2019

Directory of Kabul River Basin

TECHNICAL SPECIFICATION FOR DECENTRALIZED WASTEWATER TREATMENT SOLUTION (DEWATS)

AUTHOR!

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1/1/2019

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INTRODUCTION

Decentralized Wastewater Treatment System (DEWATS) were developed by an international network of organizations and experts. The term DEWATS may be applied in singular or plural from, referring to a single specific system, to the modular systems approach or the whole range of systems. The approach incorporates lessons learned from the limitations of conventional centralized and decentralized wastewater-treatment solution, thereby assisting to meet the rapidly growing demand for on-site-wastewater management. DEWATS are characterized by the following features:

Wastewater management systems can be either conventional centralized systems or decentralized systems. Centralized systems are usually planned, designed and operated by government agencies which collect and treat large volumes of wastewater for the entire communities. On the other hand, decentralized wastewater management (DWWM) systems treat wastewater of individual houses, apartment blocks or small communities close to their origin. Typically, the decentralized system is a combination of many technologies within a given geographical boundary, namely, onsite systems, low cost collection systems and dispersed siting of treatment facilities. Wastewater treatment systems such as pit latrines, septic tanks, DEWATS etc., which are used for partially treating wastewater in individual residences or a small cluster of houses, are termed as "On Site Wastewater Treatment (OSWT)" systems. OSWT need not have any wastewater collection system, while a DWWM may have a small sewerage system. It may also be noted that any city or town can have a combination of centralized, decentralized and on-site wastewater management systems, to meet the overall city sanitation.

- ✓ DEWATS encompass an approach, not just a technical hardware package. Besides technical and engineering aspects, the specific local economic and social situation is also taken into consideration.
- ✓ DEWATS provides treatment for wastewater flows with COD/BOD ratios from 1 to 1000 per day and unit.
- ✓ DEWATS can treat wastewaters from domestic or industrial sources. They can provide, secondary and tertiary treatment for wastewaters from sanitation facilities, housing colonies, public entities like hospitals, or from businesses, especially those involved in food production and processing.
- ✓ DEWATS are can be an integral part of comprehensive wastewater strategies. The systems may be used for complementary treatment in addition to other centralized and decentralized wastewater-treatment options.
- ✓ DEWATS can provide renewable water for irrigation. Depending on the technical layout, biogas supplies energy for cooking, lighting or power generation.
- ✓ DEWATS are based on a set of design and layout principles. Reliability, longevity, tolerance towards inflow fluctuation, cost efficiency and, most importantly, low control and maintenance requirements.
- ✓ DEWATS usually function without technical energy inputs. Independence from outside energy source and sophisticated technical equipment

provides more reliable operation and, thereby, fewer fluctuations in effluent quality. Pumping may be necessary for water lifting.

- ✓ DEWATS are based on a modular, technical configuration concept. Appropriate combinations of treatment modules can be selected, depending on the required treatment efficiency, costs, land availability, etc.
- ✓ DEWATS units are quality products which can be constructed from indigenous materials and with local workforce. High quality standards in planning and construction for sound DEWATS design are based on a good comprehension of the process of wastewater-treatment.
- ✓ DEWATS require few operation and maintenance skills. While most operational tasks can be carried out by the users, some maintenance services might require a local service provider. In some cases, both operation and maintenance can be delivered by a service provider.
- ✓ DEWATS can reduce pollution load to fit legal requirements. Like all other wastewater - treatment systems, generated solid waste (sludge) must be handled, treated and disposed of in accordance with hygiene and environmental standards.
- ✓ DEWATS consider the socio-economic environment of a location. Neglecting these conditions will result in the failure of the technology.

ACRONYMS

ABR	Anaerobic Baffled Reactor
AD	Anaerobic digestion
AF	Anaerobic Filter
BGD	Biogas digester
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CODin	feed COD concentration
CODp	particulate COD
CODs	soluble COD
CODt	total COD
conc.	concentration
CSTR	Completely Stirred Tank Reactor
DALY	Disability-Adjusted Life Year
DEWATS	Decentralized Wastewater Treatment Sy
EC	Electric Conductivity
Exp. ch.	Expansion chamber (part of a biogas digester)
MO	Micro-organisms
NGO	Non-governmental organization
O&M	Operation and maintenance
per cap	Per capita
PGF	Planted Gravel Filter
pretr.	pre-treatment
Q	Volumetric flow-rate
rem.	Removal
RSD	Relative Standard Deviation
SD	Standard Deviation
S/I	Substrate to inoculum ratio
SBS	School Based Sanitation
SMA	Specific Methanogenic Activity
SMAmax	Maximum Specific Methanogenic Activity
SME	Small and Medium Enterprise
SMP	Soluble Microbial Product
sol.	Soluble
SOP	Standard Operational Procedure
SP	Sampling Point
SRT	Sludge Retention Time
SS	Settable Solids
SSS	Small Sewer System
synth.	Synthetic
t	Time
T	Temperature
TS	Total Solids
UA	Uncertainty Analysis
UASB	Up-flow Anaerobic Sludge Blanket (reactor)
VFA	Volatile Fatty Acids
VIP	Ventilated Improved Pit-latrine
Vol.	Volume
VS	Volatile Solids

DPR	Detailed project Report
VSS	Volatile Settable Solids
WAS	Waste Activated Sludge
WSP	Water and Sanitation Program
ww	Wastewater
WWTP	Wastewater Treatment Plant
FSTP	Faecal Sludge Treatment Plant
FT	Feeding Tank
HH	Household
HRT	Hydraulic Retention Time
FS	Faecal Sludge
FSM	Faecal Sludge Management

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DIVISION 02

SECTION 02 03 04
EXIST CONDITIONS

PART 1 GENERAL

1. REFERENCES

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

AIR-CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI Guideline K	(2005) Guideline for Containers for Recovered Non Flammable Fluorocarbon Refrigerants

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 145	(1991; R 2004) Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
AASHTO T 180	(2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE A10.6	(2006) Safety Requirements for Demolition Operations

CARPET AND RUG INSTITUTE (CRI)

CRI 104	(2002) Standard for Installation Specification Commercial Carpet
EM 385-1-1	(2003) Safety -- Safety and Health Requirements
DLA 4145.25	(June 2000) Storage and Handling of Liquefied and Gaseous

Compressed Gases and Their Full and Empty Cylinder

FAA AC 70/7460-1	(Rev K; Change 1) Obstruction Marking and Lighting
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASA	American Standard Association
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Material

BSI	British Standards Institute
ICAO	International Civil Aviation Organization
BSICP	British Standard Institute Code of Practice
PCA	Portland Cement Association
UBC	Uniform Building Code

In the absence of other Standards being required by the Contract Documents, all work and materials shall meet the requirement of the Uniform Building Code of the United States, and/or applicable American Society for Testing Materials(ASTM) American Association of State Highway and Transportation Officials (AASHTO) Specifications and the latest American Concrete Institute Manual of Concrete Practice and American Institute of Steel Construction (AISC) Manual relevant to the Works except in cases where the Afghanistan Building Code requires a higher standard. In such cases the Afghanistan Code shall govern.

The Contractor shall supply and have at his site office:

- Copies of all latest editions of codes and standards referred to in these specifications by number, or equivalent codes and standards approved by the Project Manager.
- Catalogues and published recommendations from manufacturers supplying products and materials for the project.
- The Contractor shall provide manufacturer's or supplier's certificates to the Project Manager for all products and materials which must meet the requirements of a specific code or standard as stated in these Specifications.

2. GENERAL REQUIREMENTS

The General Conditions of Contract and Special Conditions of Contract shall form an integral part of these General Requirements.

The Contractor shall notify all sub-contractors of the provisions of the Conditions of Contract and the General Requirement of this Specification.

The arrangement and divisions of these Specifications is not to be construed as establishing the limits of responsibility of sub-trades.

The Contractor is responsible for delineating the scope of Sub-Contracts and for coordinating all the Works.

All works shall be carried out in accordance with the following specifications, supplemented by detailed specifications contained in the following sections. Any inconsistencies or ambiguities shall be brought to the notice of the Project Manager for his clarification/ decision. Decision and direction of the Project Manager, in all such cases, shall be final and

binding.

The Contractor shall make himself thoroughly familiar with the site conditions, foresee any and all problems likely to the encountered during execution of the works, and shall be able and ready to solve them effectively. Proposals for solutions to the problems shall be submitted to the Project Manager for approval before proceeding with the work.

3. SUBMITTALS

AUWSSC approval is required for submittals with a "A" designation; submittals not having a "A" designation are for information only. When used, a designation following the "A" designation identifies the office that will review the submittal for the AUWSSC.

4. REGULATORY AND SAFETY REQUIREMENTS

Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the safety requirements contained in ASSE/SAFE A10.6.

SECTION 02 01 01
SURVEY

Under this item the Contractor shall make the stakeout survey for construction purposes with competently qualified men, consistent with the current practices. The work shall proceed immediately upon the award of the contract and shall be expeditiously progressed to completion in a manner and at a rate satisfactory to the Project Manager. The Contractor shall keep the Project Manager fully informed as to the progress of the stakeout survey. The scope of this section of specifications is covered by detailed specifications as laid down herein.

SECTION 02 09 03
DEMOLATION

1. GENERAL REQUIREMENTS

Do not begin demolition until authorization is received from the Contracting Officer. The work of this section is to be performed in a manner that maximizes salvage and recycling of materials. Remove rubbish and debris from the project site; do not allow accumulations inside or outside the building. The work includes demolition, salvage of identified items and materials, and removal of resulting rubbish and debris. Remove rubbish and debris from Government property daily, unless otherwise directed. Store materials that cannot be removed daily in areas specified by the Contracting Officer. In the interest of occupational safety and health, perform the work in accordance with EM 385-1-1, Demolition, and other applicable Sections.

Furnish timely notification of demolition projects to AUWSSC authorities in accordance with 40 CFR 61, Subpart M. Notify the AUWSSC environmental protection organization, local air pollution control district/organization and the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M. If unexpected asbestos/hazardous waste is encountered at the site, the Contracting Officer will investigate the conditions, determine the extent of the affected area, and authorize the Contractor, in writing, to remove and dispose of the asbestos/waste as directed and specified. Payment for such work will be made as specified in Contract. The Contractor will not be required to perform or arrange for this work.

2. DUST AND DEBRIS CONTROL

Prevent the spread of dust and debris and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.

3. PROTECTION

3.1 Traffic Control Signs

Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights. Notify the Contracting Officer prior to beginning such work.

3.2 Existing Conditions Documentation

Before beginning any demolition work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Contracting Officer showing the condition of structures and other facilities adjacent to areas of alteration or removal. Photographs sized 100 mm will be acceptable as a record of existing conditions. Include in the record the elevation of the walls, finish floor elevations, possible conflicting electrical conduits, plumbing lines, the location and extent of existing cracks and other damage and description of surface conditions that exist prior to before starting work. It is the Contractor's

responsibility to verify and document all required outages which will be required during the course of work, and to note these outages on the record document.

3.3 Items to Remain in Place

Take necessary precautions to avoid damage to existing items to be the property of the Government. Repair or replace damaged items if/as required by the Contracting Officer. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports if/as required. Do not overload structural elements for government property.

3.4 Existing Construction Limits and Protection

Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove snow, dust, dirt, and debris from work areas daily.

3.5 Trees

Protect trees within the project site which might be damaged during demolition or deconstruction, and which are indicated to be left in place, by a 1.8 m high fence. Erect and secure fence a minimum of 1.5 m from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Replace any tree designated to remain that is damaged during the work under this contract with like-kind or as approved by the Contracting Officer.

3.6 Utility Service

Maintain existing utilities indicated to stay in service and protect against damage during demolition and deconstruction operations. Prior to start of work, utilities serving each area of removal will be shut off by the AUWSSC and disconnected and sealed by the Contractor if/as required or directed.

3.7 Facilities

If/as required or directed, protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities.

3.8 Protection of Personnel

Before, during and after the demolition work the Contractor shall continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

3.9 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

3.10 RELOCATIONS

Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the work involved. Items to be relocated which are damaged by the Contractor shall be repaired or replaced with new undamaged items as approved by the Contracting Officer.

3.11 REQUIRED DATA

Prepare a Demolition Plan. Include in the plan procedures for careful removal and disposition of materials specified to be salvaged, coordination with other work in progress, a disconnection schedule of utility services, as applicable, a detailed description of methods and equipment to be used for each operation and of the sequence of operations. Identify components and materials to be salvaged for reuse or recycling with reference to paragraph Existing Facilities to be Removed. Append tracking forms for all removed materials indicating type, quantities, condition, destination, and end use. Coordinate with Waste Management Plan. Provide procedures for safe conduct of the work in accordance with EM 385-1-1. Plan shall be approved by AUWSSC prior to work beginning.

3.12 ENVIRONMENTAL PROTECTION

Comply with the Environmental Protection Agency requirements specified.

3.13 USE OF EXPLOSIVES

Use of explosives will not be permitted.

3.14 AVAILABILITY OF WORK AREAS

Areas in which the work is to be accomplished will be available at the notice-to-proceed.

3.15 FILL MATERIAL

Comply with excavating, backfilling, and compacting procedures for soils used as backfill material to fill basements, voids, depressions or excavations resulting from demolition or deconstruction of structures.

Fill material must conform to the definition of satisfactory soil material as defined in AASHTO M 145, Soil Classification Groups A-1, A-2-4, A-2-5 and A-3.

In addition, fill material must be free from roots and other organic matter, trash, debris, frozen materials, and stones larger than 50 millimeters in any dimension.

Soil classification	AASHTO M 145
Moisture-density relations	AASHTO T 180, Method B or D

3.16 EXISTING FACILITIES TO BE REMOVED

Inspect and evaluate existing structures on site for reuse. Existing construction scheduled to be removed for reuse shall be disassembled.

Dismantled and removed materials are to be separated, set aside, and prepared as specified, and stored or delivered to a collection point for reuse, remanufacture, recycling, or other disposal, as specified. Materials shall be designated for reuse on site whenever possible.

3.17 Structures

a. Remove existing structures indicated to be removed to 1.2 meters below grade. Break up basement slabs to permit drainage. Remove sidewalks, curbs, gutters and street light bases as indicated.

b. Demolish structures in a systematic manner from the top of the structure to the ground. Complete demolition work above each tier or floor before the supporting members on the lower level are disturbed. Demolish concrete and masonry walls in small sections. Remove structural framing members and lower to ground by means of derricks, platforms hoists, or other suitable methods as approved by the AUWSSC/WWMD.

c. Locate demolition and deconstruction equipment throughout the structure and remove materials so as to not impose excessive loads to supporting walls, floors, or framing.

d. Building, or the remaining portions thereof, not exceeding 25 m in height may be demolished by the mechanical method of demolition.

3.18 Utilities and Related Equipment

Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the AUWSSC/WWMD representative. Do not interrupt existing utilities serving facilities occupied and used by the Government except when approved in writing and then only after temporary utility services have been approved and provided. Do not begin demolition or deconstruction work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.

3.19 Disconnecting Existing Utilities

Remove existing utilities as indicated or directed and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by AUWSSC/WWMD. When utility lines are encountered that are not indicated on the drawings, the Contracting Officer shall be notified prior to further work in that area. Remove meters and related equipment and deliver to a location in accordance with instructions of the Contracting Officer.

3.20 Chain Link Fencing

Remove chain link fencing, gates and other related salvaged items scheduled for removal and transport to designated areas. Remove gates as whole units. Cut chain link fabric to 7 m lengths and store in rolls off the ground.

3.21 Paving and Slabs

If/as directed, remove concrete and asphaltic concrete paving and slabs as indicated or as directed to a depth below existing adjacent or new finish grade. Provide neat saw cuts at limits of pavement removal. Pavement and slabs designated to be recycled and utilized in this project shall be moved, ground and stored if/as directed by AUWSSC/WWMD. Pavement and slabs not to be used in this project shall be removed from the Installation at Contractor's expense.

3.22 Masonry

Masonry removed in whole blocks shall be salvaged and stored for reuse. Masonry removed in pieces shall be crushed for use as aggregate.

3.23 Concrete

Saw concrete along straight lines to a depth of a minimum 50 mm. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the concrete. Salvage removed concrete.

3.24 Structural Steel

Dismantle structural steel at field connections and in a manner that will prevent bending or damage. Salvage for recycle structural steel, steel joists, girders, angles, plates, columns and shapes. Transport steel joists and girders as whole units and not dismantled. Transport structural steel shapes to a designated storage area, recycling facility or area as directed by the Contracting Officer, stacked according to size, type of member and length, and stored off the ground, protected from the weather.

3.25 Miscellaneous Metal

Salvage shop-fabricated items such as access doors and frames, steel gratings, metal ladders, wire mesh partitions, metal railings, metal windows and similar items as whole units. Salvage light-gage and cold-formed metal framing, such as steel studs, steel trusses, metal gutters, roofing and siding, metal toilet partitions, toilet accessories and similar items. Recycle scrap metal as part of demolition and deconstruction operations.
Provide separate containers to collect scrap metal and transport to a scrap metal collection or recycling facility, in accordance with the Waste Management Plan.

3.26 Carpentry

Salvage for recycle lumber, millwork items, and finished boards, and sort by type and size. Chip or shred and recycle salvaged wood unfit for reuse,

except stained, painted, or treated wood. Salvage windows, doors, frames, and cabinets, and similar items as whole units, complete with trim and accessories. Salvage hardware attached to units for reuse. Brace the open end of door frames to prevent damage.

3.27 Carpet

Remove existing carpet for reclamation in accordance with manufacturer recommendations and as follows. Remove used carpet in large pieces, roll tightly, and pack neatly in a container. Remove adhesive according to recommendations of the Carpet and Rug Institute (CRI). Adhesive removal solvents shall comply with CRI 104. Recycle removed carpet cushion.

3.28 Cylinders and Canisters

Remove all fire suppression system cylinders and canisters and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting Substance (ODS)."

3.29 Mechanical Equipment and Fixtures

Disconnect mechanical hardware at the nearest connection to existing services to remain, unless otherwise noted. Mechanical equipment and fixtures must be disconnected at fittings. Remove service valves attached to the unit. Salvage each item of equipment and fixtures as a whole unit; listed, indexed, tagged, and stored. Salvage each unit with its normal operating auxiliary equipment. Transport salvaged equipment and fixtures, including motors and machines, to a designated storage area as directed by the Contracting Officer. Do not remove equipment until approved. Do not offer low efficiency equipment for reuse; provide to recycling service for disassembly and recycling of parts.

3.30 Preparation for Storage

Remove water, dirt, dust, and foreign matter from units; tanks, piping and fixtures shall be drained; interiors, if previously used to store flammable, explosive, or other dangerous liquids, must be steam cleaned. Seal openings with caps, plates, or plugs. Secure motors attached by flexible connections to the unit. Change lubricating systems with the proper oil or grease.

3.31 Piping

Disconnect piping at unions, flanges and valves, and fittings as required to reduce the pipe into straight lengths for practical storage. Store salvaged piping according to size and type. Carefully dismantle piping that previously contained gas, gasoline, oil, or other dangerous fluids, with precautions taken to prevent injury to persons and property. Store piping outdoors until all fumes and residues are removed. Box prefabricated supports, hangers,

plates, valves, and specialty items according to size and type. Wrap sprinkler heads individually in plastic bags before boxing.
Classify piping not designated for salvage, or not reusable, as scrap metal.

3.32 Fixtures, Motors and Machines

Remove and salvage fixtures, motors and machines associated with plumbing, heating, air conditioning, refrigeration, and other mechanical system installations. Salvage, box and store auxiliary units and accessories with the main motor and machines. Tag salvaged items for identification, storage, and protection from damage. Classify [non-porcelain] broken, damaged, or otherwise unserviceable units and not caused to be broken, damaged, or otherwise unserviceable as debris and disposed of by the Contractor. Salvage and crush porcelain plumbing fixtures unsuitable for reuse.

3.33 Electrical Equipment and Fixtures

Salvage motors, motor controllers, and operating and control equipment that are attached to the driven equipment. Salvage wiring systems and components. Box loose items and tag for identification. Disconnect primary, secondary, control, communication, and signal circuits at the point of attachment to their distribution system.

3.34 Electrical Devices

Remove and salvage switches, switchgear, transformers, conductors including wire and nonmetallic sheeted and flexible armored cable, regulators, meters, instruments, plates, circuit breakers, panel boards, outlet boxes, and similar items. Box and tag these items for identification according to type and size.

3.35 Wiring Ducts or Troughs

Remove and salvage wiring ducts or troughs. Dismantle plug-in ducts and wiring troughs into unit lengths. Remove plug-in or disconnecting devices from the busway and store separately.

3.36 Conduit and Miscellaneous Items

Salvage conduit except where embedded in concrete or masonry. Consider corroded, bent, or damaged conduit as scrap metal. Sort straight and undamaged lengths of conduit according to size and type. Classify supports, knobs, tubes, cleats, and straps as debris to be removed and disposed.

3.37 CONCURRENT EARTH-MOVING OPERATIONS
Do not begin excavation, filling, and other earth-moving operations that are sequential to demolition work in areas occupied by structures to be demolished until all demolition in the area has been completed and debris removed. Fill holes, open basements and other hazardous openings.

3.38 DISPOSITION OF MATERIAL

3.38.1 Title to Materials

Except for salvaged items specified in related Sections, and for materials or equipment scheduled for salvage, all materials and equipment removed and not reused or salvaged, shall become the property of the Contractor and shall be removed from Government property. Title to materials resulting from demolition, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer of the Contractor's demolition, and removal procedures, and authorization by the Contracting Officer to begin demolition and deconstruction. AUWSSC will not be responsible for the condition or loss of, or damage to, such property after contract award. Showing for sale or selling materials and equipment on site is prohibited.

3.38.2 Salvaged Materials and Equipment

Remove materials and equipment that are listed in the Demolition Plan to be removed by the Contractor and that are to remain the property of the Government, and deliver to a storage site, as directed within 10 km of the work site.

a. Salvage items and material to the maximum extent possible.

b. Store all materials salvaged for the Contractor as approved by the Contracting Officer and remove from Government property before completion of the contract. Material salvaged for the Contractor shall not be sold on the site.

c. Remove salvaged items to remain the property of the Government in a manner to prevent damage, and packed or crated to protect the items from damage while in storage or during shipment. Items damaged during removal or storage must be repaired or replaced to match existing items. Properly identify the contents of containers. Deliver items reserved as property of the Government to the areas designated as directed.

d. Remove as directed any items reserved as property of the using service prior to commencement of work under this contract.

e. Remove historical items in a manner to prevent damage. Deliver the following historical items to the Government for disposition: Corner stones, contents of corner stones, and document boxes wherever located on the site.

3.39 Special Instructions

No more than one type of ODS (Ozone Depleting Substance) is permitted in each container. A warning/hazardous label shall be applied to the containers in

accordance with Department of Transportation regulations. All cylinders including but not limited to fire extinguishers, spheres, or canisters containing an ODS shall have a tag with the following information:

a. Activity name and unit identification code

b. Activity point of contact and phone number

c. Type of ODS and pounds of ODS contained

d. Date of shipment

e. Naval stock number.

3.40 Fire Suppression Containers

Deactivate fire suppression system cylinders and canisters with electrical charges or initiators prior to shipment. Also, safety caps must be used to cover exposed actuation mechanisms and discharge ports on these special cylinders.

3.41 Unsalvageable and Non-Recyclable Material

Dispose of unsalvageable and non-recyclable noncombustible material in an approved disposal area off-site. The fill in the disposal area must remain below grade and after disposal is completed, the disposal area must be uniformly graded to drain.

3.42 CLEANUP

Remove debris and rubbish from excavations. Remove and transport the in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

3.43 DISPOSAL OF REMOVED MATERIALS

3.43.1 Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other no salvageable materials resulting from removal operations with all applicable government regulations as contractually specified off-site in the Waste Management Plan. Storage of removed materials on the project site is prohibited.

3.43.2 Removal from Government Property

Transport waste materials removed from demolished structures, except waste soil, from Government property for legal disposal. Dispose of waste soil as directed.

-- End of Section –

DIVISION 03

SECTION 03 08 02

EARTH WORKS

1. Environmental Specification

Environmental impacts have been identified and addressed in the Environmental Impact Assessments (EIA) and Environmental Management Plans (EMP) which were carried out/ developed as part of the feasibility studies. The EIA process involved the collection of primary and secondary data as well as consultations with relevant stakeholders. The EIA identifies the environmental and social impact for both the construction and operational stages of the Project. The EIA recommends a set of mitigation measures, covering both the construction and operational stages. A Mitigation Management Matrix has been developed that summarizes the mitigation measures for each stage and, for each measure, identifies the agencies that would be responsible for implementing, monitoring and management.

Besides, environmental and social management framework (ESMF) has been developed for the Project to effectively address environmental and social opportunities and concerns. Several environmental and social issues related to the Project are well-defined and predictable. Measures to address these are described in the Environmental and Social Management Plan. The ESMF builds upon the generic safeguard framework developed for emergency operations in Afghanistan and used for all emergency operations. The ESMF prescribes specific mitigation and enhancement measures to address the social and environmental aspects of project interventions.

This section of specifications is based on the recommendations of EIA and ESMF provides the potential impacts related with during construction stage of the Project on the physical, biological and socio-economic domains of the environment. Accordingly, the mitigation measures have been identified to mitigate the negative impacts and to enhance the positive impacts. The Contractor is responsible for protection of the environmental and social interests as stipulated in the mitigation management matrix for the Project hereinafter, during execution of the Works under the Contract.

2. Impacts and Mitigations during Construction Stage

2.1 IMPACTS ON LAND RESOURCES

2.1.1 Land Acquisition

The Project will not involve the acquisition of private land on permanent basis. The land will be provided by applicant organization and must specified to Afghanistan Urban Water Supply and Sewerage Corporation (AUWSSC)technical representative. However, the Contractor may require temporary acquisition of land for aggregate quarries, disposal sites and procedures for safe disposal of surplus construction and waste material, access roads for haulage, etc.

2.1.1 Soil Erosion

Soil erosion may occur in the workshop areas as a result of improper runoff drawn from the equipment washing-yards and improper management of construction activities. Soil erosion may also occur at quarry areas, if unmanaged blasting is carried out.
Due to development of project area, velocity of runoff will be increased, which will ultimately enhance soil erosion. Once the proposed and existing sites (after rehabilitation) return to normal operation, it will be subject to a natural depreciation as high embankments become increasingly prone to soil erosion.

2.2 IMPACT ON WATER RESOURCES (SURFACE AND GROUND WATER QUALITY)

The main impact during construction phase is the increase of sediments to the surface water during clearing and grubbing, filling as well as potential release of any chemicals, oil spills being used at the site during construction stage. If these are allowed to be deposited on the site, will be included in the storm water and ultimately contaminate the surface water of nearby streams. Sewage will be generated at the construction camps. If the generated sewage is not properly treated or disposed of, this may contaminate the surface and ground water resources.

2.3 MITIGATION OF IMPACTS ON WATER RESOURCES

To avoid the increase of sediments concentration, chemicals and oil spillage in storm water runoff during excavation and filling each material should be stored with boundaries around it.
Similarly, utmost care should be taken to avoid any spills of oils and hazardous chemicals by best management practices and good housekeeping and following the Material Safety Data Sheets (MSDS).
In case of emergency spills, Standard Operating Procedures (SOP) should be developed and strictly followed by the Contractor.
Sewage from construction camps, Contractor's workshops and equipment washing-yards will be passed through gravel sand beds to remove oil/grease contaminants before discharging into soakage pits.

2.4 IMPACTS ON AIR RESOURCES

Number of machinery and equipment will be required for the construction of Sheberghan City Water Supply Project. The equipment required will depend upon the construction methodology for the various types of works. However, the equipment will broadly consist of cranes, excavators, dump/haul trucks for material excavation, transport vehicles, etc. Most of these will use diesel engines that generate noise and exhaust emissions. The possibility of exhaust emissions increases when old vehicles/plants are utilized for the execution purposes. Generally, the above activity will generate noise, particulate matter (PM), smoke, dust, CO and NO2 in the ambient air which may deteriorate the air quality and result in impacts on human health, fauna and flora. The movement of heavy machinery and vehicles on dirt tracks will also cause fugitive dust emissions. These emissions are the function of silt content of dirt tracks, vehicle speed and mean annual number of days with 0.01 inches or more rainfall. Following empirical relationship as defined by USEPA, 1975 is used for estimation of fugitive dust emissions factor:

E = (0.81s) x (S/30) x [(365-w)/365] Where,
E = emission factor, lb. per vehicle mile
s = Silt content of road surface material (%)
S = Average vehicle speed (mph)
w = mean annual number of days with 0.01 in (0.254 mm) or more of rainfall
Following engineered assumptions are made for parameters mentioned in above formula:
s = 12% (to be confirmed during the geotechnical investigations of site) S = 30 Miles per hour
w = 60 days
The emissions factor for fugitive dust (E) comes out to be 8.122 lbs./vehicle-mile or 3.68 kg/ vehicle-mile. It indicates that each vehicle moving on dirt track with a speed of 30 mph will produce 3.68 kegs of fugitive dust for each traveled mile. During the detail design stage, when total number of construction vehicles and length of dirt tracks can be estimated, total amount of fugitive dust can be quantified.

- Similarly, activities like excavation, compaction dumping and storage of excavated material will also create dust, noise and vibration.
- Due to increased anthropogenic activities ambient air quality of the site will decrease considerably. However, this impact will be of temporary nature as the ambient air quality will improve with the completion of construction stage.
- Due movement of trucks and other vehicles noise and vibration will increase and the residents of nearby settlements will be affected especially at night time.

2.5 MITIGATIONS OF IMPACTS ON AIR RESOURCES

Following are the mitigation and remedial measure, which will be adopted by contractor to control or minimize the release of air contaminants and noise levels:

- Turning of vehicles will be made mandatory to reduce the emission of NO2 and SO2, CO, Hydrocarbons (HC) and PM.
- Emissions points from Batching Plant will be controlled with appropriate control equipment
  (such as fabric filters or cyclones separators).
- Equipment powered with diesel and vehicles will be well maintained to minimize particulate emissions.
- Where dust emissions are high, (dirt) tracks will be overlain with shingle or surface treated. Where necessary, dust emissions will be reduced by regular sprinkling of water for keeping the dust settled down, at 3 hours' interval during the day span and 6 hours' interval during the night time of construction.

- Haul-trucks carrying, earth, sand, aggregate and other materials will be kept covered with tarpaulin to contain the construction materials being transported within the body of each carrier between the sites.
- AUWSSC will monitor the air quality in the Project area in accordance with the accepted International Standards based on their set up monitoring system. While, the contractor should provide the facilities for sampling and analyses, assessment of air quality at sensitive locations and would report to the Project Manager for information sharing. After testing and analysis AUWSSC will coordinate all the efforts in this area with the relevant authorities.

2.6 IMPACTS OF BIOLOGICAL RESOURCES

2.6.1 Floral Resource

Flora is sparse in the area, not a single tree exists in Project Area, only degraded forms of grasses and some small shrubs/herbs exist in the Project Area. The grass cover and the shrubby growth shall be removed during the construction phase, which will have a negligible effect on the status of existing flora.

2.6.2 Faunal Resource

Fauna in the Project Area shall be disturbed to some extent, as the reptiles like snakes and lizards, living in the holes or long tunnels, shall either get killed or shall move to adjoining area, on account of use of heavy machinery for construction of roads and other infrastructures. Their hideouts shall be destroyed of filled up during process. This is a moderate negative impact.

Similarly, birds like Mynah, House Sparrows who build nests in the small bushes in the area, shall be negatively impacted and will have to leave for adjoining areas.

During the construction phase excavations, construction of roads and buildings will involve transportation and movement of heavy constructional machinery in the area.

Personal employed for this purpose will not only visit the area frequently, but some will also stay on the site, which can cause harassment to avifauna besides noise which will scare away birds and other biota.

However, these activities will occur for a limited period as it is only a temporary phase, will not have any significant effect on the surrounding flora/fauna and habitat of the region.

2.7 MITIGATIONS OF IMPACTS ON BIOLOGICAL RESOURCES

2.7.1 Floral Resource

2.7.2

As the impact is negligible, therefore, no mitigation is required.

2.7.2 Faunal Resources

Vehicle speeds should be controlled to avoid any incidental mortality of small mammals or reptiles. There should be clear orders to staff regarding prohibiting hunting and harassing of wild life.

2.8 IMPACTS ON SOCIO-ECONOMIC RESOURCES

2.8.1 Local Communities/Workforce

The areas surrounding communities will be affected during the construction phase as follows:

- During the construction phase the general mobility of the local residents and their livestock in and around the Project area is likely to be hindered.
- Unmonitored construction activities, e.g., blasting may create an accident risk for the local residents particularly their children at quarry sites.
- Surrounding community will have to face the noise and dust problems during the construction activities.
- Induction of outside workers in the Contractor labor may cause cultural issues with the local community.
- Theft problems to the community by the Contractor workers and vice versa.

2.8.2 Income

Due to construction of the Project, locals will get a chance of employment with the construction Contractor. This may result in an increase household income. However, as 90% of the people of the Project as well as nearby area are illiterate, therefore proper training is necessary for their effective utilization.

2.8.3 Gender Issues

The induction of outside labor may create social and gender issues due to the unawareness by them of local customs and norms. It will also cause hindrance to the mobility of local women.

2.9 MITIGATION OF IMPACTS ON SOCIO-ECONOMIC RESOURCES

2.9.1 Local Communities/Workforce

The presence of migrant construction workers inevitably causes some degree of social unease and even active disputes with the local community as a result

of cultural differences. Potential social conflict will be contained by implementing the measures listed below:

- The Contractor should use the local skilled and un-skilled labor as the migrant labor may create some social problems. Employment of local labor will be added benefit to the community.
- Temporary and short duration, the Contractor has to select specific timings for construction activities at periphery of the Project along which community activities exists so as to cause least botheration to the local population considering their peak movement hours.
- Blasting will be carried out during the fixed hours (preferably during the mid-day). The timing will be made known to all the people within 500 meters from the blasting site in all directions. People, except those who actually light the fuse shall be evacuated from the area of 200 meters from the blasting site in all directions at least 15 minutes before blasting.
- The Contractor will be required to maintain close liaison with the local communities to ensure that any potential conflicts related to common resource utilization for the Project purposes are resolved quickly.
- The Contractor will take care of the local community and sensitivity towards the customs and traditions will be encouraged.
- Effective construction control by the Contractor to avoid inconvenience to the locals due to noise, smoke and fugitive dust.
- Haul-trucks carrying concrete, aggregate and sand fill materials will be kept covered with tarpaulin to contain construction materials being transported between the sites.
- Good relations with the local communities will be promoted by encouraging the Contractor to provide opportunities for skilled and un-skilled employment to the locals, as well as on-the-job training in construction for young people. The Contractor will restrict his permanent staff to mix with the locals to avoid any social problems.
- Local vendors will be provided with regular business by purchasing camp site goods and services from them.
- The Contractor will warn the workers not to involve in any theft activities and if anyone would involve in such type of activities, he will have to pay heavy penalty and would be handed over to police. Similarly, at the time of employing, the Contractor has to take care that the workers should be of good repute. The Contractor camp will be properly fenced and main gate will be locked at night with a security guard to check the theft issues from community side.

2.10 Income

In order to use the local labor, it is very necessary to take help from the

Social Development services of the Provincial Government because 60% the people of the Project in and around area are illiterate. Their main source of income or their main occupation is labor. So, there is a great need of a trainer/educator who tells them and educates them about the construction phases and instruments.

2.11 Gender Issues

Project facilities will be located at a minimum distance of 500 meters from the existing settlements and built-up areas in order to avoid disturbance to local community.
The Contractor will have to select the specific timings for the construction activities particularly along periphery of the Project, so as to cause least disturbance to the local population particularly women considering their peak movement hours.
The Contractor will take due care of the local community and sensitivity towards local customs and traditions will be encouraged.
The Contractor will warn the staff strictly not to involve in any un-ethical activities and to obey the local norms and cultural restrictions particularly with reference to women.

2.12 ENVIRONMENTAL MONITORING

The purpose of the environmental monitoring is to ensure that the Environmental Management Matrix (EMMM) is implemented on a timely and effective manner and to ensure that envisaged purpose of the Project are achieved and result in desired benefits to the targeted population without adversely affecting environmental resources. To ensure the effective implementation of the EMMM attached below, which establishes the linkages between the environmental and social impacts, mitigation strategy and the agencies/entity/ person responsible for execution. The EMMM identifies:

- The required mitigation measures recommended in EIA and ESMF;
- The person/organization directly responsible for adhering to or executing the required mitigation measures;
- The person/organization responsible for ensuring and monitoring adherence to the mitigation measures;
- The parameters which will be monitored to ensure compliance with the mitigation measures; and
- The timing at which the mitigation or monitoring has to be carried out.

It is essential that an effective monitoring system be designed and carried out. During the construction phase it will be necessary to monitor and document different construction related activities that may adversely affect the environmental resources of the area or health and safety of the population and the wild life of the area.
The Contractor shall keep updated record of "Temporary Acquisition of Land", Borrow Areas (Quarries) Identification" "Site Identification and Setting up

of Workers' Camp, Batching Plant", "Summary Mitigation and Enhancement", "Redevelopment of Borrow Areas" and "Restoration of Construction Sites". The Contractor will use prescribed Forms to keep information on above environmental parameters and will also keep photographs of different stages of development and implementation of mitigation measures.

2.13 Ancillary Site Rehabilitation

All ancillary sites have to be rehabilitated following their temporary use in order to stabilize the sites, ensure that they are non-degraded or non-polluting and return them to their previous condition.

The Contractor shall ensure that ancillary sites (e.g., stone crushing sites, borrow pits, workforce camps) are fully rehabilitated within one month of the final day of use. This shall involve the removal of all structures except, permanent buildings, if any that the landowner may have requested to remain and the Project Manager has permitted for appropriate use. All refuse, stockpiles and other temporary features shall be removed.

Used borrow areas may be converted into ponds for multipurpose uses by the local villagers / landowner. This will also act as a rainwater harvesting structure to help recharge the ground water of the area. However, the rehabilitation options shall be finalized in consultation with the landowner and shall be approved by the Project Manager.

2.14 CERTIFICATION OF COMPLETED WORKS FOR PAYMENTS

In case of any conflict between the environmental specifications and other specifications in the Contract documents, the Project Manager's decision shall be final and binding on the Contractor.

No additional Payments, unless specifically specified, shall be made to the Contractor for complying with the above environmental specifications, as most of the works generally pertains to good engineering and construction practices. Therefore, the costs for these Environmental Management works shall be considered to have been included in the unit rate of respective item of Works of the priced Bills of Quantities.

SECTION 03 02 03
CLEARING AND GRUBBING

1.SCOPE

The clearing and grubbing shall consist of clearing the designated area of all trees, down timber, snags, bush, other vegetation, rubbish and all other objectionable material, and shall include grubbing stumps, roots, and matted roots, and disposal of all spoil material resulting from the clearing and grubbing. It shall also include the removal and disposal of structures that protrude, encroach upon, or otherwise obstruct the work, except when otherwise provided for on the plans or directed by the Project Manager to be saved. The scope of this section of specifications is covered with detailed specifications laid down herein.

2.LIMIT OF AREA

2.1 Location of Works

The Project Manager will define the limit of areas where clearing and grubbing is to be done. Normally it will include all land within premises of the site and all other construction area including ditches, detours, minor road crossings and other areas shown on the plans or as specified or as directed by the Project Manager. The Project Manager will designate the fences, structures and debris and trees and bushes to be cleared where grubbing is not required. It shall not include clearing and grubbing of borrow or other pit areas from which material is secured. It shall include the leveling or removal of all bunds or mounds within the limits/ boundary of site unless otherwise directed by the Project Manager.

2.2 Grubbing and Cutting

All roots and stumps within the limits of the site shall be grubbed and excavated unless otherwise specified or approved by the Project Manager.

2.3 Disposal

All wood and bushes shall be burned or otherwise disposed of within fifteen (15) days after cutting or felling unless otherwise approved. No tree trunks, stumps or other debris shall be left within Site unless approved in writing by the Project Manager. The location of disposal areas shall be within or outside the limits of the project or as approved in writing by the Project Manager and shall be acquired by the Contractor at his own expense. Any useable material shall remain the property of the Employer.

2.4 Protection and Restoration

The Contractor shall prevent all damage to pipes, conduits, wires, cables or structures above or below ground. No land monuments, property markers, or official datum points shall be damaged or removed until the Project Manager has witnessed or otherwise referred their location and approved their removal. The Contractor shall so control his operations as to prevent damage to trees

and shrubs, which are to be preserved.
Protection may include fences and boards lashed to trees to prevent damage from machine operations. The existing covered or open benchmarks should be relocated as directed by the Project Manager.
In the event that anything specified herein to be saved and protected is damaged by the Contractor; such damages shall immediately be repaired or replaced by the Contractor at his own cost to the satisfaction of the Project Manager.
All areas cleared and grubbed must be approved by the Project Manager or Project Manager's Representative before the start of cleaning operations.

3. PAYMENT OF WORK

No payment shall be made for the Works involved within the scope of this Section of Specifications unless otherwise specifically stated in the Bills of Quantities or herein. The cost thereof shall be deemed to have been included in the quoted unit rate of other items of the Bills of Quantities.

SECTION 03 11 10
LEVELLING AND GRADING

1. SCOPE

The work to be done under this section of the specifications consists of performing all earth work required for leveling and grading the area in accordance with required levels, elevations and grades shown on the Drawing/Plans or as established by the Project Manager. The work to be done by the Contractor shall include performing the required cutting to line, levels, grade and filling the area to the desired levels and grades; providing and transporting labor, excavating, grading, leveling, and watering and all incidental operations required in performing the work as specified herein. Leveling and grading work shall be performed after completing the clearing and grubbing.

During the progress of the works, if by reason of delay, effects of bad weather; rainfall, or from any cause whatsoever, any levels, grades or profiles of the area are changed, the Contractor shall, at his own cost, be liable to bring the area to the required levels and profiles as shown on the Drawings or as directed by the Project Manager.

Prior to commencement of work the Contractor shall submit for approval of the Project Manager complete proposal with regard to methodology he proposes to adopt for cut and fill for leveling and grading works giving due consideration to the site configuration and the required levels and lines shown on the drawing.

2. APPLICABLE STANDARDS

Materials, construction and testing shall comply with the following codes and standards:

ASTM C 136	Sieve or screen analysis of fine and coarse aggregate
ASTM D 422	Test for Liquid Limit on Soil
ASTM D 424	Test for Plastic Limit

3. The Contractor shall submit, a detailed list of plant and equipment which will be undertake to bring to the site and carry out the work. The list shall satisfy the Project Manager as to type, size and quantity.
The Contractor shall jointly survey the Project area marked on the drawings or any areas designated by the Project Manager, and prepare the survey drawings showing pre work levels of natural ground profile and cross-sections and submit to the Project Manager for approval prior to start of any earthwork operation. Clearing grubbing shall be done in accordance with the provision of related specification section.
Existing utilities which are to remain in service or to be relocated and to remain in service until relocation are to be determined by the Contractor.

4. SITE PREPARATION

The Contractor shall set out the works and shall be responsible for true and perfect setting out of the same and for correctness of the positions, levels, dimensions and alignments of all parts thereof. If at any time any error in this respect shall appear during the progress of the works, the Contractor shall at his own expense rectify such error.

The Contractor shall construct and maintain accurate bench marks so that the lines and levels can be easily checked by the Project Manager.

Leveling and grading of the designated area shall be done by means of levelling equipment and grading machines. The Contractor shall be responsible for the required construction and stability of the grades in conformity with the Drawings/Plans or as determined by the Project Manager.

All suitable material from cut/excavations shall be transported to and placed in fill areas or stockpiled at locations designated by the Project Manager.

5. CUT

5.1 Classifications of Cut

No classification shall be made of any material cut/excavated as to its class, nature, origin or conditions.

5.2 Disposal of Cut Material

Suitable materials derived from cut shall be used for filling the depressions or low lying areas; any surplus or unsuitable material shall be disposed of by the Contractor, in spoil banks, waste area as designated and directed by the Project Manager.

5.3 Tolerance

Finished surface shall be smooth / even and shall not vary more than 30 mm from true grade as established by grade hubs.

5.4 Extra Cut/Excavation

In the event the Contractor cuts/excavates any area to a level lower than the required, it shall re-instate such areas to the required density levels and grades. No extra payment will be made to the Contractor on this account.

6. FILL

6.1 Fill Materials

Areas requiring filling shall be filled with select material obtained from the required cut / excavations and material obtained by stripping of top soil

from areas designated as paved. The fill material shall be free from objectionable material and to the satisfaction of the Project Manager. Filling shall be carried out in successive layers and compacted to 85% dry density as per laboratory test ASTM D 1557, not exceeding 200 mm. The Contractor shall not place fill material during periods of rain.

7. Construction of Embankment

7.1 General

It shall consist of construction of select embankment in areas designated as right of way (ROW) for roads including embankment for flood protection dyke and/or boundary wall as shown on the drawings and common embankment for the remaining project area as shown on the drawings. All embankment construction shall be made to lines, levels profiles and grades as shown on the drawings or as established by the Project Manager.

7.2 Select Embankment

Material and Formation

The soil for select embankment shall be A-1, A-2-4, A-2-5 or A-3, soil type as per AASHTO soil classification system which can be obtained from the required cut within the project site or approved borrow area. The fill material shall be free from objectionable material and to the satisfaction of the Project Manager. Filling shall be carried out in successive layers and compacted to 90% dry density as per laboratory test ASTM D 1557, not exceeding 200 mm. The Contractor shall not place fill material during periods of rain.

All embankment construction shall be made to lines, levels, profiles and grades as shown on the drawings or as established by the Project Manager. The soil for embankment shall be A-1, A-2-4, A-2-5, or A-3, type as per AASHTO soil classification system which can be obtained from the required excavation within the project sites or approval borrow areas. The fill material shall be free from objectionable materials and to the satisfaction of the Project Manager. The filling shall be carried out in successive layers and compacted to 90% dry density as per laboratory test ASTM D1557, not exceeding 200 mm.

7.3 Haul

All hauling will be considered a necessary and incidental part of the work.

7.4 Tolerances

Finished surface shall be smooth and even and shall not vary more than 30 mm from true grade as established by grade hubs.

8. QUALITY CONTROL

Field inspection will be carried out jointly by the contractor and the Project Manager. Contractor shall facilitate the inspection and the performance of tests and bear all costs thereof. A copy of all tests shall be submitted to the Project Manager for approval. Tests shall be performed in accordance with the following test procedure and frequency of testing.

Gradation:

ASTM D-422 one initial series for each material from each source and then locally will be continued.

9. MEASUREMENT AND PAYMENT

9.1 General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the undermentioned works related to the relevant items of the Bills of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective item of the Bills of Quantities.
Any fill with approved material necessitated by over cut/excavation due to fault or convenience of the Contractor.
Stock piling of the cut/excavated material at approved locations within project boundary and transporting back suitable material to places requiring fill.
Laboratory and field tests stipulated in these specifications.
Disposal of rejected unsuitable and surplus cut material within 10 kilometers free haulage limit along the most direct route from the boundary of the project.
Transporting approved quality fill material from within the project boundary.
Rolling, leveling, watering & compacting cut & fill the excavated and fill areas to required density.

9.2 Leveling and Grading by 'Cutting'

9.2.1 Measurement

Measurement of acceptably completed works of levelling and grading by cutting will be made on the basis of net actual volume of 'cut' in cubic meter in accordance with the line level and grade shown on the drawings or as directed by the Project Manager.
Quantities of cutting shall be calculated / measured for payment purposes from the pre-work levels and the levels shown on the drawings.

9.2.2 Payment

Payment will be made for acceptable measured quantity as provided above of levelling and grading in 'cut' on the basis of unit rate per cubic meter quoted in the Bill of Quantities and shall constitute full compensation of

all the works related to the item.

9.3 Leveling and Grading by 'Filling'

9.4 Measurement

Measurement of acceptably completed works of levelling and grading of 'Filling' will be made on the basis of net actual volume in cubic meter of compacted 'Fill' in accordance with the lines levels and grade as shown on the drawings as directed by the Project Manager.

Quantities of 'Filling' shall be calculated / measured for payment purposes from the pre-work levels and the levels shown on the drawings.

9.4.1 Payment

Payment will be made for acceptable measured quantity of levelling and grading in 'Filling' on the basis of unit rate per cubic meter quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

9.5 Construction of Embankment

9.5.1 Measurement

Measurement of acceptably completed works of embankment will be made on the basis of net actual volume in cubic meter of compacted 'Fill' in accordance with the lines levels and grade as shown on the drawings as directed by the Project Manager.
Quantities of 'Filling' shall be calculated / measured for payment purposes from the pre-work levels and the levels shown on the drawings.

9.5.2 Payment

Payment will be made for acceptable measured quantity of levelling and grading in 'Filling' on the basis of unit rate per cubic meter quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

10. EARTHWORK FOR PAVEMENTS

10.1.1 Excavation

All excavation shall be made to lines, levels, profiles and grades as shown on the drawings or established by the Project Manager. During progress of the work it may be found necessary or desirable by the Project Manager to vary the levels, elevations and grades of the excavations from those shown in the drawings. The contractor shall perform the excavation to the revised levels, elevations and grades as established by the Project Manager.

Suitable equipment shall be used for carrying out excavation. Water in excavation shall be controlled and discharged from pumps at locations as approved and surface drainage shall be diverted away from the work.

Unsatisfactory foundation material found at or below the elevations shown shall be excavated and replaced as directed.

Materials determined as satisfactory for use in backfill embankment shall be stock pile in designated areas. Stockpiles shall be maintained to provide drainage and stable embankment. Unsatisfactory and excess material shall be disposed of in an approved spoil area as directed by the Project Manager.

Where areas have been over excavated, the elevations shown shall be re-established as approved.

10.1.2 Embankment

It shall consist of construction of embankment for paved areas. Only approved material shall be used in the construction of embankments. The placing and compaction of approved material in areas as shown on plans or as directed by the Project Manager after removal of unsuitable materials and the placing and compacting of embankment materials in holes and other depressions in accordance with the specification and in conformity with the lines, grade, thickness and typical cross-sections shown on the plans or established by the Project Manager.

10.1.3 Materials

The material for embankment shall be free of clay, organic matter and other unsuitable matter. All suitable material from excavations shall be used for construction of embankments. The material from excavation may be improved by mixing with other good quality material as and when directed by the Project Manager. Suitable materials meeting the classification requirements may be obtained from approved borrow areas for construction of embankments. The material used in embankment shall comply with the properties as described herein.

Material for construction of embankment (i.e. paved areas) shall conform to AASHTO ClassA-1-a(o), A-1-b(o) or A-2-4 as specified in AASHTO M-145.

10.2 Execution

10.2.1 Embankment (General)

Embankment shall be constructed to the lines and elevations as specified on the drawings.

The embankment shall be formed in successive layers of not more than 20 cm (8") in loose depth for the full width of the cross-section unless otherwise approved by the Project Manager. Placement shall begin in the deepest portion of the fill and the layers shall be constructed parallel to the

finished surface.

10.2.2 Compaction

For embankment (in cut areas) the subgrade shall be scarified to 15 cm depth, broken-up and compacted to at least 95% of maximum dry density as per compaction test designated by ASTMD-1557. In fill areas the embankment shall be constructed in successive layers (20 cm layer-loose depth) and compacted to 95% of maximum dry density as per ASTMD-1557. The moisture content of the material shall be uniform and within 2% of the optimum moisture content. The contact surface between layers shall be kept damp to the required moisture content to provide satisfactory bond.

10.2.3 Tolerance

The finished surface of subgrade (in cut or fill) shall have the following tolerances from the designed grades:

Plus (+): 0 mm
Minus (-): 25 mm

10.2.4 Quality Control

A testing program shall be submitted by the Contractor. Tests shall be performed by the Contractor to ensure compliance with the specifications as required. A copy of all test reports shall be submitted to the Project Manager for approval. The tests shall be performed in accordance with the following test procedure and frequency of testing.

Prior to construction of embankment, classification and compaction tests shall be carried out on stock-piled material obtained from excavation or approved borrow areas. The tests shall be carried out as per ASTM 422, ASTM 424 and ASTM D-1557. A family of laboratory compaction curves as per ASTMD-1557 representing typical material shall be developed for approval of fill material.

The frequency of testing shall be one test in every 200 m2 area. The field density test shall be performed as per ASTM D 1557 or ASTM D 2167.

10.3 TRENCHES

10.3.1 Excavation

All excavation shall be made to the lines, levels, grades shown on the Drawings or established by the Project Manager.

The sides of the trench shall be as nearly vertical as practical. If found necessary by the Project Manager, a side slope on either side of the trench may be permitted for a trench equal to or greater than 2 m depth so that the average width of the trench does not exceed 1.5 m. Bell holes and depressions for joints shall be dug after the bottom the trench has been graded. Bell holes and depressions shall only be of such length, depth and width as

required for properly making the particular type of joints as shown on the Drawings or as directed by the Project Manager. The bottom of trench shall be properly graded and compacted with approved compacting equipment. Stones, protruding edges etc. shall be removed. When unsuitable material is encountered in the bottom of trench, material shall be removed to the required depth and the trench backfilled to proper grade and required level with coarse sand or other approved material.
If the Contractor excavates beyond the required depth it shall be back filled with approved material and thoroughly compacted at the expense of the Contractor.

Before starting the excavation, the Contractor shall ensure the correct alignment of cables / pipelines on the ground, depth and width of excavation of the trench, all in accordance with the Drawings and instructions of the Project Manager. The Contractor shall make profile with cement concrete pillars.

Excavation shall be carried out to true lines, levels, grades and widths as shown on the Drawings or as directed by the Project Manager, ensuring proper laying of the cable / pipe lines. The trench bottom shall be graded to provide even and substantial bearing over the specified bedding end of the structure.

The Contractor, at his cost shall provide to the satisfaction of the Project Manager all timbering, approved supports, shores and dressings to the sides of excavated trench and foundation in such a manner so as to secure the sides of the trench and excavations from falling or adverse movements. All responsibility connected with such shoring shall rest with the Contractor.

The bottoms of all excavations shall be carefully leveled. Any pockets of soft or loose material in the bottoms of the trenches shall be removed and the cavities so formed filled with lean concrete at the Contractors expense.

During excavation, material suitable for backfilling shall be stock piled in an orderly manner at sufficient distance from the excavated trenches for reuse in backfill.

All necessary precautions shall be taken to properly maintain the excavation while it is open and exposed. If necessary, grading shall be done to prevent surface water from flowing into trenches and any water accumulated therein shall be removed by pumping or other approved methods. If ordinary open cut excavation is not possible or advisable, sheeting and bracing shall be furnished and installed in such excavations to prevent damage and delay of work and to provide safe working conditions. Sheeting and bracing shall be removed as the work progresses.

If for any reason, the levels, grades or profiles of the excavations are changed adversely the Contractor shall, at his own cost, be liable to bring the excavations to the required levels and profiles as shown on the drawings and as directed by the Project Manager.

10.3.2 **Backfill and Compaction**

The bedding material for pipeline shall be sand or gravel/crushed stone as specified on the drawings.

The backfill material shall be placed evenly and carefully around and over the cable / pipeline in layers not exceeding 150 mm. When the material has been conditioned and placed as specified, each layer shall be thoroughly and carefully rammed with temper of adequate size and weight and watered if necessary for proper compaction. Backfill shall be done by hand until a thickness of 300 mm has been compacted over the cable/ pipeline. The remaining backfill may be done with machine. The degree of compaction desired will be at least 95 percent of maximum dry density.

The Contractor shall be responsible for any damage to installations caused by his operations in compacting of backfills and any damage to the cable shall be repaired by the Contractor at his own expense.

Backfill designated to be compacted shall be compacted to 95% in-situ density with respect to maximum density to the lines, levels and grades as shown on the drawings or established by the Project Manager. The Contractor's operations in the placing of backfill designated to be compacted shall be such as well result in an acceptable gradation of material when placed for use in backfill.

Prior to and during placement operations, the material shall have the optimum moisture content required for the purpose of compaction, as determined by the Project Manager, and the moisture content shall be uniform throughout each layer. If the moisture content is less than optimum for compaction the moisture content shall be supplemented by sprinkling and reworking the material at the site of compaction. If the moisture content is greater than optimum for compaction the material shall be dried by reworking, mixing of the dry material or other approved means.

The material obtained from excavation shall be resumed for backfilling brought from the stock pile with approval of the Project Manager.

10.3.3 **TOLERANCES**

10.3.3.1 **Excavation**

Excavation shall be performed within the tolerances for excavation limits indicated on the drawings. Where no tolerance limits are indicated excavation surface shall be smooth and even shall not vary more than 10mm in 3 meters from true profile and shall not be more than 12.5 mm from true elevation.

10.3.3.2 **Fill / Backfill**

The stabilization of compacted fill / backfill surfaces shall be smooth and

even and shall not vary more than 10 mm in 3 meters from true profile and shall not be more than 12.5 mm from true elevation.

10.3.3.3 DISPOSAL OF SURPLUS EXCAVATED MATERIAL

The rejected unsuitable material and surplus excavated material shall be disposed of within 10 km lead measured along the most direct route from boundary of the project as shown on the drawings or as directed by the Project Manager.

The disposal of surplus of unsuitable excavated material shall include loading, unloading, transporting, stacking, spreading and leveling as directed by the Project Manager.

10.3.4 MEASUREMENT AND PAYMENT

10.3.4.1 General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned items related to this section. The cost thereof shall be deemed to have been included in the quoted unit rates of the items of the Bill of Quantities under this section.

- Timber shoring, planking, strutting and providing slope for upholding the sides of excavations.
- De-watering where required to keep the excavated areas dry for pavement, structures, storm water drains and culverts, during construction.
- Any fill with approved materials necessitated by over excavation due to fault or convenience of the Contractor.
- Stock piling the excavated materials at approved location within free haulage limit of 10 km from the project boundary and transporting back suitable material to places requiring fill or backfill.
- Extra excavation involved in providing adequate working space around sides of foundations and pipe culverts.
- Providing approved quality fill/backfill material obtained from outside sources.
- Rolling, leveling, watering and compacting the fill and backfill to required density.
- All laboratory and field tests stipulated in these specifications.
- Preparation of sub-grade (infill).
- Disposal of rejected surplus and unsuitable excavated material within 10 km free haulage limit along the most direct route from the boundary

of the project.

10.3.5 Excavation for Pavement

10.3.5.1 Measurement

The quantities set out for excavation and its subsequent disposal shall be deemed to be the bulk quantity before excavating and no allowance shall be made for any subsequent variations in bulk or for any extra excavation. It shall be calculated/ measured from pre-work levels and the levels shown on the drawings. Measurement of acceptably completed works of excavation will be made on the basis of actual volume in cubic meter of material excavated for pavements as shown on the drawing or as directed by the Project Manager. It shall be calculated/ measured from pre-work levels and the levels shown on the drawing.

10.3.5.2 Payment

Payment will be made for acceptable measured quantity of excavation for pavement on the basis of unit rate per cubic meter quoted in the Bill of Quantities and shall constitute full compensation for all the Works related to the item.

10.3.6 Embankment for Pavement (in Fill)

10.3.6.1 Measurement

Measurement of acceptably completed works of embankment for Pavement will be made on the basis of actual volume in cubic meter of compacted embankment in position in accordance with the lines, levels and grade as shown on drawings or as directed by the Project Manager.

10.3.6.2 Payment

Payment will be made for acceptable measured quantity of embankment for on the basis of unit rate per cubic meter quoted in the Bills of Quantities and shall constitute full compensation for all the Work related to the item.

---END OF SECTION---

DIVISION 04

CONCRETE

SECTION 04 07 03

STRUCTURAL CONCRETE FORMWORK

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 347R (1994) Guide to Formwork for Concrete

PART 2 PRODUCTS

2.1 FORM MATERIALS

2.1.1 Forms

Forms for finished surfaces, except where concrete is placed against earth, shall be wood or steel or other approved concrete form material.

2.1.2 Form Releasing Agents

Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

PART 3 EXECUTION

3.1 FORMS

Forms shall be constructed to conform, within the tolerances specified, to shapes dimensions, lines, elevations, and positions of cast-in-place concrete members as indicated. Forms shall be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE and conforming to construction tolerance given in TABLE 1. Where forms for continuous surfaces are placed in successive units, the forms shall fit over the completed surface to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface.

Surfaces of forms to be reused shall be cleaned of mortar from previous concreting and of all other foreign material before reuse.

Form ties that are to be completely withdrawn shall be coated with a non-staining bond breaker.

3.2 Design and Construction of Formwork

Form work design and construction shall conform to ACI/MCP 205 and ACI 301. Forms shall be tight to prevent leakage of cement paste during concrete placing.

Form facing materials shall be supported by structural members spaced close to prevent deflection of form facing material.

Forms placed in successive units for continuous surfaces shall be fitted to accurate alignment to ensure a smooth completed surface within the tolerances specified.

Where necessary to maintain the tolerances specified, such as long spans where immediate supports are not possible, formwork shall be cambered for anticipated deflections in formwork due to weight and pressure of fresh concrete and to construction loads.
Exposed joints, edges, and external corners shall be chamfered a minimum of 19 millimeters by moldings placed in corners of column, beam, and wall forms.

Shores and struts shall be provided with a positive means of adjustment capable of taking up formwork settlement during concrete placing operations.

Adjustment shall be obtained with wedges or jacks or a combination thereof. When adequate foundations for shores and struts cannot be secured, trussed supports shall be provided.

Temporary openings shall be provided in wall forms, column forms, and at other points where necessary to permit inspection and to facilitate cleaning.

Forms shall be readily removable without impact, shock, or damage to concrete.

3.3 Forms for Standard Rough Form Finish

Rough form finish shall be given concrete formed surfaces that are to be concealed by other construction, unless otherwise specified.

Form facing material for standard rough form finish shall be the specified concrete form plywood or other approved form facing material that will produce concrete surfaces equivalent in smoothness and appearance to that produced by new concrete form plywood panels.

For concrete surfaces exposed only to the ground, undressed, square-edge, 25 millimeters nominal thickness lumber may be used. Horizontal joints shall be level and vertical joints shall be plumb.

3.4 Forms for Standard Smooth Form Finish

Smooth form finish shall be given concrete formed surfaces that are to be exposed to view or that are to be covered with coating material applied directly to concrete or with covering material bonded to concrete, such as waterproofing, damp proofing, painting, or other similar coating system.

Form facing material for standard smooth finish shall be the specified overlaid concrete form plywood or other approved form facing material that is nonreactive with concrete and that will produce concrete surfaces equivalent in smoothness and appearance to that produced by new overlaid concrete form plywood panels.

Maximum deflection of form facing material between supports and maximum deflection of form supports such as studs and wales shall not exceed 0.0025 times the span.
Arrangement of form facing sheets shall be orderly and symmetrical, and sheets shall be in sizes as large as practical.

Panels shall be arranged to make a symmetrical pattern of joints. Horizontal and vertical joints shall be solidly backed and butted tight to prevent leakage and fins.

3.5 Form Ties

Ties shall be factory fabricated metal, adjustable in length, removable or snap-off type that will not allow form deflection or will not spall concrete upon removal.

Portion of form ties remaining within concrete after removal of exterior parts shall be at least 38 millimeters back from concrete surface.

Form ties shall be free of devices that will leave a hole larger than 22 millimeter or less than 13 millimeters in diameter in concrete surface.

Form ties fabricated at the project site or wire ties of any type are not acceptable.

3.6 Tolerances for Form Construction

Formwork shall be constructed to ensure that after removal of forms and prior to patching and finishing of formed surfaces, concrete surfaces shall be in accordance with tolerances specified in ACI 117 and ACI/MCP 205.

3.7 Preparation of Form Surfaces

Contact surfaces of forms shall be coated with form-coating compound before reinforcement is placed. Form-coating compound shall be a commercial formulation that will not bond with, stain, nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces that entails bonding or adhesion nor impede wetting of surfaces to be cured with water or curing compounds.

Excess form-coating compound shall not be allowed to stand in puddles in the forms nor to come in contact with concrete against which fresh concrete will be placed.

Thinning of form-coating compound shall be made with thinning agent of the type, in the amount, and under the conditions recommended by form-coating compound manufacturer's printed or written directions.

3.8 **Removal of Forms**

Forms shall be removed preventing injury to the concrete and ensuring the complete safety of the structure. Formwork for columns, walls, side of beams and other parts not supporting the weight of concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 24 hours has elapsed since concrete placement.

Supporting forms and shores shall not be removed from beams, floors and walls until the structural units are strong enough to carry their own weight and any other construction or natural loads.

Supporting forms or shores shall not be removed before the concrete strength has reached 70 percent of design strength, as determined by field cured cylinders or other approved methods.

This strength shall be demonstrated by job-cured test specimens, and by a structural analysis considering the proposed loads in relation to these test strengths and the strength of forming and shoring system.

The job-cured test specimens for form removal purposes shall be provided in numbers as directed and shall be in addition to those required for concrete quality control.

The specimens shall be removed from molds at the age of 24 hours and shall receive, insofar as possible, the same curing and protection as the structures they represent.

Formwork that does not support weight of concrete, such as sides of beams, walls, columns, and similar vertical parts of the work, may be removed 24 hours after placing concrete, provided concrete is sufficiently hard not to be damaged from form-removal operations.

Formwork that supports weight of concrete, such as beam soffits, slabs, and similar horizontal parts of the work, shall remain in place at least until concrete has attained design minimum laboratory compressive strength at 28 days for applicable concrete class specified.

Form facing material may be removed before concrete has attained its required 28-day compressive strength but in no case less than 6 days after placing concrete, provided shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

Shores and other vertical supports shall remain in place until concrete has attained its required 28-day compressive strength.

Results of control tests will be used as evidence that concrete has attained sufficient strength to permit removal of supporting forms.

Test specimens shall be removed from molds at the end of 24 hours and stored in the structure as near points of sampling as possible; shall receive same protection from elements during curing as is given those portions of the structure which they represent; and shall not be removed from the structure for transmittal to the laboratory prior to expiration of three-fourths of proposed period before removal of forms.

Supporting forms of shoring shall not be removed until strength of control-test specimens has attained a value of at least 10.3 Mega Pascal for columns and 13.8 Mega Pascal for other work.

Contractor shall ensure that newly unsupported portions of the structure are not subjected to heavy construction or material loading.

Tie-rod clamps to be removed from wall shall be loosened 24 hours after concrete is placed; form ties, except for a sufficient number to hold forms in place, may be removed at that time.

Ties wholly withdrawn from wall shall be pulled toward inside face.

When formwork is removed during concrete curing period, exposed concrete shall be cured as specified.

3.9 COATING

The coating shall be used as recommended in the manufacturer's printed written instructions.

Forms for finished surfaces may be wet with water in lieu of coating immediately before placing concrete, except that in cold weather with probable freezing temperatures, coating shall be mandatory.

Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.10 Re-Use of Forms

Surfaces of forms that are to be re-used shall be cleaned and repaired, except that split, frayed, or delaminated form facing material shall not be re-used. Contact surfaces of re-used forms shall be coated as specified.

TOLERANCES FOR FORMED SURFACES

1. Variations from the plumb:	In any 3 m of length -------- 6 mm
a) In the lines and surfaces of walls	Maximum for entire length -- 25 mm
2. Variation from the level or from the indicated on the drawings:	In any 3 m of length ------- 6 mm In any bay or in any 6 m of grades length ---------- 10 mm
a. In beam soffits	Maximum for entire length - 20 mm

TOLERANCES FOR FORMED SURFACES

b. In exposed lintels,	In any bay or in any 6 m of
sills, bond beams,	length ---------- 6 mm
and other conspicuous lines	Maximum for entire length - 13 mm
3. Variation of the linear building lines from established position in plan	In any 6 m ---------- 13 mm Maximum ---------- 25 mm
4. Variation in cross-sectional dimensions of beams and walls	Minus ---------- 6 mm Plus ---------- 13 mm
5. Footings:	
a. Variation of dimensions in plan	Minus ---------- 13 mm Plus ---------- 50 mm when formed or plus 75 mm when placed against unformed excavation

b. Misplacement of eccentricity	2 percent of the footing width in the direction of misplacement but not more than --------- 50 mm
c. Reduction in thickness	Minus ----------------- 5 percent of specified thickness

SECTION 04 09 03
EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS

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 within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS(AASHTO)

AASHTO T 111	(1983; R 2004) Inorganic Matter or Ash in Bituminous Materials

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(2004) Basic Hardboard

ASTM INTERNATIONAL(ASTM)

ASTM A 1011/A 1011M	(2009a) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
ASTM A 109/A 109M	(2008) Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
ASTM A 167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 480/A 480M	(2009) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM B 152/B 152M	(2006ae1) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar

ASTM B 370	(2009) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C 919	(2008) Use of Sealants in Acoustical Applications
ASTM C 920	(2008) Standard Specification for Elastomeric Joint Sealants

ASTM D 1751	(2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (No extruding and Resilient Bituminous Types)
ASTM D 1752	(2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 2628	(1991; R 2005) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D 2835	(1989; R 2007) Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
ASTM D 4	(1986; R 2004) Bitumen Content
ASTM D 412	(2006ae1e2) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D 471	(2006; R 2008) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D 5249	(1995; R 2006) Backer Material for Use with Cold-and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints
ASTM D 6	(1995; R 2006) Loss on Heating of Oil and Asphaltic Compounds
ASTM D 7116	(2005) Standard Specification for Joint Sealants, Hot Applied, Jet Fuel Resistant Types, for Portland Cement Concrete

1.2 SUBMITTALS

SD-02 Shop Drawings
Water stops; G

Shop drawings and fabrication drawings provided by the manufacturer or prepared by the Contractor.

SD-03 Product Data

Preformed Expansion Joint Filler Sealant Water stops

Manufacturer's literature, including safety data sheets, for preformed fillers and the lubricants used in their installation; field-molded sealants and primers (when required by sealant manufacturer); preformed compression seals; and waterstops. Manufacturer's recommended instructions for installing preformed fillers, field-molded sealants; preformed compression seals; and waterstops; and for splicing non-metallic waterstops.

SD-04 Samples

Lubricant for Preformed Compression Seals

Specimens identified to indicate the manufacturer, type of material, size and quantity of material, and shipment or lot represented.

Field-Molded Type

Four liters One gallon of field-molded sealant and one L quart of primer (when primer is recommended by the sealant manufacturer) identified to indicate manufacturer, type of material, quantity, and shipment or lot represented.

Non-metallic Materials

Specimens identified to indicate manufacturer, type of material, size, quantity of material, and shipment or lot represented. Each sample shall be a piece not less than 300 mm 12-inch-long cut from each 61 m 200 ft. of finished waterstop furnished, but not less than a total of 1 m 4 ft. of each type, size, and lot furnished. One splice sample of each size and type for every 50 splices made in the factory and every 10 splices made at the job site. The splice samples shall be made using straight run pieces with the splice located at the mid-length of the sample and finished as required for the installed waterstop. The total length of each splice shall be not less than 300 mm 12 inches long.

1.3 DELIVERY AND STORAGE

Material delivered and placed in storage shall be stored off the ground and protected from moisture, dirt, and other contaminants. Sealants shall be delivered in the manufacturer's original unopened containers. Sealants whose shelf life has expired shall be removed from the site.

2. PART 2 PRODUCTS

2.1 CONTRACTION JOINT STRIPS

Contraction joint strips shall be 3 mm 1/8-inch-thick tempered hardboard conforming to AHA A135.4, Class 1. In lieu of hardboard strips, rigid polyvinylchloride (PVC) or high impact polystyrene (HIPS) insert strips specifically designed to induce controlled cracking in slabs on grade may be used. Such insert strips shall have removable top section.

2.2 PREFORMED EXPANSION JOINT FILLER

Expansion joint filler shall be performed material conforming to ASTM D 1751 or ASTM D 1752.
Unless otherwise indicated, filler material shall be 10 mm 3/8-inch-thick and of a width applicable for the joint formed. Backer material, when required, shall conform to ASTM D 5249.

2.3 SEALANT
Joint sealant shall conform to the following:

2.3.1 Preformed Polychloroprene Elastomeric Type

ASTM D 2628.

2.3.2 Lubricant for Preformed Compression Seals
ASTM D 2835.

2.3.3 Field-Molded Type

ASTM C 920, Type M, Grade P or NS, Class 25, Use T for horizontal joints. Type M, Grade NS, Class 25, Use NT for vertical joints. Bond breaker material shall be polyethylene tape, coated paper, metal foil or similar type materials. The back-up material shall be compressible, non-shrink, nonreactive with sealant, and non-absorptive material type such as extruded butyl or polychloroprene rubber.

2.4 WATERSTOPS

Intersection and change of direction waterstops shall be shop fabricated.

2.4.1 Flexible Metal

Copper waterstops shall conform to ASTM B 152/B 152M and ASTM B 370, O60 soft anneal temper and 0.686 mm 20 Oz mass per sq. ft. sheet thickness. Stainless steel waterstops shall conform to ASTM A 167 and ASTM A 480/A 480M, UNS S30453 (Type 304L), and 0.9525 mm 20-gauge thick strip.

2.4.2 Rigid Metal

Flat steel waterstops shall conform to ASTM A 109/A 109M, No. 2 (half hard) temper, No. 2 edge, No. 1 (matte or dull) finish or ASTM A 1011/A 1011M, Grade 40.

2.4.3 Non-Metallic Materials`

Non-metallic waterstops shall be manufactured from a prime virgin resin; reclaimed material is not acceptable. The compound shall contain plasticizers, stabilizers, and other additives to meet specified requirements. Rubber waterstops shall conform to COE CRD-C 513.
Polyvinylchloride waterstops shall conform to COE CRD-C 572 or BS Standard.
Thermoplastic elastomeric rubber waterstops shall conform to ASTM D 471.

2.4.5 Preformed Elastic Adhesive

Preformed plastic adhesive waterstops shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler, and shall contain no solvents, asbestos, irritating fumes or obnoxious odors. The compound shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength.

2.4.5.2 Adhesion Under Hydrostatic Pressure

The sealing compound shall not leak at the joints for a period of 24 hours under a vertical 2 m 6-foot head pressure. In a separate test, the sealing compound shall not leak under a horizontal pressure of 65 kPa 10 psi which is reached by slowly applying increments of 13 kPa 2 psi every minute.

2.4.5.3 Sag of Flow Resistance

Sagging shall not be detected when tested as follows: Fill a wooden form 25 mm 1-inch-wide and 150 mm 6 inches long flush with sealing compound and place in an oven at 58 degrees C 135 degrees F in a vertical position for 5 days.

2.4.5.4 Chemical Resistance

The sealing compound when immersed separately in a 5% solution of caustic potash, a 5% solution of hydrochloric acid, 5% solution of sulfuric acid and a saturated hydrogen sulfide solution for 30 days at ambient room temperature shall show no visible deterioration.

3. PART 3 EXECUTION

3.1 JOINTS

Joints shall be installed at locations indicated and as authorized.

3.1.1 Contraction Joints

Contraction joints may be constructed by inserting tempered hardboard strips or rigid PVC or HIPS insert strips into the plastic concrete using a steel parting bar, when necessary, or by cutting the concrete with a saw after concrete has set. Joints shall be approximately 3 mm 1/8-inch-wide and shall extend into the slab one-fourth the slab thickness, minimum, but not less than 25 mm 1 inch.

3.1.1.1 Joint Strips

Strips shall be of the required dimensions and as long as practicable. After the first floating, the concrete shall be grooved with a tool at the joint locations. The strips shall be inserted in the groove and depressed until the top edge of the vertical surface is flush with the surface of the slab. The slab shall be floated and finished as specified. Working of the concrete adjacent to the joint shall be the minimum necessary to fill voids and consolidate the concrete. Where indicated, the top portion of the strip shall be sawed out after the curing period to form a recess for sealer. The removable section of PVC or HIPS strips shall be discarded and the insert left in place. True alignment of the strips shall be maintained during insertion.

3.1.1.2 Sawed Joints

Joint sawing shall be early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling. Concrete sawing machines shall be adequate in number and power, and with sufficient replacement blades to complete the sawing at the required rate. Joints shall be cut to true alignment and shall be cut in sequence of concrete placement. Sludge and cutting debris shall be removed.

3.1.2 Expansion Joints

Preformed expansion joint filler shall be used in expansion and isolation joints in slabs around columns and between slabs on grade and vertical surfaces where indicated. The filler shall extend the full slab depth, unless otherwise indicated. The edges of the joint shall be neatly finished with an edging tool of 3 mm 1/8-inch radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, the filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed and oiled wood strip temporarily secured to the top to form a recess to the size shown on the drawings. The wood strip shall be removed after the concrete has set. Contractor may opt to use a removable expansion filler cap designed and fabricated for this purpose in lieu of the wood strip. The groove shall be thoroughly cleaned of laitance, curing compound, foreign materials, protrusions of hardened concrete, and any dust which shall be blown out of the groove with oil-free compressed air.

3.1.3 Joint Sealant

Sawed contraction joints and expansion joints in slabs shall be filled with joint sealant, unless otherwise shown. Joint surfaces shall be clean, dry, and free of oil or other foreign material which would adversely affect the bond between sealant and concrete. Joint sealant shall be applied as recommended by the manufacturer of the sealant.

3.1.3.1 Joints with Preformed Compression Seals

Compression seals shall be installed with equipment capable of installing joint seals to the prescribed depth without cutting, nicking, twisting, or otherwise distorting or damaging the seal or concrete and with no more than 5

percent stretching of the seal. The sides of the joint and, if necessary, the sides of the compression seal shall be covered with a coating of lubricant. Butt joints shall be coated with liberal applications of lubricant.

3.1.3.2 Joints with Field-Molded Sealant

Joints shall not be sealed when the sealant material, ambient air, or concrete temperature is less than 4 degrees C 40 degrees F. When the sealants are meant to reduce the sound transmission characteristics of interior walls, ceilings, and floors the guidance provided in ASTM C 919 shall be followed. Joints requiring a bond breaker shall be coated with curing compound or with bituminous paint. Bond breaker and back-up material shall be installed where required. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations.

3.2 WATERSTOPS, INSTALLATION AND SPLICES

Waterstops shall be installed at the locations shown to form a continuous water-tight diaphragm. Adequate provision shall be made to support and completely protect the waterstops during the progress of the work. Any waterstop punctured or damaged shall be repaired or replaced. Exposed waterstops shall be protected during application of form release agents to avoid being coated. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued. Splices shall be made by certified trained personnel using approved equipment and procedures.

3.2.1 Copper and Stainless Steel

Splices in copper waterstops shall be lap joints made by brazing. Splices in stainless steel waterstops shall be welded using a TIG or MIG process utilizing a weld rod to match the stainless. All welds shall not be annealed to maintain physical properties. Carbon flame shall not be used in the annealing process. Damaged waterstops shall be repaired by removing damaged portions and patching. Patches shall overlap a minimum of 25 mm 1 inch onto undamaged portion of the waterstop.

3.2.2 Flat Steel

Splices in flat steel waterstops shall be properly aligned, butt welded, and cleaned of excessive material.

3.2.3 Non-Metallic

Fittings shall be shop made using a machine specifically designed to mechanically weld the waterstop. A miter guide, proper fixturing (profile dependent), and portable power saw shall be used to miter cut the ends to be joined to ensure good alignment and contact between joined surfaces. The splicing of straight lengths shall be done by squaring the ends to be joined. Continuity of the characteristic features of the cross section of the waterstop (ribs, tabular center axis, protrusions, etc.) shall be maintained across the splice.

3.2.3.1 Rubber Waterstop

Splices shall be vulcanized or shall be made using cold bond adhesive as recommended by the manufacturer. Splices for TPE-R shall be as specified for PVC.

3.2.3.2 Polyvinyl Chloride Waterstop

Splices shall be made by heat sealing the adjacent waterstop edges together using a thermoplastic splicing iron utilizing a non-stick surface specifically designed for waterstop welding. The correct temperature shall be used to sufficiently melt without charring the plastic. The spliced area, when cooled, shall show no signs of separation, holes, or other imperfections when bent by hand in as sharp an angle as possible.

3.2.4 Non-Metallic Hydrophilic Waterstop Installation

Ends to be joined shall be miter cut with sharp knife or shears. The ends shall be adhered with cyanoacrylates (super glue) adhesive. When joining hydrophilic type waterstop to PVC waterstop, the hydrophilic waterstop shall be positioned as shown on the drawings. A liberal amount of a single component hydrophilic sealant shall be applied to the junction to complete the transition.

3.2.5 Preformed Plastic Adhesive Installation

The installation of preformed plastic adhesive waterstops shall be a prime, peel, place and pour procedure. Joint surfaces shall be clean and dry before priming and just prior to placing the sealing strips. The end of each strip shall be spliced to the next strip with a 25 mm 1-inch overlap; the overlap shall be pressed firmly to release trapped air. During damp or cold conditions, the joint surface shall be flashed with a safe, direct flame to warm and dry the surface adequately; the sealing strips shall be dipped in warm water to soften the material to achieve maximum bond to the concrete surface.

SECTION 04 03 03
CONCRETE REINFORCEMENT

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 318M/318RM	(2002) Building Code Requirements For Structural Concrete And Commentary (Metric) AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
ASTM A 82	(2001) Steel Wire, Plain, for Concrete Reinforcement
ASTM A 615/A 615M	(2001b) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 706/A 706M	(1998) Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 767/A 767M	(1997) Zinc-Coated(Galvanized) Steel Bars in Concrete Reinforcement
ASTM A 775/A 775M	(1997e1) Epoxy-Coated Reinforcement Steel Bars

1.2 MATERIAL AUTHENTICATION DATA INCLUDED IN DESIGN ANALYSIS Items

With a "G" designation require Government approval; items not having a "G" designation are for information only. The following is submitted in accordance with Section of SUBMITTALPROCEDURES FOR DESIGN/BUILD PROJECT. It is included in the Design Analysis for this project. Reinforcing Steel; G Detail drawings showing reinforcing steel placement, schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

1.3 DELIVERY AND STORAGE

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

2. PART 2 PRODUCTS

2.1 REINFORCING STEEL

Reinforcing steel shall be deformed bars conforming to ASTM A 615/A 615M or ASTM A 706/A 706M, grades and sizes as indicated. Cold drawn wire used for spiral reinforcement shall conform to ASTM A 82. In highly corrosive environments or when directed by the Government, reinforcing steel shall conform to ASTM A 767/A 767M or ASTM A 775/A 775M.

2.2 WIRE TIES

Wire ties shall be 1.6 mm (16 gauges) or heavier black steel wire.

3. PART 3 EXECUTIONS

3.1 REINFORCEMENT

Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318M/318RM. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety. Wire tie ends shall face away from the forms.

3.1.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete. Reinforcement shall be placed in accordance with ACI 318M/318RM at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI

318M/318RM. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

3.1.2 Splicing

Splices of reinforcement shall conform to ACI 318M/318RM and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical connection; except that lap splices shall not be used for bars larger than No. 11 (35 mm) unless otherwise indicated. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete.

Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 150 mm. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing.

Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

3.2 WELDED-WIRE FABRIC PLACEMENT

Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Fabric placement at joints shall be as indicated. Lap splices shall be made in such a way that the overlapped area equals the distance between the outermost cross wires plus 50 mm. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 1.2 m. Fabric shall be positioned by the use of supports.

SECTION 04 29 03
CAST-IN-PLACE 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 within the text by the basic designation only.

ACI INTERNATIONAL (ACI)

ACI 117	(2006) Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 211.1	(1991; R 2002) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 301	(2005) Specifications for Structural Concrete
ACI 318/318R	(2005) Building Code Requirements for Structural Concrete and Commentary
ACI/MCP 205	(2005) Manual of Concrete Practice Part 2 - ACI 224R-01 to ACI 313R-97
ACI/MCP 305	(2005) Manual of Concrete Practice Part 3:31599 to 343R-95
ACI/MCP 405	(2005) Manual of Concrete Practice Part 4:345R91(97) to 355.2R-04

ASTM INTERNATIONAL (ASTM)

ASTM A 615/A 615M	(2006a) Standard Specification for Deformed and 4Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C 117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(2004) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate

ASTM C 128	(2004a) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 138/C 138M	(2001a) Standard Test Method for Density ("Unit Weight"), Yield, and Air Content (Gravimetric) of Concrete
ASTM C 143/C 143M	(2005a) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM C 156	(2003) Standard Test Method for Water Retention by Concrete Curing Materials
ASTM C 171	(2003) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	(2004) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 192/C 192M	(2006) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(2004) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 233	(2004) Standard Test Method for Air-Entraining Admixtures for Concrete
ASTM C 260	(2006) Standard Specification for Air Entraining Admixtures for Concrete
ASTM C 29/C 29M	(1997; R 2003) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C 309	(2006) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2006) Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C 33	(2003) Standard Specification for Concrete Aggregates
ASTM C 39/C 39M	(2005e1) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42/C 42M	(2004) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 494/C 494M	(2005a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 566	(1997; R 2004) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C 618	(2005) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 70	(2006) Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C 881/C 881M	(2002) Standard Specification for Epoxy-Resin Base Bonding Systems for Concrete
ASTM C 932	(2005) Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering
ASTM C 94/C 94M	(2006) Standard Specification for Ready-Mixed Concrete
ASTM D 1190	(1997) Standard Specification for Concrete Joint Sealer, Hot-Applied Elastic Type
ASTM D 1557	(2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kNm/m3)
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (NoN-extruding and Resilient Bituminous Types)
ASTM E 329	(2005b) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI MSP-2 (1998) Manual of Standard Practice

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST PS 1 (1996) Construction and Industrial Plywood

1.2 SUBMITTALS

Government approval is required for submittals with a "A" designation; submittals not having a "A" designation are for information only. When used, a designation following the "A" designation identifies the office that will review the submittal for the AUWSSC.

SD-01 Preconstruction Submittals

Construction Equipment Lists shall be submitted by the Contractor prior to construction in accordance with the paragraph entitled, "General Information," of this section.

SD-03 Product Data

Manufacturer's catalog data for the following items shall include printed instructions for admixtures, bonding agents, epoxy-resin adhesive binders, waterstops, and liquid chemical floor hardeners.

Concrete Aggregates; A

Portland Cement; A

Ready-Mix Concrete; A

Form Facing Materials; A

Reinforcement Materials; A

Joint Materials; A

Concrete Curing Materials; A

SD-05 Design Data

Mix design data for each class of Ready-Mix Concrete shall be submitted at least 15 calendar days prior to start of specified work; 'A'

SD-06 Test Reports

Reports for concrete shall be in accordance with the paragraph entitled, "Quality-Control Testing During Construction," of this section. Test reports of the chemical requirements of reinforcing bars shall also be submitted; 'A'

Chemical Composition; A

Mechanical Usability; A

Soundness; A

Slump; A

Air Entrainment; A

Compressive Strength; A

SD-07 Certificates

Mill certificates shall be submitted for Steel Bar according to the paragraph entitled, "Fabrication," of this section.

Certificates for concrete shall be in accordance with the paragraph entitled, "Classification and Quality of Concrete," of this section.

Certificates shall contain project name and number, date, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer, brand name of manufactured materials, material name, values as specified for each material, and test results.

Concrete Design Mixes; A

Concrete Aggregates; A

SD-08 Manufacturer's Instructions

Installation instructions shall indicate the manufacturer's recommended method and sequence of installation for the following items:

Admixtures

SD-11 Closeout Submittals

Records of Communication shall be submitted in accordance with paragraph entitled, "General Information," of this section.

1.3 QUALIFICATIONS FOR CONCRETE TESTING SERVICE

Concrete testing shall be performed by an approved laboratory and inspection service experienced in sampling and testing concrete. Testing agency shall meet the requirements of ASTM E 329.

1.4 CONCRETE SAMPLING AND TESTING

Testing by the Contractor shall include sampling and testing concrete materials proposed for use in the work and testing the design mix for each class of concrete. Quality control testing during construction shall be performed by the Contractor.

Concrete aggregate materials proposed for use in the work shall be sampled and tested in accordance with ASTM C 33.

Portland cement shall be sampled and tested in accordance with ASTM C 150.

Air-entraining admixtures shall be sampled and tested in accordance with ASTM C 233.

1.5 CONCRETE DESIGN MIXES

Mix proportions for each concrete class shall be determined and tested as follows:

REQUIRMENT	TEST METHOD	NUMBER OF TESTS
Specific gravity absorption of fine	ASTM C 128	As required for the concrete aggre aggregate gate for each trial mix
Specific gravity and absorption of coarse aggregate	ASTM C 127	
Gradation of fine and coarse aggregates	ASTM C 117 and ASTM C 136	
Moisture content of both fine and coarse aggregates	ASTM C 70 and ASTM C 566	
Dry-rodded unit weight of coarse aggregate	ASTM C 29/C 29M	
Trial mixes using at least three different water/cement ratios, minimum allowable cement content, maximum allowable slump; both with and without air entrainment	ACI 211.1	As required to determine the concrete mix having the properties specified for each concrete class

Making and curing concrete specimens in the laboratory	ASTM C 192/C 192M	Two sets of three specimens for each design mix
Sampling fresh concrete in the laboratory	ASTM C 192/C 192M	One for each set of design mix specimens
Slump	ASTM C 143/C 143M	
Air content	ASTM C 231	
Yield	ASTM C 138/C 138M	
Compressive strength	ASTM C 39/C 39M	Three specimens tested at 7 days, and three specimens tested at 28 days for each mix design

Proportions of concrete mixtures shall be determined in accordance with ACI/MCP 205 and Method 1 of ACI 301, Section 3.8.2.1. Separate curves shall be prepared for air-entrained and non-air-entrained concretes.

1.6 DELIVERY AND STORAGE OF MATERIALS

Packaged materials shall be delivered to the project site in their original, unopened package or container bearing label clearly identifying manufacturer's name, brand name, material, weight or volume, and other pertinent information. Packaged materials shall be stored in their original, unbroken package or container in a weather tight and dry place until ready for use in the work.

Unpackaged aggregates shall be stored to avoid excessive segregation, contamination with other materials or other size aggregates, or freezing. Reinforcement and other metal items shall be protected from corrosion and shall be kept free from ice, grease, and other coatings that would destroy or reduce bond.

2 PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

2.1.1 Concrete Aggregates

Fine and coarse aggregates shall conform to ASTM C 33.

2.1.2 Portland Cement

Cement shall conform to ASTM C 150, Type I, IA, II, or IIA. One brand and type of cement shall be used for formed concrete having exposed-to-view finished surfaces.

2.1.3 Admixtures

2.1.3.1 Air-Entraining Admixtures

Air-entraining admixtures shall conform to ASTM C 260.

2.1.3.2 Water-Reducing Admixtures

Water-reducing admixtures, retarding admixtures, accelerating admixtures, water-reducing and accelerating admixtures, and water-reducing and retarding admixtures shall conform to ASTM C 494/C 494M.

2.1.3.3 Pozzolan

Fly ash or other pozzolans used as admixtures shall conform to ASTM C 618,

Class C or Class F with 4 percent maximum loss on ignition and 20 percent maximum cement replacement by weight.

2.1.4 Water

Water shall be potable.

2.2 READY-MIX CONCRETE

Concrete shall meet the requirements of ASTM C 94/C 94M.

Ready-mixed concrete manufacturer shall provide duplicate delivery tickets with each load of concrete delivered. Delivery tickets shall provide the following information in addition to that required by ASTM C 94/C 94M:

Type and brand cement

Cement content in 43 kilogram bags per cubic meter of concrete

Maximum size of aggregate

Amount and brand name of admixtures

Total water content expressed by water/cement ratio

2.3 FORM FACING MATERIALS

2.3.1 Concrete Form Plywood (Standard Rough)

Plywood shall conform to NIST PS 1, B-B, concrete form, not less than 16 millimeters thick.

2.3.2 Overlaid Concrete Form Plywood (Standard Smooth)

Plywood shall conform to NIST PS 1, B-B, high density form overlay, not less than 16 millimeters thick.

2.4 REINFORCEMENT MATERIALS

2.4.1 Reinforcing Bars

Reinforcing bars shall conform to ASTM A 615/A 615M and Supplemental S1, Grade 60, ACI/MCP 405, ACI/MCP 305 and ACI 318/318R, Section 3.5.3.2.;4218.0 kg. /sq. cm yield strength.

2.4.2 Dowels for Load Transfer in Floors

Dowels for load transfer in floors shall be of the type, design, weight, and dimensions indicated. Dowel bars shall be plain-billet steel conforming to ASTM A 615/A 615M, Grade 40. Dowel pipe shall be steel conforming to ASTM A 53/A 53M.

2.4.3 Supports for Reinforcement

Supports shall include concrete brick, bolsters, chairs, spacers, and other devices such as concrete brick necessary for proper spacing, supporting, and fastening reinforcing bars and wire fabric in place.

Supports shall be wire bar type conforming to ACI/MCP 405, ACI/MCP 305ACI 318/318R and CRSI MSP-2.

Legs of supports in contact with formwork shall be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

When using epoxy-coated reinforcement bars, coat supports with same material.

2.4.4 Anchor Bolts

Anchor bolts shall conform to ASTM A307 using A36 steel.

2.5 JOINT MATERIALS

2.5.1 Preformed Joint Filler Strips

Filler strips shall be non-extruding and resilient non-bituminous type conforming to ASTM D 1752, Type I or II.

2.5.2 Joint Sealant Compound

Compound shall be cold-applied, two-component, elastomeric polymer type conforming to FS SS-S-200.

2.5.3 Bond Break Material

Bond Break shall be polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick.

2.6 CONCRETE CURING MATERIALS

2.6.1 Absorptive Cover

Cover for curing concrete shall be burlap cloth made from jute or kenaf, weighing 300 grams plus or minus 3 percent per square meter when clean and dry, conforming to ASTM C 171, Class 3; or cover may be cotton mats as approved.

2.6.2 Moisture-Retaining Cover

Cover for curing concrete shall be waterproof paper conforming to ASTM C 171, regular or white, or polyethylene sheeting conforming to ASTM C 171, or polyethylene-coated burlap consisting of a laminate of burlap and a white opaque polyethylene film permanently bonded to the burlap; burlap shall conform to ASTM C 171, Class 3, and polyethylene film shall conform to ASTM C 171. When tested for water retention in accordance with ASTM C 156, weight of water lost 72 hours after application of moisture retaining covering material shall not exceed 0.039 gram per square centimeter of the mortar specimen surface.

2.6.3 Water

Water shall be potable.

2.6.4 Membrane-Forming Curing Compound

Compound shall be liquid type conforming to ASTM C 309, Type 1, clear, Type

1D with fugitive dye for interior work and Type 2, white, pigmented for exterior work.

2.7 CLASSIFICATION AND QUALITY OF CONCRETE

2.7.1 Concrete Classes and Usage

Concrete classes, compressive strength, requirements for air entrainment, and usage shall be as follows:

CONCRETE CLASS	MIN. 28-DAY COMPRESSIVE STRENGTH POUNDS PER MEGA pascal	REQUIREMENT FOR AIR ENTRAINMENT	USAGE
3.5A	25	Air-entrained	For foundation concrete work exposed to freezing and thawing or subjected to hydraulic pressure, such as foundation

			walls, grade beams, pits, tunnels, concrete slabs, steps, platforms, walks
3.5N	25	Nonair-entrained	For foundation concrete work not exposed to freezing and thawing or subjected to hydraulic pressure, such as footings, pile caps, foundation mats. For interior slabs on ground including garage/vehicle maintenance slabs
4A	27.6	Air-entrained	For structural concrete work exposed to freezing and thawing, unless otherwise indicated or specified, such as exterior columns and spandrels
4N	27.6	Nonair-	For structural concrete entrained work not exposed to freezing and thawing such as interior columns, beams, and supported slabs

2.7.2 Limits for Concrete Proportions

Limits for maximum water/cement ratio and minimum cement content for each concrete class shall be as follows:

CONCRETE CLASS	MAX. WATER/CEMENT RATIO BY WEIGHT	MIN. CEMENT FOR 75 TO 100 MM SLUMP, (NO. OF 43 KILO-GRAM SACKS) PER .75 CU. METER
3.5A	0.48	5.62
3.5N	0.51	5.62

2.7.3 Maximum Size of Aggregate

Size of aggregate, designated by the sieve size on which maximum amount of retained coarse aggregate is 5 to 10 percent by weight, shall be as follows:

MAXIMUM SIZE OF AGGREGATE	ASTM C 33 SIZE NUMBER	TYPE OF CONSTRUCTION
50.8 mm	357	Non-reinforced footings and other flat work having a depth of not less than 6 inches, and non-reinforced walls and other formed sections having a dimension between forms of not less than 10 inches
38.1 mm	467	Monolithic slabs on ground, concrete fill, and other flat-work having a depth of not less than 5 inches and a clear distance between reinforcing bars of not less than 2 inches
19.1 mm	67	Reinforced walls, columns, girders, beams, and other formed sections having a dimen-sion between forms of not less than 6 inches and clear distance between reinforcing bars or reinforcing bar and face of form of not less than 1 inch.

Maximum size of aggregate may be that required for most critical type of construction using that concrete class.

2.7.4 Slump

Slump for concrete at time and in location of placement shall be as follows:

TYPE OF CONSTRUCTION	SLUMP
Footings, unreinforced walls	Not less than 25 millimeters nor more than 75 millimeter

Columns, beams, reinforced walls, monolithic slabs	Not less than 25 millimeter nor more than 100 millimeter
Ramps and other sloping surfaces	0 nor more than 75 millimeters

2.7.5 Total Air Content

Air content of exposed concrete and interior concrete shall be in accordance with ASTM C 260 and/or as follows:

LIMITS	REQUIREMENT		
CONCRETE EXPOSURE	FOR AIR ENTRAINMENT	MAXIMUM SIZE OF AGGREGATE	TOTAL AIR CONTENT BY VOLUME
Exposed to freezing	Air-entrained	38.1 or 69.9 mm	4 to 6 percent
and thawing or subjected			5 to 7 percent
to hydraulic pressure		12.7 or 9.5 mm	6 to 8.5 percent

Concrete exposed to freezing and thawing or subjected to hydraulic pressure shall be air-entrained by addition of approved air-entraining admixture to concrete mix.

3 PART 3 EXECUTION

3.1 FORMWORK

3.1.1 General

Forms shall be constructed to conform, within the tolerances specified, to shapes dimensions, lines, elevations, and positions of cast-in-place concrete members as indicated. Forms shall be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

3.1.2 Design and Construction of Formwork

Form work design and construction shall conform to ACI/MCP 205 and ACI 301, Chapter 4.

Forms shall be tight to prevent leakage of cement paste during concrete placing.

Form facing materials shall be supported by structural members spaced close to prevent deflection of form facing material.

Forms placed in successive units for continuous surfaces shall be fitted to accurate alignment to ensure a smooth completed surface within the tolerances specified.

Where necessary to maintain the tolerances specified, such as long spans where immediate supports are not possible, formwork shall be cambered for anticipated deflections in formwork due to weight and pressure of fresh concrete and to construction loads.

Exposed joints, edges, and external corners shall be chamfered a minimum of 19 millimeters by moldings placed in corners of column, beam, and wall forms.

Shores and struts shall be provided with a positive means of adjustment capable of taking up formwork settlement during concrete placing operations.

Adjustment shall be obtained with wedges or jacks or a combination thereof.

When adequate foundations for shores and struts cannot be secured, trussed supports shall be provided.

Temporary openings shall be provided in wall forms, column forms, and at other points where necessary to permit inspection and to facilitate cleaning.

Forms shall be readily removable without impact, shock, or damage to concrete.

3.1.3 Forms for Standard Rough Form Finish

Rough form finish shall be given concrete formed surfaces that are to be concealed by other construction, unless otherwise specified.

Form facing material for standard rough form finish shall be the specified concrete form plywood or other approved form facing material that will produce concrete surfaces equivalent in smoothness and appearance to that produced by new concrete form plywood panels.

For concrete surfaces exposed only to the ground, undressed, square-edge, 25 millimeters nominal thickness lumber may be used. Horizontal joints shall be level and vertical joints shall be plumb.

3.1.4 Forms for Standard Smooth Form Finish

Smooth form finish shall be given concrete formed surfaces that are to be exposed to view or that are to be covered with coating material applied directly to concrete or with covering material bonded to concrete, such as waterproofing, damp proofing, painting, or other similar coating system.

Form facing material for standard smooth finish shall be the specified overlaid concrete form plywood or other approved form facing material that is nonreactive with concrete and that will produce concrete surfaces equivalent in smoothness and appearance to that produced by new overlaid concrete form plywood panels.

Maximum deflection of form facing material between supports and maximum deflection of form supports such as studs and wales shall not exceed 0.0025 times the span.

Arrangement of form facing sheets shall be orderly and symmetrical, and sheets shall be in sizes as large as practical.

Panels shall be arranged to make a symmetrical pattern of joints. Horizontal and vertical joints shall be solidly backed and butted tight to prevent leakage and fins.

3.1.5 Form Ties

Ties shall be factory fabricated metal, adjustable in length, removable or snap-off type that will not allow form deflection or will not spall concrete upon removal. Portion of form ties remaining within concrete after removal of exterior parts shall be at least 38 millimeters back from concrete surface.

Form ties shall be free of devices that will leave a hole larger than 22 millimeter or less than 13 millimeters in diameter in concrete surface. Form ties fabricated at the project site or wire ties of any type are not acceptable.

3.1.6 Tolerances for Form Construction

Formwork shall be constructed to ensure that after removal of forms and prior to patching and finishing of formed surfaces, concrete surfaces shall be in accordance with tolerances specified in ACI 117 and ACI/MCP 205.

3.1.7 Preparation of Form Surfaces

Contact surfaces of forms shall be coated with form-coating compound before reinforcement is placed. Form-coating compound shall be a commercial formulation that will not bond with, stain, nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces that entails bonding or adhesion nor impede wetting of surfaces to be cured with water or curing compounds. Excess form-coating compound shall not be allowed to stand in puddles in the forms nor to come in contact with concrete against which fresh concrete will be placed. Thinning of form-coating compound shall be made with thinning agent of the type, in the amount, and under the conditions recommended by form-coating compound manufacturer's printed or written directions.

3.1.8 Removal of Forms

Formwork that does not support weight of concrete, such as sides of beams, walls, columns, and similar vertical parts of the work, may be removed 24 hours after placing concrete, provided concrete is sufficiently hard not to be damaged from form-removal operations.

Formwork that supports weight of concrete, such as beam soffits, slabs, and similar horizontal parts of the work, shall remain in place at least until concrete has attained design minimum laboratory compressive strength at 28

days for applicable concrete class specified.

Form facing material may be removed before concrete has attained its required

28-day compressive strength but in no case less than 6 days after placing concrete, provided shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports. Shores and other vertical supports shall remain in place until concrete has attained its required 28-day compressive strength.

Results of control tests will be used as evidence that concrete has attained sufficient strength to permit removal of supporting forms. Test specimens shall be removed from molds at the end of 24 hours and stored in the structure as near points of sampling as possible; shall receive same protection from elements during curing as is given those portions of the structure which they represent; and shall not be removed from the structure for transmittal to the laboratory prior to expiration of three-fourths of proposed period before removal of forms. Supporting forms of shoring shall not be removed until strength of control-test specimens has attained a value of at least 10.3 Mega Pascal for columns and 13.8 Mega Pascal for other work. Contractor shall ensure that newly unsupported portions of the structure are not subjected to heavy construction or material loading.

Tie-rod clamps to be removed from wall shall be loosened 24 hours after concrete is placed; form ties, except for a sufficient number to hold forms in place, may be removed at that time. Ties wholly withdrawn from wall shall be pulled toward inside face.

When formwork is removed during concrete curing period, exposed concrete shall be cured as specified.

3.1.9 Re-Use of Forms

Surfaces of forms that are to be re-used shall be cleaned and repaired, except that split, frayed, or delaminated form facing material shall not be re-used. Contact surfaces of re-used forms shall be coated as specified.

3.2 REINFORCEMENT FABRICATION AND INSTALLATION

3.2.1 General

Details of reinforcement shall be in accordance with ACI/MCP 405, ACI/MCP 305 and ACI 318/318R, and as specified.

3.2.2 Fabrication

Reinforcing bars shall be shop fabricated to conform to shapes and dimensions indicated for reinforcement, and as follows:

Fabrication tolerances shall be in accordance with ACI/MCP 205, ACI/MCP 305, ACI 318/318R, and ACI 117.

Hooks and bends shall be in accordance with ACI/MCP 405, ACI/MCP 305 and ACI 318/318R.

Reinforcement shall be bent cold to shapes as indicated. Bending shall be done in the shop. Re-bending of a reinforcing bar that has been bent incorrectly shall not be permitted. Bending shall be in accordance with standard approved practice and by approved machine methods.

Tolerance on nominally square-cut, reinforcing bar ends shall be in accordance with ACI/MCP 305 and ACI 318/318R.

Reinforcing bars shall be delivered bundled, tagged, and marked. Tags shall be metal with bar size, length, mark, and other information pressed in by machine. Marks shall correspond with those used on the placing drawings.

Reinforcement which has any of the following defects shall not be used:

Bar lengths, depths, and bends beyond specified fabrication tolerances Bends or kinks not indicated on drawings or approved shop drawings

Bars with reduced cross-section due to rusting or other cause Defective reinforcement shall be replaced with new reinforcement having required shape, form, and cross-section area.

3.2.3 Placing Reinforcement

Reinforcement shall be placed in accordance with ACI/MCP 405, ACI/MCP 305 and ACI 318/318R.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, bars or welded wire fabric shall be supported on precast concrete blocks, spaced at intervals required by size of

reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

For slabs other than on grade, supports for which any portion will be less than 25 millimeters from concrete surfaces that will be exposed to view or will be painted shall be of precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units shall be wedge shaped, not larger than 90 by 90 millimeter, and of thickness equal to that indicated for concrete protection of reinforcement. Precast units shall have cast-in galvanized tie wire hooked for anchorage and shall blend with concrete surfaces after finishing is completed.

Contractor shall cooperate with other trades in setting of anchor bolts, inserts, and other embedded items. Where conflicts occur between locating reinforcing and embedded items, the Contractor shall notify the Contracting Officer so that conflicts may be reconciled before placing concrete.

Anchors and embedded items shall be positioned and supported with appropriate accessories.

Reinforcement shall be supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

Supports for reinforcing bars shall be sufficient in number and sufficiently heavy to carry the reinforcement they support, and in accordance with ACI/MCP 405, ACI/MCP 305ACI 318/318R and CRSI MSP-2. Supports shall not be used to support runways for concrete conveying equipment and similar construction loads.

Supports on ground and similar surfaces shall be equipped with sand plates.

Reinforcements shall be secured to supports by means of tie wire. Wire shall be black, soft iron wire, not less than 1.6 millimeter.

With the exception of temperature reinforcement, which shall be tied to main steel approximately 600 millimeters on center, reinforcement shall be accurately placed, securely tied at intersections with 1.3 millimeter annealed wire, and held in position during placing of concrete by spacers, chairs, or other approved supports. Wire-tie ends shall point away from the form. Unless otherwise indicated, numbers, type, and spacing of supports shall conform to ACI/MCP 305and ACI 318/318R.

Bending of reinforcing bars partially embedded in concrete will be permitted only as specified in ACI/MCP 405, ACI/MCP 305 and ACI 318/318R.

3.2.4 Spacing of Reinforcing Bars

Spacing shall be as indicated. If not indicated, spacing shall be in accordance with the ACI/MCP 405, ACI/MCP 305 and ACI 318/318R.

Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement shall be subject to approval.

3.2.5 Splices in Reinforcement

Splices shall be as indicated on the approved drawings.

3.2.6 Concrete Protection for Reinforcement

Concrete protection shall be in accordance with the ACI/MCP 405, ACI/MCP

305and ACI 318/318R. Concrete members at or below grade shall have a minimum concrete cover over 75 millimeters.

3.3 INSTALLATION OF ANCHORAGE DEVICES

3.3.1 General

Anchorage devices and embedded items required for other work that is attached to, or supported by, cast-in-place concrete shall be set and built in as part of the work of this section, using setting drawings, instructions, and directions for work to be attached thereto.

3.3.2 Placing Anchorage Devices

Anchorage devices and embedded items shall be positioned accurately and supported against displacement. Openings in anchorage devices such as slots and threaded holes shall be filled with an approved, removable material to prevent entry of concrete into openings.

3.4 PREPARATIONS FOR CONCRETE PLACING

3.4.1 General

Surfaces against which concrete is to be placed shall be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.

Standing water shall be removed without washing over freshly deposited concrete.

Flow of water shall be diverted through side drains provided for such purpose.

3.4.2 Subgrade Under Foundations and Footings

When subgrade material is semi porous and dry, subgrade surface shall be sprinkled with water as required to eliminate suction at the time concrete is deposited. When subgrade material is porous, subgrade surface shall be sealed by covering surface with specified water barrier subgrade cover; this may also be used over semi porous, dry subgrade material instead of water sprinkling.

3.4.3 Subgrade Under Slabs on Ground

Before construction of slabs on ground, underground work on pipes and conduits shall have been completed and approved.

Previously constructed subgrade or fill shall be cleaned of foreign materials and shall be inspected by the Contractor for adequate compaction and surface tolerances as specified.

Actual density of top 300 millimeter of subgrade soil material-in-place shall not be less than the following percentages of maximum density of same soil material compacted at optimum moisture content in accordance with ASTM D 1557.

SOIL MATERIAL	PERCENT MAXIMUM DENSITY
Drainage fill	100
Cohesion less soil material	100
Cohesive soil material	95

Finish surface of drainage fill under interior slabs on ground shall not show deviation in excess of 6.4 millimeter when tested with a 3000 millimeter straightedge parallel with and at right angles to building lines.

Finished surface of subgrade or fill under exterior slabs on ground shall be not more than 6.10 millimeter above or 30.50 millimeter below elevation indicated.

Subgrade or fill surface under exterior slabs on ground shall be prepared as specified for subgrade under foundations and footings.

3.4.4 Formwork

Formwork shall be complete and approved. Debris and foreign material shall be removed from interior of forms before start of concrete placing.

3.4.5 Edge Forms and Screed Strips for Slabs

Edge forms or bulkheads and intermediate screed strips for slabs shall be set to obtain indicated elevations and contours in finished slab surface and shall be strong to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment. Concrete surface shall be aligned to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

3.4.6 Reinforcement and Other Embedded Items

Reinforcement, joint materials, and other embedded materials shall be secured in position, inspected, and approved before start of concrete placing.

3.5 CONCRETE CONVEYING

3.5.1 Transfer of Concrete at Project Site

Concrete shall be handled from point of delivery and transfer to concrete conveying equipment and to locations of final deposit as rapidly as practical by methods which will prevent segregation and loss of concrete mix materials.

3.5.2 Mechanical Equipment for Conveying Concrete

Equipment shall ensure continuous delivery/flow of concrete at delivery end and shall be as approved. If/as necessary, runways for wheeled concrete conveying equipment shall be provided from concrete delivery point to locations of final deposit. Interior surfaces of concrete conveying equipment shall be free of hardened concrete, debris, water, snow, ice, and other deleterious substances.

3.6 CONCRETE PLACING

3.6.1 Weather Limitations and Protection

Concrete shall not be placed when the ambient temperature of the atmosphere exceeds 32 degrees C unless an approved chemical retardant is used, nor when the ambient air temperature is below 5 degrees C, nor during rain, sleet, or snow, unless protection is provided.

When concrete is placed at 32 degrees C or hotter it shall be covered and kept continuously wet for a minimum of 48 hours.

Protection shall be provided during cold weather in accordance with ACI/MCP 205 and ACI 301.

During inclement weather, protection material shall be watertight to prevent entry of rain, sleet, or snow onto surfaces to receive concrete and into fresh concrete.

Protection materials shall be stored at project site for use in event of unforeseen weather changes after start of concrete placing operations.

3.6.2 General Placing Requirements

Concrete shall be deposited continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be provided as specified. Concrete placing shall be performed at such a rate that concrete which is being integrated with fresh concrete is still plastic. Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to re handling or flowing. Concrete shall not be subjected to procedures which will cause segregation.

Concrete to receive other construction shall be screwed to proper level to avoid excessive skimming or grouting.

Concrete which becomes non-plastic and unworkable or does not meet quality control limits as specified or has been contaminated by foreign materials shall not be used. Use of re tempered concrete will not be permitted. Rejected concrete shall be removed from the site.

3.6.3 Placing Concrete in Forms

Concrete placed in forms shall be deposited in horizontal layers not exceeding 600 millimeters.

Temporary spreaders in forms shall be removed when concrete placing has reached elevation of spreaders.

Concrete placed in forms shall be consolidated by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Vibrators shall be designed to operate with vibratory element submerged in concrete and shall maintain a speed of not less than 9,000 impulses per minute when submerged in concrete. Vibrating equipment shall be adequate in number of units and power of each unit to properly consolidate concrete. Vibration of forms and reinforcement shall not be permitted. Vibrators shall not be used to transport concrete inside forms. Vibrators shall be inserted and withdrawn vertically at uniformly spaced points not farther apart than visible effectiveness of machine. Vibrator shall not be inserted into lower courses of concrete that have begun to set. At each insertion, duration of vibration shall be limited

to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of concrete mix.

Placing of concrete in supporting elements shall not be started until concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of 2 hours.

3.6.4 Placing Concrete Slabs

Concrete for slabs shall be placed and consolidated in a continuous operation, within the limits of approved construction joints until placing of panel or section is completed.

During concrete placing operations, concrete shall be consolidated by mechanical vibrating equipment so that concrete is worked around reinforcement and other embedded items and into corners. Concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground shall be consolidated by mechanical vibrators as specified. Concrete in remainder of slabs shall be consolidated by vibrating bridge screeds, roller pipe screeds, or other approved method. Consolidation operations shall be limited to time necessary to obtain consolidation of concrete without bringing an excess of fine aggregate to the surface. Concrete to be consolidated shall be as dry as practical and surfaces thereof shall not be manipulated prior to finishing operations. Concrete shall be brought to correct level with a straightedge and struck-off. Bull floats or darbies shall be used to smooth surface, leaving it free of humps or hollows. Sprinkling of water on plastic surface shall not be permitted.

Finish of slabs shall be as specified.

3.6.5 Bonding

Surfaces of set concrete at joints, except where bonding is obtained by use of concrete bonding agent, shall be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Surfaces shall be roughened in a manner that will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Bonding of fresh concrete that has set shall be obtained as follows:

At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete shall be dampened, but not saturated, immediately prior to placing of fresh concrete.

At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, and other structural members; and at joints in work designed to contain liquids; the roughened and cleaned surface of set concrete shall be dampened but not saturated and covered with a cement grout coating.

Cement grout coating shall consist of equal parts of Portland cement and fine aggregate by weight with not more than 22.5 liter of water per sack of cement. Cement grout shall be applied with a stiff broom or brush to a minimum thickness of 1.6 millimeter. Fresh concrete shall be deposited before cement grout has attained its initial set.

Bonding of fresh concrete to concrete that has set may be obtained by use of a concrete bonding agent. Such bonding material shall be applied to cleaned concrete surface in accordance with approved printed instructions of bonding material manufacturer.

3.7 FINISHING OF FORMED SURFACES

3.7.1 Repairing and Patching Defective Areas

Immediately after removal of forms, defective areas shall be repaired and patched with cement mortar.

Honeycomb, rock pockets, voids over 13 millimeters in diameter, and holes left by tie rods and bolts shall be cut out to solid concrete, but in no case to a depth of less than 25 millimeters. Edges of cuts shall be perpendicular to surface of concrete. Before placing cement mortar, area to be patched at least 150 millimeters adjacent thereto shall be cleaned, dampened with water, and brush coated with neat Portland cement grout. Cement mortar for patching shall consist of one-part standard Portland cement to two parts fine aggregate passing 1.18 millimeter mesh sieve and as little water as necessary for handling and placing. Where concrete surface will be exposed to view, Portland cement portion of cement mortar shall be a blend of white and standard Portland cement so that when dry, cement mortar will match surrounding concrete in color. Cement mortar shall be compacted in place and struck off slightly higher than the surrounding surface. Holes extending through concrete shall be filled by means of a plunger type gun or other

suitable device from unexposed face, using a stop held at exposed face to ensure complete filling.

3.7.2 Standard Rough Form Finish

Finish shall be the concrete surface having texture imparted by form facing material used, defective areas repaired and patched as specified, and fins and other projections exceeding 6 millimeters in height rubbed down with wood blocks.

3.7.3 Standard Smooth Finish

Finish shall be as-cast concrete surface as obtained with form facing material for standard smooth finish. Defective areas shall be repaired and patched as specified; and all fins and other projections on surface shall be removed.

3.7.4 Related Unformed Surfaces

Tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck off smooth after concrete is placed and shall be finished to a texture matching that of adjacent formed

surfaces. Final surface treatment on formed surfaces shall continue uniformly across adjacent unformed surfaces.

3.8 FINISHING OF SLABS

3.8.1 Scratch Finish

A scratch finish shall be given to slab surfaces that are to receive concrete floor topping, mortar setting beds, or other bonded, applied, cement, finish flooring material.

After placing concrete slabs, surface shall be plane to a tolerance not exceeding 6.4 millimeter in 600 millimeter or 3.2 millimeter for surfaces requiring subsequent tile finish when tested with a 600 millimeter straightedge placed on the surface at not less than two different angles. Surfaces shall be uniformly sloped to drains. After leveling, surface shall be roughened with stiff brushes or raked before final set.

3.8.2 Non-Slip Broom Finish

Finish shall be given to surfaces of exterior concrete steps and platforms, and elsewhere where indicated.

Immediately after completion of trowel finish, surface shall be slightly roughened by brooming with a fiber-bristle brush in a direction transverse to that of main traffic.

3.9 CONCRETE CURING AND PROTECTION

3.9.1 General

Freshly placed concrete shall be protected from premature drying and cold or hot temperature and shall be maintained without drying at a relatively constant temperature for the period of time necessary for hydration of cement and proper hardening of concrete.

Initial curing shall start as soon as free water has disappeared from surface of concrete after placing and finishing. Concrete shall be kept moist for minimum 72 hours.

Final curing shall immediately follow initial curing and before concrete has dried. Final curing shall continue until cumulative number of hours or fraction thereof (not necessarily consecutive) during which temperature of air in contact with the concrete is above 10 degrees C has totaled 168 hours. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, final curing may be terminated when the average compressive strength has reached 70 percent of the 28-day design compressive strength. Rapid drying at end of final curing period shall be prevented.

3.9.2 Curing Methods

Curing shall be accomplished by moist curing, by moisture-retaining cover curing, by membrane curing, and by combinations thereof, as specified and approved.

Moist curing:

Moisture curing shall be accomplished by any of the following methods:

Keeping surface of concrete wet by covering with water Continuous water spraying Covering concrete surface with specified absorptive cover for curing concrete saturated with water and keeping absorptive cover wet by water spraying or intermittent hosing. Absorptive cover shall be placed to provide coverage of concrete surfaces and edges with a slight overlap over adjacent absorptive covers.

Moisture-cover curing:

Moisture-retaining cover curing shall be accomplished by covering concrete surfaces with specified moisture-retaining cover for curing concrete. Cover shall be placed directly on concrete in widest practical width, with sides and ends lapped at least 75 millimeters. Cover shall be weighted to prevent displacement; tears or holes appearing during curing period shall be immediately repaired by patching with pressure-sensitive, waterproof tape or other approved method.

Membrane curing:

Membrane curing shall be accomplished by applying specified membrane forming curing compound to damp concrete surfaces as soon as moisture film has disappeared. Curing compound shall be applied uniformly in a two-coat operation by power-spraying equipment using a spray nozzle equipped with a wind guard. Second coat shall be applied in a direction at right angles to direction of first coat. Total coverage for two coats shall be not more than 5 square meter per liter of curing compound. Concrete surfaces which are subjected to heavy rainfall within 3 hours after curing compound has been applied shall be resprayed by method and at rate specified. Continuity of coating shall be maintained for entire curing period and damage to coating during this period shall be repaired immediately.

Membrane-curing compounds shall not be used on surfaces that are to be covered with coating material applied directly to concrete or with a covering material bonded to concrete, such as other concrete, liquid floor hardener, waterproofing, damp proofing, membrane roofing, painting, and other coatings and finish materials.

3.9.3 Curing Formed Surfaces

Curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces shall be accomplished by moist curing with forms in place for full curing period or until forms are removed.

If forms are removed before end of curing period, final curing of formed surfaces shall be accomplished by any of the curing methods specified above, as applicable.

3.9.4 Curing Unformed Surfaces

Initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, shall be accomplished by membrane curing.

Unless otherwise specified, final curing of unformed surfaces shall be accomplished by any of curing methods specified above, as applicable.

Final curing of concrete surfaces to receive liquid floor hardener of finish flooring shall be accomplished by moisture-retaining cover curing.

3.9.5 Temperature of Concrete During Curing

When temperature of atmosphere is 5 degrees C and below, temperature of concrete shall be maintained at not less than 13 degrees C throughout concrete curing period or 7 degrees C when the curing period is measured by maturity. When necessary, arrangements shall be made before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 27 degrees C and above or during other climatic conditions which will cause too rapid drying of concrete, arrangements shall be made before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete shall be uniform and shall not exceed 3 degrees C in any 1 hour nor 28 degrees C in any 24-hour period.

3.9.6 Protection from Mechanical Injury

During curing period, concrete shall be protected from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

3.9.7 Protection After Curing

Finished concrete surfaces shall be protected from damage by construction operations.

3.10 QUALITY-CONTROL TESTING DURING CONSTRUCTION

Concrete shall be sampled and tested for quality control by the Contractor during the placement of the concrete as follows:

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Sampling fresh concrete for slump per	ASTM C 172 except modified ASTM C 94/C 94M	As required for each test

Slump test	ASTM C 143/C 143M	One for each concrete load at point of discharge and one for each set of compressive strength tests
Air content by pressure method	ASTM C 231	One for each set of compressive strength tests
Compression test specimens	ASTM C 31/C 31M	One set of six standard cylinders for each compressive strength test
Concrete temperature		Hourly when air temperature is 4.4 degrees C or below and 26.7 degrees C or above; each time a set of compression test specimens is made
Compressive strength test	ASTM C 39/C 39M	One set for each 115 cubic meter or fraction thereof of each concrete class placed in any one day; two specimens tested at 7 days, three specimens tested at 28 days and one specimen retained in reserve for testing if required

Test reports for concrete for Chemical Composition, Mechanical Usability and Soundness shall be submitted by the Contractor meeting all design specifications as required by referenced standards within this section.

3.11 INSPECTION AND ACCEPTANCE PROVISIONS

3.11.1 Evaluation of Compressive Strength Tests

Concrete quality control test will be evaluated as specified.

Compressive strength tests will be considered satisfactory if the average of all sets of five consecutive compressive strength tests equal or exceed the 28-day design compressive strength, or if no individual compressive strength test (average of two cylinders) falls below the required 28-day design compressive strength by more than 350 kilopascals.

If compressive strength tests fail to meet minimum requirements specified, concrete represented by such tests will be considered deficient in strength and subject to provisions specified.

3.11.2 Strength of Concrete Structure

Strength of concrete structure in place will be considered deficient if it fails to comply with requirements which control strength of structure, including following conditions:

Failure to meet compressive strength tests as evaluated

Reinforcement not conforming to requirements specified

Concrete which differs from required dimensions or location in such a manner as to reduce strength

Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified

Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration Poor workmanship likely to result in deficient strength.

3.11.3 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements, cores drilled from hardened concrete for compressive strength determination shall be made in accordance with ASTM C 42/C 42M, and as follows:

At least three representative cores shall be taken from each member or area of concrete-in-place that is considered potentially deficient.

Location of cores will be determined by the Contracting Officer.

Cores shall be tested after moisture conditioning in accordance with ASTM C 42/C 42M if concrete they represent will be more than superficially wet under service.

Cores shall be air dried, (16 to 27 degrees C with relative humidity less than 60 percent) for 7 days before test and shall be tested dry if concrete they represent will be dry under service conditions.

Strength of cores from each member or area will be considered satisfactory if their average is equal to or greater than 85 percent of the 28-day design compressive strength of the class of concrete.

Core specimens will be taken and tested by the Government. If the results of core-boring tests indicate that the concrete as placed does not conform to the drawings and specification, the cost of such tests and restoration required shall be borne by the Contractor.

Core holes shall be filled solid with patching mortar and finished to match adjacent concrete surfaces.

Concrete work that is found inadequate by core tests shall be corrected in a manner approved by the Contracting Officer.

DIVISION 05

SECTION 05 26 03

MASONERY

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 within the text by the basic designation only.

ACI INTERNATIONAL (ACI)

ACI 318/318R	(2005) Building Code Requirements for Structural Concrete and Commentary
ACI 318M	(2005) Metric Building Code Requirements for Structural Concrete and Commentary
ACI 530	(2005) Building Code Requirements for Masonry Structures Commentaries
ACI 530.1	(2005) Specification for Masonry Structures
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 167	(1999; R 2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 615/A 615M	(2006a) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete

	Reinforcement
ASTM A 641/A 641M	(2003) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A 82/A 82M	(2005a) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM B 370	(2003) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C 1019	(2005) Standard Test Method for Sampling and Testing Grout
ASTM C 1072	(2006) Standard Test Method for Measurement of Masonry Flexural Bond Strength
ASTM C 1142	(1995; R 2001) Standard Specification for Extended Life Mortar for Unit Masonry
ASTM C 129	(2006) Standard Specification for Nonloadbearing Concrete Masonry Units
ASTM C 140	(2006) Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
ASTM C 144	(2004) Standard Specification for Aggregate for Masonry Mortar
ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM C 207	(2006) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C 27	(1998; R 2002) Fireclay and High-Alumina Refractory Brick
ASTM C 270	(2006) Standard Specification for Mortar for Unit Masonry

ASTM C 315	(2002) Clay Flue Linings
ASTM C 476	(2002) Standard Specification for Grout for Masonry
ASTM C 494/C 494M	(2005a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 578	(2006) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 593	(1985; R 2000) Fly Ash and Other Pozzolans for Use with Lime
ASTM C 62	(2005) Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 641	(1998e1) Staining Materials in Lightweight Concrete Aggregates
ASTM C 652	(2005a) Hollow Brick (Hollow Masonry Units Made from Clay or Shale)
ASTM C 67	(2006) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C 780	(2006) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C 90	(2006a) Loadbearing Concrete Masonry Units
ASTM C 91	(2005) Masonry Cement
ASTM C 94/C 94M	(2006) Standard Specification for Ready-Mixed Concrete
ASTM D 1972	(1997; R 2005) Standard Practice for Generic Marking of Plastic Products
ASTM D 2000	(2006a) Standard Classification System for Rubber Products in Automotive Applications
ASTM D 2240	(2005) Standard Test Method for Rubber Property - Durometer Hardness

ASTM D 2287	(1996; R 2001) Non rigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E 119	(2007) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E 2129	(2005) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM E 514	(2004) Water Penetration and Leakage Through Masonry

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2006) International Building Code

1.2 SUBMITTALS

AUWSSC approval is required for submittals with a "A" designation; submittals not having a "A" designation are for information only. When used, a designation following the "A" designation identifies the office that will review the submittal for AUWSSC. Submittal log is as follow:

SD-02 Shop Drawings

Structural Masonry; A

Drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections; offsets; tops, bottoms, and ends of walls; control and expansion joints; lintels; and wall openings. Bar splice locations shall be shown. If the Contractor opts to furnish inch-pound CMU products, drawings showing elevation of walls exposed to view and indicating the location of all cut CMU products shall be submitted for approval. Bent bars shall be identified on a bending diagram and shall be referenced and located on the drawings. Wall dimensions, bar clearances, and wall openings greater than one masonry unit in area shall be shown. No approval will be given to the shop drawings until the Contractor certifies that all openings, including those for mechanical and electrical service, are shown. If, during construction, additional masonry openings are required, the approved shop drawings shall be resubmitted with the additional openings shown along with the proposed changes. Location of these additional openings shall be clearly highlighted. The minimum scale for wall elevations shall be 1 to 50. Reinforcement bending details shall conform to the requirements of ACI SP-66.

SD-03 Product Data

Cold Weather Installation; A

Cold weather construction procedures.

SD-04 Samples

Concrete Masonry Units (CMU)

Color samples of three stretcher units and one unit for each type of special shape. Units shall show the full range of color and texture. Submit sample of colored mortar with applicable masonry unit.

Anchors, Ties, and Bar Positioners; A

Two of each type used.
Expansion-Joint Materials; A
One piece of each type used.

SD-05 Design Data

Pre-mixed Mortar; A

Unit Strength Method; A

Pre-mixed mortar composition. Calculations and certifications of masonry unit and mortar strength.

SD-06 Test Reports

Efflorescence Test; A
Field Testing of Mortar; A
Field Testing of Grout; A
Prism tests; A
Masonry Cement; A
Fire-rated CMU; A
Test reports from an approved independent laboratory. Test reports on a previously tested material shall be certified as the same as that proposed for use in this project.

Special Inspection; A

Copies of masonry inspector reports.

SD-07 Certificates

Clay or Shale Brick
Concrete Masonry Units (CMU)
Control Joint Keys
Anchors, Ties, and Bar Positioners
Expansion-Joint Materials
Reinforcing Steel Bars and Rods
Masonry Cement
Admixtures for Masonry Mortar

Admixtures for Grout

Certificates of compliance stating that the materials meet the specified requirements.

Insulation

Certificate attesting that the insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

Contamination

SD-08 Manufacturer's Instructions

Masonry Cement

When masonry cement is used, submit the manufacturer's printed instructions on proportions of water and aggregates and on mixing to obtain the type of mortar required.

SD-10 Operation and Maintenance Data

Plastic Identification

When not labeled, identify types in Operation and Maintenance Manual.

Take-Back Program

Documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

1.3 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered, handled, stored, and protected to avoid chipping, breakage, and contact with soil or contaminating material. Store and prepare materials in already disturbed areas to minimize project site disturbance and size of project site.

1.3.1 Masonry Units

Cover and protect moisture-controlled concrete masonry units and cementitious materials from precipitation. Conform to all handling and storage requirements of ASTM C 90. Prefabricated lintels shall be marked on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.3.2 Reinforcement, Anchors, and Ties

Steel reinforcing bars, coated anchors, ties shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

1.3.3 Cementitious Materials, Sand and Aggregates

Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with manufacturers' names and brands. Cementitious material shall be stored in dry, weather tight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Sand and aggregates shall be stored in a manner to prevent contamination or segregation.

1.4 STRUCTURAL MASONRY

1.4.1 Special Inspection

A qualified masonry inspector approved by the Contracting Officer shall perform inspection of the masonry work. Minimum qualifications for the masonry inspector shall be 5 years of reinforced masonry inspection experience or acceptance by a State, municipality, or other governmental body having a program of examining and certifying inspectors for reinforced masonry construction. The masonry inspector shall be present during preparation of masonry prisms, sampling and placing of masonry units, placement of reinforcement (including placement of dowels in footings and foundation walls), inspection of grout space, immediately prior to closing of cleanouts, and during grouting operations. The masonry inspector shall assure Contractor compliance with the drawings and specifications. The masonry inspector shall keep a complete record of all inspections and shall submit daily written reports to the Quality Control Supervisory Representative reporting the quality of masonry construction.

1.4.2 Unit Strength Method

Compute compressive strength of masonry system "Unit Strength Method," ACI 530. Submit calculations and certifications of unit and mortar strength.

1.4.3 Seismic Requirement

In addition to design requirements of ICC IBC, the Contractor shall provide additional seismic reinforcement as detailed on the drawings

Bond beams are required at the top of footings, at the bottom and top of openings at roof and floor levels, and at the top of parapet walls and additional locations where indicated.

1.5 QUALITY ASSURANCE

1.5.1 Appearance

Blocks and bricks shall be manufactured at one time and from the same batch.

1.5.2 Contamination

When using bricks containing contaminated soil, supplier shall certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants will be released, or that the product is free from hazardous contaminants.

1.5.3 Testing

Masonry strength shall be determined in accordance with ACI 530; submit test reports on three prisms as specified in ACI 530.1. The cost of testing shall be paid by the Contractor.

1.5.4 Spare Vibrator

Maintain at least one spare vibrator on site at all times.

1.5.5 Bracing and Scaffolding

Provide bracing and scaffolding necessary for masonry work. Design bracing to resist wind pressure as required by local code.

2 PART 2 PRODUCTS

2.2 GENERAL REQUIREMENTS

The source of materials which will affect the appearance of the finished work shall not be changed after the work has started except with Contracting Officer's approval.

The Contractor has the option to use either hard metric or substitute inch-pound (soft-metric) CMU products. If the Contractor decides to substitute inch-pound CMU products, the following additional requirements shall be met:

a) The metric dimensions indicated on the drawings shall not be altered to accommodate inch-pound CMU products either horizontally or vertically. The 100 mm building module shall be maintained, except for the CMU products themselves.
b) Mortar joint widths shall be maintained as specified.

c) Rebar’s shall not be cut, bent or eliminated to fit into the inch-pound CMU products module.

d) Brick and inch-pound CMU products shall not be reduced in size by more than one-third (1/3) in height and one-half (1/2) in length. Cut CMU products shall not be located at ends of walls, corners, and other openings.

e) Cut, exposed brick and CMU products shall be held to a minimum and located where they would have the least impact on the architectural aesthetic goals of the facility.

f) Other building components, built into the CMU products, such as window frames, door frames, louvers, grilles, fire dampers, etc., that are required to be metric, shall remain metric.

2.2 CLAY OR SHALE BRICK

Color range and texture of clay or shale brick shall be as indicated and shall conform to the approved sample.

Brick shall conform to ASTM C 62; Grade SW shall be used for brick in contact with earth or grade and for all exterior work and for all non-vertical surfaces.

Grade SW or MW shall be used in other brickwork.

Average dimensions of brick shall be 90 mm thick, 57 mm high, and 190 mm long (standard), subject to the tolerances specified in ASTM C 62.

Brick shall be tested for efflorescence.

Clay or shale brick units shall be delivered factory-blended to provide a uniform appearance and color range in the completed wall.

2.2.1 Refractory Brick

ASTM C 27, low-duty type.

2.3 CONCRETE BRICK

Concrete brick shall conform to ASTM C 55, Grade N. Concrete brick may be used where necessary for filling out in concrete masonry unit construction.

CONCRETE MANSONERY UNIT (CMU)

2.4 CONCRETE MASONRY UNITS (CMU)

Cement shall have a low alkali content and be of one brand. Surfaces of units which are to be plastered or stuccoed shall be sufficiently rough to provide bond elsewhere.

a. Hollow Load-Bearing Units: ASTM C 90, made with normal weight aggregate. Provide load-bearing units for exterior walls, foundation walls, load-bearing walls, and shear walls.

2.4.1 Aggregates

Lightweight aggregates and blends of lightweight and heavier aggregates in proportions used in producing the units, shall comply with the following requirements when tested for stain-producing iron compounds in accordance with ASTM C 641: by visual classification method, the iron stain deposited on the filter paper shall not exceed the "light stain" classification. Use industrial waste by-products (air-cooled slag, cinders, or bottom ash), ground waste glass and concrete, granulated slag, and expanded slag in aggregates. Slag shall comply with ASTM C 989; Grade 80.

2.4.2 Flue Linings and Thimbles

ASTM C 315, free from fractures. Sizes and shapes shall be as indicated.

2.5 MORTAR FOR STRUCTURAL MASONRY

ASTM C 270, Type M, N and S. Strength (f'm) as indicated. Test in accordance with ASTM C 780. Do not use admixtures containing chlorides. When structural reinforcement is incorporated, maximum air-content shall be 12 percent in cement-lime mortar and 18 percent in masonry cement mortar.

Use up to 40 percent Class F fly ash with type IP cement in cement-lime mortar. Fly ash shall comply with ASTM C 593.

2.6 MASONRY MORTAR

Type M mortar shall conform to ASTM C 270 and shall be used for foundation walls. Mortar Type S and N shall conform to the proportion specification of

ASTM C 270 except Type S cement-lime mortar proportions shall be 1-part cement, 1/2-part lime and 4-1/2 parts aggregate; Type N cement-lime mortar proportions shall be 1-part cement, 1-part lime and 6 parts aggregate. Type

N or S mortar shall be used for non-load-bearing, non-shear-wall interior masonry; approved commercial fire clay mortar (air setting refractory mortar such as "Sairset" from RHI Refractories) or refractory cement (calcium aluminate) mortar for fire brick and flue liners; and Type S for remaining masonry work; except where higher compressive strength is indicated on structural drawings. When masonry cement ASTM C 91 is used the maximum air content shall be limited to 12 percent and performance equal to cement-lime mortar shall be verified. Verification of masonry cement performance shall be based on ASTM C 780 and ASTM C 1072. Pointing mortar in showers and kitchens shall contain ammonium stearate, or aluminum tri-stearate, or calcium stearate in an amount equal to 3 percent by weight of cement used. Cement shall have a low alkali content and be of one brand. Aggregates shall be from one source.

2.6.1 Admixtures for Masonry Mortar

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494/C 494M, Type C.

2.6.2 Hydrated Lime and Alternates

Hydrated lime shall conform to ASTM C 207, Type S. Lime alternates which have a current ICBO, ICBO UBC, Evaluation Report number whose findings state it may be used as an alternate to lime for Type M, S, N, and O mortars will be deemed acceptable provided the user follows the manufacturer's proportions and mixing instructions as set forth in ICBO report.

2.6.3 Cement

Portland cement shall conform to ASTM C 150, Type I. Masonry cement shall conform to ASTM C 91, Type S M. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar.

Incorporate to the maximum extent, without conflicting with other requirements of this section, up to 40 percent fly ash, up to 70 percent slag, up to 10 percent cenospheres, and up to 10 percent silica fume. Additives shall conform to requirements in Section 03 30 00.00 40 CAST-INPLACE CONCRETE.

2.6.4 Sand and Water

Sand shall conform to ASTM C 144. Water shall be clean, potable, and free from substances which could adversely affect the mortar.

2.7 GROUT AND READY-MIXED GROUT

Grout shall conform to ASTM C 476, fine. Cement used in grout shall have a low alkali content. Grout slump shall be between 200 and 250 mm. Minimum grout strength shall be 14 MPa in 28 days, as tested by ASTM C 1019. Grout shall be used subject to the limitations of Table III. Proportions shall not be changed and materials with different physical or chemical characteristics shall not be used in grout for the work unless additional evidence is furnished that the grout meets the specified requirements. Ready-Mixed grout shall conform to ASTM C 94/C 94M.

2.7.1 Admixtures for Grout

In cold weather, a non-chloride based accelerating admixture may be used subject to approval; accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494/C 494M, Type C. In general, air-entrainment, anti-freeze or chloride admixtures shall not be used except as approved by the Contracting Officer.

2.7.2 Grout Barriers

Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

2.8 BAR POSITIONERS

Joint reinforcement in interior walls, and in exterior or interior walls exposed to moist environment shall conform to ASTM A 641/A 641M; coordinate with paragraph JOINT REINFORCEMENT below.

2.8.1 Bar Positioners

Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 9-gauge steel wire or equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell.

2.9 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A 615/A 615M, Grade 60.

2.10 CONTROL JOINT KEYS

Control joint keys shall be a factory fabricated solid section of natural or synthetic rubber (or combination thereof) conforming to ASTM D 2000or polyvinyl chloride conforming to ASTM D 2287. The material shall be resistant to oils and solvents. The control joint key shall be provided with a solid shear section not less than 16 mm thick and 10 mm thick flanges, with a tolerance of plus or minus 2 mm. The control joint key shall fit neatly, but without forcing, in masonry unit jamb sash grooves. The control joint key shall be flexible at a temperature of minus 34 degrees C after five hours

exposure, and shall have a durometer hardness of not less than 70 when tested in accordance with ASTM D 2240.

2.11 EXPANSION-JOINT MATERIALS

Backer rod and sealant shall be adequate to accommodate joint compression equal to 50 percent of the width of the joint. The backer rod shall be compressible rod stock of polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, non-absorptive material as recommended by the sealant manufacturer. Sealant shall conform to Section 07 92 00 JOINT SEALANTS, and shall be penetrating with a maximum volatile organic compound (VOC) content of 600 grams/liter.

2.12 FLASHING

Flashing shall be as specified in Section 07 60 00 FLASHING AND SHEET METAL. Provide one of the following types except that flashing indicated to terminate in reglets shall be metal or coated-metal flashing and except that the material shall be one which is not adversely affected by damp proofing material.

a. Stainless Steel Flashing: Copper, ASTM B 370, minimum 450 kg weight; stainless steel, ASTM A 167, Type 301, 302, 304, or 316, 4 mm thick, No. 2D finish.

b. Provide with factory-fabricated deformations that mechanically bond flashing against horizontal movement in all directions. Deformations shall consist of dimples, diagonal corrugations, or a combination of dimples and transverse corrugations.

3 PART 3 EXECUTION

3.1 PREPARATION

Prior to start of work, masonry inspector shall verify the applicable conditions as set forth in ACI 530.1, inspection. The Contracting Officer will serve as inspector or will select a masonry inspector.

3.1.1 Hot Weather Installation

The following precautions shall be taken if masonry is erected when the ambient air temperature is more than 37 degrees C in the shade and the relative humidity is less than 50 percent or the ambient air temperature exceeds 32 degrees C and the wind velocity is more than 13 km/h. All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than 1.2 m ahead of masonry; masonry units shall be set within one minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

3.1.2 Cold Weather Installation

Before erecting masonry when ambient temperature or mean daily air temperature falls below 4 degrees C or temperature of masonry units is below 4 degrees C, a written statement of proposed cold weather construction procedures shall be submitted for approval.

The following precautions shall be taken during all cold weather erection. Conform to ACI 530.1 for hot and cold weather masonry erection.

3.1.2.1 Protection

Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

a. Air Temperature 4 to 0 degrees C. Sand or mixing water shall be heated to produce mortar temperatures between 4 and 49 degrees C

b. Air Temperature 0 to minus 4 degrees C. Sand and mixing water shall be heated to produce mortar temperatures between 4 and 49 degrees Temperature of mortar on boards shall be maintained above freezing.

c. Air Temperature minus 4 to minus 7 degrees C. Sand and mixing water shall be heated to provide mortar temperatures between 4 and 49 degrees C.

Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is in excess of 24 km/hour.

d. Air Temperature minus 7 degrees C and below. Sand and mixing water shall be heated to provide mortar temperatures between 4 and 49 degrees

e. Enclosure and auxiliary heat shall be provided to maintain air temperature above 0 degrees C. Temperature of units when laid shall not be less than minus 7 degrees C.

3.1.2.2 Completed Masonry and Masonry Not Being Worked On

a. Mean daily air temperature 4 to 0 degrees C. Masonry shall be protected from rain or snow for 24 hours by covering with weather resistive membrane.

b. Mean daily air temperature 0 to minus 4 degrees C. Masonry shall be completely covered with weather-resistant membrane for 24 hours.

c. Mean Daily Air Temperature minus 4 to minus 7 degrees C. Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.

d. Mean Daily Temperature minus 7 degrees C and Below. Masonry temperature shall be maintained above 0 degrees C for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

3.1.3 Stains

Protect exposed surfaces from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Protect base of walls from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.

3.1.4 Loads

Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

3.1.5 Surfaces

Surfaces on which masonry is to be placed shall be cleaned of laitance, dust, dirt, oil, organic matter, or other foreign materials and shall be slightly roughened to provide a surface texture with a depth of at least 3 mm. Sandblasting shall be used, if necessary, to remove laitance from pores and to expose the aggregate.

3.2 LAYING MASONRY UNITS

Coordinate masonry work with the work of other trades to accommodate built-in items and to avoid cutting and patching. Masonry units shall be laid in running bond pattern. Each unit shall be adjusted to its final position while mortar is still soft and plastic. Units that have been disturbed after the mortar has stiffened shall be removed, cleaned, and re-laid with fresh mortar. Air spaces, cavities, chases, expansion joints, and spaces to be grouted shall be kept free from mortar and other debris. Units used in exposed masonry surfaces shall be selected from those having the least amount of chipped edges or other imperfections detracting from the appearance of the finished work. Vertical joints shall be kept plumb. Units being laid and surfaces to receive units shall be free of water film and frost. Solid units shall be laid in a non-furrowed full bed of mortar. Units shall be shoved into place so that the vertical joints are tight. Vertical joints of brick and the vertical face shells of concrete masonry units, except where indicated at control, expansion, and isolation joints, shall be completely filled with mortar. Mortar will be permitted to protrude up to 13 mm into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below.

3.2.1 Forms and Shores

Provide bracing and scaffolding as required. Design bracing to resist wind pressure as required by local codes. Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed in less than 10 days.

3.2.2 Reinforced Concrete Masonry Units Walls

Where vertical reinforcement occurs and as noted for exterior and shear walls, fill cores solid with grout. Lay units in such a manner as to preserve the

unobstructed vertical continuity of cores to be filled. Embed the adjacent webs in mortar to prevent leakage of grout. Remove mortar fins protruding from joints before placing grout. Minimum clear dimensions of vertical cores shall be 50 by 75 mm. Position reinforcing accurately as indicated before placing grout. As masonry work progresses, secure vertical reinforcing in place at vertical intervals not to exceed 160 bar diameters. Use puddling rod or vibrator to consolidate the grout. Minimum clear distance between masonry and vertical reinforcement shall be not less than 13 mm. Unless indicated or specified otherwise, form splices by lapping bars not less than 40 bar diameters and wire tying them together.

3.2.3 Concrete Masonry Units

Units in piers, pilasters, columns, starting courses on footings, solid foundation walls, lintels, and beams, and where cells are to be filled with grout shall be full bedded in mortar under both face shells and webs. Other units shall be full bedded under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Foundation walls below grade shall be grouted solid. Jamb units shall be of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, gable slopes, and elsewhere as approved. Double walls shall be stiffened at wall-mounted plumbing fixtures by use of strap anchors, two above each fixture and two below each fixture, located to avoid pipe runs, and extending from center to center of the double wall. Walls and partitions shall be adequately reinforced for support of other work if/as shown.

3.2.4 Clay or Shale Brick Units

Brick facing shall be laid with the better face exposed. Brick shall be laid in running bond with each course bonded at corners, unless otherwise indicated. Molded brick shall be laid with the frog side down. Brick that is cored, recessed, or has other deformations may be used in sills, treads, soldier courses, except where deformations will be exposed to view. Lay fire brick by dipping each brick in a soft mixture of fire clay and water and then rubbing the brick into place with joints as thin as practicable or provide refractory mortar with joints not more than 10 mm thick.

3.2.4.1 Wetting of Units

Wetting of clay, shale brick, or hollow brick units having an initial rate of absorption of more than 0.155 gm per minute per square cm of bed surface shall be in conformance with ASTM C 67. The method of wetting shall ensure that each unit is nearly saturated but surface dry when laid. Test clay or shale brick daily on the job, prior to laying, as follows: Using a wax pencil, draw a circle the size of a quarter on five randomly selected bricks.

Apply 20 drops of water with a medicine dropper to the surface within the circle on each brick. If the average time that the water is completely

absorbed in the five bricks is less than 1-1/2 minutes, wet bricks represented by the five bricks tested.

3.2.4.2 Hollow Units

Hollow units shall be laid as specified for concrete masonry units.

3.2.4.3 Chimneys

Construct chimneys of brick with clay flue linings of the sizes indicated.

Extend flue linings from 300 mm below the smoke inlet to 100 mm above the chimney cap. Place thimbles as indicated, flush with inside of or up to 25 mm into the flue lining. Set linings in fire clay mortar or refractory mortar and fill and smooth the joints on the inside. Set each section of flue lining before surrounding brickwork reaches top of flue lining section below. Build brickwork around lining, and fill the space between lining and brickwork with grout. Do not cut linings after they are installed in chimney. Unless indicated otherwise, provide a chimney cap of air-entrained concrete. Slope cap to a minimum edge thickness of 50 mm and reinforce with two rings of No. 3 gage galvanized steel wire.

3.2.5 Tolerances

Masonry shall be laid plumb, true to line, with courses level. Bond pattern shall be kept plumb throughout. Corners shall be square unless noted otherwise. Except for walls constructed of prefaced concrete masonry units, masonry shall be laid within the following tolerances (plus or minus unless otherwise noted):

TABLE II

TOLERANCES

Variation from the plumb in the lines and surfaces of columns, walls and arises.

In adjacent masonry units	3 mm
In 3 m	6 mm
In 6 m	10 mm
In 12 m or more	13 mm

Variations from the plumb for external corners, expansion joints, and other conspicuous lines

In 6 m	6 mm

In 12 m or more	13 mm

Variations from the level for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines

In 6 m	6 mm
In 12 m or more	13 mm

Variation from level for bed joints and top surfaces of bearing walls

In 3 m	6 mm
In 12 m or more	13 mm

Variations from horizontal lines

In 3 m	6 mm
In 6 m	10 mm
In 12 m or more	13 mm

Variations in cross sectional dimensions of columns and in thickness of walls

Minus	6 mm
Plus	13 mm

3.2.6 Cutting and Fitting

Full units of the proper size shall be used wherever possible, in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp. Openings in the masonry shall be made carefully so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Reinforced masonry lintels shall be provided above openings over 300 mm wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

3.2.7 Jointing

Joints shall be tooled when the mortar is thumbprint hard. Horizontal joints shall be tooled last. Joints shall be brushed to remove all loose and excess mortar. Mortar joints shall be finished as follows:

3.2.7.1 Flush Joints

Joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas shall be flush cut. Flush cut joints shall be made by cutting off the mortar flush with the face of the wall. Joints in unparged masonry walls below grade shall be pointed tight. Flush joints for architectural units, such as fluted units, shall completely fill both the head and bed joints.

3.2.7.2 Tooled Joints

Joints in exposed exterior and interior masonry surfaces shall be tooled slightly concave. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit.

Tooling shall be performed so that the mortar is compressed and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

3.2.7.3 Door and Window Frame Joints

On the exposed interior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 10 mm. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 10 mm.

3.2.8 Joint Widths

Joint widths shall be as follows:

3.2.8.1 Concrete Masonry Units

Concrete masonry units shall have 10 mm joints, except for prefaced concrete masonry units.

3.2.8.2 Brick

Brick joint widths shall be the difference between the actual and nominal dimensions of the brick in either height or length. Brick expansion joint widths shall be as shown.

3.2.9 Embedded Items

Spaces around built-in items shall be filled with mortar. Openings around flush-mount electrical outlet boxes in wet locations shall be pointed with mortar. Anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in shall be embedded as the masonry work progresses. Anchors, ties and joint reinforcement shall be fully embedded in the mortar. Cells receiving anchor bolts and cells of the first course below bearing plates shall be filled with grout.

3.2.10 Unfinished Work

Unfinished work shall be stepped back for joining with new work. Too thing may be resorted to only when specifically approved. Loose mortar shall be removed and the exposed joints shall be thoroughly cleaned before laying new work.

3.2.11 Masonry Wall Intersections

Each course shall be masonry bonded at corners and elsewhere as shown.

Masonry walls shall be anchored or tied together at corners and intersections with bond beam reinforcement and prefabricated corner or tee pieces of joint reinforcement as shown.

3.2.12 Partitions

Partitions shall be continuous from floor to underside of floor or roof deck where shown. Openings in firewalls around joists or other structural members shall be filled as indicated or approved. Where suspended ceilings on both sides of partitions are indicated, the partitions other than those shown to be continuous may be stopped approximately 100 mm above the ceiling level. An isolation joint shall be placed in the intersection between partitions and structural or exterior walls as shown. Interior partitions having 100 mm nominal thick units shall be tied to intersecting partitions of 100 mm units, 125 mm into partitions of 150 mm units, and 175 into partitions of 200 mm or thicker units. Cells within vertical plane of ties shall be filled solid with grout for full height of partition or solid masonry units may be used.

Interior partitions having masonry walls over 100 mm thick shall be tied together with joint reinforcement. Partitions containing joint reinforcement shall be provided with prefabricated pieces at corners and intersections or partitions.

3.3 MORTAR

Mortar shall be mixed in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measurement of ingredients for mortar shall be by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Mortar that has stiffened because of loss of water through evaporation shall be re-tempered by adding water to restore the proper consistency and workability. Mortar that has reached its initial set or that has not been used within 2.5 hours after mixing shall be discarded.

3.4 REINFORCING STEEL

Reinforcement shall be cleaned of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within 50 mm of tops of walls.

3.4.1 Positioning Bars

Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 13 mm shall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one diameter of the reinforcement. Vertical reinforcing may be held

in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement.

Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

3.4.2 Splices

Bars shall be lapped a minimum of 48 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

3.5 JOINT REINFORCEMENT INSTALLATION

Joint reinforcement shall be installed at 400 mm on center or as indicated.

Reinforcement shall be lapped not less than 150 mm. Prefabricated sections shall be installed at corners and wall intersections. The longitudinal wires of joint reinforcement shall be placed to provide not less than 16 mm cover to either face of the unit.

3.6 PLACING GROUT

Cells containing reinforcing bars shall be filled with grout. Hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces shall be filled solid with grout. Cells under lintel bearings on each side of openings shall be filled solid with grout for full height of openings. Walls below grade, lintels, and bond beams shall be filled solid with grout. Units other than open end units may require grouting each course to preclude voids in the units. Grout not in place within 1-1/2 hours after water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of face shells of masonry units. If blowouts, blowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt.

3.6.1 Vertical Grout Barriers for Fully Grouted Walls

Grout barriers shall be provided not more than 10 m apart, or as required, to limit the horizontal flow of grout for each pour.

3.6.2 Horizontal Grout Barriers

Grout barriers shall be embedded in mortar below cells of hollow units receiving grout.

3.6.3 Grout Holes and Cleanouts

3.6.3.1 Grout Holes

Grouting holes shall be provided in slabs, spandrel beams, and other in-place overhead construction. Holes shall be located over vertical reinforcing bars or as required to facilitate grout fill in bond beams. Additional openings

spaced not more than 400 mm on centers shall be provided where grouting of all hollow unit masonry is indicated. Openings shall not be less than 100 mm in diameter or 75 by 100 mm in horizontal dimensions. Upon completion of grouting operations, grouting holes shall be plugged and finished to match surrounding surfaces.

3.6.3.2 Cleanouts for Hollow Unit Masonry Construction

Cleanout holes shall be provided at the bottom of every pour in cores containing vertical reinforcement when the height of the grout pour exceeds

1.5 m. Where all cells are to be grouted, cleanout courses shall be constructed using bond beam units in an inverted position to permit cleaning of all cells. Cleanout holes shall be provided at a maximum spacing of 800 mm where all cells are to be filled with grout. A new series of cleanouts shall be established if grouting operations are stopped for more than 4 hours. Cleanouts shall not be less than 75 by 100 mm openings cut from one face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Cleanout holes shall not be closed until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, cleanout holes shall be closed in an approved manner to match surrounding masonry.

3.6.4 Grouting Equipment

3.6.4.1 Grout Pumps

Pumping through aluminum tubes will not be permitted. Pumps shall be operated to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, waste materials and debris shall be removed from the equipment, and disposed of outside the masonry.

3.6.4.2 Vibrators

Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. At least one spare vibrator shall be maintained at the site at all times. Vibrators shall be applied at uniformly spaced points not further apart than the visible effectiveness of the machine. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing segregation.

3.6.5 Grout Placement

Masonry shall be laid to the top of a pour before placing grout. Grout shall not be placed in two-Wythe solid unit masonry cavity until mortar joints have set for at least 3 days during hot weather and 5 days during cold damp weather. Grout shall not be placed in hollow unit masonry until mortar joints have set for at least 24 hours. Grout shall be placed using a hand bucket, concrete hopper, or grout pump to completely fill the grout spaces without segregation of the aggregates. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. The height of grout pours and type of grout used shall be limited by the dimensions of grout spaces as indicated in Table III. Low-lift grout methods may be used on pours up to and including 1.5 m in

height. High-lift grout methods shall be used on pours exceeding 1.5 m in height.

3.6.5.1 Low-Lift Method

Grout shall be placed at a rate that will not cause displacement of the masonry due to hydrostatic pressure of the grout. Mortar protruding more than 13 mm into the grout space shall be removed before beginning the grouting operation. Grout pours 300 mm or less in height shall be consolidated by mechanical vibration or by puddling. Grout pours over 300 mm in height shall be consolidated by mechanical vibration and reconsolidated by mechanical vibration after initial water loss and settlement has occurred.

Vibrators shall not be inserted into lower pours that are in a semi solidified state. Low-lift grout shall be used subject to the limitations of Table III.

TABLE III

POUR HEIGHT AND TYPE OF GROUT FOR VARIOUS GROUT SPACE DIMENSIONS

Maximum Grout Pour Height (m) (4)	Grout Type	Grouting Procedure	Minimum Dimensions of the Total Clear Areas Within Grout Spaces and Cells (mm) (1,2) Multiwythe Masonry (3)	Hollow-unit Masonry
0.3	Fine	Low Lift	20	40 x 50
1.5	Fine	Low Lift	50	50 x 75
0.3	Coarse	Low Lift	40	40 x 75
1.5	Coarse	Low Lift	50	65 x 75

Notes:

(1) The actual grout space or cell dimension must be larger than the sum of the following items:

a) The required minimum dimensions of total clear areas given in the table above;

b) The width of any mortar projections within the space;

c) The horizontal projections of the diameters of the horizontal reinforcing bars within a cross section of the grout space or cell.

(2) The minimum dimensions of the total clear areas shall be made up of one or more open areas, with at least one area being 20 mm or greater in width.

(3) For grouting spaces between masonry Wythe's.

(4) Where only cells of hollow masonry units containing reinforcement are grouted, the maximum height of the pour shall not exceed the distance between horizontal bond beams.

3.7 BOND BEAMS

Bond beams shall be filled with grout and reinforced as indicated on the drawings. Grout barriers shall be installed under bond beam units to retain the grout as required. Reinforcement shall be continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated on the drawings. Where splices are required for continuity, reinforcement shall be lapped 48 bar diameters. A minimum clearance of 13 mm shall be maintained between reinforcement and interior faces of units.

3.8 CONTROL JOINTS

Control joints shall be provided as indicated in accordance with the details shown on the drawings. Sash jamb units shall have a 19 by 19 mm groove near the center at end of each unit. The vertical mortar joint at control joint locations shall be continuous, including through all bond beams. This shall be accomplished by utilizing half blocks in alternating courses on each side of the joint. The control joint key shall be interrupted in courses containing continuous bond beam steel. In single Wythe exterior masonry walls, the exterior control joints shall be raked to a depth of 19 mm; backer rod and sealant shall be installed in accordance with Section 07 92 00 JOINT SEALANTS. Exposed interior control joints shall be raked to a depth of 6 mm. Concealed control joints shall be flush cut.

3.9 SHELF ANGLES

Shelf angles shall be adjusted as required to keep the masonry level and at the proper elevation. Shelf angles shall be galvanized. Shelf angles shall be provided in sections not longer than 3 m and installed with a 6 mm gap between sections. Shelf angles shall be mitered and welded at building corners with each angle not shorter than 1.2 m, unless limited by wall configuration.

3.10 LINTELS

3.10.1 Lintels

All lintels shall be constructed as cast-in-place concrete as shown and reinforced with a minimum of two No. 13 bars in the bottom course unless otherwise indicated on the drawings. Lintel reinforcement shall extend beyond each side of masonry opening 40 bar diameters or 600 mm, whichever is greater. Reinforcing bars shall be supported in place and shall be located 13 mm above the bottom inside surface of the lintel unit.

3.11 SILLS AND COPINGS

Sills and copings shall be set in a full bed of mortar with faces plumb and true.

3.12 ANCHORAGE TO CONCRETE AND STRUCTURAL STEEL

3.12.1 Anchorage to Concrete

Anchorage of masonry to the face of concrete columns, beams, or walls shall be with dovetail anchors spaced not over 400 mm on centers vertically and 600 mm on center horizontally.

3.12.2 Anchorage to Structural Steel

Masonry shall be anchored to vertical structural steel framing with adjustable steel wire anchors spaced not over 400 mm on centers vertically, and if applicable, not over 600 mm on centers horizontally.

3.13 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, mortar and grout daubs or splashing's shall be completely removed from masonry-unit surfaces that will be exposed or painted. Before completion of the work, defects in joints of masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Immediately after grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high pressure stream of water and a stiff bristled brush. Masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Masonry surfaces shall be left clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

3.13.1 Concrete Masonry Unit and Concrete Brick Surfaces

Exposed concrete masonry unit and concrete brick surfaces shall be drybrushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.13.2 Clay or Shale Brick Surfaces

Exposed clay or shale brick masonry surfaces shall be cleaned as necessary to obtain surfaces free of stain, dirt, mortar and grout daubs, efflorescence, and discoloration or scum from cleaning operations. After cleaning, the sample panel of similar material shall be examined for discoloration or stain as a result of cleaning. If the sample panel is discolored or stained, the method of cleaning shall be changed to assure that the masonry surfaces in the structure will not be adversely affected. The exposed masonry surfaces shall be water-soaked and then cleaned with a solution proportioned 30 mL tri sodium phosphate and 30 mL laundry detergent to 1 L of water or cleaned with a proprietary masonry cleaning agent specifically recommended for the color and texture by the clay products manufacturer. The solution shall be applied with stiff fiber brushes, followed immediately by thorough rinsing with clean water. Proprietary cleaning agents shall be used in conformance with the

cleaning product manufacturer's printed recommendations. Efflorescence shall be removed in conformance with the brick manufacturer's recommendations.

3.14 BEARING PLATES

Bearing plates for beams, joists, joist girders and similar structural members shall be set to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated. Bedding mortar and non-shrink grout shall be as specified in Section 03 30 00.00 40 CAST-IN-PLACE CONCRETE.

3.15 PROTECTION

Facing materials shall be protected against staining. Top of walls shall be covered with non-staining waterproof covering or membrane when work is not in progress. Covering of the top of the unfinished walls shall continue until the wall is waterproofed with a complete roof or parapet system. Covering shall extend a minimum of 600 mm down on each side of the wall and shall be held securely in place. Before starting or resuming, top surface of masonry in place shall be cleaned of loose mortar and foreign material.

3.16 TEST REPORTS

3.16.1 **Field Testing of Mortar**

At least three specimens of mortar shall be taken each day. A layer of mortar 13 to 16 mm thick shall be spread on the masonry units and allowed to stand for one minute. The specimens shall then be prepared and tested for compressive strength in accordance with ASTM C 780.

3.16.2 Field Testing of Grout

Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C 1019. A minimum of three specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 13.8 MPa at 28 days.

3.16.3 Efflorescence Test

Brick which will be exposed to weathering shall be tested for efflorescence.

Tests shall be scheduled far enough in advance of starting masonry work to permit retesting if necessary. Sampling and testing shall conform to the applicable provisions of ASTM C 67. Units meeting the definition of "effloresced" will be subject to rejection.

3.16.4 Prism Tests

At least one prism test sample shall be made for each 465 square meters of wall but not less than three such samples shall be made for any building.

Three prisms shall be used in each sample. Prisms shall be tested in accordance with ACI 530.1. Seven-day tests may be used provided the relationship between the 7- and 28-day strengths of the masonry is established by the tests of the materials used. Compressive strength shall not be less than 10.3 MPa at 28 days. If the compressive strength of any prism falls below the specified value by more than 3.5 MPa, steps shall be taken to assure

that the load-carrying capacity of the structure is not jeopardized. If the likelihood of low-strength masonry is confirmed and computations indicate that the load-carrying capacity may have been significantly reduced, tests of cores drilled, or prisms sawed, from the area in question may be required. In such case, three specimens shall be taken for each prism test more than 3.5 MPa below the specified value. Masonry in the area in question shall be considered structurally adequate if the average compressive strength of three specimens is equal to at least 85 percent of the specified value, and if the compressive strength of no single specimen is less than 75 percent of the specified value. Additional testing of specimens extracted from locations represented by erratic core or prism strength test results shall be permitted.

3.17 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

Special inspections and testing for seismic-resisting systems and components shall be done in accordance with IBC.

---END OF SECTION---

DIVISION 06

SECTION 06 49 03

PLUMBING

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 within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22	(1999; R 2001) Relief Valves for Hot Water Supply Systems

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

ASHRAE 90.1 - IP	(2004; Addenda's a, b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,r,s,t,u,v,x,ak 2006; Supp to Addenda's 2006; Errata 2007) Energy Standard for Buildings Except Low-Rise Residential Buildings, I-P Edition
ASHRAE 90.1 - SI	(2004; Addenda's a, b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,r,s,t,u,v,x,ak 2006; Supp to Addenda's 2006; Errata 2007) Energy Standard for Buildings Except Low-Rise Residential Buildings, SI Edition

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2002) Atmospheric Type Vacuum Breakers
ASSE 1005	(1999) Water Heater Drain Valves 3/4 Inch Size
ASSE 1010	(2004) Water Hammer Arresters
ASSE 1011	(2004; Errata 2004) Hose Connection Vacuum Breakers
ASSE 1012	(2002) Backflow Preventer with Intermediate Atmospheric Vent
ASSE 1013	(2005) Reduced Pressure Principle Backflow

	Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers
ASSE 1019	(2004; Errata 2005) Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type
ASSE 1020	(2004; Errata 2004) Pressure Vacuum Breaker Assembly
ASSE 1037	(1990) Performance Requirements for Pressurized Flushing Devices (Flushometer) for Plumbing Fixtures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2005) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(2004) Hypochlorite's
AWWA B301	(2004) Liquid Chlorine
AWWA C203	(2002) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2004; Errata 2004) Specification for Filler Metals for Brazing and Braze Welding
AWS B2.2	(1991) Brazing Procedure and Performance Qualification

ASME INTERNATIONAL (ASME)

ASME A112.1.2	(2004) Standard for Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water- Connected Receptors)
ASME A112.19.1M	(1994; R 2004) Enameled Cast Iron Plumbing Fixtures
ASME A112.19.3	(2000: R 2004) Stainless Steel Plumbing Fixtures (Designed for Residential Use)
ASME A112.36.2M	(1991; R 2002) Cleanouts
ASME A112.6.1M	(1997; R 2002) Floor Affixed Supports for Off the-Floor Plumbing Fixtures for Public Use
ASME A112.6.3	(2001) Standard for Floor and Trench Drains
ASME B1.20.1	(1983; R 2001) Pipe Threads, General Purpose (Inch)
ASME B16.12	(1998) Cast Iron Threaded Drainage Fittings
ASME B16.21	(2005) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.3	(1998) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.34	(2004) Valves - Flanged, Threaded and Welding End
ASME B16.39	(1998) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.4	(1998) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2003) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME B40.100	(2006) Pressure Gauges and Gauge Attachments

ASME BPVC SEC IX	(2004; 2005 Addenda; 2006 Addenda) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2004; 2005 Addenda; 2006 Addenda) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME CSD-1	(2004) Control and Safety Devices for Automatically Fired Boilers

ASTM INTERNATIONAL (ASTM)

ASTM A 105/A 105M	(2005) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A 183	(2003) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	(2006a) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 47/A 47M	(2004) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 515/A 515M	(2003) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A 516/A 516M	(2006) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 53/A 53M	(2006a) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 536	(1984; R 2004) Standard Specification for Ductile Iron Castings
ASTM A 733	(2003) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A 74	(2006) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A 888	(2005) Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B 152/B 152M	(2006a) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM C 564	(2003a) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM D 1004	(2003) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2000	(2006a) Standard Classification System for Rubber Products in Automotive Applications
ASTM D 2241	(2005) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(2006) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

ASTM D 2564	(2004e1) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2665	(2004e2) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2672	(1996a; R 2003) Joints for IPS PVC Pipe Using Solvent Cement
ASTM D 2822	(2005) Asphalt Roof Cement
ASTM D 2855	(1996; R 2002) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3139	(1998; R 2005) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3212	(1996a; R 2003e1) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3311	(2006a) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM D 4060	(2001) Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D 4551	(1996; R 2001) Poly(Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane
ASTM D 638	(2003) Standard Test Method for Tensile Properties of Plastics
ASTM E 1	(2003a) Standard Specification for ASTM Liquidin-Glass Thermometers
ASTM E 2129	(2005) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM E 96	(2005) Standard Test Methods for Water Vapor Transmission of Materials
ASTM F 1760	(2001) Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content
ASTM F 409	(2002) Thermoplastic Accessible and Replaceable

Plastic Tube and Tubular Fittings

ASTM F 477 (2002e1) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301 (2004) Hub less Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

CISPI 310 (2004) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015 (1994; R 1995) Copper Tube Handbook

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

FCCCHR Manual (1988e9) Manual of Cross-Connection Control

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

UPC (2003) Uniform Plumbing Code

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC (2003; Errata 2003; Errata 2004 Errata 2005) International Plumbing Code

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ISEA Z358.1 (1998) Emergency Eyewash and Shower Equipment

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

MSS SP-110 (1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

MSS SP-25 (1998) Standard Marking System for Valves, Fittings, Flanges and Unions

MSS SP-44 (2006) Steel Pipeline Flanges

MSS SP-58	(2002) Standard for Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(2002a; R 2004) Standard for Butterfly Valves
MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application
MSS SP-70	(2006) Standard for Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2005) Standard for Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(1999) Standard for Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-73	(2003) Brazing Joints for Copper and Copper Alloy Pressure Fittings
MSS SP-78	(2005a) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2003) Bronze Gate, Globe, Angle and Check Valves
MSS SP-83	(2006) Standard for Class 3000 Steel Pipe Unions Socket Welding and Threaded
MSS SP-85	(2002) Standard for Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

NACE INTERNATIONAL (NACE)

NACE RP0169	(2002) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 31	(2006; Errata 2006) Installation of Oil Burning Equipment
NFPA 58	Liquefied Petroleum Gas Code 2004 Edition
NFPA 90A	(2002; Errata 2003; Errata 2005) Standard for the Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF 14	(2006) Plastics Piping System Components and Related Materials
NSF 61	(2005; Addendum 2005) Drinking Water System Components - Health Effects

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA-01	(1998) Plastic Pipe in Fire Resistive Construction

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(1992) Water Hammer Arresters Standard

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1508	(1997) Hose Clamp Specifications

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 5	(2000; E 2004) White Metal Blast Cleaning

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System
40 CFR 50.12	National Primary and Secondary Ambient Air Quality Standards for Lead
PL 102-486	(1992) Residential Energy Efficiency Ratings

UNDERWRITERS LABORATORIES (UL)

UL 174	(2004; Rev thru May 2006) Household Electric

	Storage Tank Water Heaters
UL 1951	(1994) Standard for Electric Plumbing Accessories
UL 499	(2005; Rev thru Mar 2006) Electric Heating Appliances
UL 732	(1995; Rev thru Feb 2005) Oil-Fired Storage Tank Water Heaters

3.1 SUBMITTALS

AUWSSC approval is required for submittals with a "A" designation; submittals having a "FIO" designation are for Information only and for Contractor Quality Control approval.

When used, a designation following the "A" designation identifies the office that will review the submittal for the AUWSSC.

SD-02 Shop Drawings

Plumbing System; GA

Detail drawings consisting of schedules, performance charts, instructions, diagrams, and other information to illustrate the requirements and operations of systems that are not covered by the Plumbing Code. 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.

SD-03 Product Data

Fixtures

For the following equipment to be provided under this contract the contractor shall submit the manufacturer's standard catalog data, installation, operation and maintenance manuals:

Water closets; A

Faucets and trim, all locations; A

Utility sinks; A

Water heaters; A

Hose bibs and wall hydrants; A

Backflow prevention assemblies; A

Emergency eyewashes; A

Shower Faucets; A

Valves; A

Drains and Cleanouts; A

Pipe Insulation; A

Propane Storage Tanks; A

Welding; FIO

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

Vibration-Absorbing Features; FIO

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

Plumbing System

Diagrams, instructions, and other sheets proposed for posting.

Manufacturer's recommendations for the installation of bell and spigot and hub less joints for cast iron soil pipe.

SD-06 Test 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.

Test of Backflow Prevention Assemblies; A

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-07 Certificates

Materials and Equipment

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

Written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements.

SD-10 Operation and Maintenance Data

Valves, Faucets, Hydrants, and Fixtures - Submit Data Package 2 in accordance with Section 01 78 23 "OPERATION AND MAINTENANCE DATA".

3.1 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. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

1.3.1 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.3.2 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.3 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.4 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.5 PERFORMANCE REQUIREMENTS

Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting

Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record. Structural members shall be welded in accordance with Section 05 12 00 STRUCTURAL STEEL.

1.5.1 Welding

1.5.2 Cathodic Protection and Pipe Joint Bonding

Cathodic protection and pipe joint bonding systems shall be in accordance with paragraph 3.1.4.

1.5.3 Plumbing Fixtures

Water flow and consumption rates shall at a minimum comply with requirements in PL 102-486.

1.6 REGULATORY REQUIREMENTS

Unless otherwise required herein, plumbing work shall be in accordance with ICC IPC.

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.

1.8 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated **AUWSSC** personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.

Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the **AUWSSC** for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.9 ACCESSIBILITY OF EQUIPMENT

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

2 PART 2 PRODUCTS

2.1 MATERIALS

PVC pipe shall contain a minimum of 25 percent recycled content, with a minimum of 15 percent post-consumer recycled content. Steel pipe shall contain a minimum of 25 percent recycled content, with a minimum of 16 percent post-consumer recycled content. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service shall bear the NSF seal "NSF-PW." Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing lead shall not be used in any potable water system. In line devices such as building valves, check valves, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF 61, Section 8. End point devices such as lavatory faucets, supply stops and end point control valves used to dispense water for drinking must meet the

requirements of NSF 61, Section 9. Hub less cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors. Cast-iron pipe shall contain a minimum of 100 percent recycled content. Plastic pipe shall not be installed in air plenums. Plastic pipe shall not be installed in a pressure piping system in buildings greater than three stories including any basement levels.

2.1.1 Pipe Joint Materials

Grooved pipe and hub less cast-iron soil pipe shall not be used underground.

Solder containing lead shall not be used with copper pipe. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Institute. 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 hub less 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 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. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe.

e. Flexible Elastomeric Seals: ASTM D 3139, ASTM D 3212 or ASTM F 477.

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

g. 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.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Water Hammer Arrester: PDI WH 201. Water hammer arrester shall be diaphram or piston type.

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

c. Hose Clamps: SAE J1508.

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

e. Metallic Cleanouts: ASME A112.36.2M.

f. Hypochlorite's: AWWA B300.

g. Liquid Chlorine: AWWA B301.

h. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.100.

i. Thermometers: ASTM E 1. Mercury shall not be used in thermometers.

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 and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 80 mm and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78

Steel Valves, Socket Welding and Threaded	Ends ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Water Heater Drain Valves	ASSE 1005
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22
Temperature and Pressure Relief Valves Fired Hot	ASME CSD-1 for Automatically
Water Boilers	Safety Code No., Part CW, Article 5

2.3.1 Wall Faucets (HB-1)

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

2.3.2 Wall Hydrants (Frost proof) (WH-1)

ASSE 1019 with vacuum-breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 20 mm exposed hose thread on spout and 20 mm male pipe thread on inlet.

2.3.3 Relief Valves

Water heaters 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 minimum inlets, and 20 mm outlets. Relief valves for systems where the maximum rate of heat input is greater than 59 kW (200,000 Btuh) shall have 25 mm minimum inlets, and 25 mm outlets. The discharge pipe from the relief valve shall be the size of the valve outlet.

2.3.4 Thermostatic Mixing Valves

Provide thermostatic mixing valve for storage water heaters. Mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced shall be line size and shall be constructed with rough or finish bodies either with or without plating. Each valve shall he 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, corrosion-resisting steel 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.

2.4 FIXTURES

Fixtures shall be water conservation type, in accordance with ICC IPC.

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 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. Internal parts of flush and/or flush meter valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory 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.

The following plumbing fixtures shall be provided:

Western Water Closet (W-1) with low consumption (6.1 Liter/Flush) flush valve assembly. Provide acid resisting fired porcelain enameled cast iron water closet complete with rotating No-Hub 'P' trap and No-Hub coupling to meet piping requirements. western Style water closet shall be furnished with integral non-skid foot pads and bowl wash down non-splashing flushing rim. The water closet shall be completely self-supporting requiring no external mounting hardware and shall be flush with floor. The western Style water closet shall incorporate waterproofing membrane flashing flange. Provide a cold water spigot 300mm above finished floor on the right (from a perspective of standing inside of the cubicle and looking out) sidewall of the cubicle. Toilets shall be oriented north and south. Toilets shall not face east or west.

Lavatories (L-1). All sinks shall be trough type constructed of block and concrete with ceramic tile exterior and lining capable of withstanding abuse.

Lavatories (L-2). Enameled cast iron, wall mounted. Brass fittings provided for water supplies. Faucets shall be chrome plated brass single lever mixing type.

Janitor's Sink (MB-1). Floor mount janitor, enameled cast iron with copper alloy rim guard. Provide hot and cold water valves with manual mixing. Faucet handles shall be copper alloy. Include a stainless steel shelf and three mop holders.

Shower (SH-1). Showerhead and faucet handles shall be copper alloy. Provide for manual mixing with hot and cold water valves. In addition to a shower head, provide each shower stall with a threaded faucet approximately 1.2 m AFF with hot and cold-water controls, mixing valve and a diverter type valve so water can be directed to either the shower or to the lower faucet.

Diverter valve shall be factory made for this specific package, by the mixing valve manufacturer. Shower shall be provided with low (9.5 LPM) flow shower head. The shower head shall be surface mounted, heavy duty type and securely fastened to the wall. Shower pan membrane shall be "elastomeric sheet waterproofing membrane.

Sink (S-1). Single bowl, Type 304, 18-8, 18-gauge stainless steel countertop ledge back sink, 508 mm x 495 mm x 190 mm deep, three (3) hole punching. Sound deadened. Self-rim. Chrome faucet with swing spout; lever handles, and aerator. Stainless steel drain and tailpiece assembly; P-trap; stops. Countertop openings by others.

Sink (S-2): Single bowl, wall mounted, type 302, 18-8, 18-gauge stainless steel, 559mm x 495mm x 190mm deep, three (3) hole punching, with 63mm high backsplash. Two (2) stainless steel wall support brackets, also wall hanger.

Sound deadened. Chrome gooseneck faucet with rigid/swing, wrist blade handles, and aerator. Stainless steel drain and tailpiece assembly; P-trap; and stops.

Sink (S-3): Two (2) bowl kitchen sink, complete with trim, furnished and Sink (S-4): Three (3) bowl kitchen sink, complete with trim, furnished and installed by Plumbing Contractor. Completely connected by this contractor.

Sink (S-5): Pot sink faucet, provide hot and cold water valves with manual mixing. Faucet handles shall be copper alloy.

Sink (UT-1). Single bowl, floor mounted, stainless steel, approximately 600 mm x 600 mm x 350 mm deep. Chrome faucet with vacuum breaker swing spout and hose thread outlet. Drain, tailpiece assembly, drain plug; P-trap; stops. Provide 775 mm hose, hose hanger bracket, and rubber grip. Provide 1m rubber hose.

Emergency Eye and Face Wash Assembly (EW-1). Provide emergency eye and face wash assembly in facilities where appropriate. Provide a drain at each area.

Emergency eye and face wash assembly shall be ISEA Z358.1, wall-mounted, self-cleaning, non-clogging eye and face wash with quick opening, full-flow valves, stainless steel eye and face wash receptor. Unit shall deliver 0.19 L/S of aerated water at 207 kPa (gage) flow pressure, with eye and face wash nozzles 838 to 1143 mm above finished floor. Provide copper alloy control valves. Provide an air-gap with the lowest potable eye and face wash water outlet located above the overflow rim by not less than the International Plumbing Code minimum.

Floor or Shower Drain (FD-1). Cast iron construction with galvanized body, integral seepage pan, and adjustable perforated or slotted chromium plated bronze, nickel-bronze, or nickel brass strainer consisting of a grate and threaded collar. Toilet room floor drains are similar except are provided with built-in, solid, hinged grate.

Funnel/Floor Drain (FD-2). Cast iron construction with galvanized body, with slotted cast iron gate. Drain shall be factory furnished with a cast iron oval funnel assembly, 229 mm diameter.

Funnel/Floor Drain (FD-3). Floor drain construction same as FD-1, except drain shall be factory furnished with a chromium plated bronze, nickel bronze, or nickel-brass round funnel assembly, 175 mm diameter.

Trench Drain (TR-1). Cast iron construction with galvanized body, integral seepage and adjustable perforated or slotted chromium plated bronze, nickel bronze, or nickel brass strainer consisting of a grate and threaded collar.

This style of drain shall be employed in the kitchen area of the DFACs in response to kitchen cleaning practices of the local national staff. Also, access needs to be provided to the solids collector for routine emptying.

Room hose bibs and floor drains shall be provided as required. Afghan dining facility area clean-up hose bib (HB-2) to be supplied with connecting hose on reel including approximately 12 meters of hose. Provide clean-up spray nozzle on end of hose assembly.

Provide P-Traps per International Plumbing Code IPC for all fixture drains, floor and trench drains, and shower drains. P-traps shall have minimum of 50 mm water seal.

installed by Plumbing Contractor. Completely connected by this contractor.

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 (non-pressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with FCCCHR Manual. Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type

vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in plumbing systems shall conform to ASME A112.1.2.

2.6 TRAPS

Unless otherwise specified, traps shall be plastic per ASTM F 409. Traps shall be with a clean out. Provide traps with removable access panels for easy clean-out at sinks and lavatories. 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. The interior diameter shall be not more than 3.2 mm over or under the nominal size, and interior surfaces shall be reasonably smooth throughout.

2.7 WATER HEATERS

Water heater types and capacities shall be as indicated. Each water heater shall have replaceable anodes. Each primary water heater shall have controls with an adjustable range that includes 32 to 71 degrees C. Plastic materials polyetherimide (PEI) and polyether sulfone (PES) are forbidden to be used for vent piping of combustion gases. A factory pre-charged expansion tank shall be installed on the cold water supply to each water heater. Expansion tanks shall be specifically designed for use on potable water systems and shall be rated for 93 degrees C water temperature and 1034 kPa working pressure. The expansion tank size and acceptance volume shall be as indicated.

2.7.1 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.

2.7.1.1 Electric Type (HWH-1)

Electric type water heaters shall conform to UL 174 with dual heating elements. Each element shall be of KW noted. The elements shall be wired so that only one element can operate at a time. A phenolic resin coating shall be provided as specified herein.

2.7.2 Phenolic Resin Coatings

The phenolic resin coating shall be applied at coating manufacturer's factory. The coating shall be a product specifically intended for use on water heaters and shall be acceptable for use in potable water systems.

Steel, copper, copper alloy, or stainless steel coatings shall be capable of withstanding temperatures up to 204 degrees C dry bulb; and meet the requirements of 21 CFR 175. The entire exterior surface shall be coated with three components phenolic resin coating system. The system shall consist of

the following: wash primer, pigmented base coat, and the clear top coat. Immediate and final cure times and temperatures shall be as recommended by the coating manufacturer.

2.7.2.1 Sub Title

The wash primer shall be composed of a combination of polyvinyl butyral and a heat hardening phenolic resin. The weight per liter shall be between 0.8388 kg per liter minimum and 0.8867 kg per liter maximum.

2.7.2.2 Pigmented Base Coat

The pigmented baking phenolic base coat shall consist of heat hardening phenolic resins, suitable pigments of the earth type, and softening agents, and shall not contain drying oils or cellulose material. The weight per liter shall be between 1.2 kg per liter minimum and 1.3 kg per liter maximum. The non-volatile solids content shall be between 60 percent minimum and 64 percent maximum by weight.

2.7.2.3 Clear Top Coat

The clear non-pigmented baking phenolic top coat shall have a weight per liter of between 1.0 kg per liter minimum and 1.1 kg per liter maximum. The non-volatile solids content shall be between 48 percent minimum and 52 percent maximum by weight.

2.7.2.4 Certificate of Compliance

A certificate of compliance shall be submitted by the coating manufacturer that documents successful use of coating system under service conditions indicated on the drawings for a minimum of 2 years at three different locations, and that the coating material and application comply with the testing procedures outlined.

2.7.2.5 Test Panels

Steel test panel substrate shall be 0.607 mm in thickness. The panels shall be coated with one coat wash primer, then pigmented baking phenolic to a dry film thickness of 0.10 to 0.15 mm, then clear baking phenolic to a total dry film thickness of 0.13 to 0.18 mm. The panels shall then be subjected to the tests specified below:

a. Heat Test: Test panel shall be minimum 70 x 150 mm in size. A coated test panel shall show no cracking, flaking, or other failure after the panel has been tested in accordance with ASTM D 2485, with a furnace temperature of 204 degrees C.

b. Abrasion Test: A coated test panel shall show no more than a 40 milligram loss when tested in accordance with ASTM D 4060, utilizing a Tabor

Abraser CS-17F wheel with a 1000 g weight for 1000 cycles.

c. Corrosion Test: A coated test panel shall show no corrosion after being subjected to a 500-hour salt spray test in accordance with ASTM B 117.

2.7.2.6 Hot Water Storage Tank

Hot-water storage tank shall be constructed by one manufacturer; ASME stamped for the working pressure, 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. 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 7-inch scale. Thermometer shall have a separable socket suitable for a 3/4 inch tapped opening. Tank shall be equipped with a pressure gauge 6-inch minimum diameter face. Tank shall include a factory-insulated jacket, with an "R" value of not less than 14. Jacket shall be prime-coated steel or PVC. Storage tank capacity shall be as shown.

2.8 ELECTRICAL WORK

Provide electrical motor driven equipment specified complete with motors, motor starters, and controls as specified herein and in Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, corresponding to the applications in accordance with NEMA MG 11. In addition to the requirements of Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM, provide polyphaser, squirrel-cage medium induction motors with continuous ratings, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

Motors shall be rated for continuous duty with the enclosure specified.

Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

Controllers and contactors shall have auxiliary contacts for use with the controls provided. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers, including the required monitors and timed restart.

2.9 MISCELLANEOUS PIPING ITEMS

2.9.1 Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide chromium-plated on copper alloy plates or polished stainless steel finish in finished spaces. Provide paint finish on plates in unfinished spaces.

2.9.2 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors. Provide 25 mm minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide a mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal both ends of sleeves or core-drilled holes with UL listed fill, void, or cavity material.

2.9.2.1 Sleeves in Masonry and Concrete

Provide steel pipe sleeves or schedule 40 PVC plastic pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.

2.9.3 Sleeves Not in Masonry and Concrete

Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves.

2.9.4 Pipe Hangers (Supports)

Provide MSS SP-58 and MSS SP-69, Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.

2.9.5 Nameplates

Provide 3.2 mm thick melamine laminated plastic nameplates, black matte finish with white center core, for equipment, gages, thermometers, and valves; valves in supplies to faucets will not require nameplates.

Accurately align lettering and engrave minimum of 6.4 mm high normal block lettering into the white core. Minimum size of nameplates shall be 25 by 63 mm. Key nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule.

2.10 SPARE PARTS

2.10.1 General Requirements

The contractor shall furnish to the Contracting Officer, fifteen per cent (15%) spare parts of total items installed, as directly coordinated with the Contracting Officer. Spare parts shall include such items as:

faucets, flush valves, shower heads, shower mixing valves, hoses, hose valves, spray nozzles, wall hydrant and hose bib components, backflow preventer parts of each type, fixture stops and traps, heater relief valves, internal valve components for each type of valve, hangers, pipe hammer arrestors, hose clamps, PVC solvent cement, pipe couplings, gaskets, flanges, nuts, bolts, faucet cartridges, pump bearings, pump micro switches, and floor drain and cleanout tops.

2.10.2 Itemizing and Tagging Spare Parts

All spare parts shall be itemized, tagged for future use, and stored by the contractor where directed by the Contracting Officer. Spare parts shall be handled, loaded, unloaded, and stored by the contractor. Final decision of spare part items shall be directly coordinated with the Contracting Officer.

2.11 PROPANE TANKS, PIPING, AND VALVES

Propane tanks (cylindrical bottles), piping, and valve installations shall be furnished and installed under this Contract, including under floor pipe sleeves and sleeve vent piping, in accordance with NFPA 58. Provide standard tank regulating equipment for the bottles. Propane tanks shall be secured in such a manner that they do not move or topple over. The Project will require that the Contractor provide the agreed to amount of fuel tanks filled with propane fuel at time of completion.

The Contractor shall furnish and install propane gas piping from service entrance tank equipment to the various propane gas-consuming equipment shown.

Make final connections to the tanks. Surface mounted piping shall not be susceptible to damage or cause any safety hazards. Piping passing through exterior walls shall be provided with pipe sleeves.

Propane tanks (bottles) shall be of number shown, 100 lb. (45 kilograms) steel construction, with automatic MIG/submerged arc welded gas containment welds. 100% leak tested before/after mechanical valve installation. Large collars, heavy duty footrings, and powder coated finish, free-of-scale interiors. Size of bottle, 1200 mm H. with 163 mm x 128 mm H. collar and 363 mm diameter footring (1238 mm H. overall with cap and flange); providing 89 liters LPG capacity. Manufactured to Department of Transportation specifications.

3 PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Plastic pipe shall not be installed in air plenums. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA-01. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 1.5 m outside the building, unless otherwise indicated. A 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 average local frost depth 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.

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, hydrants, 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 accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 100 mm 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 bib with renewable seat and ball valve ahead of hose bib. 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 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 or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths.

Horizontal runs of pipe over 15 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. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.1.1.7 Thrust Restraint

Plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 100 mm in diameter or larger shall be provided with thrust blocks, to prevent movement. Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 14 MPa after 28 days.

Blocking shall be placed between solid ground and the fitting to be anchored. The base and thrust bearing sides of the thrust block shall be poured against

undisturbed earth. The side of the thrust block not subject to thrust shall be poured against forms. The area of bearing will be as shown. Blocking shall be placed so that the joints of the fitting are accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

3.1.1.8 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on hot- and Coldwater supplies, flush valve systems, quick-closing valves, and similar locations 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 ASSE 1010. Vertical or horizontal 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 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 65 mm and smaller; flanges shall be used on pipe sizes 80 mm and larger.

3.1.2.3 Cast Iron Soil, Waste and Vent Pipe

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

3.1.2.4 Plastic Pipe

PVC pipe shall have joints made with solvent cement elastomeric, threading,

(threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

3.1.3 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have

temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.1.4 Corrosion Protection for Buried Pipe and Fittings

Ductile iron, cast iron, and steel pipe, fittings, and joints shall have a protective coating. Additionally, ductile iron, cast iron, and steel pressure pipe shall have a cathodic protection system and joint bonding. Coatings shall be selected, applied, and inspected in accordance with NACE

RP0169 and as otherwise specified. The pipe shall be cleaned and the coating system applied prior to pipe tightness testing. Joints and fittings shall be cleaned and the coating system applied after pipe tightness testing. For tape coating systems, the tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer utilized with tape type coating systems shall be as recommended by the tape manufacturer.

3.1.5 Pipe Sleeves and Flashing

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

3.1.5.1 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 supply, drainage, waste and vent 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 using galvanized 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 clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic. 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 07 92 00 JOINT SEALANTS. The annular space between pipe and sleeve, between bare insulation 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 damp proofing/waterproofing materials that are to be applied over the joint sealant.

3.1.5.2 Flashing Requirements

Pipes passing through roof shall be installed through a 4.9 kg per square meter 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. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 250 mm 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.

3.1.5.3 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.

3.1.5.4 Optional Counter flashing

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, counter flashing may be accomplished by utilizing the following:

a. A standard roof coupling for threaded pipe up to 150 mm in diameter.

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

3.1.5.5 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, a groove 6 to 13 mm wide by 6 to 10 mm deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant as specified in Section 07 92 00 JOINT SEALANTS.

3.1.5.6 Pipe Penetrations

Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed to prevent infiltration of air, insects, and vermin.

3.1.6 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 07 84 00 FIRESTOPPING.

3.1.7 Supports

3.1.7.1 General

Hangers used to support piping 50 mm 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.

3.1.7.2 Pipe Supports and Structural Bracing, Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads. Design for vibration isolation using NEBB TABLES, NEBB Procedural Standards ASHRAE-05, Chapter 42, as applicable. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided.

Pipe Vibration Isolation

Isolators shall be devices with contained chloroprene-elastomer elements for connecting to building-structure attachments. Devices shall be loaded by supported system during operating conditions to produce a minimum elastomer static deflection of 10 millimeters.

3.1.7.3 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 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.

(2) Be used on insulated pipe 100 mm and larger when the temperature of the medium is 15 degrees C or less.

(3) Have a high density insert for all pipe sizes. 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. Operating temperatures in determining hanger spacing for PVC pipe shall be 49 degrees C for PVC. 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.

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.

k. 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 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 a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

(3) On pipe 100 mm 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.

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

m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm or by an amount adequate for the insulation, whichever is greater.

n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.7.4 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floor or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only.

3.1.8 Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and re-welded.

After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.9 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 100 mm will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two
1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 100 mm. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, 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

3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater. 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 water heater and mounted above and within 150 mm above the top of the water heater.

3.2.2 Installation of Electric Water Heaters

Shall conform to the National Electrical Code Standards. Heat traps shall be installed in the same manner as previously specified for oil heaters.

3.2.3 Phenolic Resin Application Process

The phenolic resin coating shall be applied at the coating manufacturer's factory. The exterior surface shall be coated with the three-component coating system in the following sequence and manner. For immediate and final cure times and temperature, the recommendations of the coating manufacturer shall be followed.

a. Wash Primer. One coat of wash primer shall be applied by flooding.

a. Pigmented Base Coat. Pigmented baking phenolic coating shall be applied in several coats by immersion or flooding to a dry film thickness of 0.10 to 0.15 mm.

b. Clear Top Coat. Clear non-pigmented baking phenolic top coat shall be applied in several coats by immersion or flooding. The final coat may be applied by spraying. The dry film thickness of the total coating system shall be between 0.13 and 0.18 mm.

3.2.4 Heat Traps

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

3.2.5 Connections to Water Heaters

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

3.2.6 Expansion Tanks

A pre-charged expansion tank shall be installed on the cold water supply between each water heater inlet and the cold water supply shut-off valve. The Contractor shall adjust the expansion tank air pressure, as recommended by the tank manufacturer, to match incoming water pressure. Valve inlet to each tank.

3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. 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. 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 Flush meter Valves

Flush meter 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. Flush meter valves for water closets shall be installed 1 m above the floor as directed by the Contracting Officer.

3.3.3 Height of Fixture Rims Above Floor

Lavatories and treatment sinks shall be mounted with rim 775 mm above finished floor. Wall-hung utility sinks shall be mounted with rim 700 mm above the floor.

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 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 Concrete-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 concrete 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.

3.3.5.4 Support for Wood Stud Construction

Where floor is a concrete slab, a floor-anchored chair carrier shall be used. Where entire construction is wood, wood crosspieces shall be installed. Fixture hanger plates, supports, brackets, or mounting lugs shall be fastened with not less than No. 10 wood screws, 6 mm (1/4 inch) thick minimum steel hanger, or toggle bolts with nut. The wood crosspieces shall extend the full width of the fixture and shall be securely supported.

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 non-potable water. Backflow preventers shall be installed where indicated and in accordance with ICC IPC at all other locations necessary to preclude a cross connect or interconnect between a potable water supply and any non-potable

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 non-potable 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 non-potable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. 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 05 50 00 METAL: MISCELLANEOUS AND FABRICATIONS.

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 shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D 3311.

3.3.10 Shower Pans

3.3.10.1 General

The floor of each individual shower, the shower-area portion of combination shower and drying room, and the entire shower and drying room where the two are not separated by curb or partition, shall be made watertight with a shower pan fabricated in place. The shower pan material shall be cut to size and shape of the area indicated, in one piece to the maximum extent practicable, allowing a minimum of 150 mm for turn up on walls or partitions, and shall be folded over the curb with an approximate return of 1/4 of curb height. The upstands shall be placed behind any wall or partition finish.
Subflooring shall be smooth and clean, with nail heads driven flush with surface, and shall be sloped to drain. Shower pans shall be clamped to drains with the drain clamping ring.

3.3.10.2 No plasticized Polyvinyl Chloride (PVC) Shower Pans

Non-plasticized PVC shall be turned up behind walls or wall surfaces a distance of not less than 150 mm in room areas and 75 mm above curb level in curbed spaces with sufficient material to fold over and fasten to outside face of

curb. Corners shall be pig-ear type and folded between pan and studs. Only top 25 mm of upstand shall be nailed to hold in place. Nails shall be galvanized large-head roofing type. Approved duct tape shall be used on metal framing or studs to secure pig-ear fold and membrane. Where no backing is provided between studs, the membrane slack shall be taken up by pleating and stapling or nailing to studding at top inch of upstand. To adhere the membrane to vertical surfaces, the back of the membrane and the surface to which it is to be applied shall be coated with adhesive that becomes dry to the touch in 5 to 10 minutes, after which the membrane shall be pressed into place. Trim for drain shall be exactly the size of drain opening. Bolt holes shall be pierced to accommodate bolts with a tight fit.
Adhesive shall be used between pan and sub drain. Clamping ring shall be bolted firmly. A small amount of gravel or porous materials shall be placed at weep holes so that holes remain clear when setting bed is poured. Membrane shall be solvent welded with PVC solvent cement. Surfaces to be solvent welded shall be clean (free of grease and grime). Sheets shall be laid on a flat surface with an overlap of about 50 mm. Top edge shall be folded back and surface primed with a PVC primer. PVC cement shall be applied and surfaces immediately placed together, while still wet. Joint shall be lightly rolled with a paint roller, then as the joint sets shall be rolled firmly but not so hard as to distort the material. In long lengths, about 600 or 900 mm at a time shall be welded. On wood subflooring, two layers of
0.73 kg per square meter (15 pound) felt shall be installed prior to installation of shower pan to ensure a smooth surface installation.

3.4 VIBRATION-ABSORBING FEATURES

Mechanical equipment, shall be isolated from the building structure by approved vibration-absorbing features, unless otherwise shown.

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 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 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.5.3 Color Coding Scheme for Locating Hidden Utility Components

Scheme shall be provided in buildings having suspended grid ceilings. The color coding scheme shall identify points of access for maintenance and operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components shall include valves, dampers, switches, linkages and

thermostats. The color coding scheme shall consist of a color code board and colored metal disks. Each colored metal disk shall be approximately 12 mm in diameter and secured to removable ceiling panels with fasteners. The fasteners shall be inserted into the ceiling panels so that the fasteners will be concealed from view. The fasteners shall be manually removable without tools and shall not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks shall follow completion of the finished surface on which the disks are to be fastened. The color code board shall have the approximate dimensions of 1 m width, 750 mm height, and 12 mm thickness. The board shall be made of wood fiberboard and framed under glass or 1.6 mm transparent plastic cover.
Unless otherwise directed, the color code symbols shall be approximately 20 mm in diameter and the related lettering in 12 mm high capital letters. The color code board shall be mounted and located in the mechanical or equipment room. The color code system shall be as shown.

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 09 90 00 PAINTS AND COATINGS.

3.7.1 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

3.7.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B 117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 3 mm on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 50 degrees C, the factory painting system shall be designed for the temperature service.

3.7.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 50 degrees C shall be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

a. Temperatures Less Than 50 Degrees C: Immediately after cleaning, the metal surfaces subject to temperatures less than 50 degrees C shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.0076 mm, one coat of primer applied to a minimum dry film thickness of 0.0255 mm; and two coats of enamel applied to a minimum dry film thickness of 0.0255 mm per coat.

b. Temperatures Between 50 and 205 Degrees C: Metal surfaces subject to temperatures between 50 and 205 degrees C shall receive two coats of 205 degrees C heat-resisting enamel applied to a total minimum thickness of 0.05 mm.

c. Temperatures Greater Than 205 Degrees C: Metal surfaces subject to temperatures greater than 205 degrees C shall receive two coats of 315 degrees C heat-resisting paint applied to a total minimum dry film thickness of 0.05 mm.

3.8 TESTS, FLUSHING AND DISINFECTION

3.8.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with ICC IPC except that the drainage and vent system final test shall include the smoke test. The Contractor has the option to perform a peppermint test in lieu of the smoke test. If a peppermint test is chosen, the Contractor must submit a testing procedure to the Contracting Officer for approval.

a. Drainage and Vent Systems Tests. The final test shall include a smoke test.

b. Building Sewers Tests.

c. Water Supply Systems Tests.

e. Propane Gas Supply, Sleeve, and Vent Systems Tests.

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 M14). 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.

3.8.1.2 Shower Pans

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

3.8.1.3 Western Toilet Pans

After installation of the pan and finished floor, the toilet drain outlet shall be temporarily plugged and floor area flooded as described for shower pans, with rejection, repair, or retest as a result in water level drop as described for shower pans.

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

During Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 1.2 meters per second (4 fps) through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility.
Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. All faucets and drinking water fountains, to include any device considered as an end point device by NSF 61, Section 9, shall be flushed a minimum of 1 L per 24-hour period, ten times over a 14-day period.

3.8.3.1 After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing 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 according to manufacturer's instructions.
Comply with ASHRAE 90.1 - SI for minimum efficiency requirements. Lead levels shall not exceed limits established by 40 CFR 50.12 Part 141.80(c)(1). The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

3.8.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory installation, connections, adjustments, and 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. Temperature of each domestic hot-water supply.

f. Operation of each floor drain, shower, and Eastern closet by flooding with water.

g. Operation of each vacuum breaker and backflow preventer.

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 hypochlorite's or liquid chlorine. Except as herein specified, water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652. 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 hypo chlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. If after the 24 hour and 6 hour holding periods, the residual solution contains less than 25 ppm and 50 ppm chlorine respectively, flush the piping and tank with potable water, and repeat the above procedures until the required residual chlorine levels are satisfied. The system including the tanks shall then be flushed with clean water until the residual chlorine level is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. Samples of water in disinfected containers shall be obtained from several locations selected by the Contracting Officer. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. Disinfection 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 WASTE MANAGEMENT

Place materials defined as hazardous or toxic waste in designated containers. Return solvent and oil soaked rags for contaminant recovery and laundering or for proper disposal. Close and seal tightly partly used sealant and adhesive containers and store in protected, well-ventilated, fire-safe area at moderate temperature. Place used sealant and adhesive tubes and containers in areas designated for hazardous waste. Separate copper and ferrous pipe waste in accordance with the Waste Management Plan and place in designated areas for reuse.

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.

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 - SI, Addenda B.

3.12 TABLES

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

		SERVICE			
Item #	Pipe and Fitting Materials	A	B	C	D
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A 74 with compression gaskets. Pipe and fittings shall be marked with the	X	X	X	X

CISPI trademark.

2 Cast iron soil pipe and fittings hub less, X X X
CISPI 301 and
ASTM A 888. Pipe and
fittings shall be marked with the
CISPI trademark.

3 Cast iron drainage fittings, threaded, X X X
ASME B16.12

4 Cast iron screwed fittings (threaded) X
ASME B16.4

5 Polyvinyl Chloride plastic drain, X X X X waste and vent pipe and fittings,
ASTM D 2665,
ASTM F 891, (Sch 40)
ASTM F 1760

SERVICE:

A - Underground Building Soil, Waste and Drain

B - Aboveground Soil, Waste, Drain In Buildings

C - Underground Vent

D - Aboveground Vent

TABLE II

PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

		SERVICE					
Item No.	Pipe and Fitting Materials	A	B	D	E	F	G
1	Malleable-iron threaded fittings,	X	X	X			
	a. Galvanized, ASME B16.3 for use with Item 4a						
	b. Same as "a" but not galvanized for use with Item 4b						

2 Steel pipe:		X	X	X	
a. Seamless, galvanized				X	
ASTM A 53/A 53M, Type S, Grade B					
b. Seamless, black, ASTM A 53/A 53M, Type S, Grade B		X	X		X
3 Polyvinyl chloride (PVC) plastic pipe Schedules 40, 80, and 120, ASTM D 1785	X	X			
4 Polyvinyl chloride (PVC) pressure-rated pipe (SDR Series), ASTM D 2241	X	X			
5 Polyvinyl chloride (PVC) plastic pipe fittings, Schedule 40, ASTM D 2466	X	X			
6 Socket-type polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2467 for use with Items 6 and 7	X	X			
7 Threaded polyvinyl chloride (PVC) plastic pipe fittings, schedule 80, ASTM D 2464	X	X			
8 Joints for IPS PVC pipe using solvent cement, ASTM D 2672	X	X			
9 Steel pipeline flanges, MSS SP-44	X	X			
10 Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B 828	X	X			
11 Fittings: forged, threaded or socket weld ASME B16.11			X	X	

12	Carbon steel pipe unions, socket-welding and threaded, MSS SP-83	X	X		X
13	Fittings: butt weld			X	X
14	Malleable-iron threaded pipe unions ASME B16.39	X	X		X
15	Nipples, pipe threaded ASTM A 733	X	X		X
16	Wrought iron pipe, ASTM B36.10M				X

A - Cold Water Service Aboveground

B - Hot and Cold Water Distribution 82-degree C Maximum Aboveground

D - Cold Water Service Belowground

E - Propane Gas in Buildings, Including Sleeves and Vent Piping Indicated types are minimum wall thicknesses.

TABLE III

STANDARD RATING CONDITIONS AND MINIMUM PERFORMANCE RATINGS FOR WATER HEATING EQUIPMENT

A. STORAGE WATER HEATERS

FUEL	STORAGE CAPACITY LITERS		INPUT RATING	TEST PROCEDURE	REQUIRED PERFORMANCE
Elect.	100 max.		12 kW max.	10 CFR 430	EF = 0.95-0.00132V minimum
Elect.	50 min.	OR	12 kW min.	ASHRAE 90.1 - SI (Addenda B)	SL = 1.9 W/0.09 sq.m. maximum

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

-- End of Section -

DIVISION 07

PIPING
SECTION 07 02 03
PIPE FITTING

1 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 within the text by the basic designation only.

The works under this section of the specifications include furnishing all plant, labor, equipment, appliances and materials and in performing all operations required in connection with the supply, installation, testing, disinfection only in case of potable water system, flushing and commissioning of black steel pipes and pipe fittings as specified herein, in bill of quantities, as shown on the drawings, and/or as directed by the Project Manager.

ASTM D 2466	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(2004e1) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2665	(2004e2) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2464	(2006) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2241	(2005) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120

ASTM D 2672	(1996a; R 2003) Joints for IPS PVC Pipe Using Solvent Cement
ASTM D 3311	(2006a) Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM D 4551	(1996; R 2001) Poly(Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane
ASTM F 1760	(2001) Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed- Recycled Content
CISPI 310	(2004) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
NSF 14	(2006) Plastics Piping System Components and Related Materials

2. GENERAL REQUIREMENTS

2.1 Pipes and fittings shall be new and unused renowned manufacturers.

2.2 Where manufacturers of pipes and fittings are specified, they shall be of the same manufacturers unless otherwise approved by the Project Manager.

2.3 Where more than one similar items of pipes and fittings are specified, they shall be of the same manufacturer.

2.4 The Contractor shall submit to the AUWSSC for approval of the following information regarding the specified/proposed items of pipes and fittings.

- ✓ Name and address of the manufacturers
- ✓ Country of origin, make and model
- ✓ Dimensions and wall thicknesses of pipes and fittings
- ✓ Material and thicknesses of coating and lining
- ✓ MTC - mill test certificate from the manufacturers
- ✓ Heat number should be embossed on all pipes,fittings and flanges
- ✓ Warranty if so provided by the manufacturers
- ✓ Method of jointing, testing and commissioning

2.5 Approval by the Project Manager shall not be construed as authorizing any deviation(s) from the specifications unless they are Specifically brought to notice of the Project Manager.

2.6 Approval by the Project Manager shall not relieve the Contractor from any of his contractual responsibility regarding satisfactory performance and other requirements of the pipes and fittings.

3. SPECIAL REQUIREMENTS

3.1 Pipes and fittings shall be suitable for the intended use.

3.2 Each pipe and fitting shall be permanently marked or engraved giving the following information:

- ✓ Make and Nominal diameter
- ✓ Class, Duty or Service (Pressure) Rating
- ✓ Standards according to which the pipes and fittings have been manufactured.

3.3 Unless otherwise specified diameters of pipes and fittings shall be nominal. Actual inside and outside diameters and tolerances in diameters of pipes and fittings shall be according to the specified standards.

3.4 Pipes and fittings shall be seamless or welded as specified herein or in bill of quantities, as shown on the drawings and/or as directed by the Project Manager. If the Contractor so desires, seamless pipes and fittings may be substituted for welded pipes and fittings at no risk or cost to the owner. Where neither seamless nor welded pipes and fittings are specified, pipes and fittings shall be seamless unless otherwise approved by the Project Manager.

3.5 Unless otherwise specified, service ratings of pipes and fittings shall not be less than the maximum pressure to which they will be subjected to.

3.6 Unless otherwise specified, wall thicknesses of the pipes shall be according to the class, schedule or duty of the pipes. The wall thicknesses shall be measured at locations excluding the jointing ends. The tolerances in wall thicknesses shall be according to the specified standards. Wall thicknesses of fittings shall not be less than those of corresponding pipes to which they are joined together.

3.7 Pipes and fittings ends shall be matching and compatible with each other and with the ends of valves and appurtenances to which they are joined.

3.8 Unless otherwise approved by the Project Manager, pipes and fittings, jointing materials such as rubber rings, gaskets, nuts and bolts and jointing compound etc. shall be of the same manufacturers as those of the pipes and fittings.

SECTION 07 05 08
POLYETHYLENE (PE) PIPES AND FITTINGS

1. **SCOPE**

The work under this section of the specifications includes furnishing all plant, labor, equipment, appliances, materials and in performing all operations required in connection with providing and laying of polyethylene Pipes and Pipe fittings, in accordance with the Contract or as directed by the Project Manager and the manufacturer's recommendations.

2. **GENERAL REQUIREMENTS**

2.1 Pipes and fittings shall be new, unused and of renowned manufacturers such as Dadex, TYCO, Hi-Tech, or equivalent.
2.2 Where manufacturers of pipes and fittings are specified, they shall be of the same manufacturers unless otherwise approved by the Project Manager.
2.3 Where more than one similar items of pipes and fittings are specified, they shall be of the same manufacturer.
2.4 The Contractor shall submit to the contracting officer for approval the following information regarding the specified/proposed items of pipes and fittings.

- ✓ Name and address of the manufacturers
- ✓ Country of origin, make and model
- ✓ Dimensions and wall thicknesses of pipes and fittings
- ✓ Material and thicknesses of coating and lining
- ✓ MTC - mill test certificate from the manufacturers
- ✓ Method of jointing, testing and commissioning
- ✓ Manufacturer has the following Accreditations:
  - ISO 9001 and 14001
  - Third Party International Inspection Certificate.
  - Manufacturer’s Submittal of QA/QC Document.

2.5 Approval by the Project Manager shall not be construed as authorizing any deviation(s) from the specifications unless they are specifically brought to notice of the Project Manager.
2.6 Approval by the Project Manager shall not relieve the Contractor from any of his contractual responsibility regarding satisfactory performance and other requirements of the works.

3. **SPECIAL REQUIREMENTS**

3.1 Pipes and fittings shall be suitable for the intended use.
3.2 Every pipe shall be tested at the manufacturer's works to specified hydraulic test pressure in the presence of consultant/client representative and the contractor is responsible to pay all the expenses

for consultant/client conducting the test. The test pressure shall be maintained for sufficiently long time for proof and inspection.

3.3 Each pipe and fitting shall be permanently marked or engraved giving the following information: - i Manufacturers Name or Trademark

- ✓ Manufacturing date
- ✓ Manufacturing number
- ✓ Nominal diameter in mm
- ✓ Class or pressure rating
- ✓ Manufacturers Inspection mark
- ✓ Standards according to which the pipes and fittings have been manufactured.
- ✓ Heat number should be embossed on all pipes, fittings and flanges

3.4 Unless otherwise specified, diameters of pipes and fittings shall be nominal. Actual inside and outside diameters and tolerances in diameters of pipes and fittings shall be according to the specified standards.

3.5 Unless otherwise specified, service ratings of pipes and fittings shall not be less than the maximum pressure to which they will be subjected to.

3.6 Unless otherwise specified, wall thicknesses of the pipes shall be according to the class, schedule or duty of the pipes. The wall thicknesses shall be measured at locations excluding the jointing ends. The tolerances in wall thicknesses shall be according to the specified standards.

Wall thicknesses of fittings shall not be less than those of corresponding pipes to which they are joined together.

3.7 Pipes and fittings ends shall be matching and compatible with each other and with the ends of valves and appurtenances to which they are joined.

3.8 Unless otherwise approved by the Project Manager, pipes and fittings, jointing materials etc. shall be of the same manufacturers as those of the pipes and fittings

4. MATERIALS

4.1 General

Materials shall conform to the latest referenced specifications and/or other provisions specified herein. Materials shall be new and unused. In cases where manufacturers are specified, materials shall be of the same manufacturers. In all other cases, the Contractor shall submit the names of the manufacturer from whom he intends to buy. Other information such as diagrams, drawings and descriptive data shall be supplied as desired by the Project Manager. Approval of materials under this provision shall not be construed as authorizing any deviations from specifications.

4.2 Manufacturing

The material from which the pipe is produced shall consist substantially of polyethylene, to which may be added only those additives that are needed to facilitate the manufacture of the polymer, and production of sound, durable pipe of good surface finish, mechanical strength. None of these additives shall be used separately or together in quantities sufficient to constitute a

toxic hazard, or to impair the fabrication of welding properties of the pipe, or to impair its chemical and physical properties.

4.3 Pipe

Pipes shall conform to International Standards Organization (ISO) recommendations, I.S.O-4427, PE-100, and PN-10 and shall be of specified class capable of withstanding the specified working pressure and test pressure.

4.4 Quality

The pipe shall not have any detrimental effect on composition of the water flowing through them. The quantities of any toxic substances extracted from the internal wall, of the pipes shall not exceed the values specified in ISO 4427:1966(E).

4.5 Fittings

Compatible fittings and specials for use with polyethylene Pressure Pipes shall be of the appropriate class and shall conform to ISO 3458, 3459, 3501, 3503 or BS 5114.

5. HANDLING AND STORAGE

5.1 General

The Contractor shall be responsible for proper handling, as per manufacturer’s recommendations, of pipes and pipe fittings etc. All the material shall be stacked in accordance with the manufacturer's recommendations at approved places as directed by the Project Manager.

5.2 Transport

Transportation of pipes shall be done in such a way that they are secure and that no more than an absolute minimum of movement can take place on the vehicle during transit. The same care is needed if pipes are to be transferred from one vehicle to another, how short the final journey may be.

5.3 Off-loading

Cranes shall be used for off-loading. Whole sequence of operations shall be carried out smoothly and without snatch. Rope or nylon slings, lifting beams with flattened hooks or scissor-dog shall be used. Hooks and dogs shall be well paid to prevent the pipe being damaged and shall be fitted with locking device. Steadying ropes are essential.

5.4 Storage

Pipes, and fittings damaged during handling, transporting or lowering shall be rejected and replaced at the Contractor's expense. Storage shall be under shade so that all polyethylene pipes and fittings are not exposed to sunlight and extreme heat.

5.5 Stringing and Inspection

Stringing, consists of placing pipes on the ground in line ready for laying. Care is again needed to prevent damage during this operation.

The turned ends of all pipes shall be inspected to ensure that they are free from any local irregularities which could affect the water tightness of the joint. All pipe shall also be visually inspected for evidence of impact damage. When such damage is detected, a thorough examination of internal surface in region of the pipe ends shall be made for sign of hair cracks. Damaged pipes, joints, and fittings shall be rejected and replaced at the expense of the Contractor.

6. JOINTING

Jointing shall be made by butt fusion or electrofusion socket fusion using plain/socket ended polyethylene fittings except for joining of valves and appurtenances.

7. HYDROSTATIC PRESSURE TEST

The completed pipeline or each completed section as convenient to the Contractor or as necessary in Project Manager's opinion due to differences in elevation shall be subjected to specified hydrostatic test pressure that must not be less than 1.5 times the maximum pressure subjects to the system. All fittings, specials, valves, etc. shall also be subjected to hydrostatic testing while installed in the pipeline. The test reach in no case shall exceed 1500 feet.

Before testing, the pipeline shall be cleaned as specified in British Standard CP 2010: Part-1. Before starting of the test, the whole of the pipeline shall be inspected.

After filling, the pipeline shall be left under lower pressure for a period in order to achieve conditions as stable as possible for testing. More water shall be pumped in until the test pressure is reached and then the section shall be completely closed off. The test pressure shall be applied and maintained for at least 4 hours.

If the pressure measurements are not made at the lowest point of the section, an allowance shall be made for the static head between the lowest point and the point of measurement to ensure that the specified works test pressure is not exceeded at the lowest point. If a drop in pressure occurs, the quantity of water added in order to re-establish the test pressure shall be carefully measured.

If any abnormal movement, distortion, squirm, or leakage is detected, the test pressure shall be dropped immediately, and cause of such abnormal behaviors shall be investigated and rectified, in consultation with the approval of the Project Manager.

The test will be considered as satisfactory, if the quantity of water required to be added to maintain test pressure does not exceed 100 liters per meter of diameter per kilometer of pipeline per day for each 30-meter head of test pressure.

8. MEASUREMENT

5.1 General

Except otherwise specified herein or elsewhere in the Contract Documents no separate measurement and payment will be made for the under mentioned works related to the relevant items of the Bills of Quantities but shall not be limited to the following. The cost thereof shall be deemed to have been including in the quoted unit rate of the respective items of Bills of Quantities.

8.1.1 Submission of sample

8.1.2 Transportation

8.1.3 Stacking and stringing

8.1.4 Jointing/welding

8.1.5 Cutting, turning and jointing of pipes

8.1.6 Pipe fitting (tee, bend, flanges, adopters, blank flanges etc.)

8.1.7 Flushing, Testing and Disinfection and Commissioning of pipe line

8.2 Measurement of Polyethylene Pipe

Measurement of acceptable completed works of supply, erection and installation of pipes including fittings will be made on basis of actual length in running meter of pipes provided and installed in position as shown on the drawings or as directed by the Project Manager.

SECTION 07 01 01
BAFFLE PIPING

The piping system for the package shall comply with the following criteria:

a) All baffle pipes into the anaerobic reactor should be provide accurate well and in one level and should be checked into the three directions (X, Y, Z).

b) The arrangement of the piping system and interconnection pipes in the prefabricated tanks shall not obstruct maintenance work of the equipment in the tanks;

c) All the buried piping shall be properly bedded and supported with the selected compacted fill material;

d) The arrangement of the above ground piping shall minimize obstruction and maneuverability;

e) Any on-site installation or assemblies of pipe support to the prefabricated tank shall not be allowed;

No bending is allowed at any sewage distribution pipe excluding the force main piping. Instead, a chamber shall be provided to any change of direction in sewage flow.

All opening for pipe connections of the prefabricated tanks shall be pre-fitted at the factory with a socket, a spigot, a flange or a 300 mm length short piece of pipe. On-site drilling of openings for pipe connection shall be prohibited

SECTION 07 01 01

VENT PIPING

The vent pipe shall be providing and construct at the beginning of anaerobic systems (Settler, ABR) to remove CH4, S2O… gases from the DEWATS system, where it should construct well protected with concrete around the pipe and should install higher than the buildings height.

DIVISION 08

MANHOLES

SECTION 08 01 03

MANHOLES AND VALVES CHAMBER

1. SCOPE

The work to be done under this section of specifications includes all plant, labor, equipment, appliances, materials and in performing all operations required in connection with construction, manholes/valve chambers including providing and fixing C.I. cover and frame, ladder rungs, etc. complete as specified herein as shown on the drawings, or as directed by the Project Manager.

2. CONSTRUCTION

Manholes and valve chambers shall be of reinforced cement concrete top, walls and base slab shall be of R.C.C. of the sizes, thickness, and class of concrete as shown on the drawings. The work of excavation, backfilling, disposal of surplus/rejected earth, plain and reinforced cement concrete, formwork, reinforcement C.I. cover and frame, ladder rungs, benching, etc. are to be done under this section and shall be executed in accordance with the specifications as stated above. The C.I. frame and ladder rungs shall be well set in place at the time of pouring of concrete.

3. MEASUREMENT

3.1 General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement will be made for the under mentioned specified works related to the relevant items of the Bills of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bills of Quantities.

a) Earth work, formwork plain and reinforced concrete reinforcement and steel embedded parts, steel pipe sleeves with packing and sealant, PCC valve supports concrete benching etc.
b) Provision and installation of C.I. cover with frame, gratings and ladder rungs.

3.2 Measurement

Measurement of acceptably completed works of manhole/valve chambers will be made on the basis of actual number of manholes/valve chambers as shown on the drawings and or as directed by the Project Manager.

SECTION 08 02 04
CAST IRON COVERS WITH FRAMES & LADDER RUNGS

1. SCOPE OF WORK

The work to be done under this section of the specifications consists of furnishing all plant, labor, equipment, appliances, materials and performing all operations required in connection with the installation of RCC & C.I. cover with frame, gratings and ladder rungs, complete as specified herein, as shown on the drawings and or as directed by the Project Manager.

2. CAST IRON COVERS WITH FRAME

Cast iron cover and frame shall be of the sizes and duty as specified on the drawings. The specified size means the clear opening. The cover shall be complete with frame. Top of cover shall be roughened in an approved pattern. Locking and licking arrangement shall also be provided. The frame shall be well set in place at the time of pouring of concrete. The cover shall tightly fit in the frame. It shall be airtight and water-tight. The duty, weight, test and working load for 600mm circular or square C.I. cover and frame shall be as follows: -

Class/Duty of Cover and Frame	Gross Weight (Approx.)	Peak or Test Load	Services Working Load
Extra Heavy Duty	275-285 Kg	35 Ton	11.5 Ton
Heavy Duty	200-210 Kg	15 Ton	5 Ton
Medium Duty	130-140 Kg	5 Ton	1.5 Ton
Light Duty	70-80 Kg	1 Ton	

3. LADDER RUNGS

Galvanized steel ladder rungs shall be fabricated to the size specified on the drawings or as directed by the Project Manager. The galvanized mild steel ladder rungs shall be fitted by approved fittings at locations shown on the drawings or as directed by the Project Manager.

4. MEASUREMENT AND PAYMENT

4.1 C.I Cover with frame and ladder rungs

4.1.1 Payment of Works

No measurement and payment will be made for C.I cover, frame and ladder rungs. The work shall be deemed to be included in the respective item of manhole and valve chamber.

However, other than manhole and valve chambers, the C.I. cover frame and ladder rungs shall be paid in number for the quoted price.

Cast iron manhole cover must be ordered during construction as designed in drawing details. The manhole cover design should be ideally being in size of (60x60), (65x65) and (70x70). In case of deviation from given size, all manhole covers should have perfect fit for cast iron covers.

---END OF SECTION---

DIVISION 09

SECTION 09 05 09

PUMPING MACHIENERY & ACCESSORIES

1. SCOPE

The work to be done under this section of the specifications includes furnishing all plant, labor, equipment, appliances and materials and in performing all operations required in connection with the installation of pumping machinery including all accessories as specified herein or shown on the Drawings or as directed by the Project Manager.

2. MATERIALS AND PRODUCTS

Materials and machinery shall conform to the latest referenced specifications and other provisions specified herein and shall be new and unused. In case where manufacturers are specified, materials and equipment will be of the same manufacturers. In all other cases the Contractor shall submit the names and addresses of the Manufacturers and trade names of the materials and equipment that he intends to buy. Other information such as diagram, drawing and descriptive data will be supplied if so desired by the Project Manager. Approval of materials and all the machinery under this provision shall not be construed as authorizing any deviations from the specifications. The approval of machinery of manufacturer other than that specified will be purely on the discretion of the Project Manager. The Project Manager will fully ascertain the facts and satisfy himself as to the performance of the machinery offered by the Contractor.

The pumping machinery (pumps, motor and accessories) shall be new, unused and of renowned manufacturers such as KSB, TYCO, Grundfos-HMA or equivalent.

3. SPECIAL REQUIREMENTS OF PUMPS

The Contractor shall furnish with each pump properly identified characteristic curves prepared and certified by the manufacturer showing capacity, head, efficiency and brake horsepower throughout the entire range of the pump.

The pumps shall have stable throttling curves and be suitable for unrestricted parallel operation. All pumps shall be electric driven.

The pumps and their drives shall not overload or trip when operating against zero pressure.

The design, construction and materials shall be such that damage as a result of cavitation is completely eliminated.

Pumps shall have bearings and be suitable for continuous as well as intermittent operation without external sealing or cooling water. The pumps shall be such that they shall come into operation at once after a prolonged

shutdown period without having to take special measures. Pumps shall be capable of delivering specified quantity of treated water at the specified pressure.

Pumps shall be tested at site before their final acceptance. Pumps shall be installed at positions shown on the Drawings and/or as directed by the Project Manager.

Pumps and their drives shall be in perfect alignment when installed in position.

Pump set shall be provided with reducer/enlarger if necessary on pump discharge pipe, and suction piece on the suction end.

Motors shall run on 3-phase, 400 volts + 10%, 50 c/s A/C power. Motors shall be protected from low voltage, overload, over- heating and phase failure.

4. PUMP AND MOTOR

4.1 Horizontal Centrifugal Pump & Motor (for Fire Water) (Not used)

The pump sets will consist of horizontal centrifugal pump and motor of specified capacity and head and duty and shall be horizontal, totally enclosed, fan cooled, squirrel cage induction motors of specified power.

Pump materials shall be as under:

Body :Fine grained grey cast iron

Impeller :Stainless Steel

Pump Shaft :Stainless Steel

Shaft Sleeve :Stainless steel or Bronze

Pumps shall have mechanical seal. The suction and discharge flanges shall be rated for working pressure of 10 bars. The flanges shall be drilled to BS 10 (Table 'D' or 'E') or BS 4504.

4.2 Multistage Horizontal / Vertical Pump & Motor (for Fire Water) (Not used)

The pump set shall consist of horizontal / vertical multistage centrifugal pump and motor of the specified capacity and head with radially split casing of ring section design, having shaft- protecting sleeve. Pump material shall be as under:

Suction casing :Grey cast iron

Discharge casing :Grey cast iron

Impeller :Grey cast iron / iron bronze

Shaft :Gr. Steel

4.3 Submersible Drainage Pump & Motor (for Wastewater)

The pump shall consist of submersible non-clogging wastewater pump and motor of the specified capacity and head and shall be integral sealed unit with strainer.

Pump material shall be as under:

Casing	:Cast Iron
Impeller/bowl	:Stainless Steel/cast iron
Shaft	:Stainless Steel
Bearing	:Pre-lubricated bearing
Motor	:Air filled water tight

The pumps shall be installed inside the pit as shown on drawing. The discharge flange shall be threaded to BS 21 and shall be rated for working pressure of 10 kg/cm2.

5. PUMP ACCESSORIES

Pumps shall be provided inclusive of the following accessories:

(i) Pressure gauge, pressure switches, flow switches etc.

(ii) Strainer on pump suction pipe.

(iii) Reducer/enlarger is necessary if the pump discharge size is different from discharge piping.

6. MOTOR PROTECTION

Motors of 3kw or less power shall be started direct on line. Larger motors shall be started by star-delta starter.

Motor shall be protected against under voltage over voltage, overload, over-heating and phase failure.

Motor shall be rated for normal operation against a voltage fluctuation of + 10% and frequency fluctuation of + 2Hz.

7. CONTROL

7.1 **Horizontal Centrifugal Pump & Motor (for Fire Water) (Not used)**

Operation of pumps shall be controlled by level switches installed inside the high point surface reservoir.

- ✓ one pumps shall be duty and one shall be standby.

- ✓ Pumps shall stop at low water level indicated on the drawing to protect against dry running.
- ✓ Pump shall start at low high water level to protect against overflow.
- ✓ If the duty pump fails to start, the standby pump shall automatically come into operation.

- ✓ If the standby pump fail to start, an alarm shall be sounded/Signal shall reach the control room at high water level.

7.2 **Submersible Drainage Pump (Wastewater)**

- ✓ Operation of pumps shall be controlled by level switches installed inside the sewage lift station.
- ✓ one pumps shall be duty and one shall be standby (in Phase-I).
- ✓ Pumps shall start and stop at the designated water levels inside the lift station or other than specified.
- ✓ If duty pumps fail to start, the standby pump shall automatically come into operation.
- ✓ If standby pump fails to start, an alarm shall be sounded at high water level.

8. PRESSURE GAUGE

Pressure gauge shall be of copper alloy, bourdon tube type with 100mm diameter dial face. The dial shall be englaved in black on white background from zero to 16 bars or 1.5 times the working pressure whichever is larger. Gauge shall be installed to socket welded to the pipeline with an isolating plug/ball valve. If the pipeline installation is such that the above requirement cannot be met pressure gauge of remote reading type shall be installed.

9. MAINTENANCE MANUALS AND TOOLS

9.1 A book or books containing the complete information in connection with the assembly, operation, lubrication, adjustment and repair of the pumping equipment, electric motor, together with detailed parts list with drawings or photographs shall be furnished in duplicate.

9.2 For the pump room, special tools necessary for maintenance and repair of the pumps and electric motors including tools kits, grease guns etc. with accessories shall be furnished.

9.3 The manufacturer's recommended list of spare parts to be stocked by the CLIENT shall be submitted by the Contractor to the Project Manager for approval. Such spare parts will also be furnished by the Contractor.

9.4 All the maintenance manuals, tools, spare parts etc., shall be supplied by the Contractor at no cost of the CLIENT and all cost shall be deemed to be included by the Contractor in his bid against item of pumping set.

The minimum control mechanism for the pumps installed within the package shall be:

a) Automatic by float switch for sewage transfer pump;

b) Automatic by timer and interlock with solenoid valve for return and waste sludge pump in sedimentation tank;

c) Manual by push button for sludge transfer pumps to remove the sludge from sludge holding tank.

---END OF SECTION---

DIVISION 10

SECTION 10 02 01

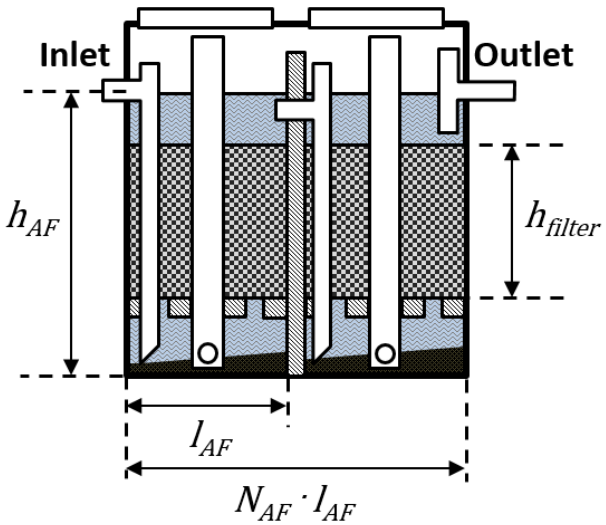
FILTER MATERIAL

1. AF FILTER MATERIAL

bacteria digest the dispersed or dissolved organic matter within a short retention time. Most of the bacteria are immobile; they attach themselves to solid particles or, for example, the reactor walls. Filter material, such as gravel, rocks, cinder or specially formed plastic shapes, provide additional surface area for bacteria to settle. By forcing the fresh wastewater to flow through this material, intensive contact with active bacteria is established; the larger the surface for bacterial growth, the quicker the digestion. Good filter material provides 90 to 300 m^2 surface area per m^3 of occupied reactor volume. Rough surfaces provide a larger area, at least in the starting phase; the bacterial film that grows on the filter mass quickly closes the smaller grooves and holes.

Anaerobic filters are very reliable and robust. Experience shows, however, that between 25 to 30% of the total filter mass may be inactive due to clogging. While a cinder or rock filter may not-completely become clogged, reduced treatment efficiency is indicative of clogging in some parts. Sand or gravel filters may block up completely due to smaller pore size. Clogging happens when wastewater finds a channeled way through just a few open pores; eventually, the less used voids clog and higher flow velocities occur in the few remaining open. This leads to reduced retention time and active bacteria are washed away.

When the bacterial film becomes too thick it must be removed. This may be done either by back-washing or by removing the filter mass for cleaning outside the reactor.



The treatment efficiency of well-operated anaerobic filters ranges between 70 to 90% BOD removal. They are suitable for domestic wastewater and all industrial wastewater with low suspended-solids content. Pre-treatment in settlers or septic tanks may be necessary to eliminate larger solids before the wastewater enters the filter. An important design criterion is the equal distribution of wastewater across the filter area. Equal distribution is facilitated by providing adequate free-flow space across the full width before and after the filter. This is why full-width down-flow shafts are preferred to down-flow pipes. The length of the filter chamber should not be greater than the depth of the water.

For smaller and simple structures, the filter mass consists of cinder (5 to 15 cm in diameter) or rocks (5 to 10 cm in diameter), which are bedded on perforated concrete slabs. The filter starts with a layer of sized rocks at the bottom. The slabs rests on beams, which are parallel to the direction of flow, approximately 50 to 60 cm above the ground slab. Pipes of at least 15 cm diameter, or down-shafts over the full width, permit desludging at the bottom with the help of pumps from the top. In case the sludge-drying beds are located directly beside the filter, sludge may also be drawn via hydraulic-pressure pipes. Head losses of 30 to 50 cm have to be considered.

Since the treatment process depends on a surplus of active bacterial mass, active sludge (for example, from septic tanks) should be sprayed on the filter material before continuous operation is started. If possible, start with only a quarter of the daily flow, and increase the flow slowly over three months. As this might not be possible in practice, full treatment is likely to be operating at full capacity until approximately six to nine months later.

As with septic tanks, desludging should be done at regular intervals. Where possible, the filter should be back-washed before sludge removal.

SECTION 10 03 01
PGF FILTER MATERIAL

1. Planted Gravel Filter (PGF)

Horizontal filters comply with DEWATS criteria, as they are simple in principle and require almost no maintenance – if well designed and constructed.

1.1 Principle

Planted horizontal gravel filters – also referred to as subsurface flow wetlands (SSF) or root zone treatment plants – provide natural treatment for pre-settled wastewater of a maximum COD content of 500 mg/l. They are ideal, therefore, as tertiary treatment for wastewater, which has already undergone secondary treatment in units, such as baffled reactors, anaerobic filters or biogas digesters. They are also appropriate for treating pre-settled greywater directly.

Although PGFs do not look complicated – and are quite simple to operate, designing of sand and gravel filters requires a solid understanding of the treatment process and good knowledge of the filter medium that is to be used. Before deciding on filter treatment, one should therefore always consider the alternative of constructing wastewater ponds instead. Filter treatment, however, has the great advantage of keeping the wastewater below ground, thereby avoiding smell and insect breeding.

Since clogging is the biggest problem with horizontal ground filters, the wastewater must be pre-treated so that suspended solids are removed before it enters the treatment unit. When testing wastewater, after 60 minutes in an Imhoff cone the sediment should not be more than 1 ml/l.

The treatment process in horizontal ground filters is complex and not yet fully understood. Unlike the vertical filter, the horizontal filter is permanently soaked with water and operates partly aerobic (free oxygen present), partly anoxic (no free oxygen but nitrate, NO_3, present) and partly anaerobic (no free oxygen and no nitrate present). Combined with physical-filtration processes, the influence of plantation on the biological-treatment process and oxygen intake, the interaction of the separate treatment processes is difficult to predict.

Round, uniform gravel of 6-12 mm or 8-16 mm is best. Use the larger grains in the front and the smaller grains in the later sections of the filter. Care must be taken when changing from a larger to a smaller grain size because blockages mostly happen at the point of change. A rather flat slope (<45°) should join one grain size to the other to ensure a larger connecting area.

Filter clogging normally results in surface flow of wastewater. This is usually not desired, although it hardly reduces the treatment efficiency if flow on the surface maintains the assumed retention time inside the filter (this could be the case with dense plant coverage). When filters are well-protected and a long way from residential areas, there is no harm in letting some of the wastewater run above the horizontal surface.

Knowledge of the amount of void space within the filter material is essential for calculating the retention time and planning the treatment process. Gravel has 30 to 45% voids, depending on size and shape. Void space can easily be determined by measuring the water that can be added to a bucket full of gravel.

The filter-bed should not be deeper than the depth to which plant roots can grow (30 - 60 cm), as water will tend to flow faster below the dense cushion of roots. However, treatment performance is generally best in the upper 15 cm because of oxygen diffusion from the surface.

Uniform distribution of wastewater throughout the filter requires an equally distributed supply of water at the inlet – and equally distributed reception at the outlet side. A perforated pipe, which is connected to the outlet pipe, lies below the strip of rocks that form the collection trench. The height of the outlet can be adjusted by a swivel arm, fixed to a flexible elbow While the top of the filter is kept strictly horizontal to prevent erosion, the bottom slopes down from inlet to outlet ideally at 1%. The percolation of wastewater into the ground is not desirable so the bottom of the filter must be sealed. While solid-clay packing might be sufficient, heavy plastic foils are more common.

In a dry climate, trees search for water and their roots may break the walls and grow into the filter. Whenever possible, trees should not be planted directly beside the filter.

The plants are not normally harvested. *Phragmites australis* (reeds), found almost anywhere, are considered to be ideal because their roots form horizontal rhizomes that guarantee a perfect root-zone filter bed. Most swamp and water grasses are also suitable, but not all of them have extending or deep-enough roots. Depending on the type of wastewater, different plants might be preferable: *Typha angustifolia* (cat-tails), together with *Scirpus lacustris* (bull rush), have been to be found the most suitable plants for wastewater from petrol refineries, while the large, red- or orange-flowering iris (sometimes known as "mosquito lily") is a beautiful plant, which grows well on wastewater but is only suitable for shallow, domestic gravel beds.

Within a horizontal filter, plants seem to be "catalysts" rather than "actors". Plants transport oxygen via their roots into the ground. Some scientists claim that this process also supplies surplus oxygen, thereby creating an aerobic environment, while others have shown that plants only transfer as much oxygen as they need to fulfil their own nutrient requirements. The uptake of nutrients by plants is of relatively little importance, especially when plants are not harvested.

Young plant seedlings may not grow on wastewater. So it is advisable to start feeding the plant with plenty of fresh water and to let the pollution load grow parallel to plant growth. When plants are under full load, the outlet level is adjusted according to flow.

Water should not stand on the surface near the inlet. If this happens, the swivel arm at the outlet should be lowered. Optimal water distribution at the inlet side is important and must be controlled from time to time.

Replacement of the filter media might be necessary when treatment efficiency declines.

To prevent clogging of the filter with fine soil, storm water should neither be mixed with the wastewater before the treatment step, nor should outside storm water be allowed to overflow the filter bed. Erosion trenches around the filter-bed should always be kept in proper functioning condition.

1.2 Planted Gravel Filter (PGF) A horizontal PGF is a large gravel and gravel-filled channel that is planted with aquatic vegetation. As wastewater flows horizontally through the channel, the filter material filters out particles and microorganisms degrade organics. The water level in a PGF is maintained at 5 to 15cm below the surface to ensure subsurface flow. The bed should be wide and shallow so that the flow path of the water is maximized. A wide inlet zone should be used to evenly distribute the flow. Pre-treatment is essential to prevent clogging and ensure efficient treatment.

The bed should be lined to prevent leaching. Small, round, evenly sized gravel is most commonly used to fill the bed to a depth of 0.60 m. To limit clogging, the gravel should be clean and free of fines. Sand is also acceptable, but is more prone to clogging.

The removal efficiency of the filter is a function of the surface area (length multiplied by width), while the cross-sectional area (width multiplied by depth) determines the maximum possible flow. A well-designed inlet that allows for even distribution is important to prevent short-circuiting. The outlet should be variable so that the water surface can be adjusted to optimize treatment performance.

The filter media acts as both a filter for removing solids, a fixed surface upon which bacteria can attach, and a base for the vegetation. Although facultative and anaerobic bacteria degrade most organics, the vegetation transfers a small amount of oxygen to the root zone so that aerobic bacteria can colonize the area and degrade organics as well. The plant roots play an important role in maintaining the permeability of the filter.

Any plant with wide roots that can grow in the wet, nutrient-rich environment is appropriate

SECTION 10 01 01
PERCOLLATION PIT or SOAK PIT FILTER MATERIAL

Materials required Stones (large, medium, small): 1 cart load Plastic or metal perforated plate (15 cm diameter): 1 PVC pipe (30 mm diameter) 75 cm - 1 m Cement: 2 kg Bricks: 12 Polythene or gunny bags: 4 Sand: 2 cubic ft Masonry and labor charges (digging, fitting, and finishing construction of the pit.

The Soak Pit can be left empty and lined with a porous material (to provide support and prevent collapse), or left unlined and filled with coarse rocks and gravel.

The rocks and gravel will prevent the walls from collapsing, but will still provide adequate space for the wastewater.

In both cases, a layer of sand and fine gravel should be spread across the bottom to help disperse the flow.

DIVISION 11

SECTION 11 13 03
PLASTERING
LATHING AND PLASTERING

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 within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A 580/A 580M	(2006) Standard Specification for Stainless Steel Wire
ASTM A 853	(2004) Standard Specification for Steel Wire, Carbon, for General Use
ASTM B 164	(2003) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM C 1002	(2004) Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
ASTM C 1032	(2006) Standard Specification for Woven Wire Plaster Base
ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM C 206	(2003) Standard Specification for Finishing Hydrated Lime
ASTM C 29/C 29M	(1997; R 2003) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C 472	(1999; R 2004) Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete
ASTM C 61/C 61M	(2000) Gypsum Keene's Cement
ASTM C 645	(2006) Nonstructural Steel Framing Members
ASTM C 754	(2004) Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM C 841	(2003) Installation of Interior Lathing and Furring

ASTM C 847	(2006) Standard Specification for Metal Lath
ASTM C 897	(2000) Aggregate for Job-Mixed Portland Cement-Based Plasters
ASTM C 926	(2006) Application of Portland Cement-Based Plaster
ASTM C 933	(2005) Welded Wire Lath
ASTM C 955	(2006) Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases

1.2 SUBMITTALS

AUWSSC/WWMD approval is required for submittals with a "A" designation;

submittals not having a "A" designation are for information only. When used, a designation following the "A" designation identifies the office that will review the submittal for the AUWSSC.

SD-02 Shop Drawings

Approved Detail Drawings; A

Drawings including installation details, ceiling framing, and furring.

SD-03 Product Data

Lathing Installation; A

Manufacturer's pre-printed descriptive data, catalog cuts, and installation instructions for plastering materials and accessories.

SD-04 Samples

Portland Cement Plaster

One 1 m square sample panel of each specified finish.

SD-07 Certificates

Qualifications

Manufacturer's experience in specified work.

1.3 QUALIFICATIONS

Manufacturer shall specialize in manufacturing the types of material specified, and shall have a minimum of 5 years of documented successful experience.

Applicator shall specialize in the type of lath and plaster work required to meet requirements, with a minimum of 3 years of documented experience.

1.4 DELIVERY, STORAGE AND HANDLING

Materials shall be delivered to project site in the original containers bearing the name of manufacturer, contents, and brand name. Plaster, cement, and lime shall be stored off the ground under weather tight cover and away from sweating walls and other damp surfaces until ready for use. Accessories shall be stored off the ground in a weather tight structure for protection.

Damaged or deteriorated materials shall be removed from project site.

1.5 ENVIRONMENTAL CONDITIONS

A temperature between 4 and 27 degrees C shall be evenly maintained in the building for a period of not less than 1 week prior to application of plaster, and for a period of at least 1 week after the gypsum plaster is set, in accordance with ASTM C 842. Interior spaces shall be ventilated in accordance with ASTM C 842 immediately after applying plaster.

2 PART 2 PRODUCTS

2.1 NON-LOADBEARING WALLS

2.1.1 Studs

Studs for non-loadbearing walls shall conform to ASTM C 645. Studs shall be C-shaped, roll-formed steel with minimum uncoated design thickness of 0.72mm<ENG> 0.0284 inch</ENG> made from G40 hot-dip galvanized coated sheet.

2.1.2 Runner Tracks

Prefabricated floor and ceiling runner tracks shall conform to ASTM C 645.

Tracks shall be prefabricated, U-shaped, unpunched web, thickness to match studs, made from G40 hot-dip galvanized coated sheet.

2.2 METAL WALL FURRING

Metal wall furring channels shall conform to ASTM C 645. Furring channels shall be formed from cold-rolled steel, 19 mm wide by 11 mm deep, made from G40 hot-dip galvanized coated sheet.

2.3 SUSPENDED CEILING FRAMING

Suspended ceiling framing system shall have the capability to support the finished ceiling, light fixtures, air diffusers, and accessories, as shown. The suspension system shall have a maximum deflection of L/240. Carrying channels shall be formed from minimum 1.40 mm thick cold-rolled steel, 38mmwide by 11 mm deep. Cross furring members shall conform to ASTM C 645, and shall be formed from cold-rolled steel, 19 mm wide by 11 mm deep. Carrying channels and furring members shall be made from hot-dip galvanized coated sheet.

2.4 TRIM, MOLDINGS, AND ACCESSORIES

2.4.1 Hangers

Suspended ceiling runner channel hangers shall be soft, annealed steel wire not less than No. 8 SWG nominal diameter, conforming to ASTM A 853 or flat iron or steel straps, at least 2 x 22 mm size, coated with zinc, cadmium, or rust-inhibiting paint.

2.4.2 Fastenings

Tie wire, rings, and other fastenings shall be corrosion-resisting steel conforming to ASTM A 580/A 580M, composition 302, 304, or 316, Condition A,

or nickel-copper alloy conforming to ASTM B 164, annealed condition. Walls, partitions, and other vertical surfaces not incorporated in ceiling construction may be erected with soft, annealed steel conforming to ASTM A 853.

2.4.2.1 Tie Wire

Tie wire for constructing partitions and vertical furring, for securing metal lath to supports, and for lacing shall be not less than No. 18 SWG diameter. Tie wire for all other applications shall be not less than No. 16 SWG diameter.

2.4.2.2 Clips

Clips used in lieu of tie wire for securing furring channels to the runner channels in ceiling construction shall be made from strips not less than 3mm thick or shall be hairpin clip formed of No. 8 SWG wire. Other clips and rings or fastenings of similar materials shall be equivalent in holding power to that provided by tie wire for the specific application.

2.4.3 Expanded Flange Corner Beads

Expanded flange corner beads shall be fabricated of 0.50 mm thick galvanized steel, with 64 mm wide flanges and 3 mm wide bead.

2.4.4 Bullnose Corner Beads

Bullnose corner beads shall be fabricated of 0.50 mm thick galvanized steel, with 64 mm wide flanges and 19 mm bead.

2.4.5 Cornerites

Cornerites shall conform to ASTM C 847. Cornerites shall be fabricated of galvanized expanded metal lath to form an angle of at least 100 degrees, with outstanding legs of not less than 50 mm.

2.4.6 Base or Parting Screed

Base screeds shall be fabricated of 0.50 mm thick galvanized steel, 13 mm depth, with not less than 50 mm wide expansion flanges.

2.4.7 Casing Beads

Casing beads shall be fabricated of galvanized 0.70 mm thick steel 13 mm depth, 25 mm wide expansion wings, front edge of face flange shaved for intended use, back slightly arched to provide a spring effect.

2.4.8 Control Joints

Control joints shall be designed for expansion and contraction of plaster work due to thermal exposure. Control joints shall be fabricated of vinyl (for interior) or galvanized steel (for exterior back to back casing beads).

2.4.9 Reveal Molding

Reveal moldings shall be fabricated of vinyl (for interior) or galvanized steel (for exterior application) or zinc. Reveal molding shall be size and shape as shown.

2.4.10 Screws

Self-drill steel screws shall conform to ASTM C 1002. Screws shall be Type S for use with steel framing and Type W for use with wood members.

2.5 METAL LATH

2.5.1 Expanded Metal Lath

Expanded metal lath shall conform to ASTM C 847. Lath shall be self-furring lath or flat rib lath, expanded from cold-rolled carbon sheet steel of commercial quality, coated with rust-inhibitive paint after fabrication, 1.8kg/square meter, with backing.

2.6 CEMENT PLASTER MATERIALS

2.6.1 Portland Cement

Portland cement shall conform to ASTM C 150, white Portland cement Type II with 13 mm chopped alkali-resistant fiberglass strands or polypropylene fibers, minimum 680 g per sack of cement.

2.6.2 Aggregates

The unit weight of aggregates shall be determined in accordance with ASTM C 29/C 29M. Portland cement based plaster aggregates shall conform to ASTM C 897, except that the gradation of natural or manufactured sand for Portland cement plaster shall be as follows:

Sand, Percentage by Weight
Retained on Each Sieve

Sieve Size (mm)	Maximum	Minimum
4.75	0	--
2.36	8	2
1.18	38	22
0.60	78	52
0.30	97	65
0.15	100	97

2.6.3 Water

Water shall be clean, fresh, potable, and free from injurious amounts of oils, acids, alkalis and organic matter injurious to the plaster and to any metal in the system.

2.6.4 Lime

Lime shall conform to ASTM C 206, Type S-Special hydrated finishing lime suitable for use in scratch brown and finish coats of Portland-cement plaster.

2.7 WALL OPENING FRAMES

Steel frames for wall openings for doors, pass-through openings, and access panels, Wood frames, wood bucks, and blocking for wall openings for doors, pass-through openings, and access panels shall be accordance to drawing.

3 PART 3 EXECUTION

3.1 PREPARATION

Project conditions shall be verified as ready to receive the work. Field measurements shall be verified for compliance with approved detail drawings and manufacturer's published recommendations. Beginning of installation means installer accepts existing conditions.

3.2 SUSPENDED CEILING FRAMING INSTALLATION

Suspended system shall be installed in accordance with ASTM C 841. Where channels are spliced, the ends shall be overlapped not less than 300 mm for 38 mm channels and not less than 200 mm for 19 mm channels with flanges of channels interlocked and securely tied near each end of the splice with two loops of the tie wire. Splices shall be staggered.

3.2.1 Hangers

Wire or strap hangers shall be attached to structural members in accordance with ASTM C 841, except hangers shall be spaced not more than 1220 mm along runner channels and 900 mm in the other direction or 1050 mm in both directions unless otherwise indicated or approved. Locations of hangers shall be coordinated with other work. Hangers at ends of runner channels shall be located not more than 150 mm from wall. Hanger wire shall be looped around bottom chord of open-web steel joist or secured to structural elements with suitable fasteners. Sags or twists in the suspended system shall be adjusted. Damaged or faulty parts shall be replaced.

3.2.2 Main Runners

Main runner channels shall be installed in accordance with ASTM C 841. Hanger wire shall be saddle-tied to runner channels, and the end of hanger wires shall be twisted three times around itself. Main runners shall not come in contact with abutting masonry or concrete walls and partitions. Main runners shall be located within 150 mm of the paralleling wall to support the ends of cross furring.

3.2.3 Furring Channels

Furring channels shall be spaced in accordance with ASTM C 841 for the type of lath used. Furring channels shall be securely saddle-tied to the runner channels and to structural supports at each crossing with tie wire, hairpin

clips, or equivalent clips or fastenings. Furring channels shall be located within 50 mm of parallel walls and beams, and 13 mm from abutting walls.

3.2.4 Light Fixtures and Air Diffusers

Light fixtures and air diffusers shall be supported directly from suspended ceiling runners. Wires shall be provided at appropriate locations to carry the weight of recessed or surface mounted light fixtures and air diffusers.

3.3 FURRED CEILING FRAMING INSTALLATION

Ceiling runners at continuous furred ceilings shall be applied directly to furring channels and secured thereto with tie wire, bolts, or screws at not more than 600 mm centers.

3.4 WALL FRAMING INSTALLATION

3.4.1 Non-Loadbearing Wall Framing

Non-load-bearing steel studs shall be installed in accordance with ASTM C 754 with spacing's as indicated in ASTM C 841 for the type of lath used. Studs shall be aligned and secure in top and bottom runners at spacing's indicated on drawings. Two beads of acoustic sealant shall be placed between runners and substrate to achieve the required air seal. Stud splicing is not acceptable. Corners shall be constructed with a minimum of three studs. Stud framing system shall be braced and made rigid.

3.4.2 Adjoining Walls and Columns

Studs which adjoin walls or columns shall be secured near the top and bottom, and at least one intermediate point, but not more than 1.5 m on centers, with wire inserts, dovetail anchors, toggle bolts, or bolts set in expansion shields.

3.4.3 Wall Bracing

Partitions more than 3 m long or 2.7 m high shall be braced with 19 mm steel channel stiffeners concealed horizontally. Stiffeners shall be spaced vertically not more than 2 m and shall be secured to each stud. Unsupported partitions 6 m or more in height shall be braced with 38 mm channel type horizontal stiffeners.

3.4.4 Corners and Intersection

Corners and intersections of partitions shall be formed of three studs. Studs at internal corners shall be placed not more than 50 mm from partition intersection.

3.4.5 Wall Openings

One loadbearing metal stud shall be installed at each jamb of door openings continuous from floor to ceiling, and shall be welded to jamb anchors and runner tracks. Jack studs shall be attached to runner track on interior of head of frame, and to runner track or 19 mm channel at ceiling. A 19 mm channel reinforcement shall be placed inside the partition 150 to 200 mm above door openings continuously through two stud spaces on each side of jambs, and

welded to the flange. Studs shall be doubled at wall openings, with not more than 50 mm each side of openings. Stud placement shall be coordinated with supports and attachments. Intermediate studs above and below openings shall be secured at same spacing as wall studs. Stud framing shall extend to ceiling or through ceiling as indicated on drawings. Clearance shall be maintained between partition and structure to avoid deflection transfer to studs of partitions which extend through ceiling to structure. Placement of insulation in stud spaces shall be made inaccessible after studs are installed.

3.4.6 Bucks, Anchors and Blocking

Installation of bucks, anchors, and blocking shall be coordinated with electrical and mechanical work to be placed in or behind stud framing, and shall be coordinated with blocking requirements for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, hardware and similar items scheduled for installation.

3.5 WALL FURRING INSTALLATION

Metal furring shall be installed in accordance with ASTM C 754 and ASTM C 841.

3.6 SINGLE/DOUBLE CHANNEL, PARTITION INSTALLATION

Channel studs for single channel and double channel stud partitions shall be spaced 400 mm on centers and shall be secured to ceiling runners and to floor runners or base clips with wire ties or sheet-metal screws. Studs on each side of door openings shall be doubled and stiffened with a 6 x 25 mm flat steel strut, shop-coated with rust-inhibiting paint. Ends of struts shall be bent and punched for bolting to floor and ceiling construction. Where rib metal lath is the plaster base in continuous lengths from ceiling runners to floor runners for partitions less than 3 m in height, steel channel studs may be excluded from the partition except at locations previously specified for door openings. Rib lath shall be firmly attached to ceiling runner tracks or cornerite and to floor runner track or base by wire ties located not more than 200 mm on centers. Stud less rib lath partitions shall be limited to not less than 50 mm thick. Partitions shall be as shown.

3.7 LATHING INSTALLATION

3.7.1 Metal Lath on Vertical Surfaces

Metal lath shall be applied with the long dimension across the supports, with true even surfaces, and without sags or buckles in accordance with ASTM C 841. Metal lath on vertical surfaces shall be oriented to provide maximum mechanical bond with plaster and the upper sheet shall be attached to overlap the lower sheet. When paper-backed lath is used, the upper sheet shall be attached to overlap the lower sheet. The lath shall be secured to supports at intervals not exceeding 150 mm. Nails or staples shall be used for securing lath to wood supports. Tie wires, rings, clips, or other approved fasteners having equivalent holding power of the tie wires shall be used for securing the plaster base to metal supports and to concrete or masonry.

Side-laps or junction of sides of plaster base shall be tied or otherwise secured at intervals not exceeding 225 mm between supports, in addition to being secured to supports.

3.7.2 Metal Lath on Ceilings

Metal lath on ceilings shall be in accordance with ASTM C 841. Lath on unrestrained ceilings shall not be turned down at junction with wall or tied to wall lath or furring. Lath on restrained ceilings shall be turned down at junction with wall, or shall be applied to cornerite or corner bead.

3.7.3 Side and End Laps

Side and end laps of metal plaster bases shall be performed in accordance with ASTM C 841 for flat lath and ribbed lath.

3.7.4 Chases and Recesses

Chases and recesses shall be lathed for plastering. Openings over 300 mm wide shall be bridged with furring channels spaced 300 mm on centers. Openings 300 mm wide and less do not need to be bridged. Lath shall extend 75 mm beyond the edges of opening. Lath shall be securely fastened by nailing or tying. Lath shall be securely fastened with nails, screws or wire ties.

3.8 OPENINGS

Reinforcement shall be provided at corners of openings in plastered areas extending 300 mm or more in any dimension by securing strip lath diagonally at corners. Strip lath shall be at least 150 mm wide by 400 mm long. Shorter lengths shall be used to preclude lapping strip lath. Strip lath shall be secured to lathing without extending fastenings into or around supporting members. Where plaster is applied directly to concrete or masonry surfaces, strip lath shall be secured to the concrete or masonry.

3.8.1 Steel Frames

Steel frames shall be securely attached through built-in anchors to the nearest stud on each side of opening with tie wire, bolts, screws, or welding or bracing where bracing is specified. Steel frames shall be grouted solid with plaster grout and a groove shall be formed within the frame returns to receive lath and plaster.

3.8.2 Ceiling Openings

Framing shall be provided for ceiling openings and supplemental supporting members for items mounted in ceiling or attached to ceiling suspension system. Frames for openings shall be secured to lath support members. Frames provided with expanded metal flanges shall be secured to lath. Intermediate structural members shall be provided for attachment or suspension of support members.

3.8.3 Openings in Hollow Partitions

Hollow partition door openings shall be additionally braced by tying together

each set of double-jamb studs with not less than four solid metal column clips evenly spaced along each jamb.

3.8.4 Openings in Partitions Not To Structure

Partitions not extending to the structural ceiling or structural supports or frame shall be strengthened at openings with angle bracing from each jamb location anchored to the structural ceiling or supports.

3.8.5 Cross Bracing

Cross bracing between partitions or similar bracing may be substituted for angle bracing as approved. Minor frames such as those required for access panels may be provided with expanded metal flanges which shall be attached to lath.

3.9 INSTALLATION OF TRIM, MOLDINGS, AND ACCESSORIES

Trim, moldings, and accessories shall be installed in standard lengths level and plumb to straight lines and as indicated on drawings. Fastenings shall be spaced not over 300 mm on centers for single-flanged accessories and not over 600 mm on centers on each flange of double-flanged accessories. Items shall be mitered or coped at corners, or prefabricated corners shall be used. Joints in straight runs shall be formed with splice or tie plates.

3.9.1 Base Screeds

Base screeds shall be installed approximately 75 mm above finished floor elevation unless indicated otherwise.

3.9.2 Corner Beads

Corner beads shall be installed in standard lengths at external plastered corners, and shall be secured to furring members or supports.

3.9.3 Cornerites

Cornerites shall be installed at internal angles formed by abutting surfaces of gypsum lath or metal lath not turned down at horizontal corners or returned around vertical corners. Cornerites shall be secured to lathed surfaces. Cornerites shall be secured to concrete or masonry where plaster is applied directly to concrete or masonry surfaces. Cornerites shall not be installed at unrestrained ceilings.

3.9.4 Casing Beads

Casing beads shall be installed at the joints of dissimilar base materials in the same plane and at exposed edges of plaster including junctions of walls and ceilings except that beads shall not be installed at restrained ceilings abutting plastered surfaces. At the perimeter of unrestrained

suspended ceilings, the casing bead shall be secured to the ceiling to provide a 10 mm opening between the abutting surfaces. The opening shall be sealed prior to plastering with sealant as specified in Section JOINT SEALANTS.

3.9.5 Expansion and Control Joint Beads

Expansion joint beads shall be installed as control joints in plasterwork at the locations indicated. Plaster base shall not be run continuous through control joints. Additional supports shall be installed as required to support the beads.

3.9.6 Trim

Trim shall be installed where indicated and as required to complete the plaster work.

3.10 PLASTER THICKNESS AND SURFACE EVENNESS

Plaster thickness and surface evenness shall be controlled by grounds or screeds of metal, wood, or plaster. Plaster thickness shall be as shown.

3.10.1 Grounds and Screeds

Grounds shall be used for securing trim items, and for finished corners and terminations. Screeds shall be installed for base screeds when wood or metal grounds are not required. Temporary screeds shall be installed when permanent screeds or grounds cannot be used. On completion of approved base coats, temporary screeds shall be removed and voids immediately filled with plaster.

3.10.2 Plaster Screeds

Plaster screeds shall be used within the plastered areas to supplement wood and metal grounds and screeds.

3.11 PLASTER GROUT

Plaster grout shall be scratch-coat material mixed to a non-fluid consistency. Plaster grout shall be used to fill steel door frames and partition bases. Heads and jambs of frames shall be filled solid with grout, and 13 mm deep grooves shall be formed in the grout, while plastic, to receive gypsum lath.

3.12 PROPORTIONS AND MIXING

3.12.1 Portland Cement Plaster Base Coat

Base coat shall be proportioned and mixed in accordance with ASTM C 926.

3.12.2 Portland Cement-Plaster Finish

The finish coat shall be proportioned and mixed in accordance with ASTM C 926.

3.13 MACHINE APPLICATION

A plastering machine may be used for the application of scratch and brown coats. Plaster for machine application shall be a special plaster compounded and packaged by the manufacturer for this purpose. Slump cone equipment shall be present on the jobsite when base-coat plastering begins, and until completion. Testing of the mix shall be the responsibility of the Contractor, but equipment shall be available for use by the Government.
Additional water shall not be added to the mix to allow pumping through extended hose lines to the plastering nozzle. The amount of water added to each batch of plaster shall be that quantity which results in a plaster slump of not more than 75 mm for gypsum and 65 mm for portland cement using a standard plaster slump cone or 150 mm for gypsum and 125 mm for portland cement using a concrete slump cone. Application of plaster shall conform to the provisions of ASTM C 842.

3.14 QUALITY CONTROL

Fluidity or stiffness of plaster shall be tested with a standard 50 x 100x150 mm plaster slump testing cone or by a 100 x 200 x 300 mm concrete slump testing cone. Method of making slump test shall be as follows:

a. Place cone on center of dry base plate located on a level, firm surface. Hold cone tightly against plate.

b. Fill the cone with plaster obtained from the hose or nozzle, without air on the nozzle, puddling with tamping rod during the operation to eliminate air bubbles or voids.

c. Screed plaster level with top of cone.

d. Lift cone straight up from base plate in a slow and uniform motion, and place it on the base plate next to plaster sample.

e. Lay a straightedge across top of cone, being careful not to disturb or jostle the plate, and measure the slump in mm from the bottom of the straightedge to the top of the plaster sample.

3.15 APPLICATION OF FINISHES

The finish coat may be omitted back of projecting bases, wainscots, structural-glass wall finish, cabinets, chalkboards, tackboards, bulletin boards, acoustic treatments, fixed equipment, and other locations where indicated. Finish coats shall not be applied above wainscots until wainscots have been installed. Plaster shall have a smooth-trowelfinish.

3.15.1 Portland Cement-Based Plaster

Two-coat portland cement-based plaster shall be applied in accordance with ASTM C 926. The final coat shall be finished to a true and even surface free from rough areas, checks, or blemishes. Nominal plaster finish thickness shall be as shown.

3.16 PATCHING

Plaster showing over sanding, cracks, blisters, pits, checks, discoloration or other defects is not acceptable. Defective plaster work shall be removed and replaced with new plaster at the expense of Contractor. Patching of defective work will be permitted only when approved by the Contracting Officer. Patching shall match existing work in texture and color.

3.17 SAMPLES OF COMPLETED WORK

Samples of completed work may be taken by the Contracting Officer at any time for laboratory inspection and tests to determine conformance.

-- End of Section --

DIVISION 12

SECTION 12 05 02

PAINTING

1. **SCOPE**

The work under this section of the Specifications consists of furnishing all materials, plant, labor, equipment, appliances and performing all operations in any floor and at any height in connection with surface preparation, mixing, painting concrete works, gates, frames, walls, ceilings and all such surfaces as shown on the Drawings and/or as directed by the Project Manager. The scope of this section of specification is covered with detailed specifications as laid down herein.

2. **APPLICABLE STANDARDS**

Latest editions of following British Standards are relevant to these specifications wherever applicable.

2.1 BSI (British Standards Institution)

245	Specification for mineral solvents (white spirits and related hydrocarbon solvents) for paints and other purposes.
2521	Lead-based priming paint for wood work.
2523	Lead based priming paint for iron and steel.
2569	Sprayed metal coatings.
4800	Paint colours for building purposes.
CP.231	Painting of building.
CP.3012	Cleaning and preparation of metal surfaces.

3 GENERAL

3.1 Except as otherwise specified, all painting shall be applied in conformity with BS CP 231 "Painting of Building" as applicable to the work.

3.2 The Contractor shall repair at his own expense all damaged or defective areas of shop-painted metal work and structural steel work. Metal surfaces against which concrete is to be placed will be furnished shop-painted and shall be cleaned prior to being embedded in concrete.

3.3 Except as otherwise specified all concrete and plastered surfaces are to be painted.

3.4 The Project Manager will furnish a schedule of colours for each area and surface. All colours shall be mixed in accordance with the manufacturer's instructions.

3.5 Colours of priming coat (and body coat) where specified, shall be lighter than those of finish coat. The Project Manager shall have unlimited

choice of colours.

3.6 Samples of all colours, and finishes shall be prepared in advance of requirement so as not to delay work and shall be submitted to the Project Manager for approval before any work is commenced. Any work done without such approval shall be redone to the Project Manager's satisfaction, without additional expense to the Employer. Samples of each type of paint shall be on separate 12" x 12" x 1/8" tempered hard board panels. Manufacturer's colour chart shall be submitted for colour specifications and selection.

4 MATERIALS

4.1 All materials shall be acceptable, proven, first grade products and shall meet or exceed the minimum standards of reputable manufacturers as approved by the Project Manager.

4.2 Colours shall be pure, non-fading pigments, mildew-proof sun-proof, finely ground in approved medium. Colours used on-plaster and concrete surfaces shall be lime-proof. All materials shall be subject to the Project Manager's approval.

4.3 All synthetic enamel paints and primers for structural steel works, metal work and wood works will be the best available of its type and shall be approved by the Project Manager prior to its procurement.

4.4 Approved quality Weather Shield/Weather Coat paint shall be used for painting the exteriors of the structures or other surfaces where specified on the drawings as directed by the Project Manager.

4.5 The plastic emulsion paint, vinyl emulsion paint or similar as approved by the Project Manager shall be used for interior surfaces.

4.6 All material for Bitumen painting shall consist of Bitumen grade 10/20. It shall be used for foundations or wherever recommended by the Project Manager. The rate of application in foundations shall not be less than 5.0 Ib/10 Sft. each coat.

4.7 Only paints approved by AUWSSC/WWMD contracting officer shall be used in this Project.

All material shall be delivered to site in their original unbroken containers or packages & bear the manufacturer's name, label, brand & formula & will be mixed and applied in accordance with his directions.

5 DELIVERY STORAGE AND CONTAINER SIZES

Paints shall be delivered to the site in sealed containers, which plainly show the type of paint, colour (formula or specifications number) batch number, quantity, date of manufacture, name of manufacturer and instructions for use. Pigmented paints shall be supplied in containers not larger than 20 liters.

All materials shall be stored under cover in a clean storage space, which should be accessible at all times to the Project Manager. If storage is allowed inside the building, floors shall be kept clean and free from paint spillage.

6 SURFACE PREPARATION

6.1 All oil, grease, dirt, dust, loose mill scale and any other foreign substance shall be removed from the surface to be painted, polished and white washed by the use of a solvent and clean wiping material. Following the solvent cleaning, the surfaces shall be cleaned by scrapping, chipping, blasting, wire brushing or other effective means as approved by the Project Manager.

6.2 In the event the surfaces become otherwise contaminated in the interval between cleaning and painting, recleaning will be done by the Contractor at no additional cost.

6.3 Surfaces of stainless steel, aluminum, bronze, and machined surfaces adjacent to metal work being cleaned or painted shall be protected by effective masking or other suitable means, during the cleaning and painting operations.

6.4 All the surfaces to be painted with approved quality paint shall be free from dust, dirt, fungus, lichen, algae etc. Oil paint, varnish and lime wash should always be removed by scraping and washing.

6.5 All surfaces to be bitumen painted shall be thoroughly cleaned of any accretion, dust, dirt etc. by scraping, wire-brushing or as directed by the Project Manager. The surface shall be primed with a coat of asphalt oil used at the rate of not less than 0.50 pound per square foot.

No work in this section shall be allowed until all surfaces or conditions have been inspected and approved by the Project Manager.

7 APPLICATION

7.1 All paint and coating materials shall be in a thoroughly mixed condition at the time of application. All work shall be done in a workman like manner, leaving the finished surface free from drips, ridges, waves, laps, and brush marks. All paints shall be applied under dry and dust free conditions. Unless approved by the Project Manager paint shall not be applied when the temperature of the metal or of the surrounding air is below 7 degrees centigrade. Surfaces shall be free from moisture at the time of painting.

All primary paint shall be applied by brushing. The first coat of paint shall be applied immediately after cleaning. When paint is applied by spraying, suitable measures shall be taken to prevent segregation of the paint in the container during painting operation.

Effective means shall be adopted for removing all free oil and moisture from the air supply lines of the spraying equipment. Each coat of paint shall be allowed to dry or harden thoroughly before the succeeding coat is applied.

Surfaces to be painted that will be inaccessible after installation shall be completely painted prior to installation.

Coats of Weather Shield/Weather Coat paint shall be applied in accordance with the manufacturer's instructions or as directed by the Project Manager.

Only as much material should be mixed as can be used up in one hour. Over-thinning will not be permitted. After the first coat the surfaces will be soaked evenly four or five times and the second coat shall be applied after leaving for at least overnight.

7.2 Where shown on Drawings all exterior finishes shall be painted with Weather Shield/weather coat paint in approved colours as per manufacturer's specifications. The number of coats shall be as shown on the drawings or as directed by the Project Manager.

7.3 All wooden doors shall be painted with approved synthetic enamel paint as per manufacturer's recommendation and instructions or after approval of the Project Manager.

7.4 Plastic emulsion paint, vinyl emulsion paint or matt enamel paint of the approved make and shade shall be applied to surfaces as shown on Drawings as per manufacturer's instructions. The number of coat shall be as indicated on the Drawings or as directed by the Project Manager.

7.5 Two coats of hot bitumen paint shall be applied to exposed concrete surfaces in contact with earth. The first coat shall be allowed to dry for about six hours before applying the second coat. During the operation of painting great care should be taken to avoid air bubbles. The manufacturer’s instructions and Project Manager's directions shall be complied with.

8 JOB CONDITIONS

8.1 Observe manufacturer's recommended minimum and maximum temperature but do not apply paint or finish to any surface unless ambient temperature is 10 degree C or above and less than 43 degree C. No painting shall be done above 90% relative humidity.

8.2 Place drop cloths to adequately protect all finished work.

8.3 Remove and replace all items of finish hardware, device plates, accessories, lighting fixtures or other removable items.

8.4 In no case shall any finish hardware or other finished item that is already fitted into place be painted, unless otherwise specified.

9 QUALITY ASSURANCE

All paint for any one surface shall be top quality, of one manufacturer and approved by the Project Manager. Deep tone accent colors shall be used and

the unavailability of final coat colors may be the basis for rejecting materials for any one surface.

2 SCHEDULE OF MEASUREMENT OF PAINT AREA:

2.1 Irrespective of prime coats and number of paint coats applied to exposed painting surface area of column, walls, projections, ceilings, false ceilings and other surfaces (Except gates, doors windows and ventilators) shall be measured as per actual paint surface area for single time only and paid in accordance with quoted rate of Bill of Quantities.

---END OF SECTION---

DIVISION 13

ELECTRICAL

SECTION 13 05 03

BASIC ELECTRICAL MATERIALS AND METHODS

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.

ASTM INTERNATIONAL (ASTM)

ASTM D 709	(2001) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2005) National Electrical Safety Code
IEEE Std 100	(2000) The Authoritave Dictionary of IEEE Standards Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005; TIA 2005) National Electrical Code

1.2 RELATED REQUIREMENTS

This section applies to all sections ELECTRICAL and UTILITIES, of this project specification unless specified otherwise in the individual sections.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.4 **ELECTRICAL CHARACTERISTICS**

Electrical characteristics for this project shall be 220/380 volts, three phase, four wire, 50 Hz.

1.5 **ADDITIONAL SUBMITTALS INFORMATION**

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

1.5.1 **Shop Drawings (SD-02)**

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.5.2 **Product Data (SD-03)**

Submittal shall include performance and characteristic curves.

1.6 **QUALITY ASSURANCE**

1.6.1 **Regulatory Requirements**

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.2 **Standard Products**

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however,

the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

1.6.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.8 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

c. Safety precautions.

d. The procedure in the event of equipment failure.

e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.9 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.10 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 3 mm thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 25 by 65 mm. Lettering shall be a minimum of 6.35 mm high normal block style.

1.11 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.12 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instructions to acquaint the operating personnel with the changes or modifications.

2 PART 2 PRODUCTS

2.1 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

3 PART 3 EXECUTION

3.1 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.1 **FIELD FABRICATED NAMEPLATE MOUNTING**

Provide number, location, and letter designation of nameplates as indicated.

Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.2 **WARNING SIGN MOUNTING**

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 9 meters apart.

---END OF SECTION---

SECTION 13 04 03
SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT

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 within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2005e13) Manual of Steel Construction

ASTM INTERNATIONAL (ASTM)

ASTM E 580	(2002e1) Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Moderate Seismic Restraint

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-03A	(2005) Seismic Design for Buildings

UNDERWRITERS LABORATORIES (UL)

UL 1598	(2004; Rev thru May 2006) Luminaires

1.2 SUBMITTALS

Government approval is required for submittals with a "A" designation; submittals not having a "A" designation are for Contractor Quality Control approval. The following shall be submitted:

SD-02 Shop Drawings

Lighting Fixtures in System
Equipment Requirements

Detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

SD-03 Product Data

Lighting Fixtures in System; A

Equipment Requirements; A

Copies of the design calculations with the detail drawings.

Calculations shall be stamped by a registered engineer and shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

Contractor Designed Bracing; A

Copies of the Design Calculations with the Drawings. Calculations shall be approved, certified, stamped and signed by a Registered

Professional Engineer. Calculations shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

1.3 SYSTEM DESCRIPTION

1.3.1 General Requirements

The requirements for seismic protection measures described in this section shall be applied to the electrical equipment and systems listed below.

1.3.2 Electrical Equipment

Electrical equipment shall include the following items to the extent required on the drawings or in other sections of these specifications:

Control Panels	Air Handling Units
Pumps with Motors	Light Fixtures Motor Control Centers
Transformers	Switchboards (Floor Mounted)

1.3.3 Electrical Systems

The following electrical systems shall be installed as required on the drawings and other sections of these specifications and shall be seismically protected in accordance with this specification:

1.3.4 Contractor Designed Bracing

The Contractor shall design the bracing in accordance with UFC 3-310-03A and additional data furnished by the Contracting Officer. Resistance to lateral forces induced by earthquakes shall be accomplished without consideration of friction resulting from gravity loads. UFC 3-310-03A uses parameters for the building, not for the equipment in the building; therefore, corresponding adjustments to the formulas shall be required. Loadings determined using UFC

3-310-03A are based on strength design; therefore, AISC 325 shall be used for the design. The bracing for the following electrical equipment and systems shall be developed by the Contractor.

1.3.5 Conduits Requiring No Special Seismic Restraints

Seismic restraints may be omitted from electrical conduit less than 64 mm trade size. All other interior conduit, shall be seismically protected as specified.

1.4 EQUIPMENT REQUIREMENTS

1.4.1 Rigidly Mounted Equipment

The following specific items of equipment are to be furnished under this contract shall be constructed and assembled to withstand the seismic forces specified in UFC 3-310-03A, Chapter 10. Each item of rigid electrical equipment shall be entirely located and rigidly attached on one side only of a building expansion joint. Piping, electrical conduit, etc., which cross the expansion joint shall be provided with flexible joints that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions.

Transformers

Switch Boards

PART 2 PRODUCTS

2.1 LIGHTING FIXTURE SUPPORTS

Lighting fixtures and supports shall conform to UL 1598.

2.2 SWAY BRACING MATERIALS

Sway bracing materials (e.g. rods, plates, rope, angles, etc.) shall be as specified.

3 PART 3 EXECUTION

3.1 SWAY BRACES FOR CONDUIT

Conduit shall be braced as for an equivalent weight pipe in accordance with Section 06 00 00 PLUMBING, GENERAL PURPOSE.

3.2 LIGHTING FIXTURES IN BUILDINGS

Lighting fixtures and supports shall conform to the following:

3.2.1 Pendant Fixtures

Pendant fixtures shall conform to the requirements of UFC 3-310-03A, Chapter 10.

3.2.2 Ceiling Attached Fixtures

3.2.2.1 Recessed Fluorescent Fixtures

Recessed fluorescent individual or continuous-row mounted fixtures shall be supported by a seismic-resistant suspended ceiling support system built in accordance with ASTM E580. Seismic protection for the fixtures shall conform to the requirements of UFC 3-310-03A, Chapter 10. Recessed lighting fixtures not over 25 kg in weight may be supported by and attached directly to the ceiling system runners using screws or bolts, number and size as required by the seismic design. Fixture accessories, including louvers, diffusers, and lenses shall have lock or screw attachments.

3.2.2.2 **Surface-Mounted Fluorescent Fixtures**

Surface-mounted fluorescent individual or continuous-row fixtures shall be attached to a seismic-resistant ceiling support system built in accordance with ASTM E580. Seismic protection for the fixtures shall conform to the requirements of UFC 3-310-03A, Chapter 10.

3.2.3 Assembly Mounted on Outlet Box

A supporting assembly, that is intended to be mounted on an outlet box, shall be designed to accommodate mounting features on 100 mm boxes, plaster rings, and fixture studs.

3.2.4 Wall-Mounted Emergency Light Unit

Attachments for wall-mounted emergency light units shall be designed and secured for the worst expected seismic disturbance at the site.

SECTION 13 06 02
PANELBOARD

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 416	(1974; R 1981) Standard for Filters, for Radio Interference
EIA 46	(1987) Test Procedure for Resistance to Soldering (Vapor Phase Technique) for Surface Mount Devices

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA PB 1	(2006; Errata 2008) Standard for Panel boards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2007; AMD 1 2008) National Electrical Code - 2008 Edition

UNDERWRITERS LABORATORIES (UL)

UL 67	(2009) Standard for Panel boards

1.2 SYSTEM DESCRIPTION

These specifications include the design, fabrication, assembly, wiring, and delivery of the items of equipment and accessories and spare parts listed in the Schedule and shown on the drawings.

1.2.1 Coordination

The general arrangement of the panel boards is shown on the contract drawings. Any modifications of the equipment arrangement or device requirements as shown on the drawings shall be subject to the approval of the Government. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. All equipment shall be completely assembled at the factory.

1.2.2 Standard Products

Material and equipment shall be standard products of a manufacturer regularly engaged in their manufacture and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. All materials shall conform to the requirements of these specifications. Materials shall be of high quality, free from defects and imperfections, of recent manufacture, and of the classification and grades designated. All materials, supplies, and articles not manufactured by the Contractor shall be the products of other recognized reputable manufacturers. If the Contractor desires for any reason to deviate from the standards designated in these specifications, he shall, after award, submit a statement of the exact nature of the deviation, and shall submit, for the approval of the Government, complete specifications for the materials which he proposes to use.

1.2.3 Nameplates

Nameplates shall be made of laminated sheet plastic or of anodized aluminum to provide white letters on a black background. The nameplates shall be fastened to the panels in proper positions.

1.3 MATERIAL AUTHENTICATION DATA INCLUDED IN DESIGN ANALYSIS

The following is submitted:

SD-02 Shop Drawings

Panel boards

The Contractor shall, within 30 calendar days after date of receipt by him of notice of award, submit for the approval of the Government six (6) copies of outline drawings of all equipment to be furnished under this contract, together with weights and overall dimensions. Drawings shall show the general arrangement and overall dimensions of the motor control centers, switchboards, and panel boards. These drawings shall show space requirements, details of any floor supports to be embedded in concrete and provisions for conduits for external cables.

The Contractor shall, within 30 calendar days after date of receipt by him of notice of award, submit for the approval of the Government six (6) copies of electrical equipment drawings. A single-line diagram, equipment list and nameplate schedule shall be provided for each switchboard and panel board.

SD-03 Product Data

Panel boards

The Contractor shall within 30 calendar days after date of receipt by him of notice of award submit for approval six (6) copies of such descriptive cuts and information as are required to demonstrate fully that all parts of the equipment will conform to the requirements and intent of the specifications. Data shall include descriptive data showing typical construction of the types

of equipment proposed, including the manufacturer's name, type of molded case circuit breakers or motor circuit protectors, performance capacities and other information pertaining to the equipment.

1.4 DOCUMENTATION FOR PROPOSED VARIANT PRODUCTS

For products not explicitly named in the specification that meet product requirement criteria named herein, product data as listed in article titled

MATERIAL AUTHENTICATION DATA INCLUDED IN DESIGN ANALYSIS shall be submitted for review. Product information will be provided to establish that proposed product meets the requirements of this specification and has the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, or other relevant characteristics that equal or exceed those of specified product. Product is consistent with the Contract Documents and will produce the indicated results, and is compatible with other portions of the Work.

1.5 MAINTENANCE

1.5.1 Spare Parts

Spare parts shall be furnished as specified below. be All spare parts shall of the same material and workmanship, shall meet and the same requirements, shall be interchangeable with the corresponding original parts furnished.

a) 2 each - Fuses of each type and size.

PART 2 PRODUCTS

2.1 MANUFACTURER

Basis of Design: As indicated in this section.

Acceptable Manufacturers:

1.Basis of Design manufacturers.

2.Equivalent product complying with requirements of this specification for proposed variant products.

2.2 General Standards

BS EN 50300-2 for general requirement for L.V. substation cable distribution boards. BS EN 60947-2 for ancillary equipment.

BS EN 60439-3, DIN 60439 and IEC 60439 for L.V. switchgear intended to be installed in places where unskilled persons have access to their use. BS 5824 and BS 5825 for L.V. switchgear industrial use.

2.3 CONNECTIONS

All bolts, studs, machine screws, nuts, and tapped holes shall be in accordance with ASME B1.1. The sizes and threads of all conduit and fittings, tubing and fittings, and connecting equipment shall be in accordance with ASME B1.20.1.

2.4 CIRCUIT BREAKERS

Circuit breakers shall conform to the applicable requirements of NEMA AB 1, UL 489, or DIN, IEC 60898-1, or BS EN 60947-2, standards. The circuit breakers

shall be manually-operated, shall be quick-make, quick-break, common trip type, and shall be of automatic-trip type unless otherwise specified or indicated on the drawings. All poles of each breaker shall be operated simultaneously by means of a common handle. The operating handles shall clearly indicate whether the breakers are in "On," "Off," or "Tripped" position and shall have provisions for padlocking in the "Off" position.

Personnel safety line terminal shields shall be provided for each breaker. The circuit breakers shall be products of only one manufacturer, and shall be interchangeable when of the same frame size.

Basis of Design: Moeller.

2.4.1 Trip Units

Except as otherwise noted, the circuit breakers, of frame sizes and the trip unit ratings as shown on the drawings, shall be provided with combination thermal and instantaneous magnetic trip units. Nonadjustable instantaneous magnetic trip units shall be set at approximately 10 times the continuous current ratings of the circuit breakers.

2.5 Panel Boards

Panel boards shall consist of assemblies of molded-case circuit breakers for the main breaker only and miniature circuit breakers with buses and terminal lugs for the control and protection of branch circuits to motors, heating devices and other equipment operating at 380 volts' ac or less. Panel boards shall be UL 67, BS EN 60439-3, DIN 60439 or IEC 60439 labeled.

Panel boards shall be designed for installation in surface-mounted or flush-mounted cabinets accessible from the front only, as shown on the drawings.

Basis of Design: GE A series or Spectra series panel boards; Eptim

Limited; Models APL-B, PP, MDP-DIN, PP1, and LP1; or model by Ekobin (EAE).

2.5.1 Enclosure

Enclosures shall meet the requirements of BS EN 62208, UL 50, IEC 60529. All cabinets shall be fabricated from sheet steel. Cabinets shall be painted in accordance with paragraph PAINTING. Enclosures shall meet NEMA 3R (IP 41) or higher for outdoor and NEMA Type 1 (IP 10) or higher for indoor application.

2.5.2 Buses

All panel boards shall be of the dead-front type with buses and circuit breakers mounted on a plate or base for installation as a unit in a cabinet. All buses shall be of copper. Copper bars and shapes for bus conductors shall conform to the applicable requirements of ASTM B 187. The sizes of buses and the details of panel board construction shall meet or exceed the requirements of NEMA PB 1, or BS EN 60947-2.

2.5.3 Components

Each branch circuit, and the main buses where so specified or shown on the drawings, shall be equipped with molded-case circuit breakers having overcurrent trip ratings as shown on the drawings. The circuit breakers shall be of a type designed for bolted connection to buses in a panel board assembly, and shall meet the requirements of paragraph CIRCUIT BREAKERS. Circuit breakers of the same frame size and rating shall be interchangeable.

2.6 MOTOR CONTROL

2.6.1 Motor Starters

Motor starters shall be provided of sizes, ratings and NEMA or equivalent type as required for motors provided and in accordance with BS EN 60947-4-1: 2001.

2.6.1.1 Manual Motor Starter

Provide single-phase, fractional HP manual motor controllers as required.

Equip with manually operated quick-make, quick-break toggle mechanisms; and with one-piece melting alloy type thermal units. Controller to become inoperative when thermal unit is removed. Enclose controller unit in NEMA Box Type as required for surface mounting. Controller shall be suitable for mounting in standard switch box and installed flush in finished room environments. Coat with manufacturer's standard color finish.

Basis of Design: Bticino, models 602 and 642.

2.6.1.2 Full Voltage Starter

Provide full-voltage non-reversing (FVNR), alternating-current combination starters consisting of controller, fused 220V control transformer, push buttons, selector switches, and indicating lights, mounted in common enclosure, as required. Equip controller with electrical interlocks as indicated. Provide controller with two normally open and two normally closed spare auxiliary contacts. Equip controller with block type manual external reset three-phase overload relay. Construct and mount controller and disconnect mechanism in manufacturer's standard color finish.

Basis of Design: Schneider Electric for contactors and components;

Ferraz Shawmut for control fuse and carrier; SDF for transformer; The Control Group for indication lamps and switches; Eldon for panel enclosures.

2.6.1.3 Combination Disconnect and Full Voltage Starter

Provide starter as specified for stand-alone full voltage nn-reversing starter, and provide with non-fused disconnect switch mounted in common enclosure. Provide operating handle for disconnect mechanism with indication of control switch position, with enclosure door either opened or closed.

Basis of Design: Bticino, GE, or Schneider Electric.

2.7 PAINTING

Interior and exterior steel surfaces of equipment enclosures shall be thoroughly cleaned and then receive a rust-inhibitive phosphatizing or

equivalent treatment prior to painting. Exterior surfaces shall be free from holes, seams, dents, weld marks, loose scale or other imperfections. Interior surfaces shall receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice. Exterior surfaces shall be primed, filled where necessary, and given not less than two coats baked enamel with semi-gloss finish. Equipment located indoors shall be Light Gray, and equipment located outdoors shall be Light Grey or Dark Gray, or according to International Building Code requirements and ASTM standards. All touch-up work shall be done with manufacturer's coatings as supplied under paragraph SPARE PARTS.

---END OF SECTION---