. This list shall also include the cost of each piece of equipment (less installation costs) F.O.B. construction site. This list shall be furnished as soon as possible after equipment is purchased. The list shall consist of one (1) reproducible and three (3) copies, and shall be furnished to the Contracting Officer not later than thirty (30) calendar days prior to completion of any segment of the contract work which has an incremental completion date.

SD-04 Drawings

As-Built Drawings; FIO.

SD-18 Records

Dust Control; GA.

Method(s) of dust control.

Excavation/Trenching Clearance; FIO.

Prior to start of any excavation or trenching work, the Contractor shall obtain clearance, in writing, from the appropriate communications agency and base or area engineer. Copies of all correspondence shall be provided the Contracting Officer. Normal coordination time for obtaining the necessary permits is approximately fifteen (15) calendar days. The Contractor shall advise the Contracting Officer promptly when it appears that the normal coordination time will be exceeded.

Contract Phasing and Traffic Control; GA

The Contractor shall submit 30 days prior to Construction, his Contract Phasing and Traffic Control plan as specified on Civil Sheets CG 3 & CG 4, for approval.

1.2 CONTRACTOR QUALITY CONTROL

To assure compliance with contract requirements, the Contractor shall establish and maintain quality control for materials and work covered by all sections of the TECHNICAL REQUIREMENTS in accordance with Section 01455 CONTRACTOR QUALITY CONTROL. Records shall be maintained for all operations including sampling and testing.

1.3 AS-BUILT DRAWINGS

As-built drawings shall be in accordance with Section 01780 CLOSEOUT SUBMITTALS.

1.4 DUST CONTROL

Dust control shall be in accordance with Section 02220 DEMOLITION.

1.5 PROTECTION

The Contractor shall take all necessary precautions to insure that no damages to private or public property will result from his operations. Any such damages shall be repaired or property replaced by the Contractor in accordance with the CONTRACT CLAUSES entitled "PERMITS AND RESPONSIBILITIES" and "PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS", without delay, and at no cost to the Government.

1.5.1 Warning Signs and Barricades

The Contractor shall be responsible for posting warning signs or erecting temporary barricades to provide for safe conduct of work and protection of property.

1.5.2 Protection of Grassed and Landscaped Areas

The Contractor's vehicles shall be restricted to paved roadways and driveways. Vehicles shall not be driven or parked on grassed and/or landscaped areas except when absolutely necessary for the performance of the work and approved in advance by the Contracting Officer. Grassed or landscaped areas damaged by the Contractor shall be restored to their original condition without delay and at no cost to the Government.

1.5.3 Protection of Trees and Plants

Where necessary, tree branches and plants interfering with the work may be temporarily tied back by the Contractor to permit accomplishment of the work in a convenient manner, so long as they will not be permanently damaged thereby. If this is not feasible, they may be pruned, subject to written approval by the Contracting Officer.

1.5.4 Protection of Building From the Weather

The interior of the building and all materials and equipment shall be protected from the weather at all times.

1.6 RESTORATION WORK

Existing conditions or areas damaged or disturbed by the Contractor's

operations shall be restored to their original condition, or near original condition as possible, to the satisfaction of the Contracting Officer.

1.7 REMOVAL AND DISPOSAL

Removal and disposal shall be in accordance with Section 02220 DEMOLITION. The Contractor shall salvage or recycle waste to the maximum extent practical as it relates to the capabilities of local industries. A record of the quantity of salvaged or recycled materials shall be maintained by the Contractor during the length of the project and submitted to the Contracting Officer at acceptance of the project. Quantities shall be recorded in the unit of measure of the industry. Reuse of materials on the site shall be considered a form of recycling. An example of such reuse would be the use of acceptable excavated materials as fill.

1.8 INTERFERENCE WITH GOVERNMENT OPERATIONS

The Contractor shall establish work procedures and methods to prevent interference with existing operations within or adjacent to the construction area. Free passage into adjoining or adjacent buildings not in the contract will not be permitted except as approved by the Contracting Officer. Procedures and methods shall also provide for safe conduct of work and protection of property which is to remain undisturbed.

1.8.1 Coordination

The Contractor shall coordinate all work with the Contracting Officer to minimize interruption and inconvenience to the occupants or to the Government. Scheduling and programming of work will be established during the pre-construction conference.

1.8.2 Utilities and Facilities

All utilities and facilities within the area shall remain operable and shall not be affected by the Contractor's work, unless otherwise approved in writing in advance by the Contracting Officer.

1.8.3 Staking and Flagging Existing Utilities

The Contractor, prior to start of any excavation or trenching work, shall verify the location of all utility lines shown on the drawings which are within the areas of work, and shall mark, stake, or flag each utility line along trench alignments and under areas of excavation under this project, as approved. Existing utility lines shall be located by walking trench alignments with approved equipment for locating underground pipes and cables. Utility lines so located shall be noted on the drawings.

1.9 CONTRACTOR'S OPERATIONS OR STORAGE AREA

Contractor operations or storage area will be as indicated on the Civil notes on the drawings.

1.10 CONTRACTOR'S PARKING

Contractor employee parking shall be limited to within construction limits. Contractor and his employees are restricted from parking anywhere within Schofield Barracks Military Base boundaries, outside of construction limits.

1.11 GOVERNMENT PROJECT OFFICE

The Contractor shall provide, for use by Government supervisory and inspection personnel, a job-site office space with a floor area not less than 1000 square feet. This office space may be within the Contractor's project office building if adjacent to the job site and if separated by a solid partition; otherwise a separate facility, adjacent to the job site, shall be provided. The office shall be provided with windows and screens, air conditioning to maintain not more than 22 degrees C, electricity, wall outlets, ceiling lights, (4) telephones and (2) cellular phones or (4) cellular phones, (4) office desks with drawers, (10) layout tables, (8) ergonomic chairs, (15) legal-size five-drawer locking file cabinets, (5) 3-shelf bookcase, (5) plan racks, and a fire extinguisher. (4) computers shall be provided with the following minimum requirements:

CPU: Pentium III, 800 Mhz
RAM: 128 MB
Hard Drive: 12 GB
Floppy Drive: 3.5-inch
Zip Drive: 100 MB
CD-ROM: 48x max
Operating system - Windows 98
Software: Microsoft Office 2000
Fax Modem: 56 kbps
Monitor: 17-inch
Other: Network card

The computers shall be networked together with one computer as a server.

Other devices (minimum requirements):

Printer: Hewlett-Packard Laserjet 4500 or approved equal (must be HP PCL compatible)
Digital Camera: Kodak D265 or approved equal

Provide potable drinking water and temporary toilet facilities for Government personnel. Contractor's copier and fax machine shall be for use by Government personnel. Contractor shall provide (4) vehicle parking spaces for Government personnel at the project office. The cost of utilities including two telephone lines with different telephone numbers (one number for the telephone instrument and one for the modem), air conditioning, and operation and maintenance costs of the Government project office shall be borne by the Contractor. The government will be responsible for its long distance calls. Upon completion of the project, the project office and furnishings shall be removed and disposed of by the Contractor.

1.12 WORKING DIRECTIVES

1.12.1 Building Orientation

The Contractor shall schedule a building orientation including a minimum of 2 hour classroom and 6 hour hands-on walk-thru of all the buildings and building systems to acquaint the building tenant and other interested parties in the building functions, operation, maintenance, service and location of all controls. Similar requirements outlined in individual specification sections may be combined with this orientation except that the number of hours and other technical requirements shall take precedence. Time and location shall be as directed by the Contracting Officer. Submit

the orientation plan and sample of handouts for Government approval.

1.13 COMMERCIAL TELEPHONE SERVICE LINES

Availability of existing commercial telephone service lines are extremely limited and/or non-existent. Contractor shall coordinate with Verizon Hawaii to verify the extent of commercial telephone service lines available and what actions may be necessary to obtain said service in the magnitude required to satisfy operational requirements. Notwithstanding the actual level of commercial telephone service lines available, the Contractor shall be responsible for all costs and necessary actions.

1.14 INSPECTION

1.14.1 Final Inspection and Acceptance

The Contractor shall give the Contracting Officer, a minimum of fourteen (14) calendar days advance notice prior to final inspection for acceptance by the Contracting Officer. All deficiencies found on final inspection shall be promptly and satisfactorily corrected by the Contractor upon notification by the Contracting Officer.

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SECTION 02811

UNDERGROUND SPRINKLER SYSTEMS

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 the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 32	(1996) Solder Metal
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM D 1785	(1996a) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(1996a) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(1996a) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1996a) 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 2774	(1994) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3261	(1996) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.2	(1983; R 1991; Errata May 1992) Gages and Gaging for Unified Inch Screw Threads
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings

ASME B16.22 (1995) Wrought Copper and Copper Alloy
Solder Joint Pressure Fittings

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1013 (1993) Reduced Pressure Principle Backflow
Preventers

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C901 (1996) Polyethylene (PE) Pressure Pipe and
Tubing, 1/2 In. Through 3 In., for Water
Service

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-51145 (Rev C) Flux, Soldering, Non-Electronic,
Paste & Liquid

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

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

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

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check
Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2 (1993) Industrial Control and Systems,
Controllers, Contactors, and Overload
Relays Rated Not More Than 2,000 Volts AC
or 750 Volts DC

NEMA ICS 6 (1993) Industrial Control and Systems,
Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999; Errata 96-4) **National Electrical
Code**

1.2 PERFORMANCE REQUIREMENTS

System shall operate with a minimum water pressure of 415 kPa at
connection to backflow prevention device and 345 kPa at the last head in
each zone.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTAL
PROCEDURES:

SD-01 Data

Framed Instructions; FIO.

Labels, signs, and templates of operating instructions that are required to be mounted or installed on or near the product for normal, safe operation.

Field Training ; FIO.

Information describing training to be provided, training aids to be used, samples of training materials to be provided, and schedules and notification of training.

Spare Parts; FIO.

Spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than the start of the field tests. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-04 Drawings

Sprinkler System; FIO.

As-built Drawings which provide current factual information showing locations of mains, heads, valves, and controllers including deviations from and amendments to the drawings and changes in the work shall be included.

SD-06 Instructions

Sprinkler System; FIO.

Detailed procedures defining the Contractor's provisions for accident prevention, health protection, and other safety precautions for the work to be done.

SD-09 Reports

Field Tests; FIO.

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

SD-13 Certificates

Sprinkler System; FIO.

The material supplier's or equipment manufacturer's statement that the supplied material or equipment meets specified requirements. Each certificate shall be signed by an official authorized to certify in behalf of material supplier or product manufacturer and shall identify quantity and date or dates of shipment or delivery to which the certificates apply.

SD-19 Operation and Maintenance Manuals

Sprinkler System; FIO.

Six copies of operation and six copies of maintenance manuals for the equipment furnished. One complete set prior to field testing and the remainder upon acceptance. Manuals shall be approved prior to the field training course. Operating manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout, simplified wiring and control diagrams of the system as installed, and system programming schedule.

1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be protected from the weather; excessive humidity and temperature variation; direct sunlight (in the case of plastic or rubber materials); and dirt, dust, or other contaminants.

1.5 FIELD MEASUREMENTS

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

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT REQUIREMENTS

2.1.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer who has produced similar systems which have performed well for a minimum period of 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Each item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.3 Extra Stock

The following extra stock shall be provided: Two sprinkler heads of each size and type, two valve keys for operating manual valves, two wrenches for removing and installing each type of head, two quick coupler keys and hose swivels, and four irrigation controller housing keys.

2.2 PIPING MATERIALS

2.2.1 Copper Tubing and Associated Fittings

Tubing shall conform to requirements of ASTM B 88, Type K. Fittings shall conform to ASME B16.22 and ASME B16.18, solder joint. Solder shall conform to ASTM B 32 95-5 tin-antimony. Flux shall conform to CID A-A-51145, Type I.

2.2.2 Polyvinyl Chloride (PVC) Pipe, Fittings and Solvent Cement

2.2.2.1 PVC Pipe

Pipe shall conform to the requirements of ASTM D 1785, PVC 1120 Schedule 40 and 80; or ASTM D 2241, PVC 1120 SDR 21, Class 200.

2.2.2.2 PVC Fittings

Solvent welded socket type fittings shall conform to requirements of ASTM D 2466, Schedule 40. Threaded type fittings shall conform to requirements of ASTM D 2464, Schedule 80.

2.2.2.3 Solvent Cement

Solvent cement shall conform to the requirements of ASTM D 2564.

2.2.3 Polyethylene (PE) Plastic Piping

Pipe shall conform to AWWA C901, outside diameter base with dimension ratio (DR) of 9.3 to provide 1034 kPa (150 psi) minimum pressure rating. Fittings shall conform to ASTM D 3261, DR of 9.3.

2.3 SPRINKLER

2.3.1 Pop-Up Spray Heads

2.3.1.1 General Requirements

Pop-up spray heads lay flush with housing, then pop up when water pressure 207 kPa is activated in system. The rising member supporting the nozzle shall be identical on full, half, third or quarter pattern sprinklers so that nozzles will be interchangeable. The sprinkler head shall be designed to be adjustable for coverage and flow. The nozzle shall be removable so head does not have to be removed for flushing or cleaning. Nozzle rises a minimum of 75 mm (3 inches) above the body. The body shall be constructed with a 13 mm female thread for installation in a fixed underground pipe system.

2.3.1.2 Shrubbery Sprinkler Heads

Sprinkler heads shall be conical spray with adjustable or non-adjustable coverage and designed for permanent aboveground mounting on riser or pop-ups at a height compatible with ground covers. Provide brass nozzles.

2.3.2 Rotary Pop-Up Sprinklers

Sprinklers shall be capable of covering 10m diameter at 345 kPa with a distribution rate of 13-56 L/second 75 mm pop-up, trajectory of 15 degrees,. Construction shall be high impact molded plastic with filter screen, reducible watering radius, and choice of 8 nozzles and have adjustable radius capabilities.

2.3.3 Dripperline

Dripperline shall consist of nominal sized low density lineal polyethylene tubing with I.D. 14.25 mm (0.57 inch) and O.D 16.5 (0.66 inch). Individual pressure compensating drippers shall be welded as an integral part of the tubing assembly. Drippers shall have a discharge rate of 3.40 liters per

hour (0.90 gallon per hour) and shall be spaced at 300 mm (12 inches) on center along the dripperline.

2.3.4 Drip Filter

Drip filter shall be multiple disc (200 mesh) type with discs constructed of chemical resistant thermoplastic for corrosion resistance. The disc filter body shall be constructed of molded plastic with male threads for both inlet and outlet. The filter shall be capable of periodic servicing by unscrewing a threaded cap.

2.4 VALVES

2.4.1 Gate Valves, Less than 80 mm (3 Inches)

Gate valves shall conform to the requirements of MSS SP-80 Bronze, Type 1, Class 125, threaded ends.

2.4.2 Quick Coupling Valves

Quick coupling valves shall have brass parts and shall be two-piece unit consisting of a coupler water seal valve assembly and a removable upper body to allow spring and key track to be serviced without shutdown of main. Lids shall be lockable vinyl with spring for positive closure on key removal.

2.4.3 Remote Control Valves, Electrical

Remote control valves shall be solenoid actuated globe valves of 20 to 80 mm (3/4 to 3 inch) size, suitable for 24 volts, 60 cycle, and designed to provide for shut-off in event of power failure. Valve shall be cast bronze or brass or plastic housing suitable for service at 1034 kPa (150 psi) operating pressure with external flow control adjustment for shut-off capability, external plug at diaphragm chamber to enable manual operation, filter in control chamber to prevent valve body clogging with debris, durable diaphragm, and accessibility to internal parts without removing valve from system.

2.4.4 Pressure Regulating Valve

Water pressure regulating master valve shall be cast bronze. Valve shall withstand initial pressure up to 2070 kPa (300 psi) with working pressure and pilot range from 172 to 517 kPa (25 to 75 psi).

2.4.5 Backflow Preventers

Reduced pressure principle assemblies shall be tested, approved, and listed in accordance with FCCCHR-01. Reduced pressure principle backflow preventers shall be in accordance with ASSE 1013.

2.5 ACCESSORIES AND APPURTENANCES

2.5.1 Valve Boxes and Concrete Pads

2.5.1.1 Valve Boxes

Valve boxes shall be plastic lockable, or precast concrete for each gate valve, manual control valve and remote control valve. Box sizes shall be adjustable for valve used. Word "IRRIGATION" shall be cast on cover.

Shaft diameter of box shall be minimum 130 mm (5-1/4 inches).

2.5.1.2 Concrete Pads

Concrete pads shall be precast or cast-in-place reinforced concrete construction for reduced pressure type backflow preventers.

2.5.2 Emitter Head Accessories

2.5.2.1 Strainer

Strainer shall be provided at inlet to each drip line. Strainer shall have stainless steel screen having equivalent of 200-mesh filtration capacity and incorporate flush valves within strainer to clean screen without disassembling unit.

2.5.2.2 Pressure Regulator

Pressure regulator shall be provided at each drip system if supply pressure exceeds 350 kPa (50 psi).

2.6 AUTOMATIC CONTROLLERS, ELECTRICAL

Controller shall conform to the requirements of NEMA ICS 2 with 120-volt single phase service, operating with indicated stations, and grounded chassis. Enclosure shall conform to NEMA ICS 6 Type 4X, with locking hinged cover, pedestal-mounted. Controller shall be hybrid (electronic programming with dials and switches for settings) having up to 40 stations, 4 watering programs with 8 start times each, and allow mixed irrigation applications in a single controller. Watering time shall be 1 minute increments up to 2 hours, and up to 12 hours for drip applications in 10 minutes increments. The controller shall have a program overlapping feature that maximizes hydraulic capacity and minimizes watering time; a 365-day calendar with leap year intelligence and an event day-off option to set any day of the month as a non-watering day for all programs; a water budget program that provides adjustments for 0 - 300% in 1% increments; a programmable rain-delay feature with auto-restart, allows manual watering by station or program; and a non-volatile 100 year memory to hold date, programs and time during power outages. The controller's power supply shall be protected by a 2.5 amp fuse and have a 9-volt rechargeable NiCad battery backup.

2.7 ELECTRICAL WORK

Wiring and rigid conduit for electrical power shall be in accordance with NFPA 70, and Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

2.8 CONCRETE MATERIALS

Concrete shall have a compressive strength of 17 MPa at 28 days as specified in Section 03300, CAST-IN-PLACE STRUCTURAL CONCRETE.

2.9 WATER SUPPLY MAIN MATERIALS

Tapping sleeves, service cut off valves, and connections to water supply mains shall be in accordance with Section 02510 WATER DISTRIBUTION SYSTEM.

2.10 INSULATING JOINTS

Insulating joints and dielectric fittings shall be in accordance with Section 02510 WATER DISTRIBUTION SYSTEM.

PART 3 EXECUTION

3.1 INSTALLATION

Sprinkler system shall be installed after site grading has been completed. Excavation, trenching, and backfilling for sprinkler system shall be in accordance with the applicable provisions of Section 02316, EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, except as modified herein.

3.1.1 Trenching

Trench around roots shall be hand excavated to pipe grade when roots of 50 mm diameter or greater are encountered. Trench width shall be 100 mm minimum or 1-1/2 times diameter of pipe, whichever is wider. Backfill shall be hand tamped over excavation. When rock is encountered, trench shall be excavated 100 mm deeper and backfilled with silty sand (SM) or well-graded sand (SW) to pipe grade. Trenches shall be kept free of obstructions and debris that would damage pipe. Subsoil shall not be mixed with topsoil. Existing concrete walks, drives and other obstacles shall be bored at a depth conforming to bottom of adjacent trenches. Pipe sleeves for bored pipe shall be two pipe diameters larger than sprinkler pipe.

3.1.2 Piping System

3.1.2.1 Cover

Underground piping shall be installed to meet the minimum depth of backfill cover specified.

3.1.2.2 Clearances

Minimum horizontal clearances between lines shall be 100 mm for pipe 50 mm (2 inches) and less; 300 mm for 65 mm (2-1/2 inches) and larger. Minimum vertical clearances between lines shall be 25 mm.

3.1.3 Piping Installation

3.1.3.1 Polyvinyl Chloride (PVC) Pipe

- a. Solvent-cemented joints shall conform to the requirements of ASTM D 2855.
- b. Threaded joints shall be full cut with a maximum of three threads remaining exposed on pipe and nipples. Threaded joints shall be made tight without recourse to wicks or fillers, other than polytetrafluoroethylene thread tape.
- c. Piping shall be joined to conform with requirements of ASTM D 2774 or ASTM D 2855, and pipe manufacturer's instructions. Pipe shall be installed in a serpentine (snaked) manner to allow for expansion and contraction in trench before backfilling. Pipes shall be installed at temperatures over 5 degrees C.

3.1.3.2 Soldered Copper Tubing

Pipe shall be reamed and burrs removed. Contact surfaces of joint shall be

cleaned and polished. Flux shall be applied to male and female ends. End of tube shall be inserted into fittings full depth of socket. After soldering, a solder bead shall show continuously around entire joint circumference. Excess acid flux shall be removed from tubings and fittings.

3.1.3.3 Threaded Brass

Prior to installation, pipe shall be reamed. Threads shall be cut in conformance with ASME B1.2. Pipe joint compound shall be applied to male end only.

3.1.3.4 Insulating Joints

Insulating and dielectric fittings shall be provided where pipes of dissimilar metal are joined and at connections to water supply mains as shown. Installation shall be in accordance with Section 02510 WATER DISTRIBUTION SYSTEM.

3.1.4 Installation of Valves

3.1.4.1 Manual Valves

Valves shall be installed in a valve box extending from grade to below valve body, with a minimum of 100 mm cover measured from finish grade to top of valve stem.

3.1.4.2 Automatic Valves

Valve shall be set plumb in a valve box extending from grade to below valve body, with minimum of 100 mm cover measured from grade to top of valve. Automatic valves shall be installed beside sprinkler heads with a valve box.

3.1.5 Sprinklers and Quick Coupling Valves

Sprinklers and valves shall be installed plumb and level with terrain.

3.1.6 Dripperline

Backfill tree pits to 150 mm (6 inches) below existing/finished grade. Assemble dripperline drip ring to match the diameter of the tree pit, place drip ring in tree pit, and connect drip ring to lateral. Test system before backfilling the remaining 150 mm (6 inches) covering the dripliner drip ring. Compact backfill to minimum 90% density.

3.1.7 Backflow Preventers

Backflow preventer shall be installed in new connection to existing water distribution system, between connection and control valves. Backflow preventer shall be installed with concrete thrust blocks.

3.1.8 Control Wire and Conduit

3.1.8.1 Wires

Low voltage wires may be buried beside pipe in same trench. Rigid conduit shall be provided where wires run under paving. Wires shall be number tagged at key locations along main to facilitate service. One control circuit shall be provided for each zone and a circuit to control sprinkler system.

3.1.8.2 Loops

A 300 mm loop of wire shall be provided at each valve where controls are connected.

3.1.8.3 Expansion and Contraction

Multiple tubes or wires shall be bundled and taped together at 6 m intervals with 300 mm loop for expansion and contraction.

3.1.8.4 Splices

Electrical splices shall be waterproof.

3.1.9 Automatic Controller

Exact field location of controllers shall be determined before installation. Coordinate the electrical service to these locations. Install in accordance with manufacturer's recommendations and NFPA 70.

3.1.10 Thrust Blocks

Concrete shall be placed so that sides subject to thrust or load are against undisturbed earth, and valves and fittings are serviceable after concrete has set. Thrust blocks shall be as specified in Section 02510 WATER DISTRIBUTION SYSTEM.

3.1.11 Backfill

3.1.11.1 Minimum Cover

Depth of cover shall be 300 mm for laterals, 450 mm for main lines, 600 mm for pipes under traffic loads, and 450 mm for low-voltage wires. Remainder of trench or pipe cover shall be filled to within 80 mm of top with excavated soil, and compact soil with plate hand-held compactors to same density as undisturbed adjacent soil.

3.1.11.2 Restoration

Top 80 mm shall be filled with topsoil and compacted with same density as surrounding soil. Lawns and plants shall be restored in accordance with Sections 02921 SEEDING, and Section 02930 EXTERIOR PLANTING. Pavements shall be restored in accordance with Section 02770, CONCRETE SIDEWALKS AND CURBS AND GUTTERS, and Section 02741, BITUMINOUS PAVING FOR ROADS, STREETS AND OPEN STORAGE AREAS.

3.1.12 Adjustment

After grading, seeding, and rolling of planted areas, sprinkler heads shall be adjusted flush with finished grade. Adjustments shall be made by providing new nipples of proper length or by use of heads having an approved device, integral with head, which will permit adjustment in height of head without changing piping.

3.1.13 Disinfection

Sprinkler system fed from a potable water system shall be disinfected upstream of backflow preventer in accordance with Section 02510 WATER

DISTRIBUTION SYSTEM.

3.1.14 Cleaning of Piping

Prior to the hydrostatic and operation tests, the interior of the pipe shall be flushed with clean water until pipe is free of all foreign materials. Flushing and cleaning out of system pipe, valves, and components shall not be considered completed until witnessed and accepted by Contracting Officer.

3.2 FIELD TESTS

All instruments, equipment, facilities, and labor required to conduct the tests shall be provided by Contractor.

3.2.1 Hydrostatic Pressure Test

Piping shall be tested hydrostatically before backfilling and proved tight at a hydrostatic pressure of 1034 kPa (150 psi) without pumping for a period of one hour with an allowable pressure drop of 35 kPa (5 psi). If hydrostatic pressure cannot be held for a minimum of 4 hours, Contractor shall make adjustments or replacements and the tests repeated until satisfactory results are achieved and accepted by the Contracting Officer.

3.2.2 Leakage Tests

Leakage tests for service main shall be in accordance with Section 02510 WATER DISTRIBUTION SYSTEM.

3.2.3 Operation Test

At conclusion of pressure test, sprinkler heads or emitter heads, quick coupling assemblies, and hose valves shall be installed and entire system tested for operation under normal operating pressure. Operation test consists of the system operating through at least one complete programmed cycle for all areas to be sprinkled.

3.3 FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the system. After as-built drawings are approved by Contracting Officer, controller charts and programming schedule shall be prepared. One chart for each controller shall be supplied. Chart shall be a reduced drawing of actual as-built system that will fit the maximum dimensions inside controller housing. Black line print for chart and a different pastel or transparent color shall indicate each station area of coverage. After chart is completed and approved for final acceptance, chart shall be sealed between two 0.505 mm (20 mil) pieces of clear plastic.

3.4 FIELD TRAINING

A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided for a total period of 4 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training

shall cover all of the items contained in the operating and maintenance manuals.

3.5 CLEANUP

Upon completion of installation of system, all debris and surplus materials resulting from the work shall be removed.

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SECTION 02922

SODDING

PART 1 GENERAL

1.1 REFERENCES

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 602	(1995a) Agricultural Liming Materials
ASTM D 4972	(1995a) pH of Soils
ASTM D 5268	(1992; R 1996) Topsoil Used for Landscaping Purposes

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Chemical Treatment Material; FIO.

Manufacturer's literature including physical characteristics, application and installation instructions for equipment and chemical treatment material.

SD-08 Statements

Delivery; FIO.

Delivery schedule.

Finished Grade and Topsoil; FIO.

Finished grade status.

Topsoil; FIO.

Availability of topsoil from the stripping and stock piling operation.

SD-09 Reports

Soil Test; FIO.

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

SD-13 Certificates

Sod; FIO. Topsoil; FIO. pH Adjuster; FIO. Fertilizer; FIO. Organic Material; FIO. Soil Conditioner; FIO. Pesticide; FIO.

Prior to the delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following:

- a. Sod. Classification, botanical name, common name, mixture percentage of species, percent purity, quality grade and field location.
- b. Topsoil. Particle size, pH, organic matter content, textural class, soluble salts, chemical and mechanical analyses.
- c. pH Adjuster. Calcium carbonate equivalent and sieve analysis.
- d. Fertilizer. Chemical analysis and composition percent.
- e. Organic Material: Composition and source.
- f. Soil Conditioner: Composition and source.
- g. Pesticide. EPA registration number and registered uses.

SD-14 Samples

Delivered Topsoil; FIO.

Samples taken from several locations at the source.

Soil Amendments; FIO.

A 4.5 kilogram sample.

Temporary Seeding; GA.

Sample of annual seed species and application rate.

SD-18 Records

Quantity Check; FIO.

Bag count or bulk weight measurements of material used compared with area covered to determine the application rate and quantity installed. The quantity of sod used shall be compared against the total area installed.

Sod Establishment Period; FIO.

Calendar time period for the sod establishment period. When there is more than one sod establishment period, the boundaries of the sodded area covered for each period shall be described.

Maintenance Record; FIO.

Maintenance work performed, area repaired or reinstalled, diagnosis for unsatisfactory stand of grass plants.

Application of Pesticide; FIO.

Pesticide treatment plan with sequence of treatment work with dates and times. The pesticide trade name, EPA registration number, chemical composition, formulation, concentration of original and diluted material, application rate of active ingredients, method of application, area treated, amount applied; and the name and state license number of the state certified applicator shall be included.

1.3 SOURCE INSPECTION

The sources of sod material and delivered topsoil shall be subject to inspection.

1.4 DELIVERY, INSPECTION, STORAGE, AND HANDLING

1.4.1 Delivery

A delivery schedule shall be provided at least 10 calendar days prior to the first day of delivery.

1.4.1.1 Sod

Sod shall be protected during delivery to prevent desiccation, internal heat buildup, or contamination.

1.4.1.2 Delivered Topsoil

Prior to the delivery of any topsoil, its availability shall be verified in paragraph TOPSOIL. A soil test shall be provided for topsoil delivered to the site.

1.4.1.3 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

1.4.1.4 Pesticides

Pesticide material shall be delivered to the site in the original, unopened containers bearing legible labels indicating the EPA registration number and the manufacturer's registered uses.

1.4.2 Inspection

Sod shall be inspected upon arrival at the job site for conformity to species. Sod shall be checked for visible broadleaf weeds, and a visible consistency with no obvious patches of foreign grasses that exceed 2 percent of the canopy. Sod that is heating up, dry, moldy, yellow, irregularly shaped, torn, or of uneven thickness shall be rejected. Other materials shall be inspected for compliance with specified requirements. Open soil amendment containers or wet soil amendments; topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 40 mm diameter; and topsoil that contains viable plants and plant parts, shall be rejected. Unacceptable materials shall be removed from the job site.

1.4.3 Storage

1.4.3.1 Sod

Sod shall be stored in designated areas and kept in a moist condition by watering with a fine mist, and covered with moist burlap, straw, or other covering. Covering shall allow air to circulate, preventing internal heat from building up. Sod shall be protected from exposure to wind and direct sunlight until installed.

1.4.3.2 Other Material Storage

Materials shall be stored in designated areas. Lime and fertilizer shall be stored in cool, dry locations, away from contaminants. Chemical treatment material shall be stored according to manufacturer's instructions and not with sod operation materials.

1.4.4 Handling

Sod shall not be damaged during handling. Except for bulk deliveries, materials shall not be dropped or dumped from vehicles.

1.4.5 Time Limitation

Time limitation between harvesting and installing sod shall be a maximum 36 hours.

PART 2 PRODUCTS

2.1 SOD

2.1.1 Sod Classification

Nursery-grown sod shall be provided as classified by applicable state laws. Sod section shall be sized to permit rolling and lifting without breaking.

2.1.2 Grass Species

Grass species shall be either one of the following species:

<u>Botanical Name</u>	<u>Common Name</u>	<u>Mixture Percent</u>
Zoysia matrellax japonica	'z-3'zoysia	95
Zoysia japonica	El Toro	95

2.1.3 Quality

Sod shall be relatively free of thatch, diseases, nematodes, soil-borne insects, weeds or undesirable plants, stones larger than 25 mm in diameter, woody plant roots, and other materials detrimental to a healthy stand of grass plants. Broadleaf weeds and patches of foreign grasses shall be a maximum 2 percent of the sod section.

2.1.4 Thickness

Sod shall be machine cut to a minimum 35 mm thickness. Measurement for

thickness shall exclude top growth and thatch.

2.1.5 Anchors

Sod anchors shall be as recommended by the sod supplier.

2.1.6 Substitutions

Substitutions will not be allowed without written request and approval from the Contracting Officer.

2.2 TOPSOIL

Topsoil shall be as defined in ASTM D 5268. When available, the topsoil shall be the existing surface soil stripped and stockpiled onsite in accordance with Section 02300 EARTHWORK. When additional topsoil is required beyond the available topsoil from stripping operation, topsoil shall be delivered and amended as recommended by the soil test for the sod species specified. Topsoil shall be free from slag, cinders, stones, lumps of soil, sticks, roots, trash, or other material over a maximum 40 mm diameter. Topsoil shall be free from viable plants and plant parts.

2.3 SOIL AMENDMENTS

Soil amendments shall consist of pH adjuster, fertilizer, organic material, and soil conditioners meeting the following requirements. Vermiculite shall not be used.

2.3.1 pH Adjuster

The pH adjuster shall be an agricultural liming material in accordance with ASTM C 602. These materials may be burnt lime, hydrated lime, ground limestone, or shells. The pH adjuster shall be used to create a favorable soil pH for the plant material specified.

2.3.1.1 Limestone

Limestone material shall contain a minimum calcium carbonate equivalent of 80 percent. Gradation: A minimum 95 percent shall pass through a 2.36 mm sieve and a minimum 55 percent shall pass through a 0.250 mm sieve. To raise soil pH, ground limestone shall be used.

2.3.1.2 Hydrated Lime

Hydrated lime shall contain a minimum calcium carbonate equivalent of 110 percent. Gradation: A minimum 100 percent shall pass through a 2.36 mm sieve and a minimum 97 percent shall pass through a 0.250 mm sieve.

2.3.1.3 Burnt Lime

Burnt lime shall contain a minimum calcium carbonate equivalent of 140 percent. Gradation: A minimum 95 percent shall pass through a 2.36 mm sieve and a minimum 35 percent shall pass through a 0.250 mm sieve.

2.3.2 Fertilizer

It shall be as recommended by the soil test. Fertilizer shall be controlled release commercial grade, free flowing, uniform in composition, and consist of a recommended nitrogen-phosphorus-potassium ratio. The

fertilizer shall be derived from sulphur coated urea, urea formaldehyde, plastic or polymer coated pills, or isobutylenediurea (IBDU). Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients.

2.3.3 Nitrogen Carrier Fertilizer

It shall be as recommended by the soil test. Nitrogen carrier fertilizer shall be commercial grade, free flowing, and uniform in composition. The fertilizer may be a liquid nitrogen solution.

2.3.4 Organic Material

Organic material shall consist of either bonemeal, rotted manure, decomposed wood derivatives, recycled compost, or worm castings.

2.3.4.1 Bonemeal

Bonemeal shall be finely ground, steamed bone product containing from 2 to 4 percent nitrogen and 16 to 40 percent phosphoric acid.

2.3.4.2 Rotted Manure

Rotted manure shall be unleached horse, chicken or cattle manure containing a maximum 25 percent by volume straw, sawdust, or other bedding materials. Manure shall contain no chemicals or ingredients harmful to plants. The manure shall be heat treated to kill weed seeds and be free of stones, sticks, and soil.

2.3.4.3 Decomposed Wood Derivatives

Decomposed wood derivatives shall be ground bark, sawdust, yard trimmings, or other wood waste material free of stones, sticks, soil, and toxic substances harmful to plants, fully composted or stabilized with nitrogen.

2.3.4.4 Recycled Compost

Compost shall be a well decomposed, stable, weed free organic matter source. Compost shall be derived from food; agricultural or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. The compost shall possess no objectionable odors and shall not resemble the raw material from which it was derived. The material shall not contain substances toxic to plants. Gradation: The compost material shall pass through a 10 mm screen, possess a pH of 5.5 to 8.0, and have a moisture content between 35-55 percent by weight. The material shall not contain more than 1 percent or less by weight of man-made foreign matter. Compost shall be cleaned of plastic materials larger than 50 mm in length.

2.3.4.5 Worm Castings

Worm castings shall be screened from worms and food source, and shall be commercially packaged.

2.3.5 Soil Conditioner

Soil conditioner shall be sand or gypsum for use singly or in combination to meet the requirements for topsoil.

2.3.5.1 Sand

Sand shall be clean and free of toxic materials. Gradation: A minimum 95 percent by weight shall pass a 2 mm sieve and a minimum 10 percent by weight shall pass a 1.18 mm sieve. Greensand shall be balanced with the inclusion of trace minerals and nutrients.

2.3.5.2 Gypsum

Gypsum shall be commercially packaged, free flowing, and a minimum 95 percent calcium sulfate by volume.

2.4 WATER

Water shall be the responsibility of the Contractor unless otherwise noted. Water shall not contain elements toxic to plant life.

2.5 PESTICIDE

Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide or miticide. For the purpose of this specification, a soil fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved.

PART 3 EXECUTION

3.1 INSTALLING SOD TIME AND CONDITIONS

3.1.1 Sodding Conditions

Sodding operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the sodding operations, proposed alternate times shall be submitted for approval.

3.1.2 Soil Test

Delivered topsoil, existing soil in smooth graded areas, and stockpiled topsoil shall be tested in accordance with ASTM D 5268 and ASTM D 4972 for determining the particle size, pH, organic matter content, textural class, chemical analysis, soluble salts analysis, and mechanical analysis. Sample collection on site shall be random over the entire site. Sample collection for stockpiled topsoil shall be at different levels in the stockpile. The soil shall be free from debris, noxious weeds, toxic substances, or other materials harmful to plant growth. The test shall determine the quantities and type of soil amendments required to meet local growing conditions for the sod species specified.

3.2 SITE PREPARATION

3.2.1 Finished Grade and Topsoil

Prior to the commencement of the sodding operation, the Contractor shall verify that finished grades are as indicated on drawings; the placing of topsoil, smooth grading, and compaction requirements have been completed in accordance with Section 02300 EARTHWORK.

3.2.2 Application of Soil Amendments

3.2.2.1 Applying pH Adjuster

The pH adjuster shall be applied at the rate recommended by the soil test. The pH adjuster shall be incorporated into the soil to a maximum 100 mm depth or may be incorporated as part of the tillage operation.

3.2.2.2 Applying Fertilizer

The fertilizer shall be applied at the rate recommended by the soil test. Fertilizer shall be incorporated into the soil to a maximum 100 mm depth or may be incorporated as part of the tillage or hydroseeding operation.

3.2.2.3 Applying Soil Conditioner

The soil conditioner shall be as recommended by the soil test. The soil conditioner shall be spread uniformly over the soil and thoroughly incorporated by tillage into the soil to a maximum 100 mm depth.

3.2.3 Tillage

Soil on slopes up to a maximum 3-horizontal-to-1-vertical shall be tilled to a minimum 100 mm deep. On slopes between 3-horizontal-to-1-vertical and 1-horizontal-to-1 vertical, the soil shall be tilled to a minimum 50 mm deep by scarifying with heavy rakes, or other method. Rototillers shall be used where soil conditions and length of slope permit. On slopes 1-horizontal-to-1 vertical and steeper, no tillage is required. Drainage patterns shall be maintained as indicated on drawings. Areas compacted by construction operations shall be completely pulverized by tillage. Soil used for repair of surface erosion or grade deficiencies shall conform to topsoil requirements. The pH adjuster, fertilizer, and soil conditioner may be applied during this procedure.

3.2.4 Prepared Surface

3.2.4.1 Preparation

The prepared surface shall be a maximum 25 mm below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas. The prepared surface shall be rolled and completed with a light raking to remove from the surface debris and stones over a minimum 16 mm in any dimension.

3.2.4.2 Protection

Areas within the prepared surface shall be protected from compaction or damage by vehicular or pedestrian traffic and surface erosion.

3.3 INSTALLATION

Prior to installing sod, any previously prepared surface compacted or damaged shall be reworked to meet the requirements of paragraph SITE PREPARATION. Areas shall be sodded as indicated. Adequate soil moisture shall be ensured prior to sodding by spraying water on the area to be sodded and wetting the soil to a maximum 25 mm depth.

3.3.1 Installing Sod

Rows of sod sections shall be placed parallel to and tightly against each other. Joints shall be staggered laterally. The sod sections shall not be

stretched or overlapped. All joints shall be butted tight. Voids and air drying of roots shall be prevented. Sod sections shall be laid across the slope on long slopes. Sod sections shall be laid at right angles to the flow of water in ditches. Sod sections shall be anchored on slopes steeper than 3-horizontal-to-1-vertical. Anchoring may be required when surface weight or pressure upon placed sod sections is anticipated to cause lateral movement. Sod anchors shall be placed a minimum 600 mm on center with a minimum 2 anchors per sod section.

3.3.2 Finishing

Displacement of the sod shall be prevented by tamping or rolling the sod in place and knitting the sod to the soil. Air pockets shall be eliminated and a true and even surface shall be provided. Frayed edges shall be trimmed, and holes or missing corners shall be patched with sod.

3.3.3 Rolling

The entire area shall be firmed with a roller not exceeding 130 kilograms per meter roller width. Slopes over a maximum 3-horizontal-to-1 vertical shall not be rolled.

3.3.4 Watering Sod

Watering shall be started immediately after completing each day of installing sod. Water shall be applied at least 3 times per week to supplement rainfall, at a rate sufficient to ensure moist soil conditions to a minimum depth of 25 mm. Run-off, puddling, and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or plant material shall be prevented.

3.4 TEMPORARY SEEDING

When directed during contract delays affecting the sodding operation or when a quick cover is required to prevent surface erosion, the areas designated shall be seeded with annual rye grass seed in accordance with Section 02921 SEEDING.

3.4.1 Soil Amendments, Tillage and Watering

When soil amendments have not been applied to the area, the quantity of 1/2 of the required soil amendments shall be applied and the area tilled in accordance with paragraph SITE PREPARATION. The area shall be watered in accordance with paragraph Watering Sod as required.

3.4.2 Remaining Soil Amendments

The remaining soil amendments shall be applied in accordance with the paragraph Tillage when the surface is prepared for installing sod.

3.5 QUANTITY CHECK

For materials provided in bags, the empty bags shall be retained for recording the amount used. For materials provided in bulk, the weight certificates shall be retained as a record of the amount used. The amount of the material used shall be compared with the total area covered to determine the rate of application. The quantity of sod used shall be compared against the total area established with sod. Differences between

the quantity applied and the quantity specified shall be adjusted as directed.

3.6 APPLICATION OF PESTICIDE

When application of a pesticide becomes necessary to remove a pest or disease, a pesticide treatment plan shall be submitted and coordinated with the installation pest management program.

3.6.1 Technical Representative

The certified installation pest management coordinator shall be the technical representative, and shall be present at all meetings concerning treatment measures for pest or disease control. They may be present during treatment application.

3.6.2 Application

A state certified applicator shall apply required pesticides in accordance with EPA label restrictions and recommendations. Clothing and personal protective equipment shall be used as specified on the pesticide label. A closed system is recommended as it prevents the pesticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying pesticide shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately.

3.7 RESTORATION AND CLEAN UP

3.7.1 Restoration

Existing turf areas, pavements, and facilities that have been damaged from the sodding operation shall be restored to original condition at Contractor's expense.

3.7.2 Clean Up

Excess and waste material shall be removed from the sodded areas and shall be disposed offsite. Adjacent paved areas shall be cleaned.

3.8 PROTECTION OF INSTALLED AREAS

Immediately upon completion of the sodding operation in an area, the area shall be protected against traffic or other use by erecting barricades and providing signage as required, or as directed. Signage shall be in accordance with Section 10430 EXTERIOR SIGNAGE.

3.9 SOD ESTABLISHMENT PERIOD

3.9.1 Commencement

The sod establishment period to obtain a healthy stand of grass plants shall begin on the first day of work under this contract and shall end 3 months after the last day of sodding operation. Written calendar time period shall be furnished for the sod establishment period. When there is more than 1 sod establishment period, the boundaries of the sodded area covered for each period shall be described. The sod establishment period

should be coordinated with Sections 02921 SEEDING and 02930 EXTERIOR PLANTING. The sod establishment period shall be modified for inclement weather, shut down periods, or for separate completion dates of areas.

3.9.2 Satisfactory Stand of Grass Plants

Grass plants shall be evaluated for species and health. A satisfactory stand of grass plants from the sodding operation shall be living sod uniform in color and leaf texture. Bare spots shall be a maximum 50 mm square. Joints between sod pieces shall be tight and free from weeds and other undesirable growth.

3.9.3 Maintenance During Establishment Period

Maintenance of the sodded areas shall include eradicating weeds, insects and diseases; protecting embankments and ditches from surface erosion; maintaining erosion control materials and mulch; protecting installed areas from traffic; mowing; watering; and post-fertilization.

3.9.3.1 Mowing

Sodded areas shall be mowed to a minimum 25 mm (1 inch) height when the turf is a maximum 50 mm (2 inch) height. Clippings shall be removed when the amount cut prevents sunlight from reaching the ground surface.

3.9.3.2 Post-Fertilization

The fertilizer shall be applied as recommended by the soil test. A maximum 4 kilograms per hectare of actual available nitrogen shall be provided to the grass plants. The application shall be timed prior to the advent of winter dormancy and shall be made without burning the installed grass plants.

3.9.3.3 Pesticide Treatment

Treatment for disease or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE.

3.9.3.4 Repair

Unsatisfactory stand of grass plants shall be repaired or reinstalled, and eroded areas shall be repaired in accordance with paragraph SITE PREPARATION.

3.9.3.5 Maintenance Record

A record of each site visit shall be furnished which describes the maintenance work performed; areas repaired or reinstalled; and diagnosis for unsatisfactory stand of grass plants.

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DIVISION 03 - CONCRETE

SECTION 03300

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SECTION 03300

CAST-IN-PLACE STRUCTURAL CONCRETE

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.

ACI INTERNATIONAL (ACI)

ACI 117/117R	(1990; Errata) Standard Tolerances for Concrete Construction and Materials
ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214.3R	(1988) Simplified Version of the Recommended Practice for Evaluation of Strength Test Results
ACI 305R	(1991) Hot Weather Concreting
ACI 318/318R	(1995) Building Code Requirements for Reinforced Concrete and Commentary

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(1991) Burlap Cloth Made From Jute or Kenaf
AASHTO M 288	(1996) Geotextile Specifications for Highway Application

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31	(1991) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1993) Concrete Aggregates
ASTM C 39	(1994) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42	(1994) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 78	(1994) Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)

ASTM C 94	(1996) Ready-Mixed Concrete
ASTM C 136	(1995a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 150	(1995) Portland Cement
ASTM C 172	(1990) Sampling Freshly Mixed Concrete
ASTM C 192	(1990a) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(1991b) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1995) Air-Entraining Admixtures for Concrete
ASTM C 309	(1997) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 881	(1990) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 1017	(1992) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1059	(1991) Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C 1064	(1986; R 1993) Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1077	(1995a) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1107	(1991a) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1315	(1995) Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 638	(1998) Standard Test Method for Tensile Properties of Plastic
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D 3786	(1987) Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: diaphragm Bursting Strength Tester Method
ASTM D 4533	(1991; R 1996) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 1996) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4833	(1988, R 1996) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM E 1709	(1995; Rev A) Standard Test Method for Measurement of Retroreflective Signs Using a Portable Retroreflective E1-1996
ASTM E 1745	(1996) Water Vapor Retarders Used in Contact with the Earth Under Concrete Slabs

CORPS OF ENGINEERS (COE)

COE CRD-C 94	(1995) Surface Retarders
COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA TMMB-01	(1992) Truck Mixer Agitator and Front Discharge Concrete Carrier Standards of the Truck Mixer Manufacturers Bureau
NRMCA QC 3	(1984) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

Application; FIO.

Manufacturer's current printed product description, material safety data sheets (MSDS) and technical data sheets for each type of hardener/sealer. Detailed application instructions, minimum and maximum application temperature, curing and drying times of hardener/sealer.

SD-08 Statements

Mixture Proportions; GA.

The results of trial mixture design studies along with a statement giving the maximum nominal coarse aggregate size and the proportions of ingredients that will be used in the manufacture of each strength or class of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an approved independent commercial testing laboratory, showing that mixture design 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 design studies without additional tests to show that the quality of the concrete is satisfactory.

SD-09 Reports

Testing and Inspection for Contractor Quality Control; GA.

Certified copies of laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.

SD-13 Certificates

Qualifications; GA.

Written documentation for Contractor Quality Control personnel.

SD-14 Samples

Surface Retarder; FIO.

Surface retarder material with manufacturer's instructions for application in conjunction with air-water cutting.

1.3 QUALIFICATIONS

Installer of hardener/sealer shall be certified and shall be on a list of preapproved applicators of the product.

1.4 TECHNICAL REPRESENTATIVE

Hardener/sealer manufacturer's Technical Representative shall be made available for initial training of applicators and field observation during installation of the hardener/sealer. Technical Representative shall certify installations for warranty.

1.5 GENERAL REQUIREMENTS

1.5.1 Tolerances

Except as otherwise specified herein, tolerances for concrete batching, mixture properties, and construction as well as definition of terms and application practices shall be in accordance with ACI 117/117R. Level and grade tolerance measurements of slabs shall be made as soon as possible after finishing; when forms or shoring are used, the measurements shall be made prior to removal.

1.5.1.1 Floors

For the purpose of this Section the following terminology correlation between ACI 117/117R and this Section shall apply:

Floor Profile Quality Classification From ACI 117/117R -----	This Section -----
Conventional Bullfloated	Same
Conventional Straightedged	Same
Flat	Float Finish or Trowel Finish
Very Flat	Same. Use only with F-system

Levelness tolerance shall not apply where design requires floors to be sloped to drains or sloped for other reasons.

1.5.1.2 Floors by the Straightedge System

The flatness of the floors shall be carefully controlled and the tolerances shall be measured by the straightedge system as specified in paragraph 4.5.7 of ACI 117/117R, using a 3 m straightedge, within 72 hours after floor slab installation and before shores and/or forms are removed. The listed tolerances shall be met at any and every location at which the straightedge can be placed.

Bullfloated	13 mm (1/2 inch)
Straightedged	8 mm (5/16 inch)
Float Finish	5 mm (3/16 inch)
Trowel Finish	5 mm (3/16 inch)

1.5.2 Strength Requirements and w/c Ratio

1.5.2.1 Strength Requirements

Specified compressive strength (f'c) shall be as indicated:

- a. Evaluation of Concrete Compressive Strength. Compressive strength specimens (152 by 305 mm cylinders) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified compressive strength f'c and no individual test result falls below the specified strength f'c by more than 3.5 MPa. A "test" is defined as the average of two companion cylinders, or if only one cylinder is tested, the results of the single cylinder test. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.

- b. Investigation of Low-Strength Compressive Test Results. When any strength test of standard-cured test cylinders falls below the specified strength requirement by more than 3.5 MPa or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. When the strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores will be determined by the Contracting Officer to least impair the strength of the structure. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. Non-destructive tests (tests other than test cylinders or cores) shall not be used as a basis for acceptance or rejection. The Contractor shall perform the coring and repair the holes. Cores will be tested by the Government.
- c. Load Tests. If the core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318/318R. Concrete work evaluated by structural analysis or by results of a load test as being understrength shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed by and at the expense of the Contractor and must be approved by the Contracting Officer, except that if all concrete is found to be in compliance with the drawings and specifications, the cost of investigations, testing, and load tests will be at the expense of the Government.

1.5.2.2 Water-Cement Ratio

Maximum water-cement ratio (w/c) for normal weight concrete shall be as follows:

WATER-CEMENT RATIO, BY WEIGHT	STRUCTURE OR PORTION OF STRUCTURE
0.60	Footings and grade beams
0.45	All Others

The maximum w/c required will be the equivalent w/c as determined from the weight ratio of water to cement.

1.5.3 Air Entrainment

All normal weight concrete shall be air entrained to contain between 3 and 5 percent total air. Concrete with specified strength over 35 MPa may have 1.0 percent less air than specified above. Specified air content shall be attained at point of placement into the forms. Air content for normal weight concrete shall be determined in accordance with ASTM C 231.

1.5.4 Slump

Slump of the concrete, as delivered to the point of placement into the forms, shall be within the following limits. Slump shall be determined in accordance with ASTM C 143.

Structural Element	Minimum	Slump	Maximum
Walls and columns	75 mm		125 mm
Foundation slab-on-grade, structural slab and all other concrete	75 mm		125 mm
Any structural concrete approved for placement by pumping: At discharge of line	25 mm		100 mm

When use of a plasticizing admixture conforming to ASTM C 1017 or when a Type F or G high range water reducing admixture conforming to ASTM C 494 is permitted to increase the slump of concrete, concrete shall have a slump of 75 to 125 mm before the admixture is added and a maximum slump of 200 mm at the point of delivery after the admixture is added.

1.5.5 Concrete Temperature

The temperature of the concrete as delivered shall not exceed 32 degrees C.

1.5.6 Size of Aggregate

Concrete aggregates shall conform with "Standard Specification for Concrete Aggregates" (ASTM-33).

1. Coarse aggregate shall be a mixture of No. 3 coarse and No. 3 fine crushed, dense, close grain, blue basaltic rock unless otherwise specified. The specific gravity of rock shall not be less than 2.65. The gradation of No. 3 crushed rock shall conform to the following requirements:

TOTAL PERCENTAGE BY WEIGHTS
PASSING SIEVES WITH SQUARE OPENINGS

<u>Sieve</u>	<u>ASTM 5 No. 3 Coarse</u>	<u>ASTM 67 No. 3 Fine</u>
38.1 mm	100	n/a
25.4 mm	90-100	100
19 mm	20-55	90-100
12.7 mm	0-10	70-90
9.5 mm	0-5	20-55
No. 4	-	0-10
No. 8	-	0-5
NOMINAL SIZE RANGE:	No. 3 Course	25.4 to 12.7 mm
	No. 3 Fine	19 mm to #4

TOTAL PERCENTAGE BY WEIGHTS
 PASSING SIEVES WITH SQUARE OPENINGS

2. Fine aggregate shall be a combination of 40% sand and 60% No. 4 Fine by weight No. 4 fine shall be of like quality as No. 3.

The gradation of No. 4 Fine shall conform to the following requirements:

TOTAL PERCENTAGES BY WEIGHT
PASSING SIEVE WITH SQUARE OPENINGS

<u>Sieve</u>	<u>Percent</u>
10 mm (No. 3/8)	100
No. 4	90-100
No. 8	65-90
No. 16	30-60
No. 50	10-30
No. 100	5-15
No. 200	0-10

Sand shall be clean, free from sticks, dirt, organic matter or other deleterious substances.

1.5.7 Special Properties and Products

Concrete may contain admixtures other than air entraining agents, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if specified or approved. Any of these materials to be used on the project shall be used in the mix design studies.

1.6 MIXTURE PROPORTIONS

Concrete shall be composed of portland cement, other cementitious materials as specified, aggregates, water and admixtures as specified.

1.6.1 Proportioning Studies for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified shall be the responsibility of the Contractor. Mixture proportions shall be based on compressive strength as determined by test specimens fabricated in accordance with ASTM C 192 and tested in accordance with ASTM C 39. Concrete with specified strength of 28 MPa shall contain at least 390 kg cement per cubic meter. Samples of all materials used in mixture proportioning studies shall be representative of those proposed for use in the project and shall be accompanied by the manufacturer's or producer's test reports indicating compliance with these specifications. Trial mixtures having proportions, consistencies, and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required on the project. Laboratory trial mixtures shall be designed for maximum permitted slump and air content. Separate sets of trial mixture studies shall be made for each combination of cementitious materials and each combination of admixtures proposed for use. No combination of either shall be used until proven by such studies,

except that, if approved in writing and otherwise permitted by these specifications, an accelerator or a retarder may be used without separate trial mixture study. Separate trial mixture studies shall also be made for concrete for any conveying or placing method proposed which requires special properties and for concrete to be placed in unusually difficult placing locations. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results, a curve shall be plotted showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, a curve shall be plotted showing the relationship between 7 day and 28 day strengths. Each mixture shall be designed to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding.

1.6.2 Average Compressive Strength Required for Mixtures

The mixture proportions selected during mixture design studies shall produce a required average compressive strength (f'_{cr}) exceeding the specified compressive strength (f'_c) by the amount indicated below. This required average compressive strength, f'_{cr} , will not be a required acceptance criteria during concrete production. However, whenever the daily average compressive strength at 28 days drops below f'_{cr} during concrete production, or daily average 7-day strength drops below a strength correlated with the 28-day f'_{cr} , the mixture shall be adjusted, as approved, to bring the daily average back up to f'_{cr} . During production, the required f'_{cr} shall be adjusted, as appropriate, based on the standard deviation being attained on the job.

1.6.2.1 Computations from Test Records

Where a concrete production facility has test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 214.3R. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths (f'_c) within 7 MPa of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days. Required average compressive strength f'_{cr} used as the basis for selection of concrete proportions shall be the larger of the equations that follow using the standard deviation as determined above:

$$f'_{cr} = f'_c + 1.34S \text{ where units are in MPa}$$

$$f'_{cr} = f'_c + 2.33S - 3.45 \text{ where units are in MPa}$$

Where S = standard deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and a modification factor from the following table:

NUMBER OF TESTS	MODIFICATION FACTOR FOR STANDARD DEVIATION
15	1.16
20	1.08
25	1.03
30 or more	1.00

1.6.2.2 Computations without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, the required average strength f'_{cr} shall be determined as follows:

- a. If the specified compressive strength f'_c is less than 20 MPa,
 $f'_{cr} = f'_c + 6.9 \text{ MPa}$
- b. If the specified compressive strength f'_c is 20 to 35 MPa,
 $f'_{cr} = f'_c + 8.3 \text{ MPa}$
- c. If the specified compressive strength f'_c is over 35 MPa,
 $f'_{cr} = f'_c + 9.7 \text{ MPa}$

1.7 STORAGE OF MATERIALS

Cement and other cementitious materials shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants and keep each material completely separated. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Aggregate shall not be stored directly on ground unless a sacrificial layer is left undisturbed. Reinforcing bars and accessories shall be stored above the ground on platforms, skids or other supports. Other materials shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not be used unless retested and proven to meet the specified requirements. Materials shall be capable of being accurately identified after bundles or containers are opened.

1.8 GOVERNMENT ASSURANCE INSPECTION AND TESTING

Day-to day inspection and testing shall be the responsibility of the Contractor Quality Control (CQC) staff. However, representatives of the Contracting Officer can and will inspect construction as considered appropriate and will monitor operations of the Contractor's CQC staff. Government inspection or testing will not relieve the Contractor of any of his CQC responsibilities.

1.8.1 Materials

The Government will sample and test aggregates, cementitious materials, other materials, and concrete to determine compliance with the specifications as considered appropriate. The Contractor shall provide facilities and labor as may be necessary for procurement of representative

test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Other materials will be sampled from storage at the jobsite or from other locations as considered appropriate. Samples may be placed in storage for later testing when appropriate.

1.8.2 Fresh Concrete

Fresh concrete will be sampled as delivered in accordance with ASTM C 172 and tested in accordance with these specifications, as considered necessary.

1.8.3 Hardened Concrete

Tests on hardened concrete will be performed by the Government when such tests are considered necessary.

1.8.4 Inspection

Concrete operations may be tested and inspected by the Government as the project progresses. Failure to detect defective work or material will not prevent rejection later when a defect is discovered nor will it obligate the Government for final acceptance.

1.9 WARRANTY

Hardener/sealer manufacturer's "Full System 10 year warranty" on the replacement of all flooring material and labor that delaminates due to moisture migration, excessive vapor emissions or contaminates, shall be provided on all concrete floors to receive carpet and/or resilient flooring.

PART 2 PRODUCTS

2.1 CEMENTITIOUS MATERIALS

Cementitious Materials shall be portland cement and shall conform to appropriate specifications listed below. Use of cementitious materials in concrete which will have surfaces exposed in the completed structure shall be restricted so there is no change in color, source, or type of cementitious material.

2.1.1 Portland Cement

ASTM C 150, Type I with a maximum 15 percent amount of tricalcium aluminate, or Type II.

2.2 AGGREGATES

Aggregates shall conform to the following.

2.2.1 Fine Aggregate

See paragraph 1.5.6.

2.2.2 Coarse Aggregate

See paragraph 1.5.6

2.3 CHEMICAL ADMIXTURES

Chemical admixtures, when required or permitted, shall conform to the appropriate specification listed. Admixtures shall be furnished in liquid form and of suitable concentration for easy, accurate control of dispensing.

2.3.1 Air-Entraining Admixture

ASTM C 260 and shall consistently entrain the air content in the specified ranges under field conditions.

2.3.2 Accelerating Admixture

ASTM C 494, Type C or E, except that calcium chloride or admixtures containing calcium chloride shall not be used.

2.3.3 Water-Reducing or Retarding Admixture

ASTM C 494, Type A, B, or D, except that the 6-month and 1-year compressive and flexural strength tests are waived.

2.3.4 High-Range Water Reducer

ASTM C 494, Type F or G, except that the 6-month and 1-year strength requirements are waived. The admixture shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of separate mixture design studies. High-range water reducers shall not be used for slabs and toppings.

2.3.5 Surface Retarder

COE CRD-C 94.

2.3.6 Other Chemical Admixtures

Chemical admixtures for use in producing flowing concrete shall comply with ASTM C 1017, Type I or II. These admixtures shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of separate mixture design studies.

2.4 CURING MATERIALS

2.4.1 Membrane-Forming Compound

Membrane-forming curing compound shall be KUEWZ DR or equivalent dissipating curing compound and shall conform to ASTM C 309, Type 1 or 1-D. This curing compound shall be used subsequent to the moist curing. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing, or flooring specified. A certified of compatibility for the covering manufacturer shall be submitted to the Contracting Officer prior to installation of curing compound. Nonpigmented compound shall contain a fugitive dye, and shall have the reflective requirements in ASTM C 309 waived.

2.4.2 Burlap and Cotton Mat

Burlap and cotton mat used for curing shall conform to AASHTO M 182.

2.5 EVAPORATION RETARDANT

Apply EUCOBAR or equivalent evaporation retardant; 1/2 gal./150 ft² coverage during floating operations and 1/2 gal./150 ft² coverage immediately after floating operations.

2.6 WATER

Water curing methods shall be used on reservoir tank. Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water may be used if it meets the requirements of COE CRD-C 400.

2.7 NONSHRINK GROUT

Nonshrink grout shall conform to ASTM C 1107, Grade C, and shall be a commercial formulation suitable for the proposed application.

2.8 LATEX BONDING AGENT

Latex agents for bonding fresh to hardened concrete shall conform to ASTM C 1059.

2.9 EPOXY RESIN

Epoxy resins for use in repairs shall conform to ASTM C 881, Type V, Grade 2. Class as appropriate to the existing ambient and surface temperatures.

2.10 EMBEDDED ITEMS

Embedded items shall be of the size and type indicated or as needed for the application. Dovetail slots shall be galvanized steel. Hangers for suspended ceilings shall be as specified in Section 09510 ACOUSTICAL CEILINGS. Inserts for shelf angles and bolt hangers shall be of malleable iron or cast or wrought steel.

2.11 FLOOR HARDENER FOR EXPOSED FLOORING (NO FLOOR COVERING)

Floor hardener shall be a colorless aqueous solution containing zinc silicofluoride or magnesium silicofluoride. These silicofluorides can be used individually or in combination. Proprietary hardeners may be used if approved in writing by the Contracting Officer.

2.11.1 Exposed Concrete Floors

All concrete floors shall be provided with hardener/sealer having a minimum of 18% solids and shall comply with ASTM C 309.

2.12 CONCRETE FLOORS TO RECEIVE FLOOR FINISH

Concrete moisture vapor treatment for concrete floors to receive floor finishes. See Section 09650 RESILIENT FLOORING and Section 09680 CARPET.

2.13 VAPOR BARRIER

Vapor barrier material shall have the following properties:

Minimum 15 mil polyoetin geomembrane.
 Manufactured with ISO certified virgin resins.
 Water Vapor Retarder ASTM E 1745 exceeds Class B

Water Vapor Transmission Rate	ASTM E 96	not exceeding 0.006 gr./ft ² /hr.
Permeance Rating	ASTM E 96	not exceeding 0.01 gr./ft ² /hr.
Puncture Resistance	ASTM E 1709	minimum 1970 grams
Tensile Strength	ASTM D 638	minimum 45.0 lbf/in.

Installation shall be in accordance with manufacturer's instructions including taping procedures, tape material used, patching procedures, and installation at vertical walls. No penetration of the vapor barrier, except required by installation of permanent utilities, shall be allowed. The vapor barrier shall not be left exposed to the ultraviolet rays for more than a day prior to the concrete slab pour. Standing water on the vapor barrier shall be air dried or removed by vacuum prior to pouring the concrete slab except that floors receiving a floor finish shall so conform to the concrete moisture vapor treatment system per Section 09650 RESILIENT FLOORING.

2.14 JOINT MATERIALS

2.14.1 Joint Fillers, Sealants, and Waterstops

Expansion joint fillers shall be preformed materials conforming to ASTM D 1751. Materials for waterstops shall be in accordance with Section 03150 EXPANSION JOINTS, SEALANTS, AND WATERSTOPS. Materials for and sealing of joints shall conform to the requirements of Section 07900 JOINT SEALING.

PART 3 EXECUTION

3.1 PREPARATION FOR PLACING

Before commencing concrete placement, the following shall be performed. Surfaces to receive concrete shall be clean and free from mud and water. Forms shall be in place, cleaned, coated, and adequately supported, in accordance with Section 03100 STRUCTURAL CONCRETE FORMWORK. Reinforcing steel shall be in place, cleaned, tied, and adequately supported, in accordance with Section 03200 CONCRETE REINFORCEMENT. Transporting and conveying equipment shall be in-place, ready for use, clean, and free of hardened concrete and foreign material. Equipment for consolidating concrete shall be at the placing site and in proper working order. Equipment and material for curing and for protecting concrete from weather or mechanical damage shall be at the placing site, in proper working condition and in sufficient amount for the entire placement. When hot, windy conditions during concreting appear probable, equipment and material shall be at the placing site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete.

3.1.1 Foundations

3.1.1.1 Concrete on Earth Foundations

Earth (subgrade, base, or subbase courses) surfaces upon which concrete is to be placed shall be clean, damp, and free from debris and standing or running water. Prior to placement of concrete, the foundation shall be well drained and shall be satisfactorily graded and uniformly compacted.

3.1.1.2 Excavated Surfaces in Lieu of Forms

Concrete for footings may be placed directly against the soil provided the earth or rock has been carefully trimmed, is uniform and stable, and meets

the compaction requirements of Section 02315 EXCAVATION, FILLING, AND BACKFILLING FOR BUILDINGS. The concrete shall be placed without becoming contaminated by loose material, and the outline of the concrete shall be within the specified tolerances.

3.1.2 Preparation of Previously Placed Concrete

Concrete surfaces to which other concrete is to be bonded shall be abraded in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Laitance and loose particles shall be removed. Surfaces shall be thoroughly washed and shall be moist but without free water when concrete is placed.

3.1.3 Vapor Barrier

Vapor barrier shall be provided beneath the interior on-grade concrete floor slabs. The greatest widths and lengths practicable shall be used to eliminate joints wherever possible. **Joints shall be taped according to manufacturers instructions. Torn, punctured, or damaged vapor barrier material shall be removed and new vapor barrier shall be provided prior to placing concrete. For minor repairs, patches may be made according to manufacturers instructions. Lapped joints shall be sealed and edges patched with manufacturer's recommended pressure-sensitive adhesive or tape not less than 100 mm wide and compatible with the membrane. Vapor barrier shall be placed directly on the granular termite barrier. In this case, the surface shall be choked with a light layer of sand, as approved, before placing the vapor barrier. Concrete and reinforcement placement shall be controlled so as to prevent damage to the vapor barrier.**

3.1.4 Separation Geotextile

The separation geotextile shall have the following properties:

	Woven	Nonwoven
Grab Strength (ASTM D 4632)	250 lbs	160 lbs
Seam Strength (ASTM D 4632)	150 lbs	140 lbs
Tear Strength (ASTM D 4533)	220 lbs	55 lbs
Puncture Strength (ASTM D 4833)	90 lbs	55 lbs
Burst Strength (ASTM D 3786)	400 psi	200 psi
*Permittivity	>0.05 sec-1	>0.05 sec-1
*AOS	<0.6mm	<0.6 mm

*Refers to AASHTO M 288-96, Geotextile Specification for Highway Applications.

3.1.5 Embedded Items

Before placement of concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Conduit and other embedded items shall be clean and free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids. Welding shall not be performed on embedded metals within 300 mm of the surface of the concrete. Tack welding shall not be performed on or to embedded items.

3.2 CONCRETE PRODUCTION

3.2.1 Batching, Mixing, and Transporting Concrete

Concrete shall be furnished from a ready-mixed concrete plant. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and nonagitating transporting units shall comply with NRMCA TMMB-01. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Approved batch tickets shall be furnished for each load of ready-mixed concrete.

3.3 TRANSPORTING CONCRETE TO PROJECT SITE

Concrete shall be transported to the placing site in truck mixers, conforming to NRMCA TMMB-01.

3.4 CONVEYING CONCRETE ON SITE

Concrete shall be conveyed from mixer or transporting unit to forms as rapidly as possible and within the time interval specified by methods which will prevent segregation or loss of ingredients using following equipment. Conveying equipment shall be cleaned before each placement.

3.4.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least 5 times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 0.2 square meters. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 1.5 cubic meters shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

3.4.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles and shall have conical-shaped discharge features. The transfer hopper shall be equipped with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Concrete shall not be held in nonagitating transfer hoppers more than 30 minutes.

3.4.3 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C 94. Nonagitating equipment shall be used only for transporting plant-mixed concrete over a smooth road and when the hauling time is less than 15 minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

3.4.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes normally attached to this equipment by the manufacturer may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

3.4.5 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means, such as discharge baffle or hopper, for preventing segregation of the concrete at the transfer points and the point of placing. Belt conveyors shall be constructed such that the idler spacing shall not exceed 900 mm. The belt speed shall be a minimum of 90 meters per minute and a maximum of 225 meters per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the conveyor shall discharge concrete into a pipe or elephant truck that is long enough to extend through the reinforcing bars.

3.4.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure type; pneumatic placing equipment shall not be used. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least 3 times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 100 mm. Aluminum pipe shall not be used.

3.5 PLACING CONCRETE

Mixed concrete shall be discharged within 1-1/2 hours or before the mixer drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates. When the concrete temperature exceeds 30 degrees C, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the transporting unit. Concrete shall be handled from mixer or transporting unit to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing. Sufficient placing capacity shall be provided so that concrete can be kept free of cold joints.

3.5.1 Depositing Concrete

Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 1.5 meters except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 300 mm thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level. Concrete shall be deposited continuously in one layer or in

layers so that fresh concrete is deposited on in-place concrete that is still plastic. Fresh concrete shall not be deposited on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. Concrete that has surface dried, partially hardened, or contains foreign material shall not be used. When temporary spreaders are used in the forms, the spreaders shall be removed as their service becomes unnecessary. Concrete shall not be placed in slabs over columns and walls until concrete in columns and walls has been in-place at least two hours or until the concrete begins to lose its plasticity. Concrete for beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as concrete for adjoining slabs.

3.5.2 Consolidation

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 100 mm thick or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 10,000 vibrations per minute, an amplitude of at least 0.6 mm, and the head diameter shall be appropriate for the structural member and the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a reasonable amount. The vibrator shall penetrate rapidly to the bottom of the layer and at least 150 mm into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then vertically withdrawn slowly while operating. Form vibrators shall not be used unless specifically approved and unless forms are constructed to withstand their use. Vibrators shall not be used to move concrete within the forms. Slabs 100 mm and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique. Frequency and amplitude of vibrators shall be determined in accordance with COE CRD-C 521. Grate tampers ("jitterbugs") shall not be used.

3.5.3 Hot Weather Requirements

When the ambient temperature during concrete placing is expected to exceed 30 degrees C, the concrete shall be placed and finished with procedures previously submitted and as specified herein. The concrete temperature at time of delivery to the forms shall not exceed the temperature shown in the table below when measured in accordance with ASTM C 1064. Cooling of the mixing water or aggregates or placing concrete in the cooler part of the day may be required to obtain an adequate placing temperature. A retarder may be used, as approved, to facilitate placing and finishing. Steel forms and reinforcements shall be cooled as approved prior to concrete placement when steel temperatures are greater than 49 degrees C. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature.

Maximum Allowable Concrete Placing Temperature

Relative Humidity, Percent, During Time of Concrete Placement	Maximum Allowable Concrete Temperature Degrees
Greater than 60	33 C
40-60	30 C
Less than 40	27 C

3.5.4 Prevention of Plastic Shrinkage Cracking

During hot weather with low humidity, and particularly with appreciable wind, the Contractor shall be alert to the tendency for plastic shrinkage cracks to develop and shall institute measures to prevent this. Particular care shall be taken if plastic shrinkage cracking is potentially imminent and especially if it has developed during a previous placement. Periods of high potential for plastic shrinkage cracking can be anticipated by use of Fig. 2.1.5 of ACI 305R. In addition the concrete placement shall be further protected by erecting shades and windbreaks and by applying fog sprays of water, sprinkling, ponding or wet covering. Plastic shrinkage cracks that occur shall be filled by injection of epoxy resin as directed, after the concrete hardens. Plastic shrinkage cracks shall never be troweled over or filled with slurry.

3.5.5 Placing Concrete in Congested Areas

Special care shall be used to ensure complete filling of the forms, elimination of all voids, and complete consolidation of the concrete when placing concrete in areas congested with reinforcing bars, embedded items, waterstops and other tight spacing. An appropriate concrete mixture shall be used, and the nominal maximum size of aggregate (NMSA) shall meet the specified criteria when evaluated for the congested area. Vibrators with heads of a size appropriate for the clearances available shall be used, and the consolidation operation shall be closely supervised to ensure complete and thorough consolidation at all points. Where necessary, splices of reinforcing bars shall be alternated to reduce congestion. Where two mats of closely spaced reinforcing are required, the bars in each mat shall be placed in matching alignment to reduce congestion. Reinforcing bars may be temporarily crowded to one side during concrete placement provided they are returned to exact required location before concrete placement and consolidation are completed.

3.6 JOINTS

Joints shall be located and constructed as indicated or approved. Joints not indicated on the drawings shall be located and constructed to minimize the impact on the strength of the structure. All reinforcement shall be continued across joints; except that reinforcement or other fixed metal items shall not be continuous through expansion joints, or through construction joints in slabs on grade. Reinforcement shall be 50 mm clear from each joint. The perimeters of the slabs shall be free of fins, rough edges, spalling, or other unsightly appearance. Reservoir for sealant for construction and contraction joints in slabs shall be formed to the dimensions shown on the drawings by removing snap-out joint-forming inserts, by sawing sawable inserts, or by sawing to widen the top portion

of sawed joints. Joints to be sealed shall be cleaned and sealed as indicated and in accordance with Section 07900 JOINT SEALING.

3.6.1 Construction Joints

For concrete other than slabs on grade, construction joints shall be located as shown on the drawings. Concrete shall be placed continuously so that each unit is monolithic in construction. Fresh concrete shall not be placed against adjacent hardened concrete until it is at least 24 hours old. Construction joints shall be located as indicated or approved. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of the Contracting Officer. Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Concrete columns and walls shall be in place at least 2 hours, or until the concrete begins to lose its plasticity, before placing concrete for slabs. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph Previously Placed Concrete.

3.6.2 Contraction Joints in Slabs on Grade

Contraction joints shall be located and detailed as shown on the drawings. Contraction Joints shall be produced by forming a weakened plane in the concrete slab by use of rigid inserts impressed in the concrete during placing operations, use of snap-out plastic joint forming inserts or sawing a continuous slot immediately after finishing operations with a concrete saw using a Soft Diamond blade. Regardless of method used to produce the weakened plane, it shall be 1/4 the depth of the slab thickness and between 3 and 5 mm wide. For saw-cut joints, cutting shall be timed properly with the set of the concrete. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent ravelling of the edges of the saw cut. Cutting shall be completed before shrinkage stresses become sufficient to produce cracking. Reservoir for joint sealant shall be formed as previously specified.

3.6.3 Expansion Joints

Installation of expansion joints and sealing of these joints shall conform to the requirements of Section 03150 EXPANSION JOINTS, SEALANTS, AND WATERSTOPS and Section 07900 JOINT SEALING.

3.6.4 Waterstops

Waterstops shall be installed in conformance with the locations and details shown on the drawings using materials and procedures specified in Section 03150 EXPANSION JOINTS, SEALANTS, AND WATERSTOPS.

3.6.5 Dowels and Tie Bars

Dowels and tie bars shall be installed at the locations shown on the drawings and to the details shown, using materials and procedures specified in Section 03200 CONCRETE REINFORCEMENT and herein. Conventional smooth "paving" dowels shall be installed in slabs using approved methods to hold the dowel in place during concreting within a maximum alignment tolerance of 1 mm in 100 mm. "Structural" type deformed bar dowels, or tie bars, shall be installed to meet the specified tolerances. Care shall be taken during placing adjacent to and around dowels and tie bars to ensure there is no displacement of the dowel or tie bar and that the concrete completely

embeds the dowel or tie bar and is thoroughly consolidated.

3.7 FINISHING FORMED SURFACES

Forms, form materials, and form construction are specified in Section 03100 STRUCTURAL CONCRETE FORMWORK. Finishing of formed surfaces shall be as specified herein. Unless another type of architectural or special finish is specified, surfaces shall be left with the texture imparted by the forms except that defective surfaces shall be repaired. Unless painting of surfaces is required, uniform color of the concrete shall be maintained by use of only one mixture without changes in materials or proportions for any structure or portion of structure that requires a Class A finish. Except for major defects, as defined hereinafter, surface defects shall be repaired as specified herein within 24 hours after forms are removed. Repairs of the so-called "plaster-type" will not be permitted in any location. Tolerances of formed surfaces shall conform to the requirements of ACI 117/117R. These tolerances apply to the finished concrete surface, not to the forms themselves; forms shall be set true to line and grade. Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter shall be repaired as specified in paragraph Damp-Pack Mortar Repair. Defects whose surface diameter is greater than their depth shall be repaired as specified in paragraph Repair of Major Defects. Repairs shall be finished flush with adjacent surfaces and with the same surface texture. The cement used for all repairs shall be a blend of job cement with white cement proportioned so that the final color after curing and aging will be the same as the adjacent concrete. Concrete with excessive honeycomb, or other defects which affect the strength of the member, will be rejected. Repairs shall be demonstrated to be acceptable and free from cracks or loose or drummy areas at the completion of the contract and, for Class A Finishes, shall be inconspicuous. Repairs not meeting these requirements will be rejected and shall be replaced.

3.7.1 Class A Finish

Class A finish is required for all. Fins, ravelings, and loose material and shall be removed for all surface defects over 12 mm in diameter or more than 12 mm deep, shall be repaired and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be reamed and filled. Defects more than 12 mm in diameter shall be cut back to sound concrete, but in all cases at least 25 mm deep. Metal tools shall not be used to finish repairs in Class A surfaces. Metal tools shall not be used to finish repairs in Class A surfaces.

3.7.2 Class C and Class D Finish

Class C finish is required for concealed surfaces not exposed to view and for all surfaces not covered by Class A & D finish. Class D finish is required for wall and foundation surfaces against which backfill will be placed. Fins, ravelings, and loose material shall be removed, and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be reamed and filled. Honeycomb and other defects more than 12 mm deep or more than 50 mm in diameter shall be repaired. Defects more than 50 mm in diameter shall be cut back to sound concrete, but in all cases at least 25 mm deep.

3.8 REPAIRS

3.8.1 Damp-Pack Mortar Repair

Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter but not over 100 mm shall be repaired by the damp-pack mortar method. Form tie holes shall be reamed and other similar defects shall be cut out to sound concrete. The void shall then be thoroughly cleaned, thoroughly wetted, brush-coated with a thin coat of neat cement grout and filled with mortar. Mortar shall be a stiff mix of 1 part portland cement to 2 parts fine aggregate passing the 1.18 mm sieve, and minimum amount of water. Only sufficient water shall be used to produce a mortar which, when used, will stick together on being molded into a ball by a slight pressure of the hands and will not exude water but will leave the hands damp. Mortar shall be mixed and allowed to stand for 30 to 45 minutes before use with remixing performed immediately prior to use. Mortar shall be thoroughly tamped in place in thin layers using a hammer and hardwood block. Holes passing entirely through walls shall be completely filled from the inside face by forcing mortar through to the outside face. All holes shall be packed full. Damp-pack repairs shall be moist cured for at least 48 hours.

3.8.2 Repair of Major Defects

Major defects will be considered to be those more than 12 mm deep or, for Class A, more than 12 mm in diameter and, for Class C and D finishes, more than 50 mm in diameter. Also included are any defects of any kind whose depth is over 100 mm or whose surface diameter is greater than their depth. Major defects shall be repaired as specified below.

3.8.2.1 Surface Application of Mortar Repair

Defective concrete shall be removed, and removal shall extend into completely sound concrete. Approved equipment and procedures which will not cause cracking or microcracking of the sound concrete shall be used. If reinforcement is encountered, concrete shall be removed so as to expose the reinforcement for at least 50 mm on all sides. All such defective areas greater than 7800 square mm shall be outlined by saw cuts at least 25 mm deep. Defective areas less than 7800 square mm shall be outlined by a 25 mm deep cut with a core drill in lieu of sawing. All saw cuts shall be straight lines in a rectangular pattern in line with the formwork panels. After concrete removal, the surface shall be thoroughly cleaned by high pressure washing to remove all loose material. Surfaces shall be kept continually saturated for the first 12 of the 24 hours immediately before placing mortar and shall be damp but not wet at the time of commencing mortar placement. The Contractor, at his option, may use either hand-placed mortar or mortar placed with a mortar gun. If hand-placed mortar is used, the edges of the cut shall be perpendicular to the surface of the concrete. The prepared area shall be brush-coated with a thin coat of neat cement grout. The repair shall then be made using a stiff mortar, preshrunk by allowing the mixed mortar to stand for 30 to 45 minutes and then remixed, thoroughly tamped into place in thin layers. If hand-placed mortar is used, the Contractor shall test each repair area for drumminess by firm tapping with a hammer and shall inspect for cracks, both in the presence of the Contracting Officer's representative, immediately before completion of the contract, and shall replace any showing drumminess or cracking. If mortar placed with a mortar gun is used, the gun shall be a small compressed air-operated gun to which the mortar is slowly hand fed and which applies the mortar to the surface as a high-pressure stream, as approved. Repairs made using shotcrete equipment will not be accepted. The mortar used shall be the same mortar as specified for damp-pack mortar

repair. If gun-placed mortar is used, the edges of the cut shall be beveled toward the center at a slope of 1:1. All surface applied mortar repairs shall be continuously moist cured for at least 7 days. Moist curing shall consist of several layers of saturated burlap applied to the surface immediately after placement is complete and covered with polyethylene sheeting, all held closely in place by a sheet of plywood or similar material rigidly braced against it. Burlap shall be kept continually wet.

3.9 FINISHING UNFORMED SURFACES

The finish of all unformed surfaces shall meet the requirements of paragraph Tolerances in PART 1, when tested as specified herein.

3.9.1 General

The ambient temperature of spaces adjacent to unformed surfaces being finished and of the base on which concrete will be placed shall be not less than 10 degrees C. In hot weather all requirements of paragraphs Hot Weather Requirements and Prevention of Plastic Shrinkage Cracking shall be met. Unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish, with additional finishing as specified below, and shall be true to the elevation shown on the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown on the drawings, properly consolidated, and left true and regular. Unless otherwise shown on the drawings, exterior surfaces shall be sloped for drainage, as directed. Where drains are provided, interior floors shall be evenly sloped to the drains. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. Grate tampers or "jitterbugs" shall not be used for any surfaces. The dusting of surfaces with dry cement or other materials or the addition of any water during finishing shall not be permitted. If bleedwater is present prior to finishing, the excess water shall be carefully dragged off or removed by absorption with porous materials such as burlap. During finishing operations, extreme care shall be taken to prevent over finishing or working water into the surface; this can cause "crazing" (surface shrinkage cracks which appear after hardening) of the surface. Any slabs with surfaces which exhibit significant crazing shall be removed and replaced. During finishing operations, surfaces shall be checked with a 10 foot straightedge, applied in both directions at regular intervals while the concrete is still plastic, to detect high or low areas.

3.9.2 Rough Slab Finish

As a first finishing operation for unformed surfaces and as final finish for slabs to receive mortar setting beds, the surface shall receive a rough slab finish prepared as follows. The concrete shall be uniformly placed across the slab area, consolidated as previously specified, and then screeded with straightedge strikeoffs immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible. Side forms and screed rails shall be provided, rigidly supported, and set to exact line and grade. Allowable tolerances for finished surfaces apply only to the hardened concrete, not to forms or screed rails. Forms and screed rails shall be set true to line and grade. "Wet screeds" shall not be used.

3.9.3 Floated Finish

All slabs at mechanical service yards shall be given a wood float finish. The screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. Then, after the concrete has stiffened so that it will withstand a man's weight without imprint of more than 6 mm and the water sheen has disappeared, it shall be floated to a true and even plane free of ridges. Floating shall be performed by use of suitable hand floats or power driven equipment. Sufficient pressure shall be used on the floats to bring a film of moisture to the surface. Hand floats shall be made of wood, magnesium, or aluminum. Concrete that exhibits stickiness shall be floated with a magnesium float. Care shall be taken to prevent over-finishing or incorporating water into the surface.

3.9.4 Troweled Finish

Unless otherwise indicated on the drawings, all surfaces not receiving a rough slab finish, a wood flat finish or a non slip finish shall be given a trowel finish. After floating is complete and after the surface moisture has disappeared, unformed surfaces shall be steel-troweled to a smooth, even, dense finish, free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. Additional trowelings shall be performed, either by hand or machine until the surface has been troweled 3 times, with waiting period between each. Care shall be taken to prevent blistering and if such occurs, troweling shall immediately be stopped and operations and surfaces corrected. A final hard steel troweling shall be done by hand, with the trowel tipped, and using hard pressure, when the surface is at a point that the trowel will produce a ringing sound. The finished surface shall be thoroughly consolidated and shall be essentially free of trowel marks and be uniform in texture and appearance. The concrete mixture used for troweled finished areas shall be adjusted, if necessary, in order to provide sufficient fines (cementitious material and fine sand) to finish properly.

3.9.5 Non-Slip Finish

Non-slip floors shall be constructed in accordance with the following subparagraphs.

3.9.5.1 Broomed

All exterior slabs, such as sidewalks, soldier gear wash area and mud rooms, except for pattern walkways as indicated on the drawings shall be given a broomed finish. After floating, the surface shall be lightly steel troweled, and then carefully scored by pulling a coarse fiber push-type broom across the surface. Brooming shall be transverse to traffic or at right angles to the slope of the slab. After the end of the curing period, the surface shall be vigorously broomed with a coarse fiber broom to remove all loose or semi-detached particles.

3.9.5.2 Abrasive Aggregate

All stairways shall be given an abrasive aggregate finish. The concrete surface shall be given a float finish. Abrasive aggregate shall then immediately be uniformly sprinkled over the floated surface at a total rate of not less than 1.25 kg per square meter spread in two applications at right angles to each other. The surface shall then be troweled to a smooth, even finish that is uniform in texture and appearance and free from blemishes including trowels marks. Immediately after curing, cement paste

and laitance covering the abrasive aggregate shall be removed by steel brushing, rubbing with abrasive stone, or sandblasting to expose the abrasive particles.

3.10 FLOOR HARDENER/SEALER

Exposed areas as indicated on the drawings shall be treated with floor hardener/sealer. Floor hardener/sealer shall be applied after the concrete has hardened and shall be applied in strict accordance with the manufacturer's recommendations and printed instructions. The floor hardener/sealer shall be applied at the rate of 18.58 sq. meters (200 SF) per gallon.

3.11 EXTERIOR SLAB AND RELATED ITEMS

3.11.1 Pits and Trenches

Pits and trenches shall be constructed as indicated on the drawings. Bottoms and walls shall be placed monolithically or waterstops and keys, shall be provided as approved.

3.12 CURING AND PROTECTION

3.12.1 General

Concrete shall be cured by the moist curing or immersion method for the period of 7 days.

Then the membrane forming curing compound method thereafter. Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, mechanical injury and damage from rain and flowing water for the duration of the curing period. Air and forms in contact with concrete shall be maintained at a temperature above 10 degrees C for the first 3 days and at a temperature above 0 degrees C for the remainder of the specified curing period. Materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat, including welding, shall be permitted near or in direct contact with the concrete at any time. Except as otherwise permitted by paragraph Membrane Forming Curing Compounds, moist curing shall be provided for any areas to receive floor hardener, any paint or other applied coating, or to which other concrete is to be bonded. Concrete containing silica fume shall be initially cured by fog misting during finishing, followed immediately by continuous moist curing. Except for plastic coated burlap, impervious sheeting alone shall not be used for curing.

3.12.2 Moist Curing

Reservoir tank shall utilize moist curing methods only. Concrete to be moist-cured shall be maintained continuously wet for the entire curing period, commencing immediately after finishing. If water or curing materials used stain or discolor concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned as approved. When wooden forms are left in place during curing, they shall be kept wet at all times. If steel forms are used in hot weather, nonsupporting vertical forms shall be broken loose from the concrete soon after the concrete hardens and curing water continually applied in this void. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Surfaces

shall be cured by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Burlap and mats shall be clean and free from any contamination and shall be completely saturated before being placed on the concrete. The Contractor shall have an approved work system to ensure that moist curing is continuous 24 hours per day.

3.12.3 Membrane Forming Curing Compounds

Membrane forming curing compounds shall not be used on reservoir tank. Membrane forming curing compounds may be used on all concrete surfaces except as specified herein. Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete, including surfaces to which a smooth finish is to be applied or other concrete to be bonded. However, a hardener/sealer meeting ASTM C 309, and ASTM C 1315 may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of carpet or resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. All surfaces shall be thoroughly moistened with water. Curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. The curing compound shall be applied in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 500 kPa, at a uniform coverage of not more than 10 cubic meters per L for each coat, and the second coat shall be applied perpendicular to the first coat. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. Surfaces on which clear compound is used shall be shaded from direct rays of the sun for the first 3 days. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3.12.4 Ponding or Immersion

Concrete shall be continually immersed throughout the curing period. Water shall not be more than 10 degrees C less than the temperature of the concrete.

3.13 BEDDING MORTOR AND NONSHRINE GROUT

3.13.1 Bedding Mortar

Damp-pack bedding mortar shall consist of 1 part cement and 3 parts fine aggregate having water content such that a mass of mortar tightly squeezed in the hand will retain its shape but will crumble when disturbed.

3.13.2 Nonshrink Grout

Nonshrink grout shall be a ready-mixed material requiring only the addition of water. Water content shall be the minimum that will provide a flowable mixture and completely fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.13.2.1 Mixing and Placing of Nonshrink Grout

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified therein. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. The space between the top of the concrete or machinery-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for completely retaining the grout on all sides and on top and shall be removed after the grout has set. The placed grout shall be carefully worked by rodding or other means to eliminate voids; however, overworking and breakdown of the initial set shall be avoided. Grout shall not be retempered or subjected to vibration from any source. Where clearances are unusually small, placement shall be under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 18 to 30 degrees C until after setting.

3.14 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL

The Contractor shall perform the inspection and tests described below and, based upon the results of these inspections and tests, shall take the action required and shall submit specified reports. When, in the opinion of the Contracting Officer, the concreting operation is out of control, concrete placement shall cease and the operation shall be corrected. The laboratory performing the tests shall conform with ASTM C 1077. Materials may be subjected to check testing by the Government from samples obtained at the manufacturer, at transfer points, or at the project site. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and as required thereafter for conformance with ASTM C 1077.

3.14.1 Grading and Corrective Action

3.14.1.1 Fine Aggregate

At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C 136 and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately reported to the Contracting Officer, concreting shall be stopped, and immediate steps taken to correct the grading.

3.14.1.2 Coarse Aggregate

At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current

test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of 5 tests are outside specification limits, the operation shall be considered out of control and shall be reported to the Contracting Officer. Concreting shall be stopped and immediate steps shall be taken to correct the grading.

3.14.2 Quality of Aggregates

Thirty days prior to the start of concrete placement, the Contractor shall perform all tests for aggregate quality required by ASTM C 33. In addition, after the start of concrete placement, the Contractor shall perform tests for aggregate quality at least every three months, and when the source of aggregate or aggregate quality changes. Samples tested after the start of concrete placement shall be taken immediately prior to entering the concrete mixer.

3.14.3 Scales, Batching and Recording

The accuracy of the scales shall be checked by test weights prior to start of concrete operations and at least once every three months. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors. Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. At the same time, the Contractor shall test and ensure that the devices for dispensing admixtures are operating properly and accurately. When either the weighing accuracy or batching accuracy does not comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

3.14.4 Batch-Plant Control

The measurement of concrete materials including cementitious materials, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate weights and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. The amount of air-entraining agent shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of cement used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic meter, amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic meter for each class of concrete batched during each day's plant operation.

3.14.5 Concrete Mixture

- a. Air Content Testing. Air content tests shall be made when test specimens are fabricated. In addition, at least two tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of concrete production. Additional tests shall be made when

excessive variation in workability is reported by the placing foreman or Government inspector. Tests shall be made in accordance with ASTM C 231 for normal weight concrete. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single test result reaches either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the air content of the batch to plot on both the air content and the control chart for range, and for determining need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate control chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph Air Entrainment. An upper warning limit and a lower warning limit line shall be set 1.0 percentage point above and below the average line, respectively. An upper action limit and a lower action limit line shall be set 1.5 percentage points above and below the average line, respectively. The range between each two consecutive tests shall be plotted on a secondary control chart for range where an upper warning limit is set at 2.0 percentage points and an upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content. If the Contractor's materials or transportation methods cause air content loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the air content at the mixer controlled as directed.

- b. Air Content Corrective Action. Whenever points on the control chart for percent air reach either warning limit, an adjustment shall immediately be made in the amount of air-entraining admixture batched. As soon as practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the secondary control chart for range reaches the warning limit, the admixture dispenser shall be recalibrated to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content shall be considered out of control and the concreting operation shall immediately be halted until the air content is under control. Additional air content tests shall be made when concreting is restarted.
- c. Slump Testing. In addition to slump tests which shall be made when test specimens are fabricated, at least four slump tests shall be made on randomly selected batches in accordance with ASTM C 143 for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, a second test shall

immediately be made. The results of the two tests shall be averaged and this average used as the slump of the batch to plot on both the control charts for slump and the chart for range, and for determining need for any remedial action. Limits shall be set on separate control charts for slump for each type of mixture. The upper warning limit shall be set at 12.5 mm below the maximum allowable slump specified in paragraph Slump in PART 1 for each type of concrete and an upper action limit line and lower action limit line shall be set at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. The range between each consecutive slump test for each type of mixture shall be plotted on a single control chart for range on which an upper action limit is set at 50 mm. Samples for slump shall be taken at the mixer. However, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer, and the slump at the mixer controlled as directed.

- d. Slump Corrective Action. Whenever points on the control charts for slump reach the upper warning limit, an adjustment shall immediately be made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount allowed by the maximum w/c ratio specified, based on aggregates which are in a saturated surface dry condition. When a single slump reaches the upper or lower action limit, no further concrete shall be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive individual slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, the concreting operation shall immediately be halted, and the Contractor shall take appropriate steps to bring the slump under control. Additional slump tests shall be made as directed.
- e. Temperature. The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064. The temperature shall be reported along with the compressive strength data.
- f. Strength Specimens. At least one set of test specimens shall be made, for compressive strength, on each different concrete mixture placed during the day for each 380 cubic meters or portion thereof of that concrete mixture placed each day. Additional sets of test specimens shall be made, as directed by the Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. A truly random (not haphazard) sampling plan shall be developed by the Contractor and approved by the Contracting Officer prior to the start of construction. The plan shall assure that sampling is done in a completely random and unbiased manner. A set of test specimens for concrete with a 28-day specified strength per paragraph Strength Requirements in PART 1 shall consist of four specimens, two to be tested at 7 days and two at 28 days. Test specimens shall be molded and cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39

for test cylinders and ASTM C 78 for test beams. Results of all strength tests shall be reported immediately to the Contracting Officer. Quality control charts shall be kept for individual strength "tests", ("test" as defined in paragraph Strength Requirements in PART 1) moving average of last 3 "tests" for strength, and moving average for range for the last 3 "tests" for each mixture. The charts shall be similar to those found in ACI 214.3R.

3.14.6 Inspection Before Placing

Foundations, construction joints, forms, and embedded items shall be inspected by the Contractor in sufficient time prior to each concrete placement in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

3.14.7 Placing

The placing foreman shall supervise placing operations, shall determine that the correct quality of concrete or grout is placed in each location as specified and as directed by the Contracting Officer, and shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume placed, and method of placement. The placing foreman shall not permit batching and placing to begin until it has been verified that an adequate number of vibrators in working order and with competent operators are available. Placing shall not be continued if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

3.14.8 Vibrators

The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made as directed when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head, and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing. Any vibrator not meeting the requirements of paragraph Consolidation, shall be immediately removed from service and repaired or replaced.

3.14.9 Curing Inspection

- a. Moist Curing or Immersion Inspections. At least once each shift, and not less than twice per day on both work and non-work days, an inspection shall be made of all areas subject to moist or immersion curing. The surface moisture condition shall be noted and recorded.
- b. Moist Curing Corrective Action. When a daily inspection report lists an area of inadequate curing, immediate corrective action

shall be taken, and the required curing period for those areas shall be extended by 1 day.

3.14.10 Mixer Uniformity

- a. Stationary Mixers. Prior to the start of concrete placing and once every 6 months when concrete is being placed, or once for every 60,000 cubic meters of concrete placed, whichever results in the shortest time interval, uniformity of concrete mixing shall be determined in accordance with ASTM C 94.
- b. Truck Mixers. Prior to the start of concrete placing and at least once every 6 months when concrete is being placed, uniformity of concrete mixing shall be determined in accordance with ASTM C 94. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.
- c. Mixer Uniformity Corrective Action. When a mixer fails to meet mixer uniformity requirements, either the mixing time shall be increased, batching sequence changed, batch size reduced, or adjustments shall be made to the mixer until compliance is achieved.

3.14.11 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

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SECTION 09650
RESILIENT FLOORING

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 2240	(1997) Rubber Property - Durometer Hardness
ASTM D 4078	(1992; R 1996) Water Emulsion Floor Polish
ASTM E 648	(1997) Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM E 662	(1995) Specific Optical Density of Smoke Generated by Solid Materials
ASTM F 1066	(1995a) Vinyl Composition Floor Tile
ASTM F 1303	(1997) Sheet Vinyl Floor Covering with Backing
ASTM F 1344	(1993) Rubber Floor Tile
ASTM F 1869	(1998) Measuring Moisture Vapor Emission of Concrete Sub-floors Using Anhydrous Calcium Chloride

RESILIENT FLOOR COVERING INSTITUTE (RFCI)

RFCI	(1995) Addressing Moisture Related Problems Relevant to Resilient Floor Coverings Installed Over Concrete
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1.2 FIRE RESISTANCE REQUIREMENTS

Flooring in corridors and exits shall have a minimum average critical radiant flux of 0.45 watts per square centimeter when tested in accordance with ASTM E 648. The smoke density rating shall be less than 450 when tested in accordance with ASTM E 662.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTALS

PROCEDURES:

SD-01 Data

Resilient Flooring and Accessories; FIO.

Manufacturer's descriptive data and installation instructions including cleaning and maintenance instructions.

SD-09 Reports

Resilient Flooring and Accessories; FIO.

Copies of test reports showing that representative product samples of the flooring proposed for use have been tested by an independent testing laboratory within the past three years or when formulation change occurred and conforms to the requirements specified.

Moisture of Alkalinity Tests; FIO.

Method of Alkalinity Test and Relative Humidity Test.

Two copies of test reports of moisture vapor and alkalinity tests of concrete sub floors. Provide starting date of test, person conducting the test and all calculations. Provide a diagram of the building showing test locations with the testing results prior to floor covering installation.

SD-14 Samples

Resilient Flooring and Accessories; FIO.

Three samples of each indicated color and type of flooring and base. Sample size shall be minimum 60 x 100 mm.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the building site in original unopened containers bearing the manufacturer's name, project identification, and handling instructions. Materials shall be stored in a clean dry area with temperature maintained above 21 degrees C for 2 days prior to installation, and shall be stacked according to manufacturer's recommendations.

1.5 SCHEDULING

Resilient flooring application shall be scheduled after the completion of other work which would damage the finished surface of the flooring.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

1.7 EXTRA MATERIALS

Extra flooring material of each color and pattern shall be furnished at the rate of 5 tiles for each 1000 tiles. Extra materials shall be from the same lot as those installed. Extra base material composed of 6 m of each color shall be furnished.

PART 2 PRODUCTS

2.1 VINYL-COMPOSITION TILE TYPE

Vinyl-composition tile shall conform to ASTM F 1066, Class 2, (through pattern tile), Composition 1, asbestos-free, and shall be 300 mm square and 3.2 mm thick. Tile shall have the color and pattern uniformly distributed throughout the thickness of the tile. Flooring in any one continuous area shall be from the same lot and shall have the same shade and pattern.

2.2 SHEET VINYL FLOORING TYPE

Sheet vinyl flooring shall be composed of a homogeneous, vinyl composition and design elements consisting of through-grained and/or solid-colored vinyl granules, and the pattern shall extend uniformly through the entire thickness of the floor. Colors shall be selected from "Armstrong, Medintech, homogeneous vinyl sheet flooring" or approved equal. Flooring shall be not less than 1800 mm wide. Sheet vinyl flooring without backing shall meet the overall thickness 2.03 mm, composition, flexibility, indentation, and the solvent resistance requirements of ASTM F 1303, Type II. The solid vinyl color and pattern shall extend through the total thickness of the material. High quality vinyl welding rods with matching pattern for heat welding of joints shall be provided.

2.2.1 VCT (Non-Static)

Non-static vinyl-composition tile shall include antistatic additive and shall have point-to-point $10^6 - 10^9$ ohms and surface to ground $10^6 - 10^9$ ohms. Static generation shall be less than 100 volts with conductive footwear at 20 percent relative humidity. Static decay of 5,000 volts to zero shall occur in less than 0.2 seconds. Provide all accessories for complete system.

2.3 RUBBER FLOORING TYPE

2.3.1 Rubber Tile

Rubber tile shall conform to ASTM F 1344 Class 1 homogeneous construction, Type B (through mottled) 300 mm square. Surface shall be smooth. Overall thickness shall be 3 mm thick.

2.4 STAIR TREADS, RISERS, AND STRINGERS

Treads, risers, and stringers shall conform to composition rubber compounded from a mixture of synthetic and reclaimed rubber. Overall thickness at treads shall be not less than 3 mm. Durometer hardness shall be 90, plus or minus 5, when tested in accordance with ASTM D 2240. Design shall be either a one piece nosing/tread/riser or a two piece nosing/tread with a matching coved riser. Installation shall include stringer angles on both the wall and banister sides, and landing trim. Surface of treads shall be raised diamond pattern.

2.5 RESILIENT BASE

Base shall be manufacturers standard rubber or vinyl, coved style (installed with resilient flooring). Base shall be 100 mm high and a minimum 3 mm thick. Preformed outside corners shall be furnished.

2.6 INTEGRAL COVERED BASE

A metal or vinyl, square cap strip and vinyl, rubber, or wood fillet strip with a minimum radius of 19 mm shall be provided for integral coved bases as shown.

2.7 FEATURE STRIP

Feature strips shall be vinyl, 25 mm wide, and of thickness to match the flooring. Color shall be as indicated.

2.8 TRANSITION STRIP

A vinyl transition strip tapered to meet abutting material shall be provided.

2.9 ADHESIVE

Adhesive for flooring and wall base shall be as recommended by the flooring manufacturer.

2.10 POLISH

Polish shall conform to ASTM D 4078.

2.11 SEALANTS

Sealants shall be in accordance with Section 07900 JOINT SEALING.

2.12 MANUFACTURER'S COLOR AND TEXTURE

Color and texture shall be as indicated on the drawings.

2.13 CONCRETE MOISTURE VAPOR TREATMENT

Concrete sub-floors exceeding 3 lbs./1000 square feet/24 hrs. of vapor emission and a pH level greater than 10, shall receive moisture vapor treatment (hereafter stated as "Treatment"). Treatment shall reduce emission levels to 3 lbs./1000 square feet/24 hrs. or lower (provide testing after curing of Treatment to verify that Treatment has reduced emission to 3 lbs./1000 square feet/24 hrs. or lower), lower pH levels to 10 or lower, and provide a suitable surface for the bonding of floor covering materials. The Treatment shall not produce detrimental conditions to the concrete slab or the floor covering materials by producing too low levels of emission or pH. Treatment material will consist of a two component penetrating polymer with elastomeric properties and vapor control at joints and cracks. The Treatment material shall be specifically formulated for flooring treatment. Installed Treatment material shall be compatible with the flooring adhesives. A written statement stating compatibility from the Treatment manufacturer shall be submitted to the Contracting Officer. Treatment manufacturer and installer will provide proof of the following:

a. Evidence of 5 successful floor Treatment projects with similar size and complexity, with a minimum of 8 years of age.

b. Warranty covering the material and installation for a period of 10 years. Manufactures standard warranty shall provide the following coverage:

1. Cover the installed moisture vapor treatment, cementitious materials, floor coverings and adhesives in the event that treatment is affected by vapor emission and/or pH levels.

2. Evidence of product liability insurance policy with an insurer of not less than an "A" rating from one of the 4 major rating services. A certificate of insurance shall be delivered in the amount of \$2,000,000.00 per occurrence to the owner and the general contractor as co-insured.

c. Installer shall provide proof of installer certification by the Treatment manufacturer and bondability in the amount of the contract.

PART 3 EXECUTION

3.1 EXAMINATION/VERIFICATION OF CONDITIONS

The Contractor shall examine and verify that site conditions are in agreement with the design package and shall report all conditions that will prevent a proper installation. The Contractor shall not take any corrective action without written permission from the Government.

3.2 SURFACE PREPARATION

Flooring shall be in a smooth, true, level plane, except where indicated as sloped. Before any work under this section is begun, all defects such as rough or scaling concrete, low spots, high spots, and uneven surfaces shall have been corrected, and all damaged portions of concrete slabs shall have been repaired as recommended by the flooring manufacturer. Concrete curing compounds, other than the type that does not adversely affect adhesion, shall be entirely removed from the slabs. Paint, varnish, oils, release agents, sealers, waxers, and adhesives shall be removed, as recommended by the flooring manufacturer. The contractor shall apply a floor hardener/sealer to areas indicated on the contract drawings. Requirements for floor hardener/sealer is found in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.3 MOISTURE TEST

The concrete slab shall be allowed to cure for a period of at least two months and then exposed to air conditioning, etc. for the purpose of acclimating the slab for at least 3-weeks prior to taking the moisture test.

This time period may be shortened if use of the Relative Humidity testing determines a shorter curing/acclimation time period is required prior to performing the moisture test. Resulting test holes in the concrete slab shall be repaired by an approved method. The concrete slab shall be protected from the weather by a Contracting Officer's approved method during the curing and acclimation period. Concrete slab shall be tested for moisture emission rate and excessive alkalinity in accordance with ASTM F 1869 (anhydrous calcium chloride test) and Resilient Floor Covering Institute (RFCI). Provide anhydrous calcium chloride at a rate of three test in areas up to 1,000 square feet and one additional test per 1,000 square feet thereafter. Provide industry standard pH testing at the same rate.

3.4 INSTALLATION OF VINYL-COMPOSITION TILE

Tile flooring shall be installed with adhesive in accordance with the manufacturer's installation instructions. Tile lines and joints shall be kept square, symmetrical, tight, and even. Edge width shall vary as necessary to maintain full-size tiles in the field, but no edge tile shall be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Flooring shall be cut to, and fitted around, all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Edge tile shall be cut, fitted, and scribed to walls and partitions after field flooring has been applied.

3.5 INSTALLATION OF SHEET VINYL FLOORING

Sheet vinyl flooring shall be installed with adhesive and heat-welded seams in accordance with the manufacturer's written installation instructions. Flooring shall be fitted to the room by hand cutting, straight scribing, or pattern scribing as necessary to suit job conditions. Flooring shall be cut to, and fitted around, all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Seams shall be cut by overlapping or underscribing as recommended by the manufacturer. Flooring shall be installed with an integral coved base as indicated.

3.6 INSTALLATION OF RUBBER FLOORING

Rubber flooring for stair landing in conjunction with rubber stair trends shall be installed with adhesive in accordance with the manufacturer's written installation instructions. Lines and joints shall be kept square, symmetrical, tight, and even. Edge width shall vary as necessary to maintain full-size tiles in the field, but no edge pieces shall be less than one-half the field size, except where irregular shaped landing make it impossible. Edges shall be cut, fitted, and scribed to guardrail.

3.7 INSTALLATION OF FEATURE STRIPS

Edge strips shall be secured with adhesive as recommended by the manufacturer. Edge strips shall be provided at locations where flooring termination is higher than the adjacent finished flooring, except at doorways where thresholds are provided.

3.8 INSTALLATION OF RESILIENT BASE

Wall base shall be installed with adhesive in accordance with the manufacturer's written instructions. Base joints shall be tight and base shall be even with adjacent resilient flooring. Voids along the top edge of base at masonry walls shall be filled with caulk.

3.9 INSTALLATION OF TREADS AND RISERS

Stair treads and risers shall be installed with adhesive in accordance with the manufacturer's written installation instructions. Treads and risers shall cover the full width of the stairs. Stairs wider than manufacturer's standard lengths shall have equal length pieces butted together to cover the treads.

3.10 INSTALLATION OF INTEGRAL COVED BASE

Integral coved base shall be formed by extending the flooring material 150 mm onto the wall surface. Cove shall be supported by a plastic, rubber or wood coved filler having a minimum radius of 19 mm. Coved base shall be installed with adhesive in accordance with the manufacturer's written

instructions. A metal or vinyl cap strip shall be provided at the top of the base. Voids along the top edge of base at masonry walls shall be filled with caulk.

3.11 CLEANING

Immediately upon completion of installation of tile in a room or an area, flooring and adjacent surfaces shall be cleaned to remove all surplus adhesive. After installation, flooring shall be washed with a cleaning solution, rinsed thoroughly with clear cold water, and, except for rubber tile, rubber stair treads, and VCT (Non-Static) given two coats of polish in accordance with manufacturers written instructions. After each polish coat, floors shall be buffed to an even luster with an electric polishing machine. Raised pattern rubber flooring, rubber tile and sheet rubber flooring, rubber stair treads, and static control vinyl tile shall be cleaned and maintained as recommended by the manufacturer.

3.12 PROTECTION

From the time of laying until acceptance, flooring shall be protected from damage as recommended by the flooring manufacturer. Flooring which becomes damaged, loose, broken, or curled shall be removed and replaced.

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SECTION 09680

CARPET

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 TEXTILE CHEMISTS AND COLORISTS (AATCC)

AATCC TM 16	(1993) Test Method: Colorfastness to Light
AATCC TM 134	(1991) Test Method: Electrostatic Propensity of Carpets
AATCC TM 165	(1993) Test Method: Colorfastness to Crocking: Carpets - AATCC Crockmeter Method

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 418	(1993; R 1997) Pile Yarn Floor Covering Construction
ASTM D 1335	(1967; R 1972) Tuft Bind of Pile Floor Coverings
ASTM D 1423	(1992) Twist in Yarns by the Direct-Counting Method
ASTM D 3278	(1996) Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
ASTM E 648	(1997) Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM F 1869	(1998) Measuring Moisture Vapor Emission of Concrete Sub-floors Using Anhydrous Calcium Chloride

CARPET AND RUG INSTITUTE (CRI)

CRI 104	(1996) Commercial Carpet Installation Standard
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CODE OF FEDERAL REGULATIONS (CFR)

16 CFR 1630	Standard for the Surface Flammability of Carpet and Rugs (FF 1-70)
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1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Carpet and Accessories; FIO.

Manufacturer's catalog data and printed documentation stating physical characteristics, durability, resistance to fading, and flame resistance characteristics for each type of carpet material and installation accessory.

SD-04 Drawings

Installation; FIO.

Three copies of drawings indicating areas receiving carpet, carpet types, textures and patterns, direction of pile, location of seams, and locations of edge molding.

SD-06 Instructions

Carpet and Accessories; FIO.

Three copies of the manufacturer's printed installation instructions for the carpet, including preparation of substrate, seaming techniques, and recommended adhesives and tapes.

SD-09 Reports

Moisture and Alkalinity Tests; FIO.

Three copies of test reports of moisture and alkalinity content of concrete slab stating date of test, person conducting the test, and the area tested.

SD-13 Certificates

Carpet and Accessories; FIO.

Certificates of compliance from a laboratory accredited by the National Laboratory Accreditation Program of the National Institute of Standards and Technology attesting that each type of carpet and carpet with cushion material conforms to the standards specified.

SD-14 Samples

Carpet and Accessories; FIO.

- a. Carpet: Two "Production Quality" samples 675 x 450 mm of each carpet proposed for use, showing quality, pattern, and color specified.
- b. Vinyl Moldings: Two pieces of each type at least 300 mm.

SD-19 Operation and Maintenance Manuals

Carpet and Accessories; FIO.

Three copies of carpet manufacturer's maintenance instructions describing recommended type of cleaning equipment and material, spotting and cleaning methods, and cleaning cycles.

1.3 REGULATORY REQUIREMENTS

Carpet and adhesives shall bear the Carpet and Rug Institute (CRI) Indoor Air Quality (IAQ) label. Carpet type bearing the label will indicate that the carpet has been tested and meets the criteria of the CRI IAQ Carpet Testing Program, and minimizes the impact on indoor air quality.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the site in the manufacturer's original wrappings and packages clearly labeled with the manufacturer's name, brand name, size, dye lot number, and related information. Materials shall be stored in a clean, dry, well ventilated area, protected from damage and soiling.

1.5 ENVIRONMENTAL REQUIREMENTS

Traffic or movement of furniture or equipment in carpeted area shall not be permitted for 24 hours after installation. Other work which would damage the carpet shall be completed prior to installation of carpet.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one-year period shall be provided.

PART 2 PRODUCTS

2.1 CARPET TYPE AT BARRACKS BUILDINGS (MOHAWK SUPERTRON)

Carpet shall be first quality; free of visual blemishes, streaks, poorly dyed areas, fuzzing of pile yarn, spots or stains, and other physical and manufacturing defects. Carpet materials and treatments shall be reasonably nonallergenic and free of other recognized health hazards. All grade carpets shall have a static control construction which gives adequate durability and performance.

2.1.1 Physical Characteristics

Carpet shall comply with the following:

- a. Carpet Construction: Woven.
- b. Type: Broadloom 3.6 m minimum usable carpet width.
- c. Pile Type: Level-loop.
- d. Pile Fiber: Commercial branded nylon continuous filament.
- e. Pile or Wire Height: Minimum 5.8 mm (.230 inch) in accordance with ASTM D 418.
- f. Yarn Ply: Minimum 2 in accordance with ASTM D 1423.

- g. Pitch: Minimum 165 POB in accordance with ASTM D 418.
- h. Rows per 25 mm (inch): 9.0.
- i. Finished Pile Yarn Weight: Minimum 1.02 kg per square meter.(30.0 oz per square yard) This does not include weight of backings. Weight shall be determined in accordance with ASTM D 418.
- j. Pile Density: Minimum 4,954.
- k. Dye Method:

Yarn (or Skein) dyed.

- l. Backing Materials: Backing materials shall be 100 percent synthetic.

2.1.2 Performance Requirements

- a. Static Control: Static control shall be provided to permanently control static buildup to less than 3.5 kV when tested at 20 percent relative humidity and 21 degrees C in accordance with AATCC TM 134.
- b. Flammability and Critical Radiant Flux Requirements: Carpet shall comply with 16 CFR 1630.
- c. Tuft Bind: Tuft bind force required to pull a tuft or loop free from carpet backing shall be a minimum 40 N average force for loop pile when tested in accordance with ASTM D 1335.

2.2 CARPET TYPE AT SOLDIER COMMUNITY (KARASTAN, OPULENT BLOCK)

Carpet shall be first quality; free of visual blemishes, streaks, poorly dyed areas, fuzzing of pile yarn, spots or stains, and other physical and manufacturing defects. Carpet materials and treatments shall be reasonably nonallergenic and free of other recognized health hazards. All grade carpets shall have a static control construction which gives adequate durability and performance.

2.2.1 Physical Characteristics

Carpet shall comply with the following:

- a. Carpet Construction: Woven
- b. Type: Broadloom 3.6 m minimum usable carpet width.
- c. Pile Type: Patterned cut and loop.
- d. Pile Fiber: Commercial branded nylon continuous filament.
- e. Pile or Wire Height: Minimum 6.4 mm (.253 inch) in accordance with ASTM D 418.
- f. Yarn Ply: Minimum 2 in accordance with ASTM D 1423.
- g. Pitch: Minimum 270 POB in accordance with ASTM D 418.

- h. Rows per 25 mm (inch): 9.4.
- i. Finished Pile Yarn Weight: Minimum 1.42 kg per square meter (42.0 oz per square yard). This does not include weight of backings. Weight shall be determined in accordance with ASTM D 418.
- j. Pile Density: Minimum 5,976.
- k. Dye Method: Yarn or Skein dyed.
- l. Backing Materials: Backing materials shall be 100 percent synthetic.

2.2.2 Performance Requirements

- a. Static Control: Static control shall be provided to permanently control static buildup to less than 3.5 kV when tested at 20 percent relative humidity and 21 degrees C in accordance with AATCC TM 134.
- b. Flammability and Critical Radiant Flux Requirements: Carpet shall comply with 16 CFR 1630.
- c. Tuft Bind: Tuft bind force required to pull a tuft or loop free from carpet backing shall be a minimum (40 N average force for loop pile and 18 N average force for cut pile when tested in accordance with ASTM D 1335).

2.3 CARPET TYPE AT BATTALION HEADQUARTERS BUILDINGS (KARASTAN, NOUVEAU)

Carpet shall be first quality; free of visual blemishes, streaks, poorly dyed areas, fuzzing of pile yarn, spots or stains, and other physical and manufacturing defects. Carpet materials and treatments shall be reasonably nonallergenic and free of other recognized health hazards. All grade carpets shall have a static control construction which gives adequate durability and performance.

2.3.1 Physical Characteristics

Carpet shall comply with the following:

- a. Carpet Construction: Woven.
- b. Type: Broadloom 3.6 m minimum usable carpet width
- c. Pile Type: Level-loop.
- d. Pile Fiber: Commercial branded nylon continuous filament.
- e. Pile or Wire Height: Minimum 3.4 mm (.135 inch) in accordance with ASTM D 418.
- f. Yarn Ply: Minimum 2 in accordance with ASTM D 1423.
- g. Gauge or Pitch: Minimum 216 POB in accordance with ASTM D 418.
- h. Rows per 25 mm: 9.0 Minimum 354 per meter.

- i. Finished Pile Yarn Weight: Minimum 1017 per square meter. This does not include weight of backings. Weight shall be determined in accordance with ASTM D 418.
- j. Pile Density: 4,696.
- k. Dye Method: Yarn (or Skein) dyed.
- l. Backing Materials: Primary backing materials shall be synthetic. Secondary backing to suit project requirements shall be those customarily used and accepted by the trade for each type of carpet, except when a special unitary back designed for gluedown is provided.

2.3.2 Performance Requirements

- a. Static Control: Static control shall be provided to permanently control static buildup to less than 3.5 kV when tested at 20 percent relative humidity and 21 degrees C in accordance with AATCC TM 134.
- b. Flammability and Critical Radiant Flux Requirements: Carpet shall comply with 16 CFR 1630. Carpet shall have a minimum average critical radiant flux of 0.45 watts per square centimeter when tested in accordance with ASTM E 648.
- c. Tuft Bind: Tuft bind force required to pull a tuft or loop free from carpet backing shall be a minimum 40 N average force for loop pile.
- d. Additional Performance Characteristics:
- e. Colorfastness to Crocking: Dry and wet crocking shall comply with AATCC TM 165 and shall have a minimum rating of step 4 on the AATCC Color Transference Chart for all colors.
- f. Colorfastness to Light: Colorfastness to light shall comply with AATCC TM 16 and shall have a minimum 4 grey scale rating after 40 hours.
- g. Delamination Strength: Delamination strength for tufted carpet with a secondary back shall be minimum of 440 N/m

2.4 ADHESIVES AND CONCRETE PRIMER

Adhesives and concrete primers for installation of carpet shall be waterproof, nonflammable, meet local air-quality standards, and shall be as recommended by the carpet manufacturer. Seam adhesive shall be waterproof, nonflammable, and nonstaining as recommended by the carpet manufacturer. Adhesives flashpoint shall be minimum 60 degrees C in accordance with ASTM D 3278.

2.5 MOLDING

Vinyl molding shall be heavy-duty and designed for the type of carpet being installed. Floor flange shall be a minimum 50 mm wide. Color shall be as selected by the Contracting Officer to match carpet.

2.6 TAPE

Tape for seams shall be as recommended by the carpet manufacturer for the type of seam used in installation.

2.7 COLOR, TEXTURE, AND PATTERN

Color, texture, and pattern shall be as indicated on the drawings.

2.8 CONCRETE MOISTURE VAPOR TREATMENT

Concrete sub-floors exceeding 3 lbs./1000 square feet/24 hrs. of vapor emission and a pH level greater than 10, shall receive moisture vapor treatment (hereafter stated as "Treatment"). Treatment shall reduce emission levels to 3 lbs./1000 square feet/24 hrs. or lower (provide testing after curing of Treatment to verify that Treatment has reduced emission to 3 lbs./1000 square feet/24 hrs. or lower), lower pH levels to 10 or lower, and provide a suitable surface for the bonding of floor covering materials. The Treatment shall not produce detrimental conditions to the concrete slab or the floor covering materials by producing too low levels of emission or pH. Treatment material will consist of a two component penetrating polymer with elastomeric properties and vapor control at joints and cracks. The Treatment material shall be specifically formulated for flooring treatment. Installed Treatment material shall be compatible with the flooring adhesives. A written statement stating compatibility from the Treatment manufacturer shall be submitted to the Contracting Officer. Treatment manufacturer and installer will provide proof of the following:

a. Evidence of 5 successful floor Treatment projects with similar size and complexity, with a minimum of 8 years of age.

b. Warranty covering the material and installation for a period of 10 years. Manufactures standard warranty shall provide the following coverage:

1. Cover the installed moisture vapor treatment, cementitious materials, floor coverings and adhesives in the event that treatment is affected by vapor emission and/or pH levels.

2. Evidence of product liability insurance policy with an insurer of not less than an "A" rating from one of the 4 major rating services. A certificate of insurance shall be delivered in the amount of \$2,000,000.00 per occurrence to the owner and the general contractor as co-insured.

c. Installer shall provide proof of installer certification by the Treatment manufacturer and bondability in the amount of the contract.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Carpet shall not be installed on surfaces that are unsuitable and will prevent a proper installation. Holes, cracks, depressions, or rough areas shall be repaired using material recommended by the carpet or adhesive manufacturer. Floor shall be free of any foreign materials and swept broom clean. Before beginning work, subfloor shall be tested with glue and carpet to determine "open time" and bond.

3.2 MOISTURE TEST

The concrete slab shall be allowed to cure for a period of at least two months and then exposed to air conditioning, etc. for the purpose of acclimating the slab for at least 3-weeks prior to taking the moisture test.

This time period may be shortened if use of the Relative Humidity testing determines a shorter curing/acclimation time period is required prior to performing the moisture test. Resulting test holes in the concrete slab shall be repaired by an approved method. The concrete slab shall be protected from the weather by a Contracting Officer's approved method during the curing and acclimation period. Concrete slab shall be tested for moisture emission rate and excessive alkalinity in accordance with ASTM F 1869 (anhydrous calcium chloride test) and Resilient Floor Covering Institute. Provide anhydrous calcium chloride at a rate of three test in areas up to 1,000 square feet and one additional test per 1,000 square feet thereafter. Provide industry standard pH testing at the same rate.

3.3 PREPARATION OF CONCRETE SUBFLOOR

Installation of the carpeting shall not commence until concrete substrate is at least 90 days old. The concrete surfaces shall be prepared in accordance with instructions of the carpet manufacturer. The contractor shall apply a floor hardener/sealer to areas indicated on the contract drawings. Requirements for floor hardener/sealer is found in Section 03300 CAST-IN PLACE STRUCTURAL CONCRETE. Type of concrete sealer shall be compatible with the carpet.

3.4 INSTALLATION

Installation shall be in accordance with the manufacturer's instructions and CRI 104. Edges of carpet meeting hard surface flooring shall be protected with molding. Installation shall be in accordance with the molding manufacturer's instructions.

3.4.1 Broadloom Installation

Broadloom carpet shall be installed direct glue down and shall be smooth, uniform, and secure, with a minimum of seams. Seams shall be uniform, unnoticeable, and treated with a seam adhesive. Side seams shall be run toward the light where practical and where such layout does not increase the number of seams. Breadths shall be installed parallel, with carpet pile in the same direction. Patterns shall be accurately matched. Cutouts, as at door jambs, columns and ducts shall be neatly cut and fitted securely. Seams at doorways shall be located parallel to and centered directly under doors. Seams shall not be made perpendicular to doors or at pivot points. Seams at changes in directions of corridors shall follow the wall line parallel to the carpet direction. Corridors with widths less than 1.8 m shall have the carpet laid lengthwise down the corridors.

3.5 CLEANING AND PROTECTION

3.5.1 Cleaning

After installation of the carpet, debris, scraps, and other foreign matter shall be removed. Soiled spots and adhesive shall be removed from the face of the carpet with appropriate spot remover. Protruding face yarn shall be cut off and removed. Carpet shall be vacuumed clean.

3.5.2 Protection

The installed carpet shall be protected from soiling and damage with heavy, reinforced, nonstaining kraft paper, plywood, or hardboard sheets. Edges of kraft paper protection shall be lapped and secured to provide a continuous cover. Traffic shall be restricted for at least 45 hours. Protective covering shall be removed when directed by the Contracting Officer.

3.6 REMNANTS

Remnants remaining from the installation, consisting of scrap pieces more than 600 mm in dimension with more than 0.6 square meters total, shall be provided. Non-retained scraps shall be removed from site.

-- End of Section --

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DIVISION 12 - FURNISHINGS

SECTION 12320

CABINETS AND COUNTERTOPS

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SECTION 12320

CABINETS AND COUNTERTOPS

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.

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA ANSI/BHMA A156.9 (1994) Cabinet Hardware

KITCHEN CABINET MANUFACTURERS ASSOCIATION (KCMA)

KCMA ANSI/KCMA A161.1 (1995) Recommended Performance & Construction Standards for Kitchen and Vanity Cabinets

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3 (1995) High-Pressure Decorative Laminates

1.2 DESIGN

Cabinets shall be wood, factory-fabricated and finished in the manufacturer's standard sizes and finishes of the type, design, and configuration indicated. Cabinets shall be constructed as specified and shall meet the requirements of KCMA ANSI/KCMA A161.1. Wall and base cabinet assemblies shall consist of individual units joined into continuous sections. Fastenings shall be accomplished to permit removal and replacement of individual units without affecting the remainder of the installation. Counters shall be provided with watertight sink rim when indicated. Drawers shall be removable and shall be equipped with position stops to avoid accidental complete withdrawals. Shelves shall be fixed or adjustable as indicated.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Cabinets and Countertops; FIO.

Manufacturer's printed data, catalog cuts, installation and cleaning instructions.

SD-04 Drawings

Cabinets and Countertops; FIO.

Drawings showing each type of cabinet and related item, and clearly indicating the complete plan, location, and elevations of the cabinets and accessories and pertinent details of construction, fabrication, and attachments.

SD-09 Reports

Cabinets and Countertops; FIO.

Test reports certifying that all cabinets comply with the requirements of KCMA ANSI/KCMA A161.1. Tests shall be conducted by independent laboratories approved by KCMA. KCMA certification seals affixed to the cabinets will be accepted in lieu of certified test reports.

SD-14 Samples

Cabinets and Countertops; FIO.

In lieu of individual samples, complete minimum size cabinets may be furnished as samples. Mock-up units are not acceptable. Samples shall be of sufficient size to show color, pattern, and method of assembly.

- a. Counter top and backsplash - One section, containing both.
- b. Door and drawer front - One of each, with hardware mounted.
- c. Melamine plastic color samples approximately 50 x 75 mm size.
- d. Color samples approximately 50 x 75 mm size.

1.4 DELIVERY AND STORAGE

Cabinets shall be delivered to the jobsite wrapped in a protective covering. Cabinets shall be stored in accordance with manufacturer's recommendations in an adequately ventilated, dry location that is free of dust, water, or other contaminants and in a manner to permit access for inspection and handling. Cabinets shall be handled carefully to prevent damage to the surfaces. Damaged items that cannot be restored to like-new condition shall be replaced.

PART 2 PRODUCTS

2.1 CABINETS

Wall and base cabinets shall be of the same construction and same outside appearance. Door design shall be solid flush face. Shelves shall be fully adjustable as indicated. Adjustable shelves shall be capable of adjusting on approximately 75 mm increments. Shelves shall be supported by self-locking clips. Clips (shelf rests) shall be approximately 8 mm in diameter by 40 mm long. Clips shall be inserted into borings for the shelf adjustments. Shelves for mortise mounted shelf standards shall be B04071 with B04091 shelf rests. Shelves shall be minimum 19 mm thick plywood. Drawer fronts shall be hardwood plywood to match cabinet door construction.

2.1.1 Frame Type Cabinets

The cabinets shall be constructed with frame fronts and solid ends, or frame construction throughout. Frame members shall be 19 mm thick by 38 mm wide; kiln-dried hardwood, glued together, and shall be either mortised and tenoned, dovetailed or doweled, nailed, stapled or screwed. Top and bottom corners shall be braced with either hardwood blocks that are glued together with water resistant glue and nailed in place, or metal or plastic corner braces. Backs of base and tall cabinets shall be 9 mm thick hardwood or hardboard as indicated. Bottoms of cabinets shall be minimum 19 mm thick plywood good grade and shall be braced with wood members glued in place. Cabinet ends shall be 19 mm thick hardwood plywood.

2.2 COUNTERTOPS AND BACKSPLASH

Countertop and backsplash shall be constructed of 19 mm thick plywood and shall be fully formed type. Fully formed type or square edge shall be a unit with shaped edges using wood nose molding at counter edge and shall include a separate backsplash. Backsplash shall be not less than 90 mm high. Edging and trim shall consist of plastic laminate cut and fitted to all exposed edges. End splashes constructed of 19 mm plywood shall be supplied.

2.3 (DELETED)

2.4 FINISH

2.4.1 Cabinet Finish

Cabinets shall be provided with a factory-applied durable plastic laminate finish in accordance with KCMA ANSI/KCMA A161.1 requirements and of a type standard with the manufacturer. Exposed exterior surfaces and semi-exposed interior surfaces shall be melamine plastic finish.

2.4.2 Melamine Laminated Interior Cabinet Finish

Plywood or tempered hardboard cabinet backs shall be finished with a melamine laminate on the exposed side. Shelves shall be covered on both sides with a laminated melamine finish. Melamine laminate shall conform to the requirements of NEMA LD 3 and laminate adhesive shall be contact type applied to both surfaces.

2.4.3 Melamine Laminates on Countertops

Continuous sheets of longest lengths practicable shall be provided. Joints in surface sheeting shall be tight and flush and held to a practicable minimum. When the countertop and backsplash are two separate units, GP50 plastic laminate shall be used. Plastic laminate shall conform to the requirements of NEMA LD 3 and plastic laminate adhesive shall be contact type applied to both surfaces.

2.4.4 Backer Sheets and Cabinet Liner

Backer Sheets of high pressure plastic laminate, shall conform to NEMA LD 3, Grade BK20 and shall be applied to the underside of all core material. Cabinet liner shall conform to NEMA LD 3, Grade CL20 and shall be applied to cabinet interiors.

2.5 HARDWARE

Hardware shall conform to BHMA ANSI/BHMA A156.9, shall be suitable for cabinet use, and shall include all miscellaneous hardware for a complete installation. Door hinges shall be self-closing type. Drawer runners shall have nylon rollers standard with the manufacturer. The types and finishes of hardware shall be as follows:

BHMA DESIGNATION		
TYPE	NUMBER	FINISH
HINGES B01251 (SELF CLOSING)	1 PER DOOR	626
DOOR PULLS B0211	1 PAIR PER DOOR	626
DRAWER SLIDES B05051	1 PAIR PER DRAWER	603
DRAWER PULL B02011	1 PER DRAWER	626
SHELF RESTS B04013	4 PER SHELF PLUS 50 PERCENT EXTRA	626

2.6 COLOR, TEXTURE, AND PATTERN

Design, color, and finish shall be as indicated.

PART 3 EXECUTION

3.1 INSTALLATION

Cabinets shall be installed level, plumb, and true to line, and shall be attached to the walls or floors with suitable devices to securely anchor each unit. Countertops, accessories, and hardware shall be installed as indicated. Installation shall be in accordance with the manufacturer's approved printed instructions. The inner edge of sink cut-outs in laminated plastic tops shall be painted with a coat of semigloss enamel paint and sink flanges shall be set in a bed of sealant. Closer and filler strips and finish moldings shall be provided as required. Prior to final acceptance, doors shall be aligned, and hardware shall be adjusted.

3.2 CLEANING

Cabinet and countertop surfaces shall be cleaned in accordance with manufacturer's instructions.

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 - 3.9.7 PLUMBING FIXTURE SCHEDULE FOR BATTALION HEADQUARTERS BUILDING ("BN-1" and "BN-2")
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PLUMBING, GENERAL PURPOSE

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 700 (1995) Specifications for Fluorocarbon and Other Refrigerants
- ARI 1010 (1994) Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- ANSI Z21.10.1 (1993; Z21.10.1a; Z21.10.1b; Z21.10.1c) Gas Water Heaters Vol. I Storage Water Heaters with Input Ratings of 75,000 Btu Per Hour or Less
- ANSI Z21.10.3 (1993; Z21.10.3a; Z21.10.3b) Gas Water Heaters Vol. III Storage, With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous Water Heaters
- ANSI Z21.22 (1986; Z21.22a) Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM A 53 (1997) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- ASTM A 74 (1996) Cast Iron Soil Pipe and Fittings
- ASTM A 105/A 105M (1996) Carbon Steel Forgings for Piping Applications
- ASTM A 193/A 193M (1997a) Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
- ASTM A 515/A 515M (1992) Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

ASTM A 516/A 516M	(1990; R 1996) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 733	(1993) Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 888	(1996) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B 32	(1996) Solder Metal
ASTM B 88	(1996) Seamless Copper Water Tube
ASTM B 88M	(1996) Seamless Copper Water Tube (Metric)
ASTM B 370	(1992) Copper Sheet and Strip for Building Construction
ASTM B 641	(1993) Seamless and Welded Copper Distribution Tube (Type D)
ASTM B 813	(1993) Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
ASTM B 828	(1992) Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM C 564	(1995a) Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 920	(1995) Elastomeric Joint Sealants
ASTM D 2822	(1991; R 1997) Asphalt Roof Cement
ASTM D 3308	(1991a) PTFE Resin Skived Tape
ASTM D 3311	(1994) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM E 1	(1995) ASTM Thermometers
ASTM F 409	(1995) Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings
AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)	
ASHRAE 34	(1992; Addenda a-j) Number Designation and Safety Classification of Refrigerants
ASHRAE 90.1	(1989; 90.1b; 90.1c; 90.1d; 90.1e; 90.1g; 90.1i) Energy Efficient Design of New Buildings Except Low-Rise Residential

Buildings

ASME INTERNATIONAL (ASME)

ASME A112.1.2	(1991) Air Gaps in Plumbing Systems
ASME A112.6.1M	(1997) Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.18.1M	(1996) Plumbing Fixture Fittings
ASME A112.19.1M	(1994) Enameled Cast Iron Plumbing Fixtures
ASME A112.19.2M	(1995; Errata) Vitreous China Plumbing Fixtures
ASME A112.19.3M	(1987; R 1996) Stainless Steel Plumbing Fixtures (Designed for Residential Use)
ASME A112.19.4M	(1994; Errata Nov 1996) Porcelain Enameled Formed Steel Plumbing Fixtures
ASME A112.21.1M	(1991) Floor Drains
ASME A112.36.2M	(1991) Cleanouts
ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B16.3	(1992) Malleable Iron Threaded Fittings
ASME B16.4	(1992) Gray Iron Threaded Fittings
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.12	(1991) Cast Iron Threaded Drainage Fittings
ASME B16.15	(1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(1996) Valves - Flanged, Threaded, and Welding End
ASME B16.39	(1986; R 1994) Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300
ASME B31.5	(1992; B31.5a) Refrigeration Piping
ASME B36.19M	(1985; R1994) Stainless Steel Pipe
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element

ASME BPV VIII Div 1 (1998) Boiler and Pressure Vessel Code;
Section VIII, Pressure Vessels Division 1
- Basic Coverage

ASME CSD-1 (1995; CSD-1a; CSD-1b) Controls and Safety
Devices for Automatically Fired Boilers

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE ANSI/ASSE 1001 (1990) Pipe Applied Atmospheric Type
Vacuum Breakers

ASSE 1002 (1986) Water Closet Flush Tank Ball Cocks

ASSE ANSI/ASSE 1003 (1995) Water Pressure Reducing Valves for
Domestic Water Supply Systems

ASSE 1005 (1986) Water Heater Drain Valves -
3/4-Inch Iron Pipe Size

ASSE ANSI/ASSE 1006 (1989) Residential Use (Household)
Dishwashers

ASSE ANSI/ASSE 1011 (1995) Hose Connection Vacuum Breakers

ASSE ANSI/ASSE 1012 (1995) Backflow Preventers with
Intermediate Atmospheric Vent

ASSE 1013 (1993) Reduced Pressure Principle Backflow
Preventers

ASSE 1018 (1986) Trap Seal Primer Valves Water
Supply Fed

ASSE ANSI/ASSE 1037 (1986; Rev thru Mar 1990) Pressurized
Flushing Devices (Flushometers) for
Plumbing Fixtures

ASSE 1037 (1990) Performance Requirement for
Pressurized Flushing Devices
(Flushometers) for Plumbing Fixtures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA-01 (1995) Standard Methods for the
Examination of Water and Wastewater

AWWA B300 (1992) Hypochlorites

AWWA B301 (1992) Liquid Chlorine

AWWA C203 (1991) Coal-Tar Protective Coatings and
Linings for Steel Water Pipelines - Enamel
and Tape - Hot-Applied

AWWA C606 (1987) Grooved and Shouldered Joints

AWWA D100 (1996) Welded Steel Tanks for Water Storage

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

AMERICAN WELDING SOCIETY (AWS)

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

AWS B2.2 (1991) Brazing Procedure and Performance Qualification

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301 (1995) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

CISPI 310 (1995) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

CISPI HSN-85 (1985) Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings

CODE OF FEDERAL REGULATIONS (CFR)

10 CFR 430 Energy Conservation Program for Consumer Products

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-238 (Rev B) Seat, Water Closet

CID A-A-240 (Rev A) Shower Head, Ball Joint

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA-02 (1995) Copper Tube Handbook

COUNCIL OF AMERICAN BUILDING OFFICIALS (CABO)

CABO A117.1 (1992; Errata Jun 1993) Accessible and Usable Buildings and Facilities

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

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

HYDRAULIC INSTITUTE (HI)

HI ANSI/HI 1.1-1.5 (1994) Centrifugal Pumps

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS

IAPMO ANSI/IAPMO Z124.1 (1995) Plastic Bathtub Units

IAPMO ANSI/IAPMO Z124.5 (1997) Plastic Toilet (Water Closets) Seats

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 (1990) Cast Iron Gate Valves, Flanged and
Threaded Ends

MSS SP-71 (1997) Cast Iron Swing Check Valves,
Flanges and Threaded Ends

MSS SP-72 (1992) Ball Valves with Flanged or
Butt-Welding Ends for General Service

MSS SP-73 (1991; R 1996) Brazing Joints for Copper
and Copper Alloy Pressure Fittings

MSS SP-78 (1987; R 1992) Cast Iron Plug Valves,
Flanged and Threaded Ends

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check
Valves

MSS SP-83 (1995) Class 3000 Steel Pipe Unions
Socket-Welding and Threaded

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 ASSOCIATION OF PLUMBING-HEATING-COOLING CONTRACTORS
(NAPHCC)

NAPHCC-01 (1996) National Standard Plumbing Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1991) Enclosures for Electrical Equipment
(1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA NFPA 54/ANSI Z223.1 (1996; Errata) National Fuel Gas Code

NFPA 90A (1996) Installation of Air Conditioning
and Ventilating Systems

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI G-101 (1996) Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data

PDI WH 201 (1992) Water Hammer Arresters

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J 1508 (1996) Hose Clamps

UNDERWRITERS LABORATORIES (UL)

UL 174 (1996; Rev thru Nov 1997) Household Electric Storage Tank Water Heaters

UL 430 (1994; Rev thru Oct 1996) Waste Disposers

UL 749 (1997) Household Dishwashers

1.2 STANDARD PRODUCTS

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

1.3 PERFORMANCE REQUIREMENTS

1.4 ELECTRICAL WORK

Motors, motor controllers and motor efficiencies shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor-driven equipment specified herein shall be provided complete with motors. Equipment shall be rated at 60 Hz, single phase, ac unless otherwise indicated. Where a motor controller is not provided in a motor-control center on the electrical drawings, a motor controller shall be as indicated. Motor controllers shall be provided complete with properly sized thermal-overload protection in each ungrounded conductor, auxiliary contact, and other equipment, at the specified capacity, and including an allowable service factor.

1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Vibration-Absorbing Features; FIO.

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

SD-04 Drawings

Plumbing System; FIO.

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

Electrical Schematics; FIO.

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

SD-06 Instructions

Plumbing System; FIO.

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

SD-09 Reports

Tests, Flushing and Disinfection; FIO.

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

Backflow Prevention Assembly Tests; FIO.

Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual performing the tests.

SD-13 Certificates

Materials and Equipment; FIO.

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

is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

Bolts; FIO.

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

SD-19 Operation and Maintenance Manuals

Plumbing System; FIO.

Six copies of the operation manual outlining the step-by-step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Six copies of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Instructions and maintenance manuals shall be submitted for approval 30 days following CQC approval of equipment/materials.

1.6 REGULATORY REQUIREMENTS

Plumbing work shall be in accordance with NAPHCC-01.

1.7 PROJECT/SITE CONDITIONS

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

PART 2 PRODUCTS

2.1 MATERIALS

Materials for various services shall be in accordance with TABLES I and II.

Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Material or equipment containing lead shall not be used in any potable water system. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors.

2.1.1 Pipe Joint Materials

Hubless cast-iron soil pipe shall not be used under ground. Joints and gasket materials shall conform to the following:

- a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A 74, AWWA C606. For hubless type: CISPI 310
- b. Coupling for Steel Pipe: AWWA C606.
- c. Flange Gaskets: Gaskets shall be made of non-asbestos material in

accordance with ASME B16.21. Gaskets shall be flat, 1.6 mm (1/16 inch) thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.

- d. Neoprene Gaskets for Hub and Cast-Iron Pipe and Fittings: CISPI HSN-85.
- e. Brazing Material: Brazing material shall conform to AWS A5.8, BCuP-5.
- f. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides. Silver brazing materials shall be in accordance with AWS A5.8.
- g. Solder Material: Solder metal shall conform to ASTM B 32 95-5 tin-antimony.
- h. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B 813, Standard Test 1.
- i. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe, ASTM D 3308.
- j. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C 564.
- k. Flanged fittings including flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A 105/A 105M. Blind flange material shall conform to ASTM A 516/A 516M cold service and ASTM A 515/A 515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193/A 193M.

2.1.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

- a. Water Hammer Arrester: PDI WH 201.
- b. Copper, Sheet and Strip for Building Construction: ASTM B 370.
- c. Asphalt Roof Cement: ASTM D 2822.
- d. Hose Clamps: SAE J 1508.
- e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.
- f. Metallic Cleanouts: ASME A112.36.2M.
- g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.

- h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines:
AWWA C203.
- i. Hypochlorites: AWWA B300.
- j. Liquid Chlorine: AWWA B301.
- k. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic
Element: ASME B40.1.
- l. Thermometers: ASTM E 1.

2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

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

2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 65 mm (2-1/2 inches) and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 80 mm (3 inches) and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Valves shall conform to the following standards:

Description	Standard
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Vacuum Relief Valves	ASSE ANSI/ASSE 1001
Water Pressure Reducing Valves	ASSE ANSI/ASSE 1003

Description	Standard
Water Heater Drain Valves	ASSE 1005
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1 Safety Code No., Part CW, Article 5

2.3.1 Hose Bibs

Hose Bibs with vacuum-breaker backflow preventer shall be brass with 20 mm (3/4 inch) male inlet threads, hexagon shoulder, and 20 mm (3/4 inch) hose connection. Hose Bib handle shall be securely attached to stem. Where indicated on drawings, provide hose bibbs integral with recessed wall hydrant boxes with bronze box construction, chrome plated finish, integral vacuum beaker, hinged locking cover and tee handle key.

2.3.2 Lawn Faucets

Lawn faucets shall be brass, with either straight or angle bodies, and shall be of the compression type. Body flange shall be provided with internal pipe thread to suit 20 mm (3/4 inch) pipe. Body shall be suitable for wrench grip. Faucet spout shall have 20 mm (3/4 inch) exposed hose threads. Faucet handle shall be securely attached to stem.

2.3.3 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22. Relief valves for systems where the maximum rate of heat input is less than 59 kW (200,000 Btuh) shall have 20 mm (3/4 inch) minimum inlets, and 20 mm (3/4 inch) outlets. Relief valves for systems where the maximum rate of heat input is greater than 59 kW (200,000 Btuh) shall have 25 mm (1 inch) minimum inlets, and 25 mm (1 inch) outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

2.3.4 Thermostatic Mixing Valves

Mixing valves, thermostatic type, shall be line size and shall be constructed with rough or finish bodies either with or without plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Mixing

valves shall maintain water temperature within 2 degrees C of any setting.

The mixing valve shall be suitable for use with hot water return systems. Factory assembled high-low manifold mixing systems shall be provided as indicated on the contract drawings. Pressured drop thru mixing valves and manifolded mixing systems shall be limited to 34.5 Kpa (5 psig).

Thermostatic mixing valve assembly flow rates shall be as follows:

Building BN-1 and BN-2: 1.17 L/S.

Building BK-1 and BK-2: 3.66 L/S.

Building SCB-1: 3.47 L/S.

2.3.5 Pressure Reducing Valves

Automatic, hydraulically controlled, pressure reducing valve capable of automatically reducing a higher inlet water pressure to a constant lower outlet water pressure regardless of changing flow rates and/or varying inlet water pressure. The pressure reducing valve assembly size, capacity, flow characteristics, pressure drop, and pressure setting as indicated on drawings. The valve assembly shall be equipped with gauges, reducers, unions, by-pass valve, isolation valves, Y-strainers, position indicators, flo-clean strainers, limit switches, and adjustable closing feature.

2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with NAPHCC-01. Fixtures for use by the physically handicapped shall be in accordance with CABO A117.1. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings.

Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 82 degrees C (180 degrees F) water temperature. Plumbing fixtures shall be as indicated in paragraph PLUMBING FIXTURE SCHEDULE.

2.4.1 Lavatories

Enameled cast-iron lavatories shall be provided with two cast-iron or steel brackets secured to the underside of the apron and drilled for bolting to the wall in a manner similar to the hanger plate. Exposed brackets shall be porcelain enameled. Vitreous china lavatories shall be oval, countertop type for use in barracks buildings.

2.4.2 Automatic Flushing System

Flushing system shall consist of solenoid-activated flush valve with electrical-operated light beam sensor to energize solenoid. Flushing devices shall be provided as described in paragraph FIXTURES AND FIXTURE TRIMMINGS. Provide 24V/115V transformers as required.

2.5 BACKFLOW PREVENTERS

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

2.6 DRAINS

2.6.1 Floor and Shower Drains

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

2.6.1.1 Drains and Backwater Valves

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

2.6.2 Area Drains

Area drains shall be plain pattern with polished stainless steel perforated or slotted grate and bottom outlet. The drain shall be circular or square with a 300 mm (12 inch) nominal overall width or diameter and 250 mm (10 inch) nominal overall depth. Drains shall be cast iron with manufacturer's standard coating. Grate shall be easily lifted out for cleaning. Outlet shall be suitable for inside caulked connection to drain pipe. Drains shall conform to ASME A112.21.1M.

2.6.3 Floor Sinks

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

2.7 TRAPS

Unless otherwise specified, traps shall be plastic per ASTM F 409 or copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall be without a cleanout. Tubes shall be copper alloy with walls not less than 0.813 mm (0.032 inch) thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 50 mm (2 inches). The interior diameter shall be not more than 3.2 mm (1/8 inch) over or under the nominal size, and interior surfaces shall be reasonably smooth throughout. **A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded or swivel joint trap wall nipple with cast brass wall flange shall be provided for lavatories.** The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.8 GREASE INTERCEPTOR

Grease interceptor of the size indicated shall be of reinforced concrete, with removable three-section, 9.5 mm (3/8 inch) checker-plate cover, and shall be installed outside the building. Interceptors shall be tested and rated in accordance with PDI G-101. Concrete shall have 21 MPa minimum compressive strength at 28 days.

2.9 WATER HEATERS

Water heater types and capacities shall be as indicated. Each primary water heater shall have controls with an adjustable range that includes 32 to 49 degrees C (90 to 120 degrees F). Each gas-fired water heater and booster water heater shall have controls with an adjustable range that includes 49 to 82 degrees C (120 to 180 degrees F). Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and standby heat losses shall conform to TABLE III for each type of water heater specified. The only exception is that storage water heaters and hot water storage tanks having more than 2000 liters storage capacity need not meet the standard loss requirement if the tank surface area is not insulated to R-12.5 and if a standing light is not used. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.9.1 Automatic Storage Type

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

2.9.1.1 Gas-Fired Type

Gas-fired water heaters shall conform to ANSI Z21.10.1 when input is 22 KW (75,000 But per hour) or less or ANSI Z21.10.3 for heaters with input greater than 22 KW (75,000 But per hour). Water heaters shall be furnished with electronic ignition. See equipment schedules on contract drawings.

2.9.1.2 Electric Type

Electric type water heaters shall conform to UL 174 with dual heating elements. Each element shall be 4.5 KW. The elements shall be wired so that only one element can operate at a time. See equipment schedules on contract drawings.

2.9.2 Electric Booster Heater

Booster heaters shall be as specified in Section 11400 FOOD SERVICE EQUIPMENT.

2.10 HOT-WATER STORAGE TANKS

Hot-water storage tanks shall be constructed by one manufacturer, ASME stamped for the working pressure of 1034 kPa (150 psi), and shall have the National Board (ASME) registration. The tank shall be cement-lined or glass-lined steel type in accordance with AWWA D100. The heat loss shall conform to TABLE III as determined by the requirements of ASHRAE 90.1. Each tank shall be equipped with a thermometer, conforming to ASTM E 1, Type I, Class 3, Range C, style and form as required for the installation, and with 175 mm (7 inch) scale. Thermometer shall have a separable socket suitable for a 20 mm (3/4 inch) tapped opening. Tanks shall be equipped with a pressure gauge 155 mm (6 inch) minimum diameter face. Insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Storage tank capacity shall be as shown.

2.11 EXPANSION TANKS

Expansion tanks shall be welded steel, constructed, tested and stamped in accordance with ASME BPV VIII Div 1 for a working pressure of 862 kPa (125 psig) and precharged to the minimum operating pressure. Expansion tanks shall have a replaceable bladder and be the captive air type. Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with an air charging valve. Tanks shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

2.12 PUMPS

2.12.1 Sump Pumps

Sump pumps shall be of capacities indicated. The pumps shall be of the automatic, electric motor-driven, submerged type, complete with necessary control equipment and with a split or solid cast-iron or steel cover plate. The pumps shall be direct-connected by an approved flexible coupling to a vertical electric motor having a continuous oiling device or packed bearings sealed against dirt and moisture. Motors shall be totally

enclosed, fan-cooled of sizes as indicated and shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosed, across-the-line, magnetic controller. Each pump shall be fitted with a high-grade thrust bearing mounted above the floor. Each shaft shall have an alignment bearing at each end, and the suction inlet shall be between 75 and 150 mm above the sump bottom. The suction side of each pump shall have a strainer of ample capacity. A float switch assembly, with the switch completely enclosed in a NEMA 250, Type 1 enclosure, shall start and stop each motor at predetermined water levels. The discharge line from each pump shall be provided with a union or flange, a nonclog swing check valve, and a stop valve in an accessible location near the pump.

2.12.2 Circulating Pumps

Domestic hot water circulating pumps shall be electrically driven, single-stage, centrifugal, with mechanical seals, suitable for the intended service. Pump capacities, efficiencies, motor sizes, speeds, and impeller types shall be as shown. Pump and motor shall be integrally mounted on a cast-iron or steel subbase, or supported by the piping on which it is installed. The shaft shall be one-piece, heat-treated, corrosion-resisting steel with impeller and smooth-surfaced housing of bronze. Motor shall be totally enclosed, fan-cooled and shall have sufficient wattage (horsepower) for the service required. Pump shall conform to HI ANSI/HI 1.1-1.5. Each pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in cover. Pump motors smaller than 746 W (Fractional horsepower pump motors) shall have integral thermal overload protection in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Guards shall shield exposed moving parts.

2.12.3 Flexible Connectors

Flexible connectors shall be provided at the suction and discharge of each pump that is 1 hp or larger. Connectors shall be constructed of neoprene, rubber, or braided bronze, with Class 150 standard flanges. Flexible connectors shall be line size and suitable for the pressure and temperature of the intended service.

2.13 PLATE HEAT EXCHANGER

a. Furnish and install as shown on the plans, a double wall Plate and Frame Heat Exchanger. The Plate and Frame Heat Exchanger manufacturer, shall have an extensive background in the design and fabrication of Plate and Frame Heat Exchangers. The manufacturer shall have a minimum of five (5) years experience in the fabrication of plate heat exchangers. Double Wall Heat Exchangers shall be designed, constructed, and tested in accordance with Section VIII, Division 1 of the ASME Pressure Vessel Code, and shall be code stamped.

b. Preference will be given to single pass designs with all connections on the fixed cover. The fixed and movable covers shall be of sufficient thickness, for the design pressure and code requirements and shall have no reinforcement or stiffeners. The moveable cover shall be provided with a steel roller bearing, for units greater than 1270 mm (50 inch) in height (from bottom of feet). This allows the movable cover to be moved without additional rigging or handling equipment. Carrying and guide bar, shall be designed to allow for expansion of at least 15%. The carrying and guide bar guiding system shall be precision manufactured of stainless steel, to prohibit corrosion and facilitate movement of the plates, painted or plated

surfaces are not permitted. Entire frame shall be bolted together to allow unit to be field assembled, to permit rigging into place. Welding of frame components is not permitted. Plate and carrying bar designs, shall permit the removal and access to any plate in the plate pack, without the need to remove any other plates. Provide lifting lugs, designed to allow lifting of the entire units flooded weight. All steel surface shall be thoroughly cleaned and prepared for painting per SSPC-SPI063T, painting over mill scale is not acceptable. All steel components shall be epoxy coated.

c. Connections equal to or less than 50 mm (2 inch) shall be stainless steel NPT type. To avoid leakage on port area, studed port design shall be provided on heat exchangers with connections greater than 50 mm (2 inch). Flanged nozzle connections are not acceptable.

d. Compression bolts shall not require special tools and shall be equipped with lock washers at the movable cover, to facilitate opening and closing of the unit from the fixed cover only. Compression bolts shall be equipped with captive nuts at the fixed cover and threaded nuts at the movable cover. Welding of the nut to the closure bolt is prohibited. Bolts with rolled threads to reduce galling, and double width hex nuts, to adequately distribute the load, shall be provided. Ball bearing box washers shall be located at all critical closing bolts on units greater than 1270 mm (50 inch) in height. Bolts, shall be liberally coated with Lubriplate FGL-2 for lubrication and rust prevention, and covered with a plastic sleeving for protection from the environment and prevent bodily injury. Zinc plating is prohibited.

e. The double wall plate and frame heat exchangers shall consists of pressed type 304 stainless steel plates (or other alloys), to provide the required heat transfer area to meet the operating conditions specified. Individual plates shall be pressed from a homogeneous single metal sheet in one step. No multi-stage pressing of one sheet is allowed. Each heat transfer plate to be with herringbone corrugations, to optimize heat transfer, with nominal pressure losses. Corrugations to be designed to provide support to adjacent plates at evenly distributed support points. This allows pressurization of each circuit to a full differential of 1.5 times the design pressure, for one hour without buckling or deformation of the heat transfer plates. All plates and gaskets shall be permanently marked to identify quality and material. Each heat transfer plate shall have a built-in-self aligning system, to accurately locate the plates in the frame assembly, and prevent lateral plate movement, while maintaining maximum gasket contact under pressure. Plates shall be reinforced on the upper and lower mounting slots, to avoid bending of the hangers on the plates. The double wall plate and frame heat exchanger, shall be designed to perform to various capacities and pressure drops as shown on the schedule. Plates to be 304 stainless steel with II B finish and tapered gasket grooves. The plate pack shall be covered with an aluminum shroud in accordance with OSHA.

f. Gaskets shall have relieving grooves to prevent intermixing of fluids and cause leakage to flow to the outside of the unit. One piece molded gaskets shall be required. These gaskets shall fit around both the heat transfer area and port holes. Preference shall be given to non-glued gasketing systems. If an adhesive is necessary, it shall be compatible with the gasket material and the fluids. The adhesive shall be a 2 component, heat cured epoxy glue.

g. The double wall plate heat exchanger shall be designed to withstand full test pressure in one circuit with zero pressure in the alternate circuit. Hydrostatic testing shall be in accordance with ASME Section VIII, Division, 1 Paragraph UG-99.

2.14 FOOD SERVICE EQUIPMENT

For Food Service Equipment Specifications, see Section 11400 FOOD SERVICE EQUIPMENT.

2.15 LEAK DETECTION SYSTEM FOR WATER

The leak detection system shall consist of a monitoring panel, cable, and water sensors. Dorlen Products "Water Alert" sensing alarm with Model RI-2 Remote indicator or approved equal. The system shall consist of the following:

- a. The panel shall contain a power on-off switch, and audible alarm, an alarm silence switch, a test switch, and an indicator light for each water sensor (minimum of 6 each). The panel shall be table mounted with a 120 volt power connection.
- b. The water sensors shall be mounted (where indicated) on the concrete floor in the crawlspace and wired to the panel.
- c. The sensor cable size and type shall be as recommended by the system manufacturer for the proper operation of the system.

2.15.1 Operation

The leak detection panel shall monitor each individual sensor. When water is detected by a sensor, the corresponding visual indicator will light and the alarm will sound. The silencer switch shall silence the audible alarm but the visual indicator shall remain lit until the water is removed from the sensor. The test switch shall illuminate all the indicators and sound the alarm to ensure proper operation of the system.

2.15.2 Installation

The installation of the leak detection system shall be in accordance with the manufacturer's recommendation.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 1.5 m outside the building, unless otherwise indicated. A full port ball valve and drain shall be installed on the water service line inside the building approximately 150 mm above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 300 mm below the finish grade or as indicated on the drawings. If trenches are closed or the pipes are

otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body. Buried piping near and under buildings shall be installed per granular termite barrier manufacturer's recommendations. All exposed piping in the kitchen of Dining Facility DN-1 shall be chromium plated copper alloy or stainless steel.

3.1.1 Water Pipe, Fittings, and Connections

3.1.1.1 Utilities

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

3.1.1.2 Cutting and Repairing

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

3.1.1.3 Protection of Fixtures, Materials, and Equipment

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

3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 12 mm between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific excepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 100 mm (4 inches) and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends

shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.1.1.5 Pipe Drains

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

3.1.1.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets, changes in direction, etc., where indicated and/or required. Risers shall be securely anchored as required to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 15 m in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining.

3.1.1.7 Commercial-Type Water Hammer Arresters

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

3.1.2 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

3.1.2.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

3.1.2.2 Union and Flanged

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

3.1.2.3 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

3.1.2.4 Copper Tube and Pipe

The tube or fittings shall not be annealed when making connections. Connections shall be made with a multiflame torch.

- a. Brazed. Brazed joints shall be made in conformance with AWS B2.2, MSS SP-73, and CDA-02 with flux and are acceptable for line sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.
- b. Soldered. Soldered joints shall be made with flux and are only acceptable for lines 50 mm (2 inches) and smaller. Soldered joints shall conform to ASME B31.5 and CDA-02.

3.1.3 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper pipe shall be made with dielectric unions or flange waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.1.4 Pipe Sleeves and Flashing

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

3.1.4.1 Sleeve Requirements

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves are not required for cast-iron soil pipe passing through concrete slab on grade, except where penetrating a membrane waterproof floor. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve with corrosion-protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 100 mm above the finished floor. Unless

otherwise indicated, sleeves shall be of a size to provide a minimum of 6 mm (1/4 inch) clearance between bare pipe and inside of sleeve or between jacket over insulation and sleeves. Sleeves in bearing walls shall be steel pipe or cast-iron pipe. Sleeves for membrane waterproof floors shall be steel pipe, cast-iron pipe, or plastic pipe. Membrane clamping devices shall be provided on pipe sleeves for waterproof floors. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or moisture-resistant fiber or plastic. Plastic sleeves shall not be used in nonbearing fire walls, roofs, or floor/ceilings. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C 920 and with a primer, backstop material and surface preparation as specified in Section 07900 JOINT SEALING. Pipes passing through sleeves in concrete floors over crawl spaces shall be sealed as specified above. The annular space between pipe and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated. Sleeves through below-grade walls in contact with earth shall be recessed 12 mm from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and concrete or masonry wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant.

3.1.4.2 Flashing Requirements

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

3.1.4.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 40 mm to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 40 mm; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall

extend not less than 200 mm from the drainpipe and shall be lapped between the floor membrane in a solid coating of bituminous cement. If cast-iron water closet floor flanges are used, the space between the pipe sleeve and drainpipe shall be sealed with sealant and the flashing guard shall be upturned approximately 40 mm to fit the outside diameter of the drainpipe and the inside diameter of the water closet floor flange. The upturned portion of the sheet fitted into the floor flange shall be sealed.

3.1.4.4 Optional Counterflashing

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

- a. A standard roof coupling for threaded pipe up to 150 mm (6 inches) in diameter.
- b. A tack-welded or banded-metal rain shield around the pipe.

3.1.4.5 Pipe Penetrations of Slab on Grade Floors

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs Flashing Requirements and Waterproofing. Penetrations shall be sealed as indicated on the drawings.

3.1.5 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07840 FIRESTOPPING.

3.1.6 Supports

3.1.6.1 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. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

3.1.6.2 Pipe Supports and Structural Bracing, Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as specified Section 13080. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided. Material used for supports shall be as specified in Section 05120 STRUCTURAL STEEL.

3.1.6.3 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

- a. Types 5, 12, and 26 shall not be used.
- b. Type 3 shall not be used on insulated pipe.
- c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.
- d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
- e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.
- f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- g. Type 39 saddles shall be used on insulated pipe 100 mm (4 inches) and larger when the temperature of the medium is 15 degrees C or higher. Type 39 saddles shall be welded to the pipe.
- h. Type 40 shields shall:
 - (1) Be used on insulated pipe less than 100 mm (4 inches).
 - (2) Be used on insulated pipe 100 mm (4 inches) and larger when the temperature of the medium is 15 degrees C or less.
 - (3) Have a high density insert for pipe 50 mm (2 inches) and larger and for smaller pipe sizes when the insulation is suspected of being visibly compressed, or distorted at or near the shield/insulation interface. High density inserts shall have a density of 128 kg per cubic meter (8 pcf) or greater.
- i. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m apart at valves. Horizontal pipe runs shall include allowances for expansion and contraction.
- j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 4.5 m nor more than 2 m from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.
- k. Type 40 shields used on insulated pipe shall have high density inserts with a density of 128 kg per cubic meter (8 pcf) or greater.
- l. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system

operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

- (1) On pipe 100 mm (4 inches) and larger when the temperature of the medium is 15 degrees C or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.
 - (2) On pipe less than 100 mm (4 inches) a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
 - (3) On pipe 100 mm (4 inches) and larger carrying medium less than 15 degrees C a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.
- m. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.
- n. 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 or by an amount adequate for the insulation, whichever is greater.

3.1.7 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 100 mm (4 inches) will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 100 mm (4 inches). Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 450 mm of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron.

3.2 WATER HEATERS AND HOT WATER STORAGE TANKS

3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater or storage tank. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 150 mm above the top of the tank or water heater.

3.2.2 Installation of Gas- Fired Water Heater

Installation shall conform to NFPA NFPA 54/ANSI Z223.1 for gas fired. Storage water heaters that are not equipped with integral heat traps and having vertical pipe risers shall be installed with heat traps directly on both the inlet and outlet. Circulating systems need not have heat traps installed. An acceptable heat trap may be a piping arrangement such as elbows connected so that the inlet and outlet piping make vertically upward runs of not less than 600 mm just before turning downward or directly horizontal into the water heater's inlet and outlet fittings. Commercially available heat traps, specifically designed by the manufacturer for the purpose of effectively restricting the natural tendency of hot water to rise through vertical inlet and outlet piping during standby periods may also be approved.

3.2.3 Heat Traps

Piping to and from each water heater and hot water storage tank shall be routed horizontally and downward a minimum of 600 mm before turning in an upward direction.

3.2.4 Connections to Water Heaters

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

3.3 FIXTURES AND FIXTURE TRIMMINGS

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

3.3.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be

made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.3.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Bumpers for water closet seats shall be installed on the flushometer stop.

3.3.3 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 775 mm above finished floor or mounted in countertops as shown on the drawings. Wall-hung drinking fountains and water coolers shall be installed with rim 1020 mm above floor. Wall-hung service sinks shall be mounted with rim 700 mm above the floor. Installation of fixtures for use by the physically handicapped shall be in accordance with CABO A117.1.

3.3.4 Shower Bath Outfits

The area around the water supply piping to the mixing valves and behind the escutcheon plate shall be made watertight by caulking or gasketing.

3.3.5 Fixture Supports

Fixture supports for off-the-floor lavatories, urinals and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.3.5.1 Support for Solid Masonry Construction

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

3.3.5.2 Support for Cellular-Masonry Wall Construction

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

3.3.5.3 Support for Steel Stud Frame Partitions

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

3.3.6 Backflow Prevention Devices

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

3.3.7 Access Panels

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

3.3.8 Sight Drains

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

3.3.9 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D 3311. Traps for acid-resisting waste shall be of the same material as the pipe.

3.4 VIBRATION-ABSORBING FEATURES

Mechanical equipment, including compressors and pumps, shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown. Each foundation shall include an adequate number of standard isolation units. Each unit shall consist of machine and floor or foundation fastening, together with intermediate isolation material, and shall be a standard product with printed load rating. Piping connected to mechanical equipment shall be provided with flexible connectors.

3.5 IDENTIFICATION SYSTEMS

3.5.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 35 mm (1-3/8 inch) minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire,

chrome-plated beaded chain, or plastic straps designed for that purpose.

3.5.2 Color Coding

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

3.6 ESCUTCHEONS

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

3.7 PAINTING

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

3.8 TESTS, FLUSHING AND DISINFECTION

3.8.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with NAPHCC-01.

- a. Drainage and Vent Systems Tests: 3 meter (10 feet) head 15 minutes
- b. Building Sewers Tests: 3 meter (10 feet) head, 15 minutes
- c. Water Supply Systems Tests: 689 kpa (100 psig), 1 hour
Hydrostatically test piping system at not less than 690 kpa (gage) or 150% of working pressure.

3.8.1.1 Test of Backflow Prevention Assemblies

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies. Gauges shall be tested annually for accuracy in accordance with the University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14). Report form for each assembly shall include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test
Location	
Test Pressure Readings	Serial Number and Test Data of
Gauges	

If the unit fails to meet specified requirements, the unit shall be

repaired and retested.

3.8.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

3.8.3 System Flushing

Before tests, potable water piping shall be flushed. In general, sufficient water shall be used to produce a minimum water velocity of 0.762 meters per second (2.5 feet per second) through piping being flushed. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced in line. After flushing and cleaning, systems shall be prepared for service by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation.

3.8.4 Operational Test

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

- a. Time, date, and duration of test.
- b. Water pressures at the most remote and the highest fixtures.
- c. Operation of each fixture and fixture trim.
- d. Operation of each valve, hydrant, and faucet.
- e. Pump suction and discharge pressures.
- f. Temperature of each domestic hot-water supply.
- g. Operation of each floor and roof drain by flooding with water.
- h. Operation of each vacuum breaker and backflow preventer.
- i. Complete operation of each water pressure booster system, including pump start pressure and stop pressure.

3.8.5 Disinfection

After operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. System shall be

flushed as specified, before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. The chlorine residual shall be checked at intervals to ensure that the proper level is maintained. Chlorine application shall continue until the entire main is filled. The water shall remain in the system for a minimum of 24 hours. Each valve in the system being disinfected shall be opened and closed several times during the contact period to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system. Water tanks shall be disinfected by the addition of chlorine directly to the filling water. Following a 6 hour period, no less than 50 ppm chlorine residual shall remain in the tank. The system including the tanks shall then be flushed with clean water until the residual chlorine is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. The Contractor shall be responsible for the sampling and testing of water in potable water systems and shall be responsible for all associated costs. From several points in the system the Contractor shall take samples of water in proper disinfection containers in the presence of the Contracting Officer for bacterial examination. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA-01. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. The sterilizing shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.9 PLUMBING FIXTURE SCHEDULE

3.9.1 Company Operations Facilities (COF-2)

P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, floor mounted. Floor flange shall be copper alloy, cast iron, or plastic.

Gasket shall be wax type.

Seat - IAPMO ANSI/IAPMO Z124.5, Type A, white plastic, elongated, open front.

Flushometer Valve - ASSE ANSI/ASSE 1037, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 66.7 mm (2-5/8 inches) at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 6 liters per flush. Flushometer shall be automatic flushing type. Flushometer shall be equipped with solenoid operator, light beam sensor and manual override button. Flushometer system shall be furnished with electrical boxes, mounting plates, and low-voltage transformers as required.

P-2 URINAL:

Wall hanging, with integral trap and extended shields, ASME A112.19.2M washout. Top supply connection, back outlet.

Flushometer Valve - Similar to Flushometer Valve for P-1. The maximum water use shall be 3.8 liters per flush. Flushometer shall be automatic flushing type.

P-3 LAVATORY:

Manufacturer's standard sink depth, vitreous china ASME A112.19.2M under-counter mounting. **Nominal size 483 mm (19 inches) wide x 432 mm (17 inches) front to back.**

Faucet - Faucets shall be single control, mixing type. Faucets shall have metal replaceable cartridge control unit or metal cartridge units with diaphragm which can be replaced without special tools. Valves and handles shall be copper alloy. Connection between valve and spout for center-set faucet shall be of rigid metal tubing. The flow shall be limited to 0.16 liters per second at a flowing pressure of 549 kPa.

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel.

P-4 LAVATORY:

Manufacturer's standard sink depth, vitreous china, straight back. Nominal size 508 mm (20 inches) wide x 457 mm (18 inches) front to back. **Furnish with concealed arm carriers.**

Faucet - Faucets shall be single control, mixing type. Faucets shall have replaceable seats and washers. Faucets shall have metal replaceable cartridge control unit or metal cartridge units with diaphragm which can be replaced without special tools. Valves and handles shall be copper alloy. Connection between valve and spout for center-set faucet shall be of rigid metal tubing. The flow shall be limited to 0.16 liters per second at a flowing pressure of 549 kPa

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel.

P-5 SERVICE SINK:

Enameled cast iron ASME A112.19.1M, copper alloy or stainless steel ASME A112.19.3M trap standard 609.6 mm wide x 508.0 mm deep (24 inches wide x 20 inches deep), splashback 228.6 mm (9 inches) high wall mounted 609.6 mm wide x 508.0 mm deep (24 inches wide x 20 inches deep), splashback 228.6 mm (9 inches) high.

Faucet and Spout - Cast or wrought copper alloy, with top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be lever type. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

Trap - Cast iron, minimum 7.5 cm diameter.

P-6 Shower: Shower heads, CID A-A-240 other than emergency showers, shall include a non-removable, tamperproof device to limit water flow to 0.16 liters per second (2.5 gpm) when tested in accordance with ASME A112.18.1M.

Wall Mounted: Shower head shall be nonadjustable spray, stainless steel or chromium plated brass with ball joint. Handles shall be chrome-plated die cast zinc alloy. Control valves shall be copper alloy and have metal integral parts of copper alloy, nickel alloy, or stainless steel. Valves shall be thermostatic mixing type. Shower head shall be vandalproof with integral back. Mixing valve shall be memory positioning type which allows user to turn valve on and off at preferred temperature without readjusting handle position each time.

P-7 WATER COOLER DRINKING FOUNTAINS:

Water cooler drinking fountains shall: be self contained, conform to ARI 1010, use one of the fluorocarbon gases conforming to ARI 700 and ASHRAE 34 which has an Ozone Depletion Potential of less than or equal to 0.05, have a capacity to deliver 30.2 liters per hour (8 gph) of water at 10 degrees C (50 degrees F) with an inlet water temperature of 27 degrees C (80 degrees F) while residing in a room environment of 32 degrees C (90 degrees F), and have self-closing valves. Self-closing valves shall have automatic stream regulators, have a flow control capability, have a push button actuation or have a cross-shaped index metal turn handle without a hood. Exposed surfaces of stainless steel shall have No. 4 general polish finish. Spouts shall provide a flow of water at least 100 mm (4 inches) high so as to allow the insertion of a cup or glass under the flow of water.

Surface Wall-Mounted - **Surface wall-mounted units shall have nominal dimensions of 336.6 mm (13-1/4 inches) wide, 330.2 mm (13 inches) deep, and have a back height of 152.4 to 203.2 mm (6 to 8 inches).** The bowl shall be made of corrosion resisting steel. The unit shall have concealed fasteners and be for interior installation.

3.9.2 Company Operations Facilities (COF-3 to COF-7)

P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, floor mounted. Floor flange shall be copper alloy, cast iron, or plastic.

Gasket shall be wax type.

Seat - IAPMO ANSI/IAPMO Z124.5, Type A, white plastic, elongated, open front.

Flushometer Valve - ASSE ANSI/ASSE 1037, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 66.7 mm (2-5/8 inches) at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 6 liters per flush. Flushometer shall be automatic flushing type. Flushometer shall be equipped with solenoid operator, light beam sensor and manual override button. Flushometer system shall be furnished with electrical boxes, mounting plates, and low-voltage transformers as required.

P-2 URINAL:

Wall hanging, with integral trap and extended shields, ASME A112.19.2M washout. Top supply connection, back outlet.

Flushometer Valve - Similar to Flushometer Valve for P-1. The maximum water use shall be 3.8 liters per flush. Flushometer shall be automatic flushing type.

P-3 LAVATORY:

Manufacturer's standard sink depth, vitreous china ASME A112.19.2M under-counter mounting. **Nominal size 483 mm (19 inches) wide x 432 mm (17 inches) front to back.**

Faucet - Faucets shall be single control, mixing type. Faucets shall have metal replaceable cartridge control unit or metal cartridge units with diaphragm which can be replaced without special tools. Valves and handles shall be copper alloy. Connection between valve and spout for center-set faucet shall be of rigid metal tubing. The flow shall be limited to 0.16 liters per second at a flowing pressure of 549 kPa.

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel.

P-4 LAVATORY:

Manufacturer's standard sink depth, vitreous china, straight back. Nominal size 508 mm (20 inches) wide x 457 mm (18 inches) front to back. **Furnish with concealed arm carriers.**

Faucet - Faucets shall be single control, mixing type. Faucets shall have replaceable seats and washers. Faucets shall have metal replaceable cartridge control unit or metal cartridge units with diaphragm which can be replaced without special tools. Valves and handles shall be copper alloy. Connection between valve and spout for center-set faucet shall be of rigid metal tubing. The flow shall be limited to 0.16 liters per second at a flowing pressure of 549 kPa

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel.

P-5 SERVICE SINK:

Enameled cast iron ASME A112.19.1M, copper alloy or stainless steel ASME A112.19.3M trap standard 609.6 mm wide x 508.0 mm deep (24 inches wide x 20 inches deep), splashback 228.6 mm (9 inches) high wall mounted 609.6 mm wide x 508.0 mm deep (24 inches wide x 20 inches deep), splashback 228.6 mm (9 inches) high.

Faucet and Spout - Cast or wrought copper alloy, with top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be lever type. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers,

couplings, stopper, etc., shall be copper alloy or stainless steel.

Trap - Cast iron, minimum 7.5 cm diameter.

P-6 MAINTENANCE SINK

Enameled cast iron ASME A112.19.1M, copper alloy or stainless steel ASME A112.19.3M trap standard 609.6 mm wide x 508.0 mm deep (24 inches wide x 20 inches deep), splashback 228.6 mm (9 inches) high wall mounted 609.6 mm wide x 508.0 mm deep (24 inches wide x 20 inches deep), splashback 228.6 mm (9 inches) high.

Faucet and Spout - Cast or wrought copper alloy, with top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be lever type. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

Trap - Cast iron, minimum 7.5 cm diameter.

P-7 Shower: Shower heads, CID A-A-240 other than emergency showers, shall include a non-removable, tamperproof device to limit water flow to 0.16 liters per second (2.5 gpm) when tested in accordance with ASME A112.18.1M.

Wall Mounted: Shower head shall be nonadjustable spray, stainless steel or chromium plated brass with ball joint. Handles shall be chrome-plated die cast zinc alloy. Control valves shall be copper alloy and have metal integral parts of copper alloy, nickel alloy, or stainless steel. Valves shall be thermostatic mixing type. Shower head shall be vandalproof with integral back. Mixing valve shall be memory positioning type which allows user to turn valve on and off at preferred temperature without readjusting handle position each time.

P-9 WATER COOLER DRINKING FOUNTAINS:

Water cooler drinking fountains shall: be self contained, conform to ARI 1010, use one of the fluorocarbon gases conforming to ARI 700 and ASHRAE 34 which has an Ozone Depletion Potential of less than or equal to 0.05, have a capacity to deliver 30.2 liters per hour (8 gph) of water at 10 degrees C (50 degrees F) with an inlet water temperature of 27 degrees C (80 degrees F) while residing in a room environment of 32 degrees C (90 degrees F), and have self-closing valves. Self-closing valves shall have automatic stream regulators, have a flow control capability, have a push button actuation or have a cross-shaped index metal turn handle without a hood. Exposed surfaces of stainless steel shall have No. 4 general polish finish. Spouts shall provide a flow of water at least 100 mm (4 inches) high so as to allow the insertion of a cup or glass under the flow of water.

Surface Wall-Mounted - Surface wall-mounted units shall have nominal dimensions of 336.6 mm (13-1/4 inches) wide, 330.2 mm (13 inches) deep, and have a back height of 152.4 to 203.2 mm (6 to 8 inches). The bowl shall be made of corrosion resisting steel. The unit shall have concealed fasteners and be for interior installation.

3.9.3 PLUMBING FIXTURE SCHEDULE FOR SOLDIER COMMUNITY BUILDING

P-1 WATER CLOSET ACCESSIBLE:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, floor mounted. Floor flange shall be copper alloy, cast iron, or plastic. Height of top rim of bowl shall be in accordance with CABO A-1171.1.

Gasket shall be wax type.

Seat - IAPMO ANSI/IAPMO Z124.5, Type A, white plastic, elongated, open front.

Flushometer Valve - ASSE ANSI/ASSE 1037, electronically controlled, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 66.7 mm (2-5/8 inches) at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 6 liters per flush. Provide 24V/115V transformer as required.

P-2 WHEELCHAIR LAVATORY:

Vitreous china, ASME A112.19.2M, wheelchair lavatory with wrist or elbow controls 527 mm wide x 457 mm deep (21 inches wide x 18 inches deep) with gooseneck spout. The flow shall be limited to 0.16 liters per second at a flowing water pressure of 549 kPa.

Drain - Strainer shall be copper alloy or stainless steel.

P-3 KITCHEN SINK:

Ledge back with holes for faucet and spout single bowl 609.6 x 533.4 mm x 255 mm deep (24 x 21 inches x 10 inches) deep stainless steel ASME A112.19.3M.

Faucet and Spout - Cast or wrought copper alloy. Aerator shall have internal threads. The flow shall be limited to 0.16 liters per second at a flowing water pressure of 549 kPa.

Handle - Cast copper alloy, wrought copper alloy, or stainless steel. Single lever type.

Drain Assembly - Compatible with disposer installation.

P-4 SERVICE SINK:

Enameled cast iron ASME A112.19.1M, corner, floor mounted 711.2 mm (28 inches) square, 171.5 mm (6-3/4 inches) deep.

Faucet and Spout - Cast or wrought copper alloy, with top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be lever type. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

Trap - Cast iron, minimum 7.5 cm diameter.

P-5 LAUNDRY TRAY

Counter top 600 wide x 533.4 mm front to back (24 x 21 inch, sink 340 mm

(13-1/2 inches) deep, 18 gauge, type 302 stainless steel.

Faucet and Spout - Cast or wrought copper alloy, without top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Strainers shall have internal threads. Combination faucets with two valves and spouts shall be provided.

Handles - Cast or wrought copper alloy. Lever type.

P-6 WATER COOLER DRINKING FOUNTAINS (DUAL HEIGHT LEVELS)

Water cooler drinking fountains shall: be self contained, conform to ARI 1010, use one of the fluorocarbon gases conforming to ARI 700 and ASHRAE 34 which has an Ozone Depletion Potential of less than or equal to 0.05, have a capacity to deliver 30.2 liters per hour (8 gph) of water at 10 degrees C (50 degrees F) with an inlet water temperature of 27 degrees C (80 degrees F) while residing in a room environment of 32 degrees C (90 degrees F), and have self-closing valves. Self-closing valves shall have automatic stream regulators, have a flow control capability, have a push button actuation or have a cross-shaped index metal turn handle without a hood. Exposed surfaces of stainless steel shall have No. 4 general polish finish. Spouts shall provide a flow of water at least 100 mm (4 inches) high so as to allow the insertion of a cup or glass under the flow of water.

Surface Wall-Mounted - Surface wall-mounted units shall have nominal dimensions of 336.6 mm (13-1/4 inches) wide, 330.2 mm (13 inches) deep, and have a back height of 152.4 to 203.2 mm (6 to 8 inches). The bowl shall be made of corrosion resisting steel. The unit shall have concealed fasteners and be for interior installation.

Handicapped - Handicapped units shall be surface wall-mounted. The dimensions shall be 381.0 mm (15 inches) wide, 508.0 mm (20 inches) deep, with a back height of 152.4 to 203.2 mm (6 to 8 inches). The unit shall clear the floor or ground by at least 200 mm (8 inches). A clear knee space shall exist between the bottom of the bowl and the floor or ground of at least 685 mm (27 inches) and between the front edge of the bowl and the body of the unit of at least 200 mm (8 inches). A 200 mm (8 inch) wide clear space shall exist on both sides of the unit. The spout height shall be no more than 1 m (36 inches) above the floor or ground to the outlet. The spout shall be at the front of the unit and direct the water flow in a trajectory that is parallel or nearly parallel to the front of the unit. The bowl shall be 165.1 mm (6-1/2 inches) high, made of corrosion resisting steel and be for interior installation.

P-7 FOOD WASTE DISPOSER:

Food waste disposers shall be in accordance with UL 430.

P-8 DISHWASHING MACHINES

Household dishwashing machines shall conform to UL 749 and ASSE ANSI/ASSE 1006, 600 mm x 650 mm x 850 mm high (24 x 24-3/4 x 34 inch high)

3.9.4 PLUMBING FIXTURE SCHEDULE FOR REMOTE SWITCHING CENTER BUILDING

P-1 Emergency Showers

Head for Emergency and Emergency Eye and Face Wash. Shower control shall be 25 mm (1 inch) or 40 mm (1-1/2 inch) stay-open type control valve. Unit

shall be corrosion-resisting steel and shall be pedestal mounted.

3.9.5 PLUMBING FIXTURE SCHEDULE FOR TRAINING FACILITY

P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, Wall mounted.

Seat - IAPMO ANSI/IAPMO Z124.5, Type A, white plastic, elongated, open front.

Flushometer Valve - ASSE ANSI/ASSE 1037, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 66.7 mm (2-5/8 inches) at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 6 liters per flush.

P-2 WATER CLOSET HANDICAPPED:

Height of top rim of bowl shall be in accordance with CABO A117.1; other features are the same as P-2.

P-3 URINAL:

Wall hanging, with integral trap and extended shields, ASME A112.19.2M siphon jet. Top supply connection, back outlet.

Flushometer Valve - Similar to Flushometer Valve for P-2. **The maximum water use shall be 3.8 liters per flush.**

P-4 LAVATORY:

Manufacturer's standard sink depth, vitreous china ASME A112.19.2M, ledge back. **Nominal size 508 mm (20 inches) wide x 457 mm (18 inches) front to back.**

Faucet - Faucets shall be single type. Faucets shall have replaceable seats and washers. Valves and handles shall be copper alloy.

Handles - Four arm type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel.

P-5 SERVICE SINK:

Enameled cast iron ASME A112.19.1M, copper alloy or stainless steel ASME A112.19.3M trap standard 609.6 mm wide x 508.0 mm deep (24 inches wide x 20 inches deep), splashback 228.6 mm (9 inches) high, splashback 228.6 mm (9 inches) high.

Faucet and Spout - Cast or wrought copper alloy, without top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be four arm type. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

Trap - Cast iron, minimum 7.5 cm diameter.

P-6 WATER COOLER DRINKING FOUNTAINS:

Water cooler drinking fountains shall: be self contained, conform to ARI 1010, use one of the fluorocarbon gases conforming to ARI 700 and ASHRAE 34 which has an Ozone Depletion Potential of less than or equal to 0.05, have a capacity to deliver 30.2 liters per hour (8 gph) of water at 10 degrees C (50 degrees F) with an inlet water temperature of 27 degrees C (80 degrees F) while residing in a room environment of 32 degrees C (90 degrees F), and have self-closing valves. Self-closing valves shall have automatic stream regulators, have a flow control capability, have a push button actuation or have a cross-shaped index metal turn handle without a hood. Exposed surfaces of stainless steel shall have No. 4 general polish finish. Spouts shall provide a flow of water at least 100 mm (4 inches) high so as to allow the insertion of a cup or glass under the flow of water.

Interior Free Standing - Free standing units shall have nominal dimensions of 1016 to 1054.1 mm (40 to 41-1/2 inches) high, 304.8 to 457.2 mm (12 to 18 inches) wide, and 304.8 to 355.6 mm (12 to 14 inches) deep. The bowl shall be made of corrosion resisting steel and be for interior installation.

3.9.6 PLUMBING FIXTURE SCHEDULE FOR BARRACKS BUILDING ("BK-1" and "BK-2")

P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, floor mounted. Floor flange shall be copper alloy, cast iron, or plastic.

Gasket shall be wax type.

Seat - IAPMO ANSI/IAPMO Z124.5, Type A, white plastic, elongated, open front.

Flush Tank - An adequate quantity of water shall be provided to flush and clean the fixture served. The water supply to flush tanks equipped for manual flushing shall be controlled by a float valve or other automatic device designed to refill the tank after each discharge, and to completely shut off the water flow to the tank when the tank is filled to operational capacity. Water closets having their flush valve seat located below the flood level rim of the closet bowl shall have a ballcock installed within a sheath or in a separate and isolated compartment of the tank, both to have visible discharge onto the floor in case of failure. Provision shall be made to automatically supply water to the fixture so as to refill the trap seal after each flushing. The water supply to flush tanks equipped for automatic flushing shall be controlled by a suitable timing device. Ballcocks shall meet ASSE 1002.

P-2 LAVATORY:

Manufacturer's standard sink depth, 483 mm (19 inches) wide x 381 mm (15 inches) front to back enameled cast iron, self rimming type, ASME A112.19.1M countertop, oval.

Faucet - Faucets shall be single control, mixing type. Faucets shall have metal replaceable cartridge control unit or metal cartridge units with diaphragm which can be replaced without special tools. Valves and handles shall be copper alloy. Connection between valve and spout for center-set

faucet shall be of rigid metal tubing. The flow shall be limited to 0.16 liters per second at a flowing pressure of 549 kPa.

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Pop-up drain shall include stopper, lift rods, jam nut, washer, and tail piece.

P-3 BATHTUB:

Straight front, recessed, 1.524 m x 812.8 mm x 406.4 mm (60 x 32 x 16 in), enameled cast iron, ASME A112.19.1M raised bottom or porcelain enameled formed steel with structural composite reinforcement ASME A112.19.4M. Structural reinforcement shall be in accordance with IAPMO ANSI/IAPMO Z124.1 including appendix.

Drain Assembly - Plug, cup strainer, overflow assembly, washers, couplings, pop-up lever or trip lever, stopper, fittings, etc., shall be brass, cast copper alloy, or wrought copper alloy. See paragraph FIXTURES for optional plastic accessories.

P-3 Shower: Shower heads, CID A-A-240 other than emergency showers, shall include a non-removable, tamperproof device to limit water flow to 0.16 liters per second (2.5 gpm) when tested in accordance with ASME A112.18.1M.

Bath Showers: Bath showers shall include bathtub spout, shower head, valves, diverters. A shower head mounting with ball joint shall be provided. Diverter shall be integral with single mixing valves or mounted hot and cold water valves. Tub spout shall be copper alloy. Control valves shall be copper alloy and have metal integral parts of copper alloy, nickel alloy, or stainless steel. Valves shall be pressure balanced type.

P-4 KITCHEN SINK:

Ledge back with holes for faucet and spout single bowl 609.6 wide x 533.4 mm front to back (24 x 21 inches) .188 mm (7-1/2 inch) deep, stainless steel ASME A112.19.3M.

Faucet and Swing Spout - Cast or wrought copper alloy. Aerator shall have internal threads. The flow shall be limited to 0.16 liters per second at a flowing water pressure of 549 kPa.

Handle - Cast copper alloy, wrought copper alloy, or stainless steel. Lever type.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

P-5 SERVICE SINK:

Enameled cast iron ASME A112.19.1M, copper alloy or stainless steel ASME A112.19.3M trap standard 609.6 mm wide x 508.0 mm deep (24 inches wide x 20 inches deep), splashback 228.6 mm (9 inches) high.

Faucet and Spout - Cast or wrought copper alloy, with top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be lever type. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

Trap - Cast iron, minimum 7.5 cm diameter.

3.9.7 PLUMBING FIXTURE SCHEDULE FOR BATTALION HEADQUARTERS BUILDING ("BN-1" and "BN-2")

P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, floor mounted. Floor flange shall be copper alloy, cast iron, or plastic.

Gasket shall be wax type.

Seat - IAPMO ANSI/IAPMO Z124.5, Type A, white plastic, elongated, open front.

Flushometer Valve - ASSE ANSI/ASSE 1037, electronically controlled, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 66.7 mm (2-5/8 inches) at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 6 liters per flush. Provide 24v/115v transformer as required.

P-1A WATER CLOSET HANDICAPPED:

Height of top rim of bowl shall be in accordance with CABO A117.1; other features are the same as P-1.

P-2 LAVATORY:

Manufacturer's standard sink depth, wall hung, 527 mm wide x 457 mm front to back, vitreous china, ASME A112.19.1M straight back. Finish with concealed arm carriers.

Faucet - Faucets shall be single control, mixing type. Faucets shall have metal replaceable cartridge control unit or metal cartridge units with diaphragm which can be replaced without special tools. Valves and handles shall be copper alloy. Connection between valve and spout for center-set faucet shall be of rigid metal tubing. The flow shall be limited to 0.16 liters per second at a flowing pressure of 549 kPa.

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel.

P-2A WHEELCHAIR LAVATORY:

Vitreous china, ASME A112.19.2M, wheelchair lavatory with wrist or elbow controls 508.0 mm wide x 457 mm deep (20 inches wide x 18 inches deep) with gooseneck spout. The flow shall be limited to 0.16 liters per second at a flowing water pressure of 549 kPa.

P-3 URINAL:

Wall hanging, with integral trap and extended shields, ASME A112.19.2M washout. Top supply connection, back outlet.

Flushometer Valve - Similar to Flushometer Valve for P-1. The maximum water use shall be 3.8 liters per flush.

P-3A URINAL HANDICAPPED:

Height of top rim of bowl shall be in accordance with CABO A117.1; other features same as P-3.

Drain - Strainer shall be copper alloy or stainless steel.

P-4 WHEELCHAIR SINK:

Ledge back with holes for faucet and spout single bowl 609.6 wide x 533.4 mm front to back (24 x 21 inches).138 mm (5-1/2 inch) deep stainless steel ASME A112.19.3M.

Faucet and Gooseneck Spout - Cast or wrought copper alloy. Aerator shall have internal threads. The flow shall be limited to 0.16 liters per second at a flowing water pressure of 549 kPa.

Handle - Cast copper alloy, wrought copper alloy, or stainless steel. Lever type.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

P-5 Shower: Shower heads, CID A-A-240 other than emergency showers, shall include a non-removable, tamperproof device to limit water flow to 0.16 liters per second (2.5 gpm) when tested in accordance with ASME A112.18.1M.

Control valves shall be copper alloy and have metal integral parts of copper alloy, nickel alloy, or stainless steel. Valves shall be pressure balanced type. Adjustable spray hand-held shower head with swivel fitting, 1524 mm minimum flexible polished, stainless steel hose and in-line vacuum breaker 635 mm grab bar with sliding spray holder that locks at any height to allow the use of the unit as either a hand-held spray or a fixed shower head. Flow shall not exceed 9.5 L/m at 549 kPa flow pressure.

P-6 SERVICE SINK:

Enameled cast iron ASME A112.19.1M, corner, floor mounted 711.2 mm (28 inches) square, 171.5 mm (6-3/4 inches) deep.

Faucet and Spout - Cast or wrought copper alloy, with top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be lever type. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

Trap - Cast iron, minimum 7.5 cm diameter.

P-7 WATER COOLER DRINKING FOUNTAINS (DUAL HEIGHT LEVELS)

Water cooler drinking fountains shall: be self contained, conform to ARI 1010, use one of the fluorocarbon gases conforming to ARI 700 and ASHRAE 34 which has an Ozone Depletion Potential of less than or equal to 0.05, have a capacity to deliver 30.2 liters per hour (8 gph) of water at 10 degrees

C (50 degrees F) with an inlet water temperature of 27 degrees C (80 degrees F) while residing in a room environment of 32 degrees C (90 degrees F), and have self-closing valves. Self-closing valves shall have automatic stream regulators, have a flow control capability, have a push button actuation or have a cross-shaped index metal turn handle without a hood. Exposed surfaces of stainless steel shall have No. 4 general polish finish. Spouts shall provide a flow of water at least 100 mm (4 inches) high so as to allow the insertion of a cup or glass under the flow of water.

Surface Wall-Mounted - Surface wall-mounted units shall be 336.6 mm (13-1/4 inches) wide, 330.2 mm (13 inches) deep, and have a back height of 152.4 to 203.2 mm (6 to 8 inches). The bowl shall be made of stainless steel. The unit shall have concealed fasteners and be for interior installation.

Handicapped - Handicapped units shall be surface wall-mounted. **The dimensions shall have nominal dimensions of 381.0 mm (15 inches) wide, 508.0 mm (20 inches) deep, with a back height of 152.4 to 203.2 mm (6 to 8 inches).** The unit shall clear the floor or ground by at least 200 mm (8 inches). A clear knee space shall exist between the bottom of the bowl and the floor or ground of at least 685 mm (27 inches) and between the front edge of the bowl and the body of the unit of at least 200 mm (8 inches). A 200 mm (8 inch) wide clear space shall exist on both sides of the unit. The spout height shall be no more than 1 m (36 inches) above the floor or ground to the outlet. The spout shall be at the front of the unit and direct the water flow in a trajectory that is parallel or nearly parallel to the front of the unit. The bowl shall be 165.1 mm (6-1/2 inches) high, made of stainless steel and be for interior installation.

3.9.8 Plumbing Fixture Schedule for Dining Facility (DN-1)

P-1 WATER CLOSET:

Siphon-jet, elongated bowl, top supply spud, ASME A112.19.2M, wall mounted. Flush volume shall be no more than 6 liters of water per flush.

Gasket shall be wax type.

Seat - CID A-A-238, Type A, white plastic, elongated, open front.

Flushometer Valve - ASSE 1037, large diaphragm type with non-hold-open feature, backcheck angle control stop, and vacuum breaker. Minimum upper chamber inside diameter of not less than 66.7 mm (2-5/8 inches) at the point where the diaphragm is sealed between the upper and lower chambers. The maximum water use shall be 6 liters per flush.

P-2 WATER CLOSET HANDICAPPED:

Top rim of bowl shall be 457 mm (18 inches) above the floor; other features are the same as P-1.

P-3 URINAL:

Wall hanging, with integral trap and extended shields, ASME A112.19.2M washout. Top supply connection, back outlet.

Flushometer Valve - Similar to Flushometer Valve for P-1. The maximum water use shall be 3.8 liters per flush.

P-4 LAVATORY, COUNTERTOP TYPE, PATRON TOILETS:

Manufacturer's standard sink depth, corian, see toilet countertop drawings.

Faucet - Faucets shall be single type. Faucets shall have metal replaceable cartridge control unit or metal cartridge units with diaphragm which can be replaced without special tools. Valves and handles shall be copper alloy. The flow shall be limited to 0.16 liters per second at a flowing pressure of 549 kPa.

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel.

P-5 LAVATORY, COUNTERTOP TYPE, EMPLOYEE TOILETS

Manufacturer's standard sink depth, corian, see toilet countertop drawings.

Faucet - Faucets shall be center set, single control, mixing type. Faucets shall have metal replaceable cartridge control unit or metal cartridge units with diaphragm which can be replaced without special tools. Valves and handles shall be copper alloy. The flow shall be limited to 0.16 liters per second at a flowing pressure of 549 kPa.

Handles - Lever type. Cast, formed, or drop forged copper alloy.

Drain - Strainer shall be copper alloy or stainless steel.

P-6 LAVATORY; COUNTERTOP TYPE, HANDICAPPED; PATRON TOILETS

Same as P-4 above, except finished with 100 mm long blade type, wrist control handles and gooseneck spout.

P-7 LAVATORY, COUNTERTOP TYPE, HANDICAPPED; EMPLOYEE TOILETS

Same as P-5 above, except faucet shall be centerset, mixing type and furnished with 100 mm long blade type, wrist control handles and gooseneck spout.

P-8 SERVICE SINK:

Stainless steel ASME A112.19.3M floor mounted 838.2 mm (33 inches) wide, 254 mm (10 inches) deep.

Faucet and Spout - Cast or wrought copper alloy, with top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be lever type. Strainers shall have internal threads.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc. shall be copper alloy or stainless steel.

Trap - Cast iron.

P-9 HAND SINK:

Manufacturer's standard sink depth, stainless steel, splash back, with wrist control handles and goose neck spout. Flow shall be limited to 0.16 liters per second. **Nominal overall size: 432 mm wide x 381 mm front to back (17 by 15 inches).**

Drain - Strainer shall be stainless steel

P-10 WATER COOLER DRINKING FOUNTAINS: Water cooler drinking fountains shall: be self contained, conform to ARI 1010, use one of the fluorocarbon gases conforming to ARI 700 and ASHRAE 34 which has an Ozone Depletion Potential of less than or equal to 0.05, have a capacity to deliver 30.2 liters per hour (8 gph) of water at 10 degrees C (50 degrees F) with an inlet water temperature of 27 degrees C (80 degrees F) while residing in a room environment of 32 degrees C (90 degrees F), and have self-closing valves. Self-closing valves shall have automatic stream regulators, have a flow control capability, have a push button actuation or have a cross-shaped index metal turn handle without a hood. Exposed surfaces of stainless steel shall have No. 4 general polish finish. Spouts shall provide a flow of water at least 100 mm (4 inches) high so as to allow the insertion of a cup or glass under the flow of water.

Handicapped - Handicapped units shall be surface wall-mounted. **The dimensions shall have nominal dimensions of 381.0 mm (15 inches) wide, 508.0 mm (20 inches) deep, with a back height of 152.4 to 203.2 mm (6 to 8 inches).** A clear knee space shall exist between the bottom of the bowl and the floor or ground of at least 685 mm (27 inches) and between the front edge of the bowl and the body of the unit of at least 200 mm (8 inches). A 200 mm (8 inch) wide clear space shall exist on both sides of the unit. The spout height shall be no more than 1 m (36 inches) above the floor or ground to the outlet. The spout shall be at the front of the unit and direct the water flow in a trajectory that is parallel or nearly parallel to the front of the unit. The bowl shall be 165.1 mm (6-1/2 inches) high, made of corrosion resisting steel and be for interior installation.

P-11 WASHDOWN STATION

Cast or wrought copper alloy faucet and spout. Furnish with backflow preventer. Faucets shall have replaceable seat. Furnish with 15.2 meter long, high pressure, high temperature hose and nozzle.

3.9.9 Plumbing Fixture Schedule For Central Plant Building

P-1 Emergency Showers

Emergency and Emergency Eye and Face Wash. Shower control shall be 25 mm or 40 mm stay-open type control valve and thermal purge valve. Unit shall be corrosion-resisting steel and shall be pedestal mounted.

3.10 POSTED INSTRUCTIONS

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

3.11 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, overall efficiency.

ET = Thermal efficiency with 21 degrees C delta T.

EC = Combustion efficiency, 100 percent - flue loss when smoke = 0 (trace is permitted).

SL = Standby loss in W/0.093 sq. m. based on 27 degrees C delta T, or in percent per hour based on nominal 38 degrees C delta T.

HL = Heat loss of tank surface area.

V = Storage volume in liters

3.11.1 Storage Water Heaters

3.11.1.1 Electric

a. Storage capacity of 454 liters or less, and input rating of 12 kW or less: minimum energy factor (EF) shall be 0.95-0.00132V per 10 CFR 430.

b. Storage capacity of more than 454 liters or input rating more than 12 kW: maximum SL shall be 1.9 w/0.093 sq. m. per ASHRAE 90.1, Addenda B.

3.11.1.2 Gas

a. Storage capacity of 379 liters or less, and input rating of 21980 W or less: minimum EF shall be 0.62-0.0019V per 10 CFR 430.

b. Storage capacity of more than 379 liters - or input rating more than 21980 W: Et shall be 77 percent; maximum SL shall be $1.3+38/V$, per ANSI Z21.10.3.

3.11.2 Unfired Hot Water Storage

Volumes and inputs: maximum HL shall be 20.5 W/sq. meter.

3.12 FOOD SERVICE EQUIPMENT FOR DINING FACILITY DN-1

For the Dining Facility, the contractor shall be required to coordinate the plumbing requirements for food service equipment listed in Section 11400 FOOD SERVICE EQUIPMENT with the equipment suppliers. All required plumbing connections for food service equipment shall be clearly indicated in the Plumbing System detailed drawing required under paragraph 1.5, "Submittals, SD-04 Drawings".

3.13 TABLES

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

Item #	Pipe and Fitting Materials	SERVICE					
		A	B	C	D	E	F
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A 74 with compression gaskets	X	X	X	X	X	
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A 888		X		X		
3	Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 6				X		
4	Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 6				X	X	
5	Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 6				X	X	
6	Steel pipe, seamless galvanized, ASTM A 53, Type S, Grade B				X	X	
7	Stainless steel pipe, and threaded fittings, Grade TP304 Schedule 105 conforming to ASME B36.19M.						X

SERVICE:

- A - Underground Building Soil, Waste and Storm Drain
- B - Aboveground Soil, Waste, Drain In Buildings
- C - Underground Vent
- D - Aboveground Vent
- E - Interior Rainwater Conductors Aboveground
- F - Food Service Equipment Drains
- * - Hard Temper

TABLE II
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item No.	Pipe and Fitting Materials	SERVICE			
		A	B	C	D
1	Seamless copper water tube, ASTM B 88, ASTM B 88M	X**	X**	X**	X***
2	Seamless and welded copper distribution tube (Type D) ASTM B 641	X**	X**	X**	X****
3	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Items 1 and 2	X	X	X	X
4	Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B 828	X	X		
5	Carbon steel pipe unions, socket-welding and threaded, MSS SP-83	X	X	X	
6	Malleable-iron threaded pipe unions ASME B16.39	X	X		
7	Nipples, pipe threaded ASTM A 733	X	X	X	

A - Cold Water Aboveground

B - Hot Water 82 degree C Maximum Aboveground

C - Compressed Air Lubricated

D - Cold Water Service Belowground

Indicated types are minimum wall thicknesses.

** - Type L - Hard

*** - Type K - Hard temper with brazed joints only or type K-soft temper
without joints in or under floors

**** - In or under slab floors only brazed joints

TABLE III
STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING
EQUIPMENT

A. STORAGE WATER HEATERS

FUEL PERFORMANCE	STORAGE CAPACITY LITERS		INPUT RATING	TEST PROCEDURE	REQUIRED
Elect.	454 max.		12 KO max.	10 CFR 430	EF = 0.95-0.00132V minimum
Elect.	454 min.	OR	12 kW min.	ASHRAE 90.1 (Addenda B)	SL = 1.9 W/0.09 sq. m. maximum
Gas	380 max.		22 kW max.	10 CFR 430	EF = 0.62-0.0019V minimum
Gas	380 min.	OR	22 kW min.	ANSI Z21.10.3	ET= 77 percent; SL = 1.3+38/V max.

B. Unfired Hot Water Storage.

Volumes and inputs: maximum HL shall be 20.5 W/sq. meter

TERMS:

EF = Energy factor, overall efficiency.

ET = Thermal efficiency with 21 degrees C delta T.

EC = Combustion efficiency, 100 percent - flue loss when smoke = 0
(trace is permitted).

SL = Standby loss in W/0.09 sq. m. based on 27 degrees C delta T, or in
percent per hour based on nominal 32 degrees C delta T.

HL = Heat loss of tank surface area

V = Storage volume in gallons

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SECTION 16263

DIESEL-GENERATOR SET STATIONARY 100-2500 KW, WITH AUXILIARIES

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 NATIONAL STANDARDS INSTITUTE (ANSI)

- | | |
|-------------|--|
| ANSI C12.11 | (1987; R 1993) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV) |
| ANSI C39.1 | (1981; R 1992) Requirements for Electrical Analog Indicating Instruments |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- | | |
|-------------------|--|
| ASTM A 53 | (1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 106 | (1995) Seamless Carbon Steel Pipe for High-Temperature Service |
| ASTM A 181/A 181M | (1995b) Carbon Steel Forgings for General-Purpose Piping |
| ASTM A 234/A 234M | (1996b) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures |
| ASTM D 975 | (1996a) Diesel Fuel Oils |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

- | | |
|-------------|--|
| ASME B16.3 | (1992) Malleable Iron Threaded Fittings |
| ASME B16.5 | (1996) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24 |
| ASME B16.11 | (1991) Forged Fittings, Socket-Welding and Threaded |
| ASME B31.1 | (1995; B31.1a; B31.1b) Power Piping |
| ASME BPV IX | (1995; Addenda Dec 1995, Dec 1996) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE ANSI/IEEE C57.13.1	(1981; R 1992) IEEE Guide for Field Testing of Relaying Current Transformers
IEEE Std 43	(1974; R 1991) Testing Insulation Resistance of Rotating Machinery
IEEE Std 95	(1977; R 1991) Insulation Testing of Large AC Rotating Machinery with High Direct Voltage
IEEE Std 112	(1991) Standard Test Procedure for Polyphase Induction Motor and Generators
IEEE Std 115	(1995) Test Procedures for Synchronous Machines

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

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-80	(1997) Bronze Gate, Globe, Angle and Check Valves

MILITARY STANDARDS (MIL-STD)

MIL-STD 705	(Rev C) Generator Sets, Engine Driven Methods of Tests and Instructions
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NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures
NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3) Motors and Generators
NEMA PB 1	(1990) Panelboards
NEMA PB 2	(1995) Deadfront Distribution Switchboards
NEMA SG 5	(1990) Power Switchgear Assemblies

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(1996; Errata) Flammable and Combustible
---------	--

Liquids Code

NFPA 37 (1997) Installation and Use of Stationary
Combustion Engines and Gas Turbines

NFPA 70 (1996; Errata) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE ARP 892 (1994; R 1994) D-C Starter-Generator,
Engine

SAE J 537 (1994) Storage Batteries

UNDERWRITERS LABORATORIES (UL)

UL 1236 (1994; Rev thru Apr 1996) Battery Chargers
for Charging Engine-Starter Batteries

1.2 SYSTEM DESCRIPTION

Each engine-generator set shall be provided and installed complete and totally functional, with all necessary ancillary equipment to include: air filtration; starting system; generator controls, protection, and isolation; instrumentation; lubrication; fuel system; cooling system; and engine exhaust system. Each engine-generator set shall satisfy the requirements specified in the Engine-Generator Parameter Schedule.

1.2.1 Engine-Generator Parameter Schedule

ENGINE-GENERATOR PARAMETER SCHEDULE

Power Rating	Standby
Overload Capacity (Prime applications only)	110 percent of Service Load for 1 hour in 12 consecutive hours
Service Load	370 kVA
Motor Starting kVA	462 kVA
Power Factor	0.8 lagging
Engine-Generator Applications	stand-alone
Maximum Speed	1800 rpm
Heat Exchanger Type	fin-tube (radiator)
Governor Type	Isochronous
Frequency Bandwidth (steady state)	plus/minus 0.4 percent
Governor Type	Droop
Frequency Regulation (droop) (No Load to Full Load)	3 percent (maximum)

ENGINE-GENERATOR PARAMETER SCHEDULE

Frequency Bandwidth (steady state)	plus/minus 0.4 percent
Voltage Regulation (No Load to Full Load)	plus/minus 2 percent (maximum)
Voltage Bandwidth (steady state)	plus/minus 0.5 percent
Frequency	60 Hz
Voltage	480 volts
Phases	3 Phase, Wye
Minimum Generator Subtransient Reactance	18 percent
Max Step Load Increase	25 percent of Service Load at 80% PF
Transient Recovery Time with Step Load Increase (Voltage)	5 seconds
Transient Recovery Time with Step Load Increase (Frequency)	3 seconds
Maximum Voltage Deviation with with Step Load Increase	20 percent of rated voltage
Maximum Frequency Deviation with Step Load Increase	2.5 percent of rated frequency
Max Step Load Decrease (without shutdown)	100 percent of Service Load at PF
Max Time to Start and be Ready to Assume Load	10 seconds
Max Allowable Heat Transferred To Engine Generator Space at Rated Output Capacity	350 MBTU/hr
Max Summer Outdoor Temp (Ambient)	105 degrees
Min Winter Outdoor Temp (Ambient)	60 degrees
Seismic Zone	2A
Installation Elevation	259 m above sea level

1.2.2 Rated Output Capacity

Each engine-generator-set shall provide power equal to the sum of Service Load plus the machine's efficiency loss and associated ancillary equipment

loads. Rated output capacity shall also consider engine and/or generator oversizing required to meet requirements in paragraph Engine-Generator Parameter Schedule.

1.2.3 Power Ratings

Each prime power engine-generator set application shall be capable of 8760 hours of continuous operation per year (subject to normal outages for periodic and preventive maintenance) at output capacity. Each standby power engine-generator set application shall be capable of 500 cumulative hours of operation per year with a maximum period of continuous operation of 300 hours at output capacity.

1.2.4 Transient Response

The engine-generator set governor and voltage regulator shall cause the engine-generator set to respond to the maximum step load changes such that output voltage and frequency recover to and stabilize within the operational bandwidth within the transient recovery time. The engine-generator set shall respond to maximum step load changes such that the maximum voltage and frequency deviations from bandwidth are not exceeded.

1.2.5 Reliability and Durability

Each standby engine-generator set shall have both an engine and a generator capable of delivering the specified power on a standby basis with an anticipated mean time between overhauls of no less than 5,000 hours up to 400 kW, 7,500 hours up to 800 kW, 10,000 hours up to 1250 kW, and 15,000 hours up to 2500 kW operating with an 80 percent load factor. Two like engines and two like generators shall be cited that have performed satisfactorily in a stationary power plant, independent and separate from the physical location of the manufacturer's and assembler's facilities, for standby without any failure to start, including all periodic exercise. Each like engine and generator shall have had no failures resulting in downtime for repairs in excess of 72 hours nor any failure due to overheating during the 2 consecutive years of service. Like engines shall be of the same model, speed, bore, stroke, number and configuration of cylinders, and rated output capacity. Like generators shall be of the same model, speed, pitch, cooling, exciter, voltage regulator and rated output capacity.

1.3 GENERAL REQUIREMENTS

1.3.1 Engine-Generator Set

Each set shall consist of one engine, one generator, and one exciter mounted, assembled, and aligned on one base; and other necessary ancillary equipment which may be mounted separately. Sets having a capacity of 750 kW or smaller shall be assembled and attached to the base prior to shipping. Sets over 750 kW capacity may be shipped in sections. Each set component shall be environmentally suitable for the location shown and shall be the manufacturer's standard product offered in catalogs for commercial or industrial use. Any nonstandard products or components and the reason for their use shall be specifically identified in paragraph SUBMITTALS.

1.3.2 Nameplates

Each major component of this specification shall have the manufacturer's name, type or style, model or serial number and rating on a plate secured to the equipment. As a minimum, nameplates shall be provided for:

Engines	Relays
Generators	Transformers (CT & PT)
Regulators	Governors
Pumps and pump motors	Air Starting System
Generator Breaker	Heat exchangers (other than base mounted)
Economizers	

Where the following equipment is not provided as a standard component by the diesel engine generator set manufacturer, the nameplate information may be provided in the maintenance manual in lieu of nameplates.

Battery charger	Heaters
Switchboards	Exhaust mufflers
Switchgear	Silencers
Battery	Exciters

1.3.3 Personnel Safety Devices

Exposed moving parts, parts that produce high operating temperatures, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. The safety devices shall be installed so that proper operation of the equipment is not impaired.

1.3.4 Verification of Dimensions

Before performing any work, the premises shall be visited and all details of the work verified. The Contracting Officer shall be advised in writing of any discrepancies.

1.3.5 Conformance to Codes and Standards

Where equipment is specified to conform to requirements of any code or standard such as UL, NEMA, etc., the design, fabrication and installation shall also conform to the code.

1.3.6 Site Welding

Structural members shall be welded in accordance with Section 05120 STRUCTURAL STEEL. For all other welding, procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1. Welder qualification tests shall be performed for each welder whose qualifications are not in compliance with the referenced standards. The Contracting Officer shall be notified 24 hours in advance of qualification tests. The qualification tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

1.3.7 Engine-Generator Set Enclosure

The engine-generator set enclosure shall be corrosion resistant and fully weather resistant. The enclosure shall contain all set components and

provide ventilation to permit operation at Service Load under secured conditions. Doors shall be provided for access to controls and equipment requiring periodic maintenance or adjustment. Removable panels shall be provided for access to components requiring periodic replacement. The enclosure shall be capable of being removed without disassembly of the engine-generator set or removal of components other than the exhaust system.

1.3.8 Vibration Limitation

The maximum engine-generator set vibration in the horizontal, vertical, and axial directions shall be limited to 0.15 mm (peak-peak RMS), with an overall velocity limit of 24 mm/second RMS.

1.3.9 Vibration Isolation

The engine-generator set shall be provided with a vibration-isolation system in accordance with the manufacturer's standard recommendation. Vibration-isolation systems shall be designed and qualified (as an integral part of the base and mounting system) to the seismic zone specified. Where the vibration-isolation system does not secure the base to the structure floor or unit foundation, seismic restraints shall be provided in accordance with the seismic zone specified.

1.3.10 Harmonic Requirements

Non-linear loads to be served by each engine-generator set are as indicated. The maximum linear load demand (kVA @ PF) when non-linear loads will also be in use is as indicated.

1.3.11 Starting Time Requirements

Upon receipt of a signal to start, each engine generator set will start, reach rated frequency and voltage and be ready to assume load within the time specified. For standby sets used in emergency power applications, each engine generator set will start, reach rated frequency and voltage, and power will be supplied to the load terminals of the automatic transfer switch within the starting time specified.

1.3.12 Experience

Each component manufacturer shall have a minimum of 3 years experience in the manufacture, assembly and sale of components used with stationary diesel engine-generator sets for commercial and industrial use. The engine-generator set manufacturer/assembler shall have a minimum of 3 years experience in the manufacture, assembly and sale of stationary diesel engine-generator sets for commercial and industrial use.

1.3.13 Field Engineer

The engine-generator set manufacturer or assembler shall furnish a qualified field engineer to supervise the complete installation of the engine-generator set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment. The field engineer shall have attended the engine generator manufacturer's training courses on installation operation and maintenance of engine generator sets.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment and Performance; GA.

Calculations of the engine and generator output power capability, including efficiency and parasitic load data.

Harmonic and Non-linear Load Capability; FIO.

Description of the generator features which mitigate the effects of the non-linear loads listed.

Torsional Vibration; FIO.

Calculations which show that no damaging or dangerous torsional vibrations will occur when the prime mover is connected to the generator.

Power Factor Capability Curve; FIO.

The generator capability curve showing generator kVA output capability (kW vs. kvar) for both leading and lagging power factors ranging from 0 to 1.0.

Cooling Equipment and Performance; FIO.

A letter which certifies that the engine-generator set and cooling system function properly in the ambient temperature specified for air entering the radiator from the generator room.

- a. The maximum allowable inlet temperature of the coolant fluid.
- b. The minimum allowable inlet temperature of the coolant fluid.
- c. The maximum allowable temperature rise in the coolant fluid through the engine.

Alarm Set Points; FIO.

The magnitude of monitored values which define alarm or action set points, and the tolerance (plus and/or minus) at which the devices activate the alarm or action for items contained within the alarm panels.

Generator Data; FIO.

Manufacturer's standard data for each generator (prototype data at the specified rating or above is acceptable), listing the following information:

- Temperature rise in accordance with NEMA MG 1, Part 22.
- Direct-Axis synchronous reactance (per unit).
- Direct-Axis transient reactance (per unit).
- Direct-Axis subtransient reactance (per unit).

Quadrature synchronous reactance (per unit).

Quadrature subtransient reactance (per unit).

Zero sequence reactance (per unit).

Negative sequence reactance and impedance (per unit).

Direct-Axis transient open-circuit time constant (seconds).

Direct-Axis short circuit time constant (seconds).

The generator kW rating and short circuit current capacity (both symmetric and asymmetric)

Manufacturer's Catalog; FIO.

Manufacturer's standard catalog data describing and depicting each engine-generator set and all ancillary equipment in sufficient detail to demonstrate complete specification compliance.

Site Welding; FIO.

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

Spare Parts; FIO.

A complete list of spare parts for each piece of equipment and a complete list of all material and supplies needed for continued operation. Lists shall include supply source and current prices. Each list shall be separated into two parts, those elements recommended by the manufacturer to be replaced after 3 years of service, and the remaining elements.

Training; FIO.

A letter giving the date proposed for conducting the onsite training course, the agenda of instruction, a description of the video taping service to be provided, and the kind and quality of the tape to be left with the Contracting Officer at the end of the instructional period.

Battery Charger; GA.

Battery charger sizing calculations.

Vibration-Isolation; FIO.

Vibration isolation system performance data for the range of frequencies generated by the engine-generator set during operation from no load to full load and the maximum vibration transmitted to the floor. Description of seismic qualification of the engine-generator mounting, base, and vibration isolation.

SD-04 Drawings

Layout and Shop Drawings; GA.

Drawings shall include the following:

- a. Base-mounted equipment, complete with base and attachments, including anchor bolt template and recommended clearances for maintenance and operation.
- b. Complete starting system.
- c. Complete fuel system.
- d. Complete cooling system.
- e. Complete exhaust system.
- f. Layout of relays, breakers, switchgear, and switches including applicable single line and wiring diagrams with written description of sequence of operation and the instrumentation provided.
- g. The complete lubrication system, including piping, pumps, strainers, filters, heat exchangers for lube oil and turbocharger cooling, electric heater, controls and wiring.
- h. Location, type, and description of vibration isolation devices for all applications.
- i. The safety system, together with a detailed description of how it is to work. Wiring schematics, safety devices with a listing of their normal ranges, alarm and shutdown values (to include operation parameters such as pressures, temperatures voltages, currents, and speeds) shall be included.
- j. One-line schematic and wiring diagrams of the generator, exciter, regulator, governor, and instrumentation.
- k. Layout of each panel.
- l. Mounting and support for each panel and major piece of electrical equipment.
- m. Engine-generator set lifting points and rigging instructions.

As-Built Drawings; GA.

Drawings which accurately depict the as-built configuration of the installation, upon acceptance of the diesel-generator set installation.

SD-06 Instructions

Posted Data; GA.

Posted data including wiring and control diagrams showing the key mechanical and electrical control elements, and a complete layout of the entire system.

Framed Instructions; GA.

Instructions including: the manufacturers pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions.

SD-08 Statements

Qualifications; FIO.

Documentation to demonstrate that:

- a. Each component manufacturer has a minimum of 3 years experience in the manufacture, assembly and sale of components used with stationary diesel engine-generator sets for commercial and industrial use.
- b. The engine-generator set manufacturer/assembler has a minimum of 3 years experience in the manufacture, assembly and sale of stationary diesel engine-generator sets for commercial and industrial use.
- c. The field engineer is qualified to perform the specified functions.
- d. Certification that the engine-generator set and cooling system function properly in the ambient temperatures specified for air entering the radiator from the generator room.

Welder Qualification; FIO.

A letter listing the welder qualifying procedures for each welder, complete with supporting data such as test procedures used, what was tested to, and a list of the names of all welders and their identification symbols.

Installation Procedures; FIO.

A copy of the manufacturer's installation procedures and a detailed description of the manufacturer's recommended break-in procedure.

Listing of Product Installations; FIO.

A list of five installations using each type of engine and generator proposed for use. Each component used as the basis for the durability and reliability certification shall be identified in the list. The list shall give the name of installations, completion dates, and name and telephone number of a point of contact.

SD-09 Reports

Factory Inspection and Tests; FIO.

Six complete reproducible copies of the factory inspection result on the checklist format specified in paragraph FACTORY INSPECTION AND TESTS.

Factory Tests; FIO.

- a. A letter giving notice of the proposed dates of factory inspections and tests at least 14 days prior to beginning tests.
- b. A detailed description of the manufacturer's procedures for factory tests.

Six copies of the Factory Test data described below in 215.9 x 279.4 mm (8-1/2 x 11 inch) binders having a minimum of 3 rings from which material

may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs. Data plots shall be full size (215.9 x 279.4 mm (8-1/2 x 11 inch) minimum), showing grid lines, with full resolution.

- (1) A detailed description of the procedures for factory tests.
- (2) A list of equipment used, with calibration certifications.
- (3) A copy of measurements taken, with required plots and graphs.
- (4) The date of testing.
- (5) A list of the parameters verified.
- (6) The condition specified for the parameter.
- (7) The test results, signed and dated.
- (8) A description of adjustments made.

On Site Tests; FIO.

- a. A letter giving notice of the proposed dates of onsite inspections and tests.
- b. A detailed description of the Contractor's procedures for onsite tests including the test plan and a listing of equipment necessary to perform the tests.
- c. Six copies of the onsite test data described below in 215.9 x 279.4 mm (8-1/2 x 11 inch) binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs. Data plots shall be full size (215.9 x 279.4 mm (8-1/2 x 11 inch) minimum), showing grid lines, with full resolution.
 - (1) A detailed description of the procedures for onsite tests.
 - (2) A list of equipment used, with calibration certifications.
 - (3) A copy of measurements taken, with required plots and graphs.
 - (4) The date of testing.
 - (5) A list of the parameters verified.
 - (6) The condition specified for the parameter.
 - (7) The test results, signed and dated.
 - (8) A description of adjustments made.

SD-13 Certificates

Torsional Vibration; FIO.

Torsional analysis and calculations which certify and demonstrate that no

damaging or dangerous torsional vibrations will occur when the prime mover is connected to the generator, at synchronous speeds, plus/minus 10%.

Prototype Tests; FIO.

Manufacturer's standard certification that prototype tests were performed for the generator model proposed.

Reliability and Durability; FIO.

A reliability and durability certification letter from the manufacturer and assembler to prove that existing facilities are and have been successfully utilizing the same components proposed to meet this specification, in similar service. Certification may be based on components, i.e. engines used with different models of generators and generators used with different engines, and does not exclude annual technological improvements made by a manufacturer in his basic standard-model component on which experience was obtained, provided parts interchangeability has not been substantially affected and his current standard model meets the performance requirements specified.

Emissions; FIO.

A certification from the engine manufacturer stating that the engine emissions meet the federal, state, and local regulations and restrictions specified.

Site Visit; FIO.

A letter stating the date the site was visited and listing discrepancies found.

Flywheel Balance; FIO.

A certification stating that the flywheel has been statically and dynamically balanced and is capable of being rotated at 125 percent of rated speed without vibration or damage.

Standards Compliance; FIO.

A certification stating that where materials or equipment are specified to comply with requirements of UL, written proof of such compliance has been obtained. The label or listing of the specified agency, or a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency are acceptable as proof.

Functional Facilities; FIO.

A letter certifying that all facilities are complete and functional; that each system is fully functional; and that each item of equipment is complete, free from damage, adjusted, and ready for beneficial use.

SD-19 Operation and Maintenance Manuals

Operation Manual; GA.

Six copies of the operation manual in 215.9 x 279.4 mm (8-1/2 x 11 inch)

binders, having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each system or subsystem. Sections shall be separated by heavy plastic dividers with tabs which identify the material in the section. Drawings shall be folded blue lines, with the title block visible, and placed in 215.9 x 279.4 mm (8-1/2 x 11 inch) plastic pockets with reinforced holes. One full size reproducible mylar of each drawing shall accompany the booklets. Mylars shall be rolled and placed in a heavy cardboard tube with threaded caps on each end. The manual shall include: step-by-step procedures for system startup, operation, and shutdown; drawings, diagrams, and single-line schematics to illustrate and define the electrical, mechanical, and hydraulic systems together with their controls, alarms, and safety systems; the manufacturer's name, model number, and a description of equipment in the system. The instructions shall include procedures for interface and interaction with related systems to include automatic transfer switches and fire alarm/suppression systems. Each booklet shall include 1.44 megabyte, 88.9 mm (3-1/2 inch) floppy disks containing an ASCII file of procedures. The floppy disks shall be placed in 215.9 x 279.4 mm (8-1/2 x 11 inch) plastic pockets with reinforced holes. The operation manual shall be submitted and approved prior to commencing onsite tests. Operation manuals shall be submitted for approval 30 days following CQC approval of equipment/material.

Maintenance Manual; GA.

Six copies of the maintenance manual containing the information described below in 215.9 x 279.4 mm (8-1/2 x 11 inch) binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each item listed. Each section shall be separated by a heavy plastic divider with tabs. Drawings shall be folded, with the title block visible, and placed in plastic pockets with reinforced holes.

- a. Procedures for each routine maintenance item.
- b. Procedures for troubleshooting.
- c. Factory-service, take-down overhaul, and repair service manuals, with parts lists.
- d. A copy of the posted instructions.
- e. A component list which includes the manufacturer's name, address, type or style, model or serial number, rating, and catalog number for the major components specified for nameplates.

Six complete reproducible copies of the final relay and protective device settings. The settings shall be recorded with the name of the company and individual responsible for their accuracy. Maintenance manuals shall be submitted for approval 30 days following CQC approval of equipment material.

Special Tools and Filters; FIO.

Two complete sets of special tools required for maintenance (except for electronic governor handset). Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. The tools shall be supplied complete with a suitable tool box. One handset shall be provided for each electronic governor when required to indicate and/or change governor response settings. Two

complete sets of filters shall be supplied in a suitable storage box.

1.5 STORAGE AND INSTALLATION

The Contractor shall properly protect material and equipment, before, during, and after installation. Stored items shall be protected from the weather and contamination. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Filter Elements

Fuel-oil, lubricating-oil, and combustion-air filter elements shall be manufacturer's standard.

2.1.2 Instrument Transformers

ANSI C12.11.

2.1.3 Pipe (Sleeves, Fuel/Lube-Oil, Compressed Air, Coolant, Crankcase Breather Vent and Exhaust)

ASTM A 53, or ASTM A 106 steel pipe. Pipe smaller than 50 mm (2 inches) shall be Schedule 80. Pipe 50 mm (2 inches) and larger shall be Schedule 40.

- a. Flanges and Flanged Fittings: ASTM A 181/A 181M, Class 60, or ASME B16.5, Grade 1, Class 150.
- b. Pipe Welding Fittings: ASTM A 234/A 234M, Grade WPB or WPC, Class 150 or ASME B16.11, 1360.7 kg (3000 lb).
- c. Threaded Fittings: ASME B16.3, Class 150.
- d. Valves: MSS SP-80, Class 150.
- e. Gaskets: Manufacturer's standard.

2.1.4 Thermometer for Oil or Water Service

Flush-mounted dial with range to suit the service encountered, standard with the manufacturer.

2.1.5 Pipe Hangers

MSS SP-58 and MSS SP-69.

2.1.6 Electrical Enclosures

2.1.6.1 General

NEMA ICS 6.

2.1.6.2 Power Switchgear Assemblies

NEMA SG 5.

2.1.6.3 Switchboards

NEMA PB 2.

2.1.6.4 Panelboards

NEMA PB 1.

2.1.7 Pressure Gauges

Manufacturer's standard.

2.1.8 Electric Motors

Electric motors shall conform to the requirements of NEMA MG 1. Motors shall have sealed ball bearings and a maximum speed of 1800 rpm. Motors used indoors shall have drip-proof frames; those used outside shall be totally enclosed. Alternating current motors larger than 373 W (1/2 Hp) shall be of the squirrel-cage induction type for operation on 208 volts or higher, 60 Hz, and three-phase power. Alternating current motors 373 W (1/2 Hp) or smaller, shall be suitable for operation on 120 volts, 60 Hz, and single-phase power.

2.1.9 Motor Controllers

Motor controllers and starters shall conform to the requirements of NFPA 70 and NEMA ICS 2.

2.2 ENGINE

Each engine shall operate on No. 2-D diesel fuel conforming to ASTM D 975, shall be designed for stationary applications and shall be complete with ancillaries. The engine shall be a standard production model described in the manufacturer's catalog. The engine shall be naturally aspirated, supercharged, or turbocharged. The engine shall be 4-stroke-cycle and compression-ignition type. The engine shall be vertical in-line, V- or opposed-piston type, with a solid cast block or individually cast cylinders. The engine shall have a minimum of two cylinders. Opposed-piston type engines shall have not less than four cylinders. Each block shall have a coolant drain port.

2.2.1 Transient Load Capability

Each engine shall be capable of receiving and responding to specified maximum step load changes within the transient loading recovery time.

2.2.2 Speed Sensor

Each engine shall be equipped with an overspeed sensor.

2.3 FUEL SYSTEM

The entire fuel system for each engine-generator set shall conform to the requirements of NFPA 30 and NFPA 37 and contain the following elements.

2.3.1 Pumps

2.3.1.1 Main Pump

Each engine shall be provided with an engine driven pump. The pump shall supply fuel at a minimum rate of 200 percent of the expected fuel consumption at 110 percent of full rated output capacity.

2.3.2 Fuel Filter

A minimum of one full-flow fuel filter shall be provided for each engine. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked. An indicating differential pressure gauge shall be provided across the filter.

2.3.3 Relief/Bypass Valve

A relief/bypass valve shall be provided to regulate pressure in the fuel supply line, return excess fuel to a return line and prevent the build-up of excessive pressure in the fuel system.

2.3.4 Fuel Tank

Each generator shall be furnished with an integral weatherproof, subbase fuel tank.

2.4 LUBRICATION

Each engine shall have a separate lube-oil system conforming to NFPA 30 and NFPA 37. Each system shall be pressurized by engine-driven pumps. System pressure shall be regulated as recommended by the engine manufacturer. A pressure relief valve shall be provided on the crankcase. The crankcase shall be vented in accordance with the manufacturer's recommendation except that it shall not be vented to the engine exhaust system. Crankcase breathers, if provided on engines installed in buildings or enclosures, shall be piped to vent to the outside. The system shall be readily accessible for service such as draining, refilling, etc. Each system shall permit addition of oil and have oil-level indication with the set operating. The system shall utilize an oil cooler as recommended by the engine manufacturer.

2.4.1 Lube-Oil Filter

One full-flow filter shall be provided for each pump. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked. An indicating differential pressure gauge shall be provided across the filter.

2.4.2 Lube-Oil Sensors

Each engine shall be equipped with lube-oil temperature and pressure sensors. Temperature sensors shall provide signals for Pre-High and High Lube-Oil indication and alarms. Pressure sensors shall be located downstream of the filters and provide signals for Pre-Low and Low Lube-Oil indication and alarms.

2.5 COOLING

Each engine shall have its own cooling system. Each system shall operate automatically while its engine is running. The cooling system coolant

shall use a combination of cooling water conditioner, water and ethylene-glycol sufficient for freeze protection at the minimum winter outdoor temperature specified and in concentration as recommended by the engine manufacturer. The maximum temperature rises of the coolant across each engine shall not exceed that recommended and submitted in paragraph SUBMITTALS.

2.5.1 Coolant Pumps

Coolant pumps shall be the centrifugal type. Each engine shall have an engine-driven primary pump. Secondary pumps shall be electric motor driven and have automatic controllers.

2.5.2 Heat Exchanger

Each heat exchanger shall be of a size and capacity to limit the maximum allowable temperature rise in the coolant across the engine to that recommended and submitted in paragraph SUBMITTALS for the maximum summer outdoor design temperature and site elevation and for the specified temperature of air entering the radiator. Each heat exchanger shall be corrosion resistant, suitable for service in ambient conditions of application. Frame shall be galvanized.

2.5.2.1 Fin-Tube-Type Heat Exchanger (Radiator)

Heat exchanger shall be vertical, engine-mounted radiator type, with copper fins, brass coolant tubes, fan and integral fuel oil cooler. Radiator shall be sized for 43.3 degrees C (110 degrees F) temperature air entering the radiator from the generator room and heat rejection shall include total of exhaust water jacket, oil cooler, after cooler, fuel oil and engine water jacket at 110% of full load and 43.3 degrees C (110 degrees F) combustion air intake to the engine. Heat exchanger core shall be factory coated with corrosion resistant film, provided that correction measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via over sizing, or other compensating methods. Provide additional core surface area to compensate for the lower heat transfer coefficient because of the coating. Internal surfaces shall be compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Heat exchangers shall be pressure type incorporating a pressure valve, vacuum valve and a cap. Caps shall be designed for pressure relief prior to removal. Each heat exchanger and the entire cooling system shall be capable of withstanding a minimum pressure of 48 kPa (7 psi) and shall be protected with a strong grille or screen guard. Each heat exchanger shall have at least two tapped holes; one tapped hole shall be equipped with a drain cock, the rest shall be plugged.

2.5.3 Thermostatic Control Valve

A modulating type, thermostatic control valve shall be provided in the coolant system to maintain the coolant temperature range submitted in paragraph SUBMITTALS.

2.5.4 Temperature Sensors

Each engine shall be equipped with coolant temperature sensors. Temperature sensors shall provide signals for pre-high and high indication and alarms.

2.5.5 Ductwork

Ductwork shall be as specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM except that a flexible connection shall be used to connect the duct to the diesel engine radiator. Material for the connection shall be wire-reinforced glass. The connection shall be rendered as airtight as possible.

2.6 SOUND LIMITATIONS

The limits listed are applicable only as referenced in this specification.

Frequency Band (Hz)	Maximum Acceptable Sound Level (Decibels)	
20-75	87	81
75-150	77	71
150-300	70	64
300-600	64	58
600-1,200	61	55
1,200-2,400	60	54
2,400-4,800	60	54
4,800-10 kHz	62	56

2.7 AIR INTAKE EQUIPMENT

Filters and silencers shall be provided in locations that are convenient for servicing. The silencer shall be of the high-frequency filter type, located in the air intake system as recommended by the engine manufacturer.

Silencer shall be capable of reducing the noise level at the air intake to a point below the maximum acceptable levels specified in paragraph SOUND LIMITATIONS. A combined filter-silencer unit meeting requirements for the separate filter and silencer items may be provided. Expansion elements in air-intake lines shall be copper or rubber.

2.8 EXHAUST SYSTEM

The system shall be separate and complete for each engine. Piping shall be supported to minimize vibration. Where a V-type engine is provided, a V-type connector, with necessary flexible sections and hardware, shall connect the engine exhaust outlets.

2.8.1 Exhaust Muffler

A chamber type exhaust muffler shall be provided. The muffler shall be of welded steel and designed for outside mounting. Eyebolts, lugs, flanges, or other items shall be provided as necessary for support in the location and position indicated. Pressure drop through the muffler and exhaust piping system shall not exceed the recommendations of the engine manufacturer. Outside mufflers shall be zinc coated or painted with high temperature 500 degrees resisting paint. Unless otherwise indicated on the drawings, the muffler and exhaust piping together shall reduce the noise level to less than the maximum acceptable level listed for sound limitations in paragraph SOUND LIMITATIONS, at a distance of 22.9 m (75 feet) from the end of the exhaust piping directly along the path of discharge for horizontal discharged exhausts; or at a radius of 22.9 m (75 feet) from the muffler/discharge piping, at 45 degrees apart in all directions, for vertically discharged exhausts, with the engine-generator

set operating at 100 percent of rated output capacity. The muffler shall have a drain valve, nipple, and cap at the low-point of the muffler.

2.8.2 Exhaust Piping

Horizontal sections of exhaust piping shall be sloped downward away from the engine to a drip leg for collection of condensate with drain valve and cap. Changes in direction shall be long radius. Exhaust piping, mufflers and silencers installed inside any building shall be insulated in accordance with paragraph THERMAL INSULATION and covered to protect personnel. Vertical exhaust piping shall be provided with a hinged, gravity-operated, self-closing, rain cover.

2.8.3 Expansion Joints

An expansion joints shall be provided at each engine exhaust connection. Expansion joints shall have flanged connections. Expansion joints shall be bellows type with stainless steel elements suitable for diesel-engine exhaust gas at 650 degrees C (1200 degrees F). Expansion elements shall be capable of absorbing vibration from the engine and compensating for thermal expansion and contraction.

2.9 EMISSIONS

The finished installation shall comply with Federal and local regulations and restrictions regarding the limits of emissions.

2.10 STARTING SYSTEM

2.10.1 Controls

An engine start-stop switch shall be provided with functions including: test, reset, manual-run/start, manual stop, and automatic modes. Start-stop logic shall be provided for adjustable cycle cranking and cooldown operation. The logic shall be arranged for manual starting and fully automatic starting in accordance with paragraph AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION. Electrical starting systems shall be provided with an adjustable cranking limit device to limit cranking periods from 8 seconds up to the maximum duration.

2.10.2 Capacity

The starting system shall be of sufficient capacity, at the maximum outdoor summer temperature specified to crank the engine without damage or overheating. The system shall be capable of providing a minimum of three cranking periods with 8 second intervals between cranks. Each cranking period shall have a maximum duration of 8 seconds.

2.10.3 Electrical

An electrical starting system shall be provided to operate on a 24-volt dc system utilizing a negative circuit ground. Starting motors shall be in accordance with SAE ARP 892.

2.10.3.1 Battery

A starting battery system shall be provided and shall include the battery, battery rack, intercell connectors, spacers, automatic battery charger with overcurrent protection, metering and relaying. The battery shall be in

accordance with SAE J 537. Critical system components (rack, protection, etc.) shall be sized to withstand the seismic acceleration forces of the zone specified in paragraph Engine-Generator Parameter Schedule. The battery shall be lead-acid, with sufficient capacity, at the minimum outdoor and maximum outdoor temperature specified, to provide the specified cranking periods.

2.10.3.2 Battery Charger

A current-limiting battery charger, conforming to UL 1236, shall be provided and shall automatically recharge the batteries. The charger shall be capable of an equalize-charging rate for recharging fully depleted batteries within 8 hours which is manually adjustable in a continuous range and a floating charge rate for maintaining the batteries at fully charged condition. An ammeter shall be provided to indicate charging rate. A voltmeter shall be provided to indicate charging voltage. A timer shall be provided for the equalize-charging-rate setting.

2.10.4 Starting Aids

2.10.4.1 Glow Plugs

Glow plugs shall be designed to provide sufficient heat for combustion of fuel within the cylinders to guarantee starting at an ambient temperature of minus 32 degrees C (minus 25 degrees F).

2.10.4.2 Ether

Ether capsule injectors shall be positioned to allow injection of ether directly into the air manifold to guarantee starting at an ambient temperature of minus 23 degrees C (minus 10 degrees F).

2.10.4.3 Jacket-Coolant Heaters

A thermostatically controlled electric heater shall be mounted in the engine coolant jacketing to automatically maintain the coolant within plus or minus 1.7 degrees C (3 degrees F) of the control temperature. The heater shall operate independently of engine operation so that starting times are minimized. Power for the heaters shall be 120 volts ac.

Standby Rated Sets

The control temperature shall be the temperature recommended by the engine manufacturer to meet the starting time specified at the minimum winter outdoor temperature.

2.10.4.4 Lubricating-Oil Heaters

A thermostatically controlled electric heater shall be mounted in the engine lubricating-oil system to automatically maintain the oil temperature within plus or minus 1.7 degrees C (3 degrees F) of the control temperature. The heater shall operate independently of engine operation so that starting times are minimized. Power for the heaters shall be 120 volts ac.

2.10.5 Exerciser

A programmable, timing device or sequential controller shall be provided to

start, operate, and automatically stop the engine-generator set to permit periodic operation for a preset period of time at preset intervals. Intervals shall be adjustable from 672 hours to not less than 168 hours, and factory set at 672 hours. Running periods shall be adjustable from 1 to 1440 minutes, including the engine cool-down period, and factory set at 30 minutes. The design of the system exerciser shall include the following provisions:

- a. Manual activation switch.
- b. Manual reset switch. Reset switch shall terminate the run period and activate control logic to return system loads to the normal or preferred source, and to shut down the engine generator set after the cooldown period.
- c. Coordination with the automatic transfer switch controls and logic so that the system loads are returned to the normal or preferred source upon manual reset, and upon loss of engine generator set output voltage, if the normal or preferred source is available.

2.11 SAFETY SYSTEM

Devices, wiring, panels, etc. shall be provided and installed as a complete system to automatically activate the appropriate signals and initiate the appropriate actions. The safety system shall be provided with a self-test method to verify its operability. Alarm signals shall have manual acknowledgment and reset devices. The alarm signal systems shall reactivate for new signals after acknowledgment is given to any signal. The systems shall be configured so that loss of any monitoring device shall be dealt with as an alarm on that system element.

2.11.1 Audible Signal

The audible alarm signal shall sound at a frequency of 70 Hz at a volume of 75 dB at 3.1 m (10 feet). The sound shall be continuously activated upon alarm and silenced upon acknowledgment. Signal devices shall be located as shown.

2.11.2 Visual Signal

The visual alarm signal shall be a panel light. The light shall be normally off, activated to be blinking upon alarm. The light shall change to continuously lit upon acknowledgment. If automatic shutdown occurs, the display shall maintain activated status to indicate the cause of failure and shall not be reset until cause of alarm has been cleared and/or restored to normal condition. Shutdown alarms shall be red; all other alarms shall be amber.

2.11.3 Alarms and Action Logic

2.11.3.1 Shutdown

Simultaneous activation of the audible signal, activation of the visual signal, stopping the engine, and opening the generator field and main circuit breakers shall be accomplished.

2.11.3.2 Problem

Activation of the visual signal shall be accomplished.

2.11.4 Alarm Panel

The panel shall be as specified in paragraph PANELS and shall contain the following functions:

Function/Device	Alarm/Action
a. Red emergency stop switch)	Shutdown (push button or switch)
b. Day tank overfill limit indication (Shutdown pumpsupplying fuel to the day tank)	Problem/ (95 percent volume)
c. Engine overspeed indication (rated speed)	Shutdown (110 percent of rated speed)
d. High lube-oil temperature indication (submitted)	Shutdown (Temperature as submitted)
e. Low lube-oil pressure indication (submitted)	Shutdown (Pressure as submitted)
f. High coolant fluid outlet temperature indication (Temperature as submitted)	Shutdown
g. Pre-Low lube-oil pressure indication (low lube-oil pressure)	Problem (110 percent of low lube-oil pressure)
h. Pre-high coolant fluid temperature indication (5 degrees C lower than coolant-fluid outlet shutdown temperature)	Problem (5 degrees C lower than coolant-fluid outlet shutdown temperature)
i. Pre-high lube-oil temperature indication (5 degrees C before shutdown)	Problem (5 degrees C before shutdown)
j. Day tank low fuel limit indication (volume remaining)	Problem (70 percent volume remaining)
k. Failure to start within the specified time	Problem indication.

2.11.5 Time-Delay on Alarms

For startup of the engine-generator set, time-delay devices shall be installed bypassing the low lubricating oil pressure alarm during cranking, and the coolant-fluid outlet temperature alarm. The lube-oil time-delay device shall return its alarm to normal status after the engine starts. The coolant time-delay device shall return its alarm to normal status 5 minutes after the engine starts.

2.12 GOVERNOR

Each engine shall be provided with a governor which maintains the frequency within a bandwidth of the rated frequency, over a steady-state load range of zero to 100 percent of rated output capacity. The governor shall be configured for safe manual adjustment of the speed/frequency during operation of the engine-generator set, without special tools, from 90 to 110 percent of the rated speed/frequency.

2.12.1 Governor Performance

2.12.1.1 Isochronous Governors

Isochronous governors shall maintain the midpoint of the frequency bandwidth at the same value for steady-state loads over the range of zero to 100 percent of rated output capacity. The governor shall be configured for safe, manual, external adjustment of the droop from zero to 10 percent.

2.12.1.2 Droop Governors

Droop governors shall maintain the midpoint of the frequency bandwidth linearly for steady-state loads over the range of zero to 100 percent of rated output capacity, with 3 percent droop.

2.12.2 Bandwidths

2.12.2.1 Mechanical-Hydraulic

Hydraulic governors shall have centrifugal speed sensing and maintain a frequency bandwidth of plus or minus 0.40 percent, maximum.

2.12.2.2 Electrical

Electrical governors shall have electrical speed sensing and maintain a frequency bandwidth of plus or minus 0.25 percent, maximum.

2.12.2.3 Electro-Hydraulic

Electro-hydraulic governors shall have electrical speed and load sensing with a manually adjustable bandwidth of 0.25 to 3 percent of rated frequency. The bandwidth shall be set at 0.25 percent of rated frequency.

2.13 ENGINE PANEL

The panel shall be as specified in paragraph PANELS and shall contain the following items:

- a. Coolant-fluid inlet temperature display.
- b. Lubricating-oil pressure indicator.
- c. Lubricating-oil inlet temperatures display.
- d. Red emergency stop (push-button or switch).
- e. Run-time meter.
- f. Fuel meter display.
- g. Fuel-header-pressure display.
- h. Tachometer display.
- i. Engine start-stop switch.
- j. Start-attempt light indicator.
- k. Lubricating-oil prelubricating pump start-stop switch.

1. Alarm Panel.

2.14 GENERATOR

Each generator shall be of the synchronous type, one or two bearing, conforming to NEMA MG 1, equipped with winding terminal housings in accordance with NEMA MG 1, equipped with an amortisseur winding, and directly connected to the engine. Insulation shall be Class F. Generator design shall protect against mechanical, electrical and thermal damage due to vibration, 25 percent overspeeds, or voltages and temperatures at a rated output capacity of 110 percent for prime applications and 100 percent for standby applications. Generator ancillary equipment shall meet the short circuit requirements of NEMA MG 1. Frames shall be the drip-proof type. For two-bearing generators, the maximum voltage drop due to shaft current through the generator bearings at 100 percent output capacity shall be less than 100 mV with sealed-ball or spherical roller bearings and less than 200 mV with sleeve bearings.

2.14.1 Current Balance

At 100 percent rated output capacity, and load impedance equal for each of the 3 phases, the permissible current difference between any 2 phases shall not exceed 2 percent of the largest current on either of the 2 phases.

2.14.2 Voltage Balance

At any balanced load between 75 and 100 percent of rated output capacity, the difference in line-to-neutral voltage among the 3 phases shall not exceed 1 percent of the average line-to-neutral voltage. For a single-phase load condition, consisting of 25 percent load at unity power factor placed between any phase and neutral with no load on the other 2 phases, the maximum simultaneous difference in line-to-neutral voltage between the phases shall not exceed 3 percent of rated line to neutral voltage. The single-phase load requirement shall be valid utilizing normal exciter and regulator control. The interpretation of the 25 percent load for single phase load conditions means 25 percent of rated current at rated phase voltage and unity power factor.

2.14.3 Waveform

The deviation factor of the line-to-line voltage at zero load and at balanced rated output capacity shall not exceed 10 percent. The RMS of all harmonics shall be less than 5.0 percent and that of any one harmonic less than 3.0 percent of the fundamental at rated output capacity.

2.14.4 Space Heater

Space heater (110 VAC) shall be provided to prevent condensation and moisture build-up on winding where generator is not in use. Heater shall be automatically disconnected when generator is running.

2.15 EXCITER

The generator exciter shall be of the brushless type. Semiconductor rectifiers shall have a minimum safety factor of 300 percent for peak inverse voltage and forward current ratings for all operating conditions, including 110 percent generator output at 40 degrees C ambient. The exciter and regulator in combination shall maintain generator-output voltage within the limits specified. The exciter shall maintain output

current at the level and duration required to trip the generator breaker (IEEE device 52) under fault conditions.

2.16 VOLTAGE REGULATOR

Each generator shall be provided with a solid-state voltage regulator, separate from the exciter, which maintains the voltage within a bandwidth of the rated voltage, over a steady-state load range of zero to 100 percent of rated output capacity. Regulator shall be configured for safe manual adjustment of the engine-generator voltage output without special tools, during operation, from 90 to 110 percent of the rated voltage. Regulation drift shall not exceed plus or minus 0.5 percent for an ambient temperature change of 20 degrees C.

2.16.1 Steady State Performance

The voltage regulator shall have a maximum droop of 3 percent of rated voltage over a load range from 0 to 100 percent of rated output capacity and automatically maintain the generator output voltage within the specified operational bandwidth.

2.16.2 Regulator Bandwidth

Regulators shall have an operational bandwidth of plus or minus 0.5 percent of rated voltage.

2.17 GENERATOR PANEL

The panels shall be as specified in paragraph PANELS and shall provide controls, gauges, meters, and displays to include:

- a. Frequency meter, dial type, with a range of 90 to 110 percent of rated frequency. Vibrating-reed type meters shall not be used.
- b. Voltmeter, ac, dial type, 3-phase, with 4-position selector switch for the generator output.
- c. Ammeter, 3-phase, with 4-position selector switch.
- d. Generator field contactor or circuit breaker and discharge resistor, if provided.
- e. Voltage regulator control.
- f. Synchronizing panel.

2.18 PANELS

Each panel shall be of the type and kind necessary to provide specified functions. Panels shall be mounted on the engine-generator set base by vibration/shock absorbing type mountings. Instruments shall be mounted flush or semiflush. Convenient access to the back of panels shall be provided to facilitate maintenance. Instruments shall be calibrated using recognized industry calibration standards. Each panel shall be provided with a panel identification plate which clearly identifies the panel function. Each instrument and device on the panel shall be provided with a plate which clearly identifies the device and its function as indicated. Switch plates shall clearly identify the switch-position function.

2.18.1 Enclosures

Enclosures shall be designed for the application and environment, conforming to NEMA ICS 6. Locking mechanisms shall be keyed alike.

2.18.2 Analog

Analog electrical indicating instruments shall be true RMS indicating instruments, in accordance with ANSI C39.1 with semiflush mounting. Switchboard, switchgear, and control-room panel-mounted instruments shall have 250 degree scales with an accuracy of not less than 99 percent. Unit-mounted instruments shall have 100 degree scales with an accuracy of not less than 98 percent. The instrument's operating temperature range shall be minus 20 to plus 65 degrees C. Distorted generator output voltage waveform of a crest factor less than 5 shall not affect metering accuracy for phase voltages, hertz and amps.

2.18.3 Electronic

Electronic indicating instruments shall be true RMS indicating instruments, 100 percent solid state, state-of-the-art, microprocessor controlled to provide specified functions. Control, logic, and function devices shall be compatible as a system, sealed, dust and water tight, and shall utilize modular components with metal housings and digital instrumentation. An interface module shall be provided to decode serial link data from the electronic panel and translate alarm, fault and status conditions to set of relay contacts. Instrument accuracy shall be not less than 98 percent for unit mounted devices and 99 percent for control room, panel mounted devices, throughout a temperature range of minus 20 to plus 65 degrees C. Data display shall utilize LED or back lit LCD. Additionally, the display shall provide indication of cycle programming and diagnostic codes for troubleshooting. Numeral height shall be 13 mm.

2.18.4 Parameter Display

Continuous indication of the tachometer, lubricating-oil pressure, ac voltmeter, ac ammeter, frequency meter, and safety system parameters shall be provided. A momentary switch shall be specified for other panels.

2.19 AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION

Fully automatic operation shall be provided for the following operations: engine-generator set starting and load transfer upon loss of normal source; retransfer upon restoration of the normal source; and stopping of engine-generator set after cool-down. Devices shall automatically reset after termination of their function.

2.19.1 Automatic Transfer Switch

Automatic transfer switches shall be in accordance with Section 16410 AUTOMATIC TRANSFER AND BY-PASS/ISOLATION SWITCHES.

2.19.2 Monitoring and Transfer

Devices shall be provided to monitor voltage and frequency for the normal power source and each engine-generator set, and control transfer from the normal source and retransfer upon restoration of the normal source. Functions, actuation, and time delays shall be as described in Section 16410 AUTOMATIC TRANSFER AND BY-PASS/ISOLATION SWITCHES.

2.20 MANUAL ENGINE-GENERATOR-SET SYSTEM OPERATION

Complete facilities shall be provided for manual starting and testing of each set without load, loading and unloading of each set, and synchronization of each set with an energized bus.

2.21 BASE

The base shall be constructed of steel. The base shall be designed to rigidly support the engine-generator set, ensure permanent alignment of rotating parts, be arranged to provide easy access to allow changing of lube-oil, and ensure that alignment is maintained during shipping and normal operation. The base shall permit skidding in any direction during installation and shall withstand and mitigate the affects of synchronous vibration of the engine and generator. The base shall be provided with suitable holes for anchor bolts diameter holes for anchor bolts and jacking screws for leveling.

2.22 THERMAL INSULATION

Thermal insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.23 PAINTING AND FINISHING

The engine-generator set shall be cleaned, primed and painted in accordance with the manufacturer's standard color and practice.

2.24 FACTORY INSPECTION AND TESTS

Factory inspections and tests shall be performed on each engine-generator set. Each engine and each generator shall be tested by being operated for at least 1 hour at Service Load before being assembled into an engine-generator set. Each engine-generator set shall be run not less than 1 hour at Service Load prior to inspections. Inspections shall be completed and all necessary repairs made, prior to testing. The Contracting Officer may provide one or more representatives to witness inspections and tests.

2.24.1 Factory Inspection

Inspections shall be performed prior to beginning and after completion of testing of the assembled engine-generator set. Inspectors shall look for leaks, looseness, defects in components, proper assembly, etc. and any item found to be in need of correction shall be noted as a necessary repair. The following checklist shall be used for the inspection:

INSPECTION ITEM	GOOD	BAD	NOTES
1. Drive belts			
2. Governor and adjustments			
3. Engine timing mark			
4. Starting motor			
5. Starting aids			
6. Coolant type and concentration			
7. Radiator drains			
8. Block coolant drains			
9. Coolant fill level			

10. All coolant line connections
11. All coolant hoses
12. Combustion air filter
13. Combustion air silencer
14. Lube oil type
15. Lube oil sump drain
16. Lube-oil filter
17. Lube-oil-level indicator
18. Lube-oil-fill level
19. All lube-oil line connections
20. All lube-oil lines
21. Fuel type and amount
22. All fuel-line connections
23. All fuel lines
24. Fuel filter
25. Coupling and shaft alignment
26. Voltage regulators
27. Battery-charger connections
28. All wiring connections
29. Instrumentation
30. Hazards to personnel
31. Base
32. Nameplates
33. Paint
34. Exhaust-heat recovery unit
35. Switchboard
36. Switchgear

2.24.2 Factory Tests

The following tests shall be performed on each engine-generator set except where the component manufacturer's production line test is noted as acceptable. On engine-generator set tests where the engine and generator are required to be connected and operated together, the load power factor shall be the power factor specified in the engine generator set parameter schedule. For engine-generator set with dual-fuel operating capability the following tests shall be performed using the primary fuel type. Tests specified as MIL-STD 705 tests may be performed in accordance with the equivalent NEMA MG 1 or IEEE Std 115, or IEEE Std 112 tests. Manufacturer's standard test instruments may be substituted for test instruments specified in MIL-STD 705 tests, as approved by the Contracting Officer. In the following tests where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings.

- a. Insulation Resistance for Stator and Exciter Test, per MIL-STD 705 method 301.1: to the performance criteria in NEMA MG 1, 22.51, minimum of 1 megohm per 1000 Volts of rated voltage for armature and field or the recommended polarization index in IEEE Std 43, whichever is more stringent. Generator manufacturer's production line test is acceptable.
- b. High Potential Test, per MIL-STD 705 method 302.1: to the performance criteria in MIL-STD 705 or NEMA MG 1, 22.51 and the recommended polarization index in IEEE Std 95. Generator manufacturer's production line test is acceptable.

- c. Winding Resistance Test, per IEEE Std 115. Generator manufacturer's production line test is acceptable.
- d. Start-and-Stop Test. Record: the starting time; engine manufacturer's after-starting checks and inspections; readings of gauges and instruments; and the time to stop after activation of the manual emergency stop switch. The set shall operate for 5 minutes at rated voltage and frequency and no load prior to activation of the manual emergency stop switch.
- e. The engine generator-set shall be operated for at least: 15 minutes at 50 percent of Service Load; 75 percent of Service Load for at least 15 minutes; 100 percent of Service Load at least 30 minutes; and 110 percent of Service Load at least 30 minutes for prime rated sets. Readings of gauges and instruments shall be checked after each load change.
- f. Torsion-graphic Test, per MIL-STD 705 method 504.2: to determine that the maximum torsional stress is 34.5 MPa (5000 psi) or less. The test shall be performed at a maximum frequency of 61.8 Hz. and a minimum frequency of 58.2 Hz. Alternatively the engine-generator set manufacturer may submit calculations which clearly demonstrate that the maximum torsional stress is not exceeded.
- g. Overspeed Vibration Test, per MIL-STD 705 method 505.1a: to the performance criteria in NEMA MG 1, Part 22. The test shall be performed at 110 percent of rated speed for 5 minutes. The vibration shall be measured at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Vibration amplitude and speed shall be recorded at one minute intervals.
- h. Overspeed Protective Device Test, per MIL-STD 705 method 505.2a: to the performance criteria specified in paragraph SAFETY SYSTEM. The engine overspeed alarm shall be verified.
- i. Phase Sequence Rotation Test, per MIL-STD 705 method 507.1: to the performance criteria shown on the contract drawings. Generator manufacturer's production line test is acceptable.
- j. Phase Balance Voltage Test, per MIL-STD 705 method 508.1 or IEEE Std 112: to the performance criteria specified in paragraph GENERATOR.
- k. Voltage Waveform (Oscillographic), per MIL-STD 705 method 601.1: to the performance criteria specified in paragraph GENERATOR.
- l. Voltage Waveform (Harmonic Analysis) Test, per MIL-STD 705 method 601.4: to the performance criteria specified in paragraph GENERATOR. High-speed chart recording instruments capable of recording transient voltage and speed changes shall be used.
- m. Current Balance on Stator Winding Test, by measuring the current on each phase of the winding with the generator operating at 100 percent of Service Load, with the load impedance equal for each of the three phases: to the performance criteria specified in paragraph GENERATOR. This test may be performed using any prime mover.

- n. Voltage and Frequency Droop Test. Perform and record engine manufacturer's recommended prestarting checks and inspections. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. For the following steps, verify that the output voltage and frequency return to and stabilize within the specified bandwidth values following each load change. The generator output frequency and line-line and line-neutral voltages shall be recorded following each load change.
 - 1. With the generator operating at 0 percent load, adjust voltage and frequency to rated voltage and frequency. Record the generator output frequency and line-line and line-neutral voltages.
 - 2. Apply and drop load equal to the Maximum Step Load Increase three times in succession.
 - 3. Increase load to 100 percent of Service Load in steps equal to the Maximum Step Load Increase. Adjust the load, voltage and frequency to 100 percent of Service Load and rated voltage and frequency. No further adjustments may be made to any set controls after this step.
 - 4. Reduce the load to no load in one step.
 - 5. Increase load to 100 percent of Service Load in steps equal to the Maximum Step Load Increase. Decrease load to 0 percent of Service Load in steps of 10 percent (operate at each step until voltage and frequency stabilization is achieved).
 - 6. Plot frequency vs. percent of rated load. Plot voltage vs. percent of rated load.
 - 7. Calculate the percent droop for voltage and frequency with the following equations:

$$\text{Voltage droop \%} = \frac{(\text{No-Load Volts}) - (\text{Service-Load volts})}{(\text{Service-Load Volts})} \times 100$$

$$\text{Frequency droop \%} = \frac{(\text{No-Load Hertz}) - (\text{Service-Load hertz})}{(\text{Service-Load hertz})} \times 100$$

- o. Frequency and Voltage Stability and Transient Response. Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results with high resolution, high speed strip chart recorders and express the results as detailed in MIL-STD 705 method 608.1. Data taken shall include the following:

Ambient temperature (at 15 minute intervals).

Generator output current (before and after load changes).

Generator output voltage (before and after load changes).

Frequency (before and after load changes).

Charts of momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change.

Charts which show the generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

1. Perform and record engine manufacturer's recommended prestarting checks and inspections.
 2. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.
 3. With the unit at no load, apply the Maximum Step Load Increase.
 4. Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.
 5. Repeat steps 3. through 7.
- p. Voltage Unbalance with Unbalanced Load (Line-to-Neutral) Test in accordance with MIL-STD 705 method 620.1a: to the performance criteria specified in paragraph GENERATOR. Prototype test data is acceptable in lieu of the actual test. This test may be performed using any prime mover.
- q. For two-bearing generators, perform Shaft Current Test in accordance with MIL-STD 705 method 652.1a.

PART 3 EXECUTION

3.1 GENERAL

Installation shall provide clear space for operation and maintenance in accordance with NFPA 70 and IEEE C2. Installation of pipe, duct, conduit, and ancillary equipment shall be configured to facilitate easy removal and replacement of major components and parts of the engine-generator set.

3.2 PIPING INSTALLATION

3.2.1 General

Piping shall be welded. Connections at valves shall be flanged. Connections at equipment shall be flanged except that connections to the diesel engine may be threaded if the diesel-engine manufacturers standard connection is threaded. Except where otherwise specified, welded flanged fittings shall be utilized to allow for complete dismantling and removal of each piping system from the facility without disconnecting or removing any portion of any other system's equipment or piping. Connections to equipment shall be made with flexible connectors. Pipes extending through

the roof shall be properly flashed. Piping shall be installed clear of windows, doors and openings, to permit thermal expansion and contraction without damage to joints or hangers, and shall be installed with a 15 mm (1/2 inch) drain valve with cap at each low point.

3.2.2 Support

Hangers, inserts, and supports shall be of sufficient size to accommodate any insulation and shall conform to MSS SP-58 and MSS SP-69. Supports shall be spaced not more than 2.1 m on center for pipes 50 mm (2 inches) in diameter or less, not more than 3.6 m on center for pipes larger than 50 mm (2 inches) but smaller than 100 mm (4 inches) in diameter, and not more than 5.2 m on center for pipes larger than 100 mm in diameter. Supports shall be provided at pipe bends or change of direction.

3.2.2.1 Ceiling and Roof

Exhaust piping shall be supported with appropriately sized Type 41 single pipe roll and threaded rods; all other piping shall be supported with appropriately sized Type 1 clevis and threaded rods, unless otherwise indicated on the drawings.

3.2.2.2 Wall

Wall supports for pipe shall be made by suspending the pipe from appropriately sized Type 33 brackets with the appropriate ceiling and roof pipe supports.

3.2.3 Flanged Joints

Flanges shall be Class 125 type, drilled, and of the proper size and configuration to match the equipment and diesel engine connections. Flanged joints shall be gasketed and made up square and tight.

3.2.4 Cleaning

After fabrication and before assembly, piping interiors shall be manually wiped clean of debris.

3.2.5 Pipe Sleeves

Pipes passing through construction such as ceilings, floors, or walls shall be fitted with sleeves. Each sleeve shall extend through and be securely fastened in its respective structure and shall be cut flush with each surface. The structure shall be built tightly to the sleeve. The inside diameter of each sleeve shall be minimum 15 mm (1/2 inch), and where pipes pass through combustible materials 25 mm (1 inch) larger than the outside diameter of the passing pipe or pipe insulation/covering.

3.3 ELECTRICAL INSTALLATION

Electrical installation shall comply with NFPA 70, IEEE C2, and Section 16415 ELECTRICAL WORK, INTERIOR.

3.3.1 Vibration Isolation

Flexible fittings shall be provided for conduit, cable trays, and raceways attached to engine-generator sets.

3.4 FIELD PAINTING

Field painting shall be as specified in Section 09900 PAINTING, GENERAL.

3.5 ONSITE INSPECTION AND TESTS

3.5.1 Test Conditions

3.5.1.1 Data

Measurements shall be made and recorded of all parameters necessary to verify that each set meets specified parameters. If the results of any test step are not satisfactory, adjustments, replacements, or repairs shall be made and the step repeated until satisfactory results are obtained. Unless otherwise indicated, data shall be recorded in 15 minute intervals during engine-generator set operation and shall include: readings of all engine-generator set meters and gauges for electrical and power parameters; oil pressure; ambient temperature; and engine temperatures available from meters and gauges supplied as permanent equipment on the engine-generator set.

3.5.1.2 Power Factor

For all engine-generator set operating tests the load power factor shall be the power factor specified in the engine-generator set parameter schedule power factor.

3.5.1.3 Contractor Supplied Items

The Contractor shall provide equipment and supplies required for inspections and tests including fuel, test instruments, and loadbanks at the specified power factors.

3.5.1.4 Instruments

Readings of panel gauges, meters, displays, and instruments provided as permanent equipment shall be verified during test runs, using test instruments of greater precision and accuracy. Test instrument accuracy shall be within the following: current plus or minus 1.5 percent, voltage plus or minus 1.5 percent, real power plus or minus 1.5 percent, reactive power plus or minus 1.5 percent, power factor plus or minus 3 percent, frequency plus or minus 0.5 percent. Test instruments shall be calibrated by a recognized standards laboratory within 30 days prior to testing.

3.5.1.5 Sequence

The sequence of testing shall be as specified in the approved testing plan unless variance is authorized by the Contracting Officer. Field testing shall be performed in the presence of the Contracting Officer. Tests may be scheduled and sequenced in order to optimize run-time periods; however, the following general order of testing shall be followed: Construction Tests; Inspections; Pre-operational Tests; Safety Run Tests; and Performance Tests.

3.5.2 Construction Tests

Individual component and equipment functional tests for fuel piping, coolant piping, and lubricating-oil piping, electrical circuit continuity, insulation resistance, circuit protective devices, and equipment not

provided by the engine-generator set manufacturer shall be performed prior to connection to the engine-generator set.

3.5.2.1 Piping Test

- a. Lube-oil and fuel-oil piping shall be flushed with the same type of fluid intended to flow through the piping, until the outflowing fluid has no obvious sediment or emulsion.
- b. Piping which is external to the engine-generator set shall be pressure tested with air pressure at 150 percent of the maximum anticipated working pressure, but not less than 1.03 MPa, for a period of 2 hours to prove the piping has no leaks. If piping is to be insulated, the test shall be performed before the insulation is applied.
- c. Prior to testing, isolate from the piping system all items which could be damaged by the test pressure.

3.5.2.2 Electrical Equipment Tests

- a. Insulation integrity tests shall be performed for cables connecting the generator breaker to the automatic transfer switch in accordance with Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.
- b. Ground-Resistance Tests shall be performed in accordance with Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.
- c. Circuit breakers shall be examined and tested in accordance with the manufacturer's published instructions for functional testing.

3.5.3 Inspections

The following inspections shall be performed jointly by the Contracting Officer and the Contractor, after complete installation of each engine-generator set and its associated equipment, and prior to startup of the engine-generator set. Checks applicable to the installation shall be performed. The results of those which are physical inspections (I) shall be documented by the Contractor and submitted in accordance with paragraph SUBMITTALS. The Contractor shall present manufacturer's data for the inspections designated (D) at the time of inspection. Inspections shall verify that equipment type, features, accessibility, installation and condition are in accordance with the contract specification. Manufacturer's statements shall certify provision of features which cannot be verified visually.

1. Drive belts. (I)
2. Governor type and features. (I)
3. Engine timing mark. (I)
4. Starting motor. (I)
5. Starting aids. (I)
6. Coolant type and concentration. (D)
7. Radiator drains. (I)
8. Block coolant drains. (I)
9. Coolant fill level. (I)
10. Coolant line connections. (I)
11. Coolant hoses. (I)
12. Combustion air filter. (I)

13. Intake air silencer.	(I)
14. Lube oil type.	(D)
15. Lube oil sump drain.	(I)
16. Lube-oil filter.	(I)
17. Lube-oil level indicator.	(I)
18. Lube-oil fill level.	(I)
19. Lube-oil line connections.	(I)
20. Lube-oil lines.	(I)
21. Fuel type.	(D)
22. Fuel-level.	(I)
23. Fuel-line connections.	(I)
24. Fuel lines.	(I)
25. Fuel filter.	(I)
26. Access for maintenance.	(I)
27. Voltage regulator.	(I)
28. Battery-charger connections.	(I)
29. Wiring & terminations.	(I)
30. Instrumentation.	(I)
31. Hazards to personnel.	(I)
32. Base.	(I)
33. Nameplates.	(I)
34. Paint.	(I)
35. Exhaust-heat system.	(I)
36. Exhaust muffler.	(I)
37. Switchboard.	(I)
38. Switchgear.	(I)
39. Access provided to controls.	(I)
40. Enclosure is weather resistant.	(I)
41. Engine & generator mounting bolts (application).	(I)
42. Turbo-charger/supercharger connections	(I)

3.5.4 Pre-operational Tests

3.5.4.1 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings shall be implemented in accordance with the installation coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE ANSI/IEEE C57.13.1.

3.5.4.2 Insulation Test

Generator and exciter circuits insulation resistance shall be tested with an insulation tester. Stator readings shall be taken at the circuit breaker, to include generator leads to switchboard. Results of insulation resistance tests shall be recorded. Readings shall be within limits specified by the manufacturer. Mechanical operation, insulation resistance, protective relay calibration and operation, and wiring continuity of switchboard assembly shall be verified. Precautions shall be taken to preclude damaging generator components during test.

3.5.4.3 Engine-Generator Connection Coupling Test

When the generator provided is a two-bearing machine, the engine-generator

connection coupling shall be inspected and checked by dial indicator to prove that no misalignment has occurred. The dial indicator shall measure variation in radial positioning and axial clearance between the coupling halves. Readings shall be taken at four points, spaced 90 degrees apart. Solid couplings and pin-type flexible couplings shall be aligned within a total indicator reading of 0.012 to 0.025 mm for both parallel and angular misalignment. For gear-type or grid-type couplings, 0.05 mm will be acceptable.

3.5.5 Safety Run Test

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections.
- b. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- c. Activate the manual emergency stop switch and record the time to stop.
- d. Remove the high and pre-high lubricating oil temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.
- e. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine-generator set at no load until the output voltage and frequency stabilize. Monitor the temporarily installed temperature gauges. If either temperature reading exceeds the value required for an alarm condition, activate the manual emergency stop switch.
- f. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.
- g. Remove the high and pre-high coolant temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.
- h. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine generator-set at no load until the output voltage and frequency stabilize.
- i. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

- j. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- k. Operate the engine generator-set for at least 2 hours at 75 percent of Service Load.
- l. Verify proper operation and setpoints of gauges and instruments.
- m. Verify proper operation of ancillary equipment.
- n. Manually adjust the governor to increase engine speed past the overspeed limit. Record the RPM at which the engine shuts down.
- o. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of Service Load.
- p. Manually adjust the governor to increase engine speed to within 2 percent of the overspeed trip speed previously determined and operate at that point for 5 minutes. Manually adjust the governor to the rated frequency.
- q. Manually fill the day tank to a level above the overfill limit. Record the level at which the overfill alarm sounds. Verify shutdown of the fuel transfer pump. Drain the day tank down below the overfill limit.
- r. Shut down the engine. Remove the time-delay low lube oil pressure alarm bypass and try to start the engine.
- s. Attach a manifold to the engine oil system that contains a shutoff valve in series with a connection for the engine's oil pressure sensor followed by an oil pressure gauge ending with a bleed valve. The engine's oil pressure sensor shall be moved from the engine to the manifold and its normal location on the engine temporarily sealed. The manifold shutoff valve shall be open and bleed valve closed.
- t. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of Service Load.
- u. Close the manifold shutoff valve. Slowly allow the pressure in the manifold to bleed off through the bleed valve while watching the pressure gauge. Record the pressure at which the engine shuts down. Catch oil spillage from the bleed valve in a container. Add the oil from the container back to the engine, remove the manifold, and reinstall the engine's oil pressure sensor on the engine.
- v. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 100 percent of Service Load. Record the maximum sound level in each frequency band at a distance of 22.9 m (75 feet) from the end of the

exhaust piping directly along the path of discharge for horizontally discharged exhausts, or at a radius of 22.9 m (75 feet) from the engine at 45 degrees apart in all directions for vertically discharged exhausts.

- w. Manually drain off fuel slowly from the day tank to empty it to below the low fuel level limit and record the level at which the audible alarm sounds. Add fuel back to the day tank to fill it above low level alarm limits.
- x. Manually adjust the governor to speed up the engine to a level beyond the over frequency alarm setpoint and record the frequency when the audible alarm sounds. Manually adjust the governor to slow down the engine to a level below the under frequency alarm setpoint and record the frequency when the audible alarm sounds. Return the speed to the rated value. Shut down the engine-generator set.

3.5.6 Performance Tests

In the following tests, where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings.

3.5.6.1 Engine Load Run Test

Test the engine-generator set and ancillary systems at service load to demonstrate durability; verify that heat of extended operation does not adversely affect or cause failure in any part of the system; and check all parts of the system. The engine load run test shall be accomplished principally during daylight hours. Data taken at 15 minute intervals shall include the following:

Electrical: Output amperes, voltage, real and reactive power, power factor, frequency.

Pressure: Lube-oil.

Temperature: Coolant.
Lube-oil.
Exhaust.
Ambient.

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections. Include as a minimum checking coolant fluid, fuel, and lube-oil levels.
- b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warmup period.
- c. Operate the engine generator-set for 2 hours at 75 percent of Service Load.
- d. For prime rated sets, increase load to 100 percent of Service Load and operate the engine generator-set for 2 hours. For standby rated sets, increase load to 100 percent of Service Load, operate

the engine generator-set for 4 hours, and skip the next two steps.

- e. Increase load to 110 percent of Service Load and operate the engine generator-set for 2 hours.
- f. Decrease load to 100 percent of Service Load and operate the engine generator-set for 2 hours or until all temperatures have stabilized.
- g. Remove load from the engine-generator set.

3.5.6.2 Voltage and Frequency Droop Test

For the following steps, verify that the output voltage and frequency return to and stabilize within the specified bandwidth values following each load change. Record the generator output frequency and line-line and line-neutral voltages following each load change.

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- b. With the generator operating at 0 percent load, adjust voltage and frequency to rated voltage and frequency.
- c. Apply and drop load equal to the Maximum Step Load Increase three times in succession.
- d. Increase load to 100 percent of Service Load in steps equal to the Maximum Step Load Increase. Adjust the load, voltage and frequency to 100 percent of Service Load and rated voltage and frequency. No further adjustments may be made to any set controls after this step.
- e. Reduce the load to no load in one step.
- f. Increase load to 100 percent of Service Load in steps equal to the Maximum Step Load Increase. Decrease load to 0 percent of Service Load in steps of 10 percent (operate at each step until voltage and frequency stabilization is achieved).
- g. Plot frequency vs. percent of rated load. Plot voltage vs. percent of rated load.
- h. Calculate the percent droop for voltage and frequency with the following equations.

$$\text{Voltage Droop percentage} = ((\text{No-Load Volts}) - (\text{Service-Load Volts})) / (\text{Service-Load Volts}) \times 100$$

$$\text{Frequency Droop percentage} = ((\text{No-Load Hertz}) - (\text{Service-Load Hertz})) / (\text{Service-Load Hertz}) \times 100$$

3.5.6.3 Voltage Regulator Range Test

For the following steps, record the output line-line and line-neutral voltages and frequency after performing each step instruction (after stabilization of voltage and frequency).

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- b. Apply load in steps no larger than the Maximum Step Load Increase to load the engine-generator set to 100 percent of Service Load. Adjust voltage and frequency to rated voltage and frequency. No further adjustments may be made to any set control for the remainder of this test except the control panel voltage adjust device.
- c. Remove all load.
- d. While operating at 0 percent of Service Load, adjust the voltage regulator to 110 percent of rated voltage.
- e. Increase load from 0 to 100 percent of Service Load.
- f. Decrease load from 100 to 0 percent of Service Load.
- g. While operating at 0 percent of Service Load, adjust the voltage regulator to the maximum attainable voltage or to a value just prior to actuation of the over-voltage protective device.
- h. Increase load from 0 to 100 percent of Service Load.
- i. Decrease load from 100 to 0 percent of Service Load.
- j. While operating at 0 percent of Service Load, adjust the voltage regulator to 90 percent of rated voltage.
- k. Increase load from 0 to 100 percent of Service Load.
- l. Adjust the voltage regulator to the minimum attainable value or the value just prior to activation of the undervoltage protection device.
- m. Decrease the load to 0 percent of Service Load.
- n. With the data recorded while the voltage regulator setpoint was at 110 percent rated voltage, calculate the percent voltage droop with the following equation.

$$\text{Voltage Droop percentage} = ((\text{No-Load Volts}) - (\text{Service-Load Volts})) / ((\text{Service-Load Volts}) \times 100)$$
- o. Repeat the above calculation for the data recorded for the voltage regulator setpoint of 90 percent rated voltage, and for the maximum and minimum attainable voltage levels.

3.5.6.4 Governor Adjustment Range Test

For the following steps, record the output line-line and line-neutral voltages and frequency after performing each step instruction (after stabilization of voltage and frequency). Operate for approximately two minutes at each step.

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- b. Make initial adjustments to the load, voltage and frequency to obtain rated values. No further adjustments may be made to any set control for the remainder of this test except the control panel frequency adjust device.
- c. While operating at rated voltage and 0 percent of Service Load, adjust the governor to 90 percent of rated frequency or just above the underfrequency trip setpoint.
- d. Increase load to 100 percent of Service Load in steps equal to the maximum step load increase.
- e. Decrease load from 100 to 0 percent of Service Load. Adjust the governor control to just below the engine overspeed trip setpoint.
- f. Apply 100 percent of Service Load in steps equal to the maximum step load increase and operate for approximately two minutes at each step.
- g. With the data recorded while the governor setpoint was at 90 percent rated frequency calculate the percent frequency regulation with the following equation.

$$\text{Frequency Droop percentage} = ((\text{No-Load Hertz}) - (\text{Service-Load Hertz})) / (\text{Service-Load Hertz}) \times 100$$

- h. Repeat the above calculation using the data recorded with the governor control at just below the engine overspeed trip setpoint.

3.5.6.5 Frequency and Voltage Stability and Transient Response

Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results with high resolution, high speed strip chart recorders and express the results as detailed in MIL-STD 705 method 608.1. Data taken shall include the following:

Ambient temperature (at 15 minute intervals).

Generator output current (before and after load changes).

Generator output voltage (before and after load changes).

Frequency (before and after load changes).

Charts of momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change.

Charts which show the generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

- a. Perform and record engine manufacturer's recommended prestarting checks and inspections.
- b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.
- c. With the unit at no load, apply the Maximum Step Load Increase.
- d. Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.
- e. Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100 percent of Service Load.
- f. Apply the Maximum Step Load Increase.
- g. Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.
- h. Repeat steps c. through g.

3.5.6.6 Automatic Operation Tests for Stand-Alone Operation

The automatic loading system shall be tested to demonstrate automatic starting, and loading and unloading of each engine-generator set. The loads for this test shall utilize the actual loads to be served, and the loading sequence shall be the indicated sequence. A voltage and frequency stability and transient response test shall be performed for each load change. Data taken shall include the following:

Ambient temperature (at 15 minute intervals).

Generator output current (before and after load changes).

Generator output voltage (before and after load changes).

Generator output frequency (before and after load changes).

Charts of momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change.

Charts which show the generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

- a. Initiate loss of the primary power source.
- b. Verify starting of the engine generator set and function of the automatic transfer switch. Record the time to start and assume load (voltage and frequency measurements are required on the load terminals of the automatic transfer switch). Verify stabilization

of voltage and frequency within specified bandwidths.

- c. Verify that the automatic loading system sequences load onto the system as indicated. Verify stabilization of voltage and frequency within specified bandwidths after each load change.
- d. Restore the primary power source and monitor transfer from the alternate power source to the primary power source. Verify operation and time delay settings for the automatic transfer switch. Verify stabilization of voltage and frequency of the primary system. Verify stabilization of the engine-generator set voltage and frequency at no load.
- e. Monitor the cool-down period for the engine. Record the ambient temperature, coolant temperature, and time from system transfer until engine shutdown.
- f. Verify resetting of controls to normal.

3.5.7 Final Inspection

- a. Remove the lube oil filter and have the oil and filter examined by the engine manufacturer for excessive metal, abrasive foreign particles, etc. Any corrective action shall be verified for effectiveness by running the engine for 8 hours at Service Load, then re-examining the oil and filter.
- b. Visually inspect and check engine and generator mounting bolts for tightness and visible damage.
- c. Start the engine, record the starting time, make and record all engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.
- d. Increase the load in steps no greater than the Maximum Step Load Increase to 100 percent of Service Load, and operate the engine-generator set for at least 30 minutes.
- e. Measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the same range as previous measurements and is within the required range.
- f. Remove load and shut down the engine-generator set after the recommended cool down period.

3.6 FRAMED INSTRUCTIONS

Two sets of instructions shall be typed and framed under weatherproof laminated plastic, and posted side-by-side where directed before acceptance. First set of instructions shall include wiring and control diagrams and a complete layout of the system. Second set of instructions shall include the condensed operating instructions describing manufacturer's pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Instructions shall include procedures for interrelated equipment (such as heat recovery systems, fuel oil system,

co-generation, load-shedding, and automatic transfer switches).

3.7 MANUFACTURER'S FIELD SERVICE

3.7.1 Onsite Training

The Contractor shall conduct training course for operating staff as designated by the Contracting Officer. The training period shall consist of a total 48 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance. The course instructions shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate routine maintenance operations such as oil change, oil filter change, air filter change, etc. Two copies of a VHS format video tape of the entire training session shall be submitted.

3.7.2 Field Engineer

The engine-generator set manufacturer or assembler shall furnish a qualified field engineer to supervise the complete installation of the engine-generator set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment.

3.8 ACCEPTANCE

Final acceptance of the engine-generator set will not be given until the contractor has successfully completed all tests and all defects in installation material or operation have been corrected.

-- End of Section --