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Civilian Radioactive Waste Management System Management and Operating Contractor

Site Gas/Liquid Systems Technical Report

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Prepared for:

U.S. Department of Energy
Yucca Mountain Site Characterization Office
P.O. Box 98608
Las Vegas, NV 89193-8608

Prepared by:

TRW Environmental Safety Systems, Inc.
1180 Town Center Drive
Las Vegas, NV 89134

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Prepared by: ______________________ 2/27/98
D. M. LaRue — Date
Process Engineer
Repository Surface Design
CRWMS M&O, Las Vegas

Checked by: ______________________ 2/27/98
Robert Zimmerman — Date
Product Checking Group
CRWMS M&O, Las Vegas

LDE: ______________________ FOR 2-27-98
Scott McFeely — Date
Lead, Process Engineering
Repository Surface Design
CRWMS M&O, Las Vegas

Approved by: ______________________ 2-27-98
S.J. Meyers — Date
Department Manager,
Repository Surface Design
CRWMS M&O, Las Vegas

SITE GAS/LIQUID SYSTEMS TECHNICAL REPORT

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ACRONYMS AND ABBREVIATIONS

ACDR	Advanced Conceptual Design Report
ALARA	As low as reasonably achievable
ANS	American Nuclear Society
ANSI	American National Standards Institute
A.P.I.	American Petroleum Institute
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
BOP	Balance of plant
BWR	Boiling-water reactor
CDA	Controlled Design Assumptions Document
CFR	Code of Federal Regulations
CHW	Chilled water
CSS	Carrier Staging Shed
CW	Cooling tower water
CWA	Clean Water Act
DC	Disposal canister
DOE	U.S. Department of Energy
DPC	Dual-purpose canister
DSNF	Defense spent nuclear fuel
EDE	Effective dose equivalent
HDPE	High density polyethylene
HEPA	High efficiency particulate air
HLW	High-level waste
HW	Heating water
HVAC	Heating, ventilating, and air conditioning
ISFSI	Independent Spent Fuel Storage Installation
LCC	Life cycle cost
LWR	Light-water reactor
MBH	Btu/hr x 10^3
MGDS	Mined Geologic Disposal System
MPC	Multi-Purpose Canister
MPFL	Maximum possible fire loss
NEC	National Electrical Code
NFPA	National Fire Protection Association
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site
NUREG	Nuclear Regulatory Commission publication
OSHA	Occupational Safety and Health Administration
PVC	Polyvinyl chloride

PWR	Pressurized-water reactor
QA	Quality assurance
QAP	Quality Assurance Procedure
QARD	Quality Assurance Requirements and Description
RCA	Radiological control area
RDRD	Repository Design Requirements Document
SCF	Standard cubic feet
SCFM	Standard cubic foot per minute
SNF	Spent nuclear fuel
SSC	Systems, structures, and components
TBD	To be determined
TBV	To be verified
TR	Tons of refrigeration
USC	United States Congress
WHB	Waste Handling Building
WTB	Waste Treatment Building

SITE GAS/LIQUID SYSTEMS TECHNICAL REPORT

1. PURPOSE

This technical report has been prepared to provide the initial conceptual design for those support systems and facilities which have not been addressed since the preparation of the *Site Characterization Plan Conceptual Design Report* (SCP-CDR) (Reference 5.1). The appropriate level of detail has been included to provide a credible design concept and to support the preparation of a cost estimate for Viability Assessment (VA) Design.

The utility liquid systems addressed within the scope of this technical report are primarily water systems which include:

- potable water system
- chilled water system
- cooling water system
- hot water system
- utility water softening and supply system
- deionized water treatment and supply system
- fire water system and supply
- water recycle systems
- sanitary waste system
- evaporation pond

Fuel oil storage and supply is also discussed as a liquid utility system.

The utility gas systems addressed within the scope of this technical report are:

- breathing air
- instrument and shop air
- nitrogen
- argon
- argon/helium blend
- helium.

This technical report provides information on the design and annual flowrates for the various utility systems and defines the bases for these flowrates. Performance criteria for major subsystem components are identified, and the report provides engineering sizes for major components. The report also provides line sizes for system supply headers.

This technical report reflects a conceptual level of design that is anticipated to be further refined as additional engineering definition is developed for the North Portal facilities and functions.

There is presently insufficient definition of water and air (breathing or instrument) consumption for subsurface North Portal operations to identify demand requirements on North Portal utility services for water and air. Potable water and firewater will be made available for subsurface use at the Utility Building through the use of dedicated transportable tanks. It is assumed that the demand of potable water and firewater for North Portal subsurface use is within the engineering contingency placed on North Portal Surface Facility potable water consumption. (Assumption 4.3.1.1.1)

Raw well water will be available through existing system connections for use in North Portal subsurface operations. This water will continue to be utilized through the use of transportable tanks. The addition of lithium bromide (LiBr) used as a tracer for subsurface water is not included in the scope of this report.

The potential quantity of instrument air requirements for North Portal subsurface operations has not been quantified. It is assumed that sufficient capacity of instrument air exists within the engineering contingency placed on the North Portal instrument/shop air system. (Assumption 4.3.2.2.1)

It is assumed that sufficient capacity is present with the engineering contingency placed on North Portal Surface Facility breathing air for incidental use of breathing air by North Portal subsurface operations. If it becomes evident, after detailed definition of subsurface breathing air consumption requirements, that additional capacity for North Portal Surface Facility breathing air is required to support subsurface operations, a noticeable cost impact to the breathing air system will occur. (Assumption 4.3.2.1.1)

2. QUALITY ASSURANCE

An activity evaluation has been performed in accordance with QAP-2-0 and has determined that the QA program is applicable to this technical report. The classification of permanent items described in QAP-2-3 *Classification of Permanent Items* has been performed for the Preliminary MDGS Repository Design (Reference 5.2). Therefore, items addressed in this technical report are to be considered "Q" items, and are subject to the requirements of the *Quality Assurance Requirements and Description* (QARD) (Reference 5.3). Therefore, as specified in NLP-3-18, this technical report is documented as being subject to QA controls. Table 2-1 presents the quality classification assignment for the utility services identified in Reference 5.2. Reference 5.2 does not classify all utility services discussed with this technical report. It is assumed that those utility systems not classified in Reference 5.2 will have a QA classification which will make them subject to the QARD, Reference 5.3 (Assumption 4.3.6.1).

Although the results from this technical report will define utility system flowrates, equipment sizes, and space requirements for the Repository, they are considered to be at the conceptual level and will not be used directly for procurement, fabrication, or construction. Therefore, the formal To Be Verified (TBV) and To Be Determined (TBD) tracking system described in NLP-3-15 *To Be*

Table 2-1 Utility Services Quality Classification Assignment

SDD Number	System	QA Classification (Assumption 4.3.6.2)
SU43	**Site Water System**	
	Chilled Water System	QA-5
	Cooling Water System	QA-5
	Fire Water Distribution System	QA-1, QA-4, QA-5
	Potable Water System	QA-5
SU45	**Site Compressed Air System**	
	Air Compression System	QA-1
	Industrial Air Distribution System	Non-Q
	Instrument Air Distribution System	QA-1
SU47	**Site Generated Hazardous & Non-Hazardous Waste Disposal System**	
	Sanitary Waste Treatment System	Non-Q

Verified and To Be Determined Monitoring System, is not applicable. Any data from this technical report that is used as design input must be treated as unconfirmed (TBV) and tracked per NLP-3-15 prior to inclusion in documents supporting fabrication, procurement, or construction.

3. METHOD

The method used to prepare this technical report was comprised of several steps. The first step was the identification of the various utility services to be provided commonly throughout the North Portal Surface Facilities. This identification was done through a review of plans, flowsheets, and project documentation. Second, data was then collected on the present estimated consumption of utility services through review of current project documentation. Estimates of consumption were made for those utility services where no previous consumption data have been generated.

Third, the utility services identified were totaled and analyzed to develop design flowrates for the central utility service provider system. Last, these design flowrates were then used to size components, subsystems, and distribution mains through standard engineering calculation techniques.

4. DESIGN INPUTS

4.1 DESIGN PARAMETERS

In the performance of the calculations presented in this report, the following conversion factors and engineering constants were utilized:

pi = 3.14159
1 ft = 12 in
1 ft^2 = 144 in^2
1 ft3 = 7.481 gallons
1 day = 24 hr = 1440 min = 86,400 sec
1 centipoise = 1 x 10^{-2} grams/cm-sec
= 6.72 x 10^{-4} lb/ft-sec
1 gal = 3.785 liters
density of water (45° F) = 62.4 lb/ft^3

g = 32.2 ft/sec/sec
1 ton of refrigeration = 12,000 Btu/hr
1 Btu = 0.293 watt-hr
1 hp = 745.7 watt = 33,000 ft-lb/min
1 ft of water = 0.433 psig
1 mho = 1/1.0 ohm

1 lb = 454.6 g
1 gallon of water (45° F) = 8.34 lb

4.1.1 Water Systems

4.1.1.1 Potable Water System

Staffing levels (TBV) used for the definition of potable water demand and sanitary waste throughput were taken from *Repository Surface Design Engineering Files Report* (Reference 5.4). Additional specificity was provided by Interoffice Correspondence, *Operations Staffing Input for VA Technical Documents,* Reference 5.5.

4.1.1.2 Chilled Water System

The sizing (TBV) of the cooling and heating systems for the Surface Facilities of the North Portal Repository area was based on data in the *Surface Nuclear Facilities HVAC Analysis* (Reference 5.6) and from the balance of plant (BOP) load tabulation (Attachment I, Tables T-1a and 1b). The BOP Plant configuration and load sizing was based from the MGDS ACDR (Reference 5.7).

4.1.1.3 Cooling Water System

4.1.1.3.1 The design winter temperature for the site is 22.5° F dry bulb. (Reference 5.6, page I-2).

4.1.1.3.2 The cooling tower system is sized (TBV) to meet the chiller's condenser water requirements and other condenser water users.

4.1.1.4 Heating Water System

4.1.1.4.1 The BOP configuration and load sizes (TBV) were based on the MGDS ACDR (Reference 5.7).

4.1.1.4.2 The current North Portal Repository site area layout (Reference 5.4, Figure 7) was used to establish the chilled water and heating water piping distribution system. The final location of the Utility Building will be evaluated for cost effectiveness on the next design phase.

4.1.1.5 Utility Water Softening and Supply System

Design parameters for the utility water softening and supply system are as identified in assumptions in Section 4.3.1.5.

4.1.1.6 Deionized Water Treatment and Supply System

Design parameters for the deionized water treatment and supply system are as identified in assumptions in Section 4.3.1.6.

4.1.1.7 Fire Water System and Supply

Design parameters for the fire water system and supply are as identified in assumptions in Section 4.3.1.7.

4.1.1.8 Overall Water Supply Demand

The overall water system is sized (TBV) to supply and distribute water per the requirements for the various distributed water systems.

4.1.1.9 Water Recycle Systems

There are no water recycle systems identified within the utility services for the North Portal Surface Facilities.

4.1.1.10 Sanitary Waste System

Design parameters for the sanitary waste system are as identified as assumptions in Section 4.3.1.10.

4.1.1.11 Evaporation Pond

Design parameters for the evaporation pond are as identified as waste water flow rates (TBV) from the various distributed utility water systems.

4.1.1.12 Storm Water Drainage

Storm water drainage will connect into an existing surface water retainage system external to the RCA and BOP areas of the North Portal.

4.1.2 Compressed Air Systems

4.1.2.1 Breathing Air System

Design parameters for the breathing air system are as identified as assumptions in Section 4.3.2.1.

4.1.2.2 Instrument and Shop Air System

Design parameters for the instrument and shop air system are as identified as assumptions in Section 4.3.2.2.

4.1.3 Industrial Gases Systems

4.1.3.1 Nitrogen

Flowrates for nitrogen gas usage were based on WHB operations of 350 days/year (TBV), 3 eight-hour (TBV) shifts/day (Reference 5.5), and the waste throughput as defined in *Controlled Design Assumptions Document (CDA)* (Reference 5.8).

4.1.3.2 Argon

Flowrates (TBV) for welding gases are based on *Waste Package Closure Methods Report*, DI:BBA000000-01717-5705-00013, REV 00. (Reference 5.9).

4.1.3.3 Argon/Helium Blend

Flowrates (TBV) for welding gases are based on *Waste Package Closure Methods Report*, DI:BBA000000-01717-5705-00013, REV 00. (Reference 5.9).

4.1.3.4 Helium

Flowrates for helium gas usage were based on WHB operations of 350 days/year (TBV), 3 eight-hour (TBV) shifts/day (Reference 5.5), and the waste throughput as defined in *Controlled Design Assumptions Document (CDA)* (Reference 5.8).

4.1.4 Fuel Oil

No design parameters for the fuel oil system are identified.

4.1.5 Utility Building

The Utility Building will be sized to accomodate centralized utility systems located at and operated from the building.

4.2 CRITERIA

The following design criteria, which are applicable to this technical report, were developed in response to requirements found in the *Repository Design Requirements Document* (RDRD) (Reference 5.10).

All Repository Segment work places shall be designed to comply with occupational safety and health standards promulgated under 29 CFR 1910, 29 CFR 1926, and 30 CFR 57. (RDRD 3.3.6.1.B)

4.2.1 Water Systems

The Repository Segment will connect with the existing Nevada Test Site (NTS) water supply system. (RDRD 3.2.3.4.B)

4.2.1.1 Potable Water

4.2.1.1.1 Each utility service system, i.e., fire protection water, potable water for safety showers and eye washes, and breathing air, that is important to safety shall be designed so that essential safety functions can be performed under both normal and accident conditions (RDRD 3.2.5.1.4).

4.2.1.1.2 Where the possibility exists for the eyes or body of any person to be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the immediate work area for emergency use (RDRD 3.3.6.8-F).

4.2.1.1.3 Plumbing providing water for human consumption shall be lead-free in compliance with 42 USC 300g-6 (RDRD 3.7.3.3-A).

4.2.1.1.4 The potable water system shall be designed and installed to comply to Federal, State, and local requirements, administrative authorities, and process and sanctions regarding the provisions of safe drinking water (RDRD 3.7.3.3-B).

4.2.1.1.5 The water system shall be designed in accordance with DOE Order 6430.1A, Division 2 Site and Civil Engineering, and Division 15 Mechanical and applicable state laws (RDRD 3.7.3.3-C).

4.2.1.1.6 The water quality monitoring system shall have the capability to sample, measure, and analyze physical, chemical, and biological conditions consistent with the requirements of the CWA (33 USC 1251) and the Safe Drinking Water Act (42 USC 300f) in accordance with DOE Order 5400.1. Such capability must also be compatible with the type and range of concentrations/ occurrences of conditions specified in the governing regulations (e.g., 40 CFR 122, 141, 143, and State and local regulations)(RDRD 3.7.3.7-K).

4.2.1.2 Chilled Water, Cooling Water, and Hot Water System

Heating, ventillation, and air conditioning (HVAC) equipment in facilities shall be sized to conform with the guidelines in NUREG 0700 Section 6.1.5, MIL-STD-1472D Section 5.8.1, and the applicable ASHRAE standard may be used for reference (RDRD 3.2.4.2.2)

4.2.1.2.1 The capacity of the cooling and heating system is sized sufficient to handle the peak block load or the maximum simultaneous cooling and heating loads of all the buildings and in accordance with the ASHRAE Handbook, Fundamentals (Reference 5.11).

4.2.1.2.2 The chilled water (CHW), condenser or cooling tower water (CW), and the heating water (HW) distribution systems shall be designed for economical pipe sizes based on allowable pressure drop, flowrate, and pump selection criteria as prescribed by the ASHRAE Handbook, Fundamentals (Reference 5.11), ASHRAE Handbook, Systems and Equipment (Referenece 5.12), and ASHRAE Handbook, Applications (Reference 5.13).

4.2.1.2 Fire Protection

4.2.1.2.1 The design shall include explosion and fire detection alarm systems and appropriate suppression systems with sufficient capacity and capability to reduce the adverse effects of fires and explosions on systems, structures, and components (SSCs) important to safety (RDRD 3.2.1.7).

4.2.1.2.2 Each utility service system, i.e., fire protection water, potable water for safety showers and eye washes, and breathing air, that is important to safety shall be designed so that essential safety functions can be performed under both normal and accident conditions (RDRD 3.2.5.1.4).

4.2.1.2.3 Fire protection standards for the Repository Segment are imposed by various authoritative sources. In the event of conflict, the requirements affording greater protection (as determined by design technical report) prevail (RDRD 3.7.4.3).

4.2.1.2.4 Systems shall be designed to include appropriate suppression systems with sufficient capacity and capability to reduce the adverse effects of fires and explosions on SSCs important to safety (RDRD 3.7.4.3-A). These types of systems will also be installed in any building or facility that has a MPFL of $ 1,000,000 or more or is greater than 5000 ft^2 in size (DOE 5480.7).

4.2.1.2.5 The fire protection systems shall be designed in accordance with DOE Order 6430.1A, 0110-6 (RDRD 3.7.4.3-B).

4.2.1.2.6 Detection equipment for fires and explosions shall meet the requirements of DOE Order 5480.7, DOE Order 6430.1A, Division 15 and Division 16; and any applicable local, State, and Federal regulations (RDRD 3.7.4.3-C).

The fire water system shall be adequate to meet the sprinkler and hose stream demands (flow and pressure) for any fire expected in these facilities for a period of 2 hours as required by DOE 6430.1A, Section 1530.

4.2.1.2.7 The Repository Segment is to be designed and constructed to achieve the improved risk objectives prescribed by DOE Order 5480.7, paragraph 4. To this end the design shall include the compliance features and essential elements specified by DOE Order 5480.7, Paragraphs 9 and 10 (RDRD 3.7.4.3-D).

The fire protection water system design for this facility will meet the requirements of NRC and DOE. The DOE requirements are based on the fire insurance "improved risk" level of protection. The improved risk level of protection requires that the Maximum Possible Fire Loss (MPFL) be used to determine the extent of fire protection required at the facility. NRC requirements are noted in NUREG 0800, *Standard Review Plan, 9.5.1, Fire Protection Program* 10 CFR 50 Appendix R, *Fire Protection Rule*, 10 CFR 72, and DOE 5480.7A.

4.2.1.3 Sanitary Waste

4.2.1.3.1 The design, construction and operation of sanitary sewage handling and disposal systems shall be as permitted in accordance with the CWA, 33 USC 1251 et. seq. Section 1345, and applicable state laws (RDRD 3.7.3.8-F).

4.2.1.3.2 The sewerage system shall be designed in accordance with DOE Order 6430.1A, Division 2, Site and Civil Engineering and applicable state laws (RDRD 3.7.3.8).

4.2.1.3.3 The surface and underground sewage system shall be designed in accordance with DOE Order 5480.1, chg 1, 12-18-80, Chapter XII (RDRD 3.7.3.8-B).

4.2.2 Breathing Air Systems

4.2.2.1 When it is not practicable to apply process or other engineering controls in restricted areas to control the concentrations of radioactive material in air to values below those that define an airborne radioactivity area, the repository shall, consistent with maintaining the total EDE ALARA, have the capability to increase monitoring and limit intakes by one or more of the following: control of access, limitation of exposure times, use of respiratory protection equipment, or other controls (RDRD 3.2.2.3).

4.2.2.2 Each utility service system, i.e., fire protection water, potable water for safety showers and eye washes, and breathing air, that is important to safety shall be designed so that essential safety functions can be performed under both normal and accident conditions (RDRD 3.2.5.1.4).

4.2.3 Fuel Oil

Fuel storage tanks shall be designed and located in accordance with applicable regulations and shall be accessible by tank truck and rail (RDRD 3.7.4.3-E&F).

4.3 ASSUMPTIONS

The following project assumptions involve or imply the use of utility services at the surface facilities of the Repository. These assumptions shall be used as part of the basic criteria for the development and specification of site gas/liquid operations, systems and equipment.

4.3.1 Water Systems

4.3.1.1 Potable Water System

4.3.1.1.1 It is assumed that the demand of potable water and firewater for North Portal subsurface use is within the engineering contingency placed on North Portal Surface Facility potable water and firewater consumption. There is presently insufficient definition for actual determination of potable water consumption for North Portal subsurface operations. (Used in Section 1.0)

4.3.1.1.2 The potable water fed to the North Portal through the existing system is chlorinated. It is assumed that no additional water treatment for potable water is required, and that chlorine levels in the water are sufficient to maintain required chlorine levels at the demand point in all facilities served. If it is determined during the course of detailed design that augmentation of chlorination is required, the cost impact to the systems and components identified within this analysis will be insignificant. (Used in Section 7.1.1)

4.3.1.1.3 It is assumed that employees (e.g., operators, maintenance personnel, etc.) which perform manual work activities during the course of the work day will shower while at work. This is based on the requirement to provide showers in workshops or warehouses for personnel exposed to excessive heat or irritating materials, UBC (1997) Appendix Chapter 29, Section 2905 - General, Table A-29-A. Present estimates of the number of showering and non-showering employees is taken from Enclosure 4 of Reference 5.5. (Used in Section 7.1.1.1)

4.3.1.1.4 It is assumed that employees (e.g., supervisors, accountants, clerical staff, etc.) which do not perform manual work activities during the course of the work day will not shower while at work. Although certain employees in this group may shower, it is assumed that sufficient capacity is available under the defined water consumption. Present estimates of the number of showering and non-showering employees is taken from Enclosure 4 of Reference 5.5. (Used in Section 7.1.1.1)

4.3.1.1.5 It is assumed that each showering employee will consume 30 gallons/day (gpd) (TBV) of potable water per eight (8) hour shift. Although *Wastewater Engineering*, Reference 5.14, does not specifically cite a projected water consumption for showering employees in a light industrial setting, the reference does identify waste water flows for school days with cafeteria, gym, and showers (Table 2-11) at 15-30 GPD. A consumption rate of 30 GPD of potable water for showering employees is therefore a representative bounding (upper) value for the purposes of this study. (Used in Section 7.1.1.1)

4.3.1.1.6 It is assumed that each non-showering employee will consume 15 GPD (TBV) of potable water per eight (8) hour shift. *Wastewater Engineering,* Reference 5.14, cites in Table (2-10), for an industrial building, a water usage of 7-16 GPD per employee. A consumption rate of 15 GPD of potable water for non-showering employees is therefore a representative value for the purposes of this study. (Used in Section 7.1.1.1)

4.3.1.1.7 It is assumed that peak water demand is 3.0 (TBV) times the average demand. Reference 5.15, *Standard Handbook for Civil Engineers, third edition,* Table 21-18, page 21-96 which gives a national average for peaking demand of 250/100 = 2.5. This peaking demand is primarily for residential consumption. Because the majority of water consumption will occur during lunch or at end of shift, a contingency factor of 20% is applied, this brings the peaking factor to (1.2 x 2.5 =) 3.0. (Used in Section 7.1.1.1)

4.3.1.1.8 It is assumed that a pressure of 50 psig (TBV) for potable and softened water delivered to facilities is sufficient to provide a reasonable size for distribution piping within a given facility. This is based on the Uniform Plumbing Code, 1994 edition, Table 6-4, which shows that the minimum available static pressure after head loss should be greater than 45 psig. (Used in Sections 7.1.1.2, and 7.1.5.2)

4.3.1.1.9 It is assumed that water flow through pipes (well water, softened water, potable water, and deionized water) will be designed near or below a velocity of 4 fps. This velocity will lessen erosion and corrosion of piping and minimize water hammer. Reference *National Standard Plumbing Code, 1993 (4.4.4.3)* (Used in Sections 7.1.1.2, 7.1.5.3, and 7.1.6.3)

4.3.1.2 Chilled Water System

4.3.1.2.1 It is assumed that the CHW system will be designed to supply 42° F (TBV) water to the users with average temperature differentials of 12° F (TBV) for the users (distribution loop) and 10° F (TBV) for the chiller loop.
(Used in Section 7.1.2.2)

4.3.1.2.2 Pipe sizing will be based on a closed loop system for a maximum pressure drop of 4-feet of water per 100-feet (TBV) and a maximum velocity of 10 fps (See Attachment I, Table T-2a). The attached table from *Design Manual for HVAC* (Reference 5.16) is an equivalent tabulation of the ASHRAE Handbook, Fundamentals (Reference 5.11, Chapter 33) friction loss chart with the recommended pressure drop and pipe velocity design limitations. (Used in Sections 7.1.2.2 and 7.1.4.2)

4.3.1.2.3 It is assumed that multiple chillers are provided for capacities exceeding 400 tons. Wherever possible, the central cooling equipment should be designed into the chilled water (CHW) distribution systems as part of a primary-secondary loop system (DOE 6430.1A, Section 1550-2.1.1). (Used in Section 7.1.2.2)

4.3.1.2.4 It is assumed that multiple chillers with a modular size of between 1000-TR to 1500-TR (TBV) capacity with a maximum water pressure drop of 30-ft (TBV) (evaporator and condenser) will be the basis of the conceptual design selection for the chillers. This is based on manufacturer's nominal sizes. (Used in Sections 7.1.2.2 and 7.1.3.3)

4.3.1.2.5 It is assumed that high efficiency chillers with an input energy (kW/ton) not exceeding 0.70 (TBV) will be selected for energy conservation. (Used in Section 7.1.2.2)

4.3.1.2.6 It is assumed that all HVAC pumps will be selected for a minimum pump efficiency of 70% (TBV). Standby pumps will be provided for all systems, per guidance provided by DOE 6430.1A, Section 1550-2.3.2. (Used in Sections 7.1.2.2, 7.1.3.3, and 7.1.4.3)

4.3.1.2.7 It is assumed that the CHW distribution system will consist of a primary constant flow and a secondary variable flow pumping system. It is assumed for the purposes of calculating pump head requirements that the pressure drop is 15-ft (TBV) of water for both the cooling coil and the associated control valve. The secondary pumps will be driven by variable speed motors. (Used in Section 7.1.2.2)

4.3.1.2.8 It is assumed that the CHW and HW systems will be designed with a 20 % glycol solution (TBV). (See Attachment I, Table T-3c) (Used in Sections 7.1.2.2 and 7.1.4.3)

4.3.1.2.9 It is assumed that the chilled water system will consist of electric-driven, water-cooled, centrifugal-type liquid chillers utilizing environmentally acceptable refrigerant (R134 or equal). (Used in Section 7.1.2.2)

4.3.1.3 Cooling Water System

4.3.1.3.1 It is assumed that the cooling tower water (CW) system will be designed to supply 85° F (TBV) water to the condenser portion of the chillers with a temperature differential of 10° F (TBV) and design ambient wet bulb temperature of 65°F (TBV). (See page I-2 of Attachment I, Reference 5.6) (Used in Section 7.1.3.2)

4.3.1.3.2 It is assumed that pipe sizing of the CW system will be based on an open loop system for a maximum pressure drop of 6-feet of water per 100-feet (TBV) and a maximum velocity of 6 fps. (See Attachment I, Table T-2b). The attached table is an equivalent tabulation of ASHRAE Fundamental Handbook's friction loss chart with the recommended pressure drop and pipe velocity design limitations. (See Chapter 33, Reference 5.11) (Used in Section 7.1.3.2)

4.3.1.3.3 It is assumed that make-up water will be supplied to the cooling tower system to offset the sum of water losses due to drift, evaporation and blowdown. The amount of concentration recommended is between 2 to 6 cycles. A concentration of 6 times (TBV) incoming water quality (requiring less make-up water) will be used in this conceptual cooling water design. This is predicated on the use of good quality make- up water (softened), and it is a water conservation measure. (Used in Section 7.1.3.2)

4.3.1.3.4 It is assumed that the number and capacity of operating cooling towers matches the number of operating chillers. This will simplify the control interface between chillers and cooling towers. The cooling towers shall be sited to avoid problems with water drift and deposition of water treatment chemicals. (DOE 6430.1A, Section 1550-2.1.4) and shall be located, if feasible, adjacent to the Utility Building and close to the location of the chillers for piping optimization (See Figure 7, Reference 5.17). (Used in Section 7.1.3.3)

4.3.1.3.5 The CW system will be designed to be a constant flow type with the cooling tower water pumps circulating the water through the condensers of the chillers. It is assumed for the purposes of calculating pump head requirements that the cooling tower requires a lift of 12-ft (TBV) of water and a 5-ft (TBV) of water pressure drop at the nozzle. (Used in Section 7.1.3.3)

4.3.1.3.6 It is assumed that the cooling tower sump will be freeze protected. (DOE 6430.1A, Section 1550-2.1.4) (Used in Section 7.1.3.3)

4.3.1.4 Hot Water System

4.3.1.4.1 It is assumed that the CHW and HW distribution piping loop to the users will be located in a pipe trench. (See Attachment I, Figures 1b, 3b and 4) (Used in Sections 7.1.4.1 and 7.1.2.2)

4.3.1.4.2 It is assumed that the hot water (HW) system will be designed to supply water at a maximum temperature of 200° F (TBV) (DOE 6430.1A, Section 1550-2.2.2) to the users with an average temperature differential of 30° F (TBV). (Used in Section 7.1.4.2)

4.3.1.4.3 It is assumed that the hot water system will consist of two 50%-capacity (TBV), fuel oil fired, hot water boilers, and two operating circulating pumps, with one additional standby pump. This will provide for partial heating capability in the event of the failure of one boiler unit. The hot water boilers will be selected for a minimum boiler efficiency of 75% (TBV). (Used in Section 7.1.4.3)

4.3.1.4.4 It is assumed that the system will use constant flow supply pumps pumping hot water throughout the distribution loop. It is assumed for the purpose of calculating pump head requirements that pressure drop for the heating coil and associated control valve is 10-ft (TBV) water each. (Used in Section 7.1.4.3)

4.3.1.4.5 The major load on the heating system is the HVAC's space heating. No requirement for a large steam supply has been identified within the present understanding of North Portal operations. Any steam requirement will be provided locally where it is needed either by electric steam boiler or oil-fired boiler. (Used in Section 7.1.4.1)

4.3.1.5 Utility Water Softening and Supply System

4.3.1.5.1 It is assumed that 1 gal/ft^2 (TBV) of water/floor area is used when washing down concrete floors. (Used in Section 7.1.5.1)

4.3.1.5.2 It is assumed that the frequency of wash down for facilities is: Fire Station - 1/month (TBV); Central Shops - 3/year (TBV); Motor Pool - 1/month (TBV); and, Utility Building - 1/month (TBV). (Used in Section 7.1.5.1)

4.3.1.5.3 It is assumed that average flow rate from a hose used for the wash down of floors is 5 gpm (TBV). This is based on Table 2-7 *Typical Rates of Water Use for Various Devices and Appliances,* Reference 5.14. It is also assumed that a maximum of eight (8) (TBV) hoses are being used at one time. This is based on two hoses for the Fire Station, Central Shops, Motor Pool, and the Utility Building all being used at the same time. (Used in Section 7.1.5.1)

4.3.1.5.4 It is assumed that the average cooling load for the cooling tower is 0.40 (TBV). This usage factor is taken from Interoffice Correspondence, *Cooling/Heating System Usage Factors for the North Portal Surface Facilities,* Reference 5.18. (Used in Section 7.1.5.1)

4.3.1.5.5 It is assumed that the water consumed during regeneration of either the water softener unit(s) or the water deionization column(s) is equal to 7 % (TBV) of the water throughput. The basis for this is from page 373 of *Water Quality and Treatment, third edition,* The American Water Works Association (Reference 5.19), which gives the range of wastewater produced by softening as being 1.5 to 7%. (Used in Sections 7.1.5.2 and 7.1.6.1)

4.3.1.5.6 A 4 gpm/ft^2 (TBV) flowrate is assumed for the flow through the water softener bed. This is based on information from page 369 of Reference 5.19. (Used in Section 7.1.5.2)

4.3.1.5.7 It is assumed that the diameter of the water softener beds is 3 ft (TBV). This is based on vendor data for typical industrial systems. (Used in Section 7.1.5.2)

4.3.1.5.8 It is assumed that the maximum flowrate during regeneration of either the water softener system or the water deionization column(s) is experienced during fast rinse, and that the flowrate is equal to the design throughput rate. That is, the fast rinse flowrate for the deionizer is 32 gpm (TBV) and the fast rinse flowrate for the water softeners is 37.6 gpm (TBV). The basis for this is that the well water from J-13 shows a reasonably high silica content, about 40 mg/liter, References 5.20 and 5.21. This presents some concern over silica deposition on the resin beds. A high backwash flow rate should prevent unwanted silica buildup. (Used in Sections 7.1.5.2 and 7.1.6.1)

4.3.1.5.9 The height of the ion exchange resin bed is assumed to be 4 ft (TBV). This is based on catalog information from vendors. The overall height of the water softener bed is assumed at 8-ft (TBV) high. This will allow for 100% bed expansion during fast rinse, and thereby facilitate silica removal from the bed. (Used in Section 7.1.5.2)

4.3.1.5.10 The brine tank for regeneration of the water softener is assumed as 8-ft 3-in (TBV) in diameter and 8-ft (TBV) high. Actual sizing of the tank will be performed as a function of brine utilization during definitive design. (Used in Section 7.1.5.2)

4.3.1.5.11 The assumed distance between the softened water surge tank and the cooling tower is 300 ft (TBV). This is based on Assumption 4.3.1.3.4. (Used in Section 7.1.5.3)

4.3.1.5.12 The average waste water from the water softening system in the winter months is based on the assumption that the base load cooling requirement during the winter months is 20% (TBV) of peak load. This value assumes that the winter cooling load is 50% of the average load of 40%. (Used in Section 7.1.5.2 and Section 7.1.11.1)

4.3.1.6 Deionized Water Softening and Supply System

4.3.1.6.1 No specific guidance is given on the level of required deionization. A water quality with a conductivity of 2 micro-mhos is believed achievable with normal ion exchange systems using separate cation and anion beds. A requirement does exist to maintain a fuel storage pool conductivity below 20 micro-mhos (micro-siemens), per 10 CFR 50.3663 *Pool Water Purity* (Reference 5.22). This is presently not a requirement for the fuel storage pools within the WHB, but does set a reasonable water quality level for the purposes of this conceptual study. Therefore, it is assumed that deionized water with a total electrical resistance of 0.5 X 10^6 ohms, or a conductivity of 2 micro-mhos (TBV) is adequate for the WHB fuel storage pools (TBV). (Used in Section 7.1.6.1)

4.3.1.6.2 It is assumed that the lowest wet bulb temperature is 20° F (TBV), this equates to a dew point temperature of 15° F. No data is available on humidity values at the design temperature of 22.5° F. Because the actual water content of 20° F air is so low, this is a reasonable assumption for predicting the evaporation rate from the fuel storage pools. (Used in Section 7.1.6.1)

4.3.1.6.3 It is assumed that 5000 gal/yr (TBV) of deionized water is used in laboratory applications with the Surface Facilities. Insufficient information on laboratory operations is available to make a detailed estimate of deionized water consumption. Due to the significant capacity of the deionized water system, a higher laboratory consumption of deionized water should not impact system design. (Used in Section 7.1.6.1)

4.3.1.6.4 An allowance of 6000 gal/yr (TBV) for refill of the closed-loop water systems with deionized water is assumed. Insufficient design and operational information is available to make a detailed estimate of deionized water consumption for this purpose. Since the only water loss from the system should occur during addition of new systems or through maintenance of the closed-loop piping, this is a reasonable assumption considering the significant capacity of the deionized water system. (Used in Section 7.1.6.1)

4.3.1.6.5 It is assumed that a thirty (30) day period is a reasonable period of time for the filling of the three sets of assembley transfer system pools located in the WHB through the use of the facility water deionization system (TBV). This places a reasonable upper restraint of 32 gpm on the size of the water deionization system. If it is later deemed necessary to fill the fuel storage pools at a faster rate, the capacity of the water deionization system can be augmented through the use of rental deionization equipment.

4.3.1.6.6 A 4 gpm/ft^2 (TBV) flowrate is assumed for the flow through the deionization bed. This is based on information from page 369 of Reference 5.19. (Used in Section 7.1.6.2)

4.3.1.6.7 The height of the ion exchange resin beds for the deionization columns is assumed to be 6-ft (TBV). The overall height of the deionized water columns is assumed at 12-ft (TBV). This will allow for 100% bed expansion during fast rinse, and thereby facilitate silica removal from the bed. (Used in Section 7.1.6.2)

4.3.1.7 Fire Water System and Supply

4.3.1.7.1 It is assumed that the sprinkler system and hose stream demand will not exceed 2000 gpm (TBV) at 80 psig (TBV) at the loop connection to the sprinkler system. The suction tank will be at least 240,000 gallons (TBV) in size. (Used in Section 7.1.7.1)

4.3.1.7.2 It is assumed that the existing water system will be used to fill the fire protection suction tanks. Refill water will come from the existing 200,000 gallon well water tank located on a hill at N 764000 and (approximately) E 569400. The present well water system will not be able to fill a suction tank within 8 hours as required by NFPA 22, Chapter 11, Section 11-4. However, using the 200,000 gallons of water in the raw water tank on Exile Hill for immediate refill, and the well water available from the wellpumps, it will be possible to refill the suction tanks within 8 hr (TBV). This time should be acceptable to the Authority Having Jurisdiction. It is also assumed that both suction tanks will not have to be refilled at the same time. (Used in Section 7.1.7.1)

4.3.1.7.3 It is assumed that 5000 gal (TBV) of water is used per test for fire hydrants. This amount of water is believed sufficient to have the fire pumps respond to the drop in system pressure. (Used in Section 7.1.7.2)

4.3.1.7.4 It is assumed that 1000 gal (TBV) of water is used per test of sprinkler systems. This amount of water is believed sufficient to have the sprinkler alarm system respond to the drop system pressure. (Used in Section 7.1.7.2)

4.3.1.8 Overall Water Supply Demand

It is assumed that sufficient well water will be available for all water demands for operations at the North Portal Surface Facilities through modifications to the existing well water system, pumping, tankage, and water lines. (Used in Section 7.1.8)

4.3.1.9 Water Recycle Systems

There are no water recycle systems identified within the utility services of the North Portal Surface Facilities.

4.3.1.10 Sanitary Waste System

It is assumed that the amount of discharge going to the sanitary waste system is equal (TBV) to the amount of potable water consumed by employees, both showering and non-showering. A 20 % (TBV) contigency is placed on this number due to the uncertainty of future site population. (Used in Section 7.1.10)

4.3.1.11 Evaporation Pond

4.3.1.11.1 It is assumed that the precipitation (TBV) and evaporation (TBV) rates are as presented in *Surface Wastewater Calculation,* Reference 5.23. (Used in Section 7.1.11)

4.3.1.11.2 It is assumed that the deposition of solids in the evaporation pond will have an insignificant impact on water retention volume. The incoming well water has a TDS of approximately 300 mg/l (References 5.20 and 5.21), an even after evaporation in the cooling tower, the total TDS will be approximately (6 x 300 mg/l =) 1800 mg/l. Using a total flowrate per annum of 17.83 x 10^6 gallons/yr into the evaporation pond, the total solids per year is approximately (17.83 x 10^6 x 3.785 l/gal x 1800 mg/l =) 1.215 x 10^8 g/yr, or approximately (1.215 x 10^8 g/yr/454.6 g/lb =) 2.67 x 10^5 lb/yr. The well water is primarily bicarbonate in nature (References 5.20 and 5.21). The specific gravity of $NaHCO_3$ is approximately 2.20 (Reference 5.26). Using this specific gravity, the total volume of solids is approximately [2.67 x 10^5 lb/yr/(2.20 x 62.4 lb/ft^3) =] 1.95 x 10^3 ft^3. Spread over the area of the pond, 185,130 ft^2, the accumulation rate would be approximately [(1.95 x 10^3 ft^3/yr/185,130 ft^2) x 12 in/ft] = 0.13 in/yr. (Used in Section 7.1.11)

4.3.1.12 Storm Water Drainage

There are no assumptions utilized in this discussion.

4.3.2 Compressed Air Systems

4.3.2.1 Breathing Air System

4.3.2.1.1 It is assumed that sufficient capacity is present with the engineering contingency placed on North Portal Surface Facility breathing air for incidental use of breathing air by North Portal subsurface operations. If it becomes evident, after detailed definition of subsurface breathing air consumption requirements, that additional capacity for North Portal Surface Facility breathing air is required to support subsurface operations, a noticeable cost impact to the breathing air system will occur. (Used in Section 1.)

4.3.2.1.2 It is assumed that the breathing air systems will be designed per the requirements of ANSI Z88.2-92; *Practices for Respiratory Protection;* 29 CFR 1910, (OSHA) *Selected General Industry Safety and Health Standards;* and Compressed Gas Association (CGA), ANSI/CGA G-7.1-1966, *Commodity Specification for Air.* Specific Requirements are:
The compressor for supplying air shall be equipped with necessary safety and standby devices. A breathing air-type compressor shall be used. Compressors shall be constructed and situated so as to avoid entry of contaminated air into the system and suitable in-line air purifying sorbent beds and filters installed to further assure breathing air quality. A receiver of sufficient capacity to enable the respirator wearer to escape from a contaminated atmosphere in event of compressor failure, and alarms to indicate compressor failure and overheating shall be installed in the system. If an oil-lubricated compressor is used, it shall have a high-temperature or carbon monoxide alarm, or both. If only a high-temperature alarm is used, the air from the compressor shall be frequently tested for carbon monoxide to ensure that it meets the specifications of CGA G-7.1 (Used in Section 7.2.1)

4.3.2.1.3 It is assumed that 15 SCFM (TBV) of breathing air is required per breathing air outlet. This is based on hood-type breathing apparatus which consume up to 15 SCFM and on Hanford Plant Standard HPS-156-M (Reference 5.37). (Used in Section 7.2.1)

4.3.2.1.4 Detailed maintenance activities for performance of off-normal maintenance within the radiological areas of the WHB and WTB have not yet been defined. Because of this lack of definition, a bounding estimate on breathing air requirements to support these activities is assumed. It is assumed that a maximum of twenty (20) (TBV) personnel will require breathing air for entrance into WHB cell areas, and a maximum of ten (10) (TBV) personnel will require breathing air for entrance into WTB cell areas. (Used in Section 7.2.1)

4.3.2.1.5 It is assumed that no more than three (TBV) air connections will be used in an environment that has an immediate hazard to life due to the atmosphere. There are very few accident scenarios which can result in placing an individual into an environment with an immediate hazard to life. The possibility exists for requiring an individual to go into a confined space which contains insufficient oxygen. It is assumed that the maximum number of personnel placed into this situation would be two, with one individual available at standby, if there is a problem. (Used in Section 7.2.1)

4.3.2.1.6 It is assumed that a five (TBV) minute reserve air capacity is required for egress from environments with an immediate hazard to life. This is based on Reference 5.37. (Used in Section 7.2.1)

4.3.2.1.7 It is assumed that a minimum air pressure of 90 psig (TBV) is required for breathing air delivered to the mask. This requirement of 90 psig is taken from vendor data for loose fitting hood type respirator masks. (Used in Section 7.2.1)

4.3.3.2 Instrument and Shop Air

4.3.2.2.1 It is assumed that sufficient capacity of instrument air exists within the engineering contingency placed on the North Portal instrument/shop air system. This assumption is based primarily on the substantial extra capacity allocated to the North Portal Surface Facility instrument and shop air system through the use of the breathing air compressor. (Used in Section 1.0)

4.3.2.2.2 It is assumed that the air consumption for the actuation of a pneumatic valve is 2 SCF (TBV). This assumption is based on typical air requirements for air actuated valves taken from catalog cuts. (Used in Section 7.2.2)

4.3.2.2.3 It is assumed that the Central Shop has two (TBV) air driven tools operating at the same time using 50 scfm/tool (TBV). This assumption is based on page 27-5 of Reference 5.35. This assumption does not place an upper bound on the amount of shop tools in use at one time. The air system has a substantial over capacity. (Used in Section 7.2.2)

4.3.3 Industrial Gas Systems

4.3.3.1 Nitrogen

4.3.3.1.1 It is assumed that four (4) (TBV) void volumes of nitrogen will be utilized in the initial gas venting/purging of arriving transportation casks. This is based on NUREG-0383, *Directory of Certificates of Compliance for Radioactive Materials Packages,* Reference 5.24, which requires at least three purge volumes of inert gas prior to final closure. (Used in Section 7.3.1)

4.3.3.1.2 It is assumed that an arriving transportation cask has a void volume equal to 50% (TBV) of the total volume of the cask as determined by outside dimensions. Due to the variety of potential mixtures of transportation casks and fuel, and the present limited knowledge of certain casks, this assumption is believed a reasonable bounding limit for the purposes of calculations of gas consumption. (Used in Section 7.3.1)

4.3.3.1.3 It is assumed that it takes five minutes (TBV) to sample a given cask after making sampling connections. This assumption is based on the time allocation for gas sampling as identified in the *Waste Handling Systems Configuration Analysis,* (Reference 5.25) (Used in Section 7.3.1)

4.3.3.1.4 It is assumed that the amount of nitrogen lost during the making and breaking of nitrogen sampling lines during the sampling of incoming casks is equal to ten percent (10%) (TBV) of the total volume of nitrogen consumed. Insufficient design detail exists at this time to place an accurate estimate of the amount of nitrogen lost during the making and breaking of sampling connections. It is believed that this assumption places a reasonable upper bound on the amount of nitrogen used in this process step. (Used in Section 7.3.1)

4.3.3.1.5 For the purpose of sizing the system, it is assumed that four (4) (TBV) volumes of nitrogen (TBV) for the fuel drier unit will be utilized in the drying of fuel prior to placement within the DC. Drying will be accomplished by 1) pulling a vacuum on the drier unit to approximately 10 mm Hg (TBV); 2) pressurizing the fuel drier unit with nitrogen to atmospheric pressure (TBV); and, 3) alternating back and forth between steps 1) and 2) for a total of four nitrogen pressurizations per fuel assembly being dried. This is based on NUREG-0383, *Directory of Certificates of Compliance* *for Radioactive Materials Packages,* Reference 5.24, which requires at least three purge volumes of inert gas prior to final closure. (Used in Section 7.3.1)

4.3.3.1.6 It is assumed that the volume of the fuel dryer chamber is 1100 ft^3 (TBV). There is presently no formal definition of the design for the fuel dryer chamber. It is believed that this volume places a reasonable bound on the volume of the dryer for the purposes of estimating gas consumption. (Used in Section 7.3.1)

4.3.3.1.7 It is assumed that it takes 10 minutes (TBV) to fill an evacuated drier chamber with nitrogen to atmospheric pressure. This assumption is based on the time allocation for filling the dryer chamber with nitrogen as identified in the *Waste Handling Systems Configuration Analysis,* (Reference 5.25) (Used in Section 7.3.1)

4.3.3.1.8 It is assumed that DC's loaded with fuel assemblies will have a void volume of 50% (TBV) of their total volume as defined by their outside dimensions. It is believed that this assumption is a reasonable bounding limit for the purposes of calculations of gas consumption. (Used in Section 7.3.1)

4.3.3.1.9 It is assumed that it takes twenty minutes (TBV) to fill an evacuated DC with either nitrogen or helium. The time required for the evacuation and inerting of the DC prior to welding is not included in the detail presented by Reference 5.25. It is believed that the assumed time places a reasonable bound on this operation for the purposes of defining gas consumption. (Used in Sections 7.3.1 and 7.3.4)

4.3.3.2 Argon

4.3.3.2.1 The assumed flowrate of argon used in the welding of the inner lid of the DC is 100 SCFH (TBV) for 4 hr (TBV). Reference 5.9, *Waste Package Closure Methods Report.* (Used in Section 7.3.2)

4.3.3.2.2 The assumed flowrate of argon used in the welding of the outer lid of the DC is 100 SCFH (TBV) for 20 hr (TBV), Reference 5.9. (Used in Section 7.3.2)

4.3.3.3 Argon/Helium Blend

4.3.3.3.1 The assumed flowrate of argon/helium (25%/75%, respectively) (TBV) used in the welding of the inner lid of the DC is 92 SCFH (TBV) for 4 hr (TBV), Reference 5.9. (Used in Section 7.3.3)

4.3.3.3.2 The assumed flowrate of argon/helium (25%/75%, respectively) (TBV) used in the welding of the outer lid of the DC is 92 SCFH (TBV) for 20 hr (TBV), Reference 5.9. (Used in Section 7.3.3)

4.3.3.4 Helium

4.3.3.4.1 It is assumed that the amount of helium lost during the making and breaking of helium fill lines is equal to ten percent (10%) (TBV) of the total volume of helium consumed. This believed to place a reasonable bound on the amount of helium for the purposes of sizing service. (Used in Section 7.3.4)

4.3.4 Fuel Oil

4.3.4.1 It is assumed that No. 2 fuel oil (TBV) (API 33) is used for all systems consuming fuel oil. The basis for this is that the viscosity of No. 2 fuel oil remains low enough at the design temperature of 22.5° F to allow the oil to be pumped. (Reference 5.26, Figure 9-4.) (Used in Section 7.4.1)

4.3.4.2 It is assumed that the lower heating value of the No. 2 fuel oil is 130,000 BTU/gallon (TBV). (Reference 5.27, Table 9.11 and Figure 9-3, Perry's Chemical Engineering Handbook, fourth edition). No. 2 fuel oil has an index of 33° A.P.I.(Table 9.11). From Figure 9-3, the lower heating value is between approximately 126,000 and 132,000 BTU/gal depending on the sulfur content. Because No. 2 fuel oil has a required sulfur content of about 0.2 %, the 130,000 BTU/gal is a reasonable assumption. (Used in Section 7.4.1)

4.3.4.3 Fuel oil is to be delivered to the North Portal through rail tanker car, a reasonable frequency of delivery is about every two weeks (TBV). (Used in Section 7.4.2)

4.3.4.4 A two week supply of oil, during maximum consumption, would be (615.4 gallons/hr x 24 hr/day x 14 days =) 206,774 gallons (TBV). Assuming an allowance for 20% head space the tank size is (206,774 gallons x 1.2 =) 248,129 gallons, rounded to 250,000 gallons (TBV). The 20% allowance for head space is based on the high coefficient of thermal expansion for hydrocarbons. (Used in Section 7.4.2)

4.3.5 Utility Building

4.3.5.1 It is assumed that 14 personnel (TBV) will be assigned to the Utility Building. It is also assumed that the maximum number of personnel assigned at one shift will be 6 (TBV). This is based on Reference 5.5. (Used in Section 7.5.1)

4.3.5.2 It is assumed that the gender mix for operational personnel is 3:2 (TBV), men to women, respectively. (Used in Section 7.5.1)

4.3.6 Quality Assurance

4.3.6.1 It is assumed that those utility systems not classified in Reference 5.2 will have a QA classification which will make them subject to the QARD, Reference 5.3. (Used in Section 2.)

4.3.6.2 It is assumed that the QA classifications identified in Section 2, Quality Assurance, have been correctly assigned. This is based on the work performed in *Classification of the Preliminary MGDS Repository Design* (Reference 5.2) which carries a TBV for these classifications (TBV). (Used in Section 2.)

4.4 CODES AND STANDARDS

The following codes and standards have been used in the preparation of the design analyses.

4.4.1 Code of Federal Regulations (CFRs)

10 CFR 20	*Standards for Protection Against Radiation.*
10 CFR 60	*Disposal of HLW in Geologic Repositories.*
10 CFR 72	*Licensing Requirements for the Independent Storage of Spent Nuclear and High-Level Radioactive Waste.*
29 CFR 1910	*Selected General Industry Safety and Health Standards* (OSHA).
29 CFR 1926	*Safety and Health Regulations for Construction.*
30 CFR 57	*Safety and Health Standards - Underground Metal and Nonmetal Mines.*
40 CFR 122	*EPA Administered Permit Programs: The National Pollutant Discharge Elimination System (NPDES).*
40 CFR 141	*National Primary Drinking Water Regulations.*
40 CFR 143	*National Secondary Drinking Water Regulations.*

4.4.2 U.S. Nuclear Regulatory Commission (NRC)

4.4.2.1 Regulatory Guides

RG No. 3.49	Design of an Independent Spent Fuel Storage Installation (Water-Basin Type), December 1981.
RG No. 3.53	Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation, July 1982.

4.4.3 U.S. Department of Energy (DOE) Orders

DOE 420.1, Change 2 *Facility Safety* (Fire Protection only).

DOE 430.2 *Inhouse Energy Management.*

DOE 5480.1B *Environment, Safety, and Health Program for Department of Energy Operations.*

DOE 5480.7 *Fire Protection.*

DOE 6430.1A *General Design Criteria.*

DOE Fire Protection Resource Manual.

4.4.4 Industry Codes and Standards

4.4.4.1 American Nuclear Society

ANSI Z88.2-92 *Respiratory Protection.*

ANSI/CGA G-7.1-1989 *Commodity Specification for Air.*

4.4.4.2 National Fire Protection Association

NFPA-13 *Installation of Sprinkler Systems, 1996.*

NFPA-20 *Installation of Centrifugal Fire Pumps, 1996.*

NFPA-22 *Water Tank for Private Fire Protection, 1996.*

NFPA-24 *Installation of Private Fire Service Mains and Their Appurtenances, 1995.*

NFPA-231 *General Storage, 1995.*

NFPA-231C *Rack Storage of Materials, 1995.*

4.4.4.3 National Standard Plumbing Code, 1993, Section B.6.3 Manufacturers' Recommendations for Avoiding Erosion/Corrosion.

4.4.4.4 International Association of Plumbing and Mechanical Officials (IAPMO), 1993. (International standard published by IAPMO).

4.4.4.5 Uniform Plumbing Code (UPC), 1994.

4.4.4.6 Uniform Building Code (UBC), 1997.

4.4.5 State Codes

4.4.5.1 Nevada Administrative Code Chapter 444 (NAC 444); Sewage Disposal.

5. REFERENCES

5.1 *Site Characterization Plan Conceptual Design Report,* SAND84-264, SNL 1987.

5.2 *Classification of the Preliminary MGDS Repository Design,* DI:B00000000-01717-0200-00134, Rev 00.

5.3 *Quality Assurance Requirements and Description* (QARD), U. S. Department of Energy, DOE/RW-0333P, Rev 7.

5.4 *Repository Surface Design Engineering Files Report,* DI:BCB000000-01717-5705-00009 Rev 00.

5.5 Interoffice Correspondence, *Operations Staffing Input for VA Technical Documents,* S.J. Meyers to S.H. McFeely, et al, January 19,1998.

5.6 *Surface Nuclear Facilities HVAC Analysis,* DI:BCBD00000-01717-0200-00013 Rev 00.

5.7 *Mined Geologic Disposal System Advanced Conceptual Design Report* DI:B00000000-01717-5705-00027 Rev 00.

5.8 *Controlled Design Assumptions* (CDA) *Document*, DI:B00000000-01717-4600-00032, Rev 04, ICN 3.

5.9 *Waste Package Closure Methods Report,* DI:BBA000000-01717-5705-00013, Rev 00.

5.10 *Repository Design Requirements Document* (RDRD), Yucca Mountain Site Characterization Project, YMP/CM-0023, Rev 0, ICN 1.

5.11 *ASHRAE Handbook, Fundamentals*, 1997.

5.12 *ASHRAE Handbook, Systems and Equipment,* 1996.

5.13 *ASHRAE Handbook, Applications,* 1995.

5.14 *Wastewater Engineering - Treatment, Disposal, Reuse, third edition*, Metcalf and Eddy, 1991.

5.15 *Standard Handbook for Civil Engineers, third edition,* Frederick S. Merritt, editor.

5.16 *Design Manual for Heating, Ventilation, and Air Conditioning,* Kendric, Lee, Technical Standard Publications.

5.17 *Repository Surface Design Site Layout Analysis*, B00000000-01717-0200-00007, Rev 01.

5.18 Interoffice Correspondence, *Cooling/Heating System Usage Factors for the North Portal Surface Facilities,* S. J. Meyers to D. M. LaRue, dated January 29, 1998.

5.19 *Water Quality and Treatment, third edition,* American Water Works Association, 1971.

5.20 *Preliminary Near-Field Environment Report Volume II: Scientific Overview of Near-Field Environment and Phenomena,* D. G. Wilder, Lawrence Livermore National Laboratory, UCRL-LR-107476, Volume 2, April 1993.

5.21 *Nevada Nuclear Waste Storage Investigations Exploratory Shaft Facility Fluids and Materials Evaluation,* K. A. West, Los Alamos National Laboratory, LA-11398-MS, UC-721, November 1988.

5.22 10 CFR 50.3663, *Pool Water Purity.*

5.23 *Surface Wastewater Calculation,* B00000000-01717-0200-00076, Rev 00.

5.24 *Directory of Certificates of Compliance for Radioactive Materials Packages,* NUREG-0383, Volume 2, Revision 15, October 1992.

5.25 *Waste Handling Systems Configuration Analysis,* DI:BCBD00000-01717-0200-00001, Rev 00.

5.26 *Chemical Engineers Handbook, fifth edition,* Perry and Chilton, 1973.

5.27 Perry's Chemical Engineering Handbook, fourth edition.

5.28 Drawings, *ESF Water System Supply and First Access P&ID (Sheets 1,2 & 3)* , Drawing Nos. YMP-025-1-CIVL-CI108 (Rev 00), CI109(Rev 00), and CI110, (Rev 00).

5.29 *Flow of Fluids through Valves, Fittings, and Pipe,* Technical Paper 410, Crane Co.

5.30 *Secondary Waste Treatment Technical Report,* DI:BCBD00000-01717-0200-00005 Rev 00.

5.31 *Surface Nuclear Facilities Space Program Technical report,* DI:BCBD00000-01717-0200-00012, Rev 00.

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5.33 *Basic Principles and Calculations in Chemical Engineering,* 2nd edition, D. M. Himmelblau, 1967.

5.34 Factory Mutual Loss Prevention Data Sheets, 2-89, *Friction Loss Tables*, May 1973.

5.35 *Compressed Air and Gas Data, third edition,* A. W. Loomis, editor.

5.36 *Physical Chemistry,* G. W. Castellan, Addison Wesley Publishing Co., 1971.

5.37 *Standard Specification for Compressor Supplied Breathing Air Systems,* Hanford Plant Standard HPS-156-M.

5.38 *Sanitary Sewer Calculation,* B0000000-01717-0200-00077, Rev 01.

6. USE OF COMPUTER SOFTWARE

No engineering technical report computer codes were utilized in the preparation of this technical report.

7. DESIGN ANALYSES

7.1 Water Systems

This section discusses the various water systems to be provided at the North Portal. Identification of the various water requirements is made in the appropriate subsections. Potable water from the potable water tank is chlorinated, and will only be used for potable (sanitary) water use. All other water to be consumed in operations at the North Portal will utilize raw well water. Total water requirements are presented in Section 7.1.8, Overall Water Supply Demand.

Water for the present water system is provided from the Nevada Test Site (NTS) from Well J13, Drawing No. YMP-025-1-CIVL-CI108, CI109, and CI110, Rev 00, Sheets 1,2, and 3, *ESF Water System Supply and First Access P&ID* (Reference 5.28). Water is pumped from Well J13 to an existing 50,000 gallon storage tank, TK-001. Water is then pumped a distance of approximately four miles to two 20,000 gallon water tanks, WT-7008-1 and WT-7008-2. Water from these two storage tanks is then pumped to an existing 200,000 gallon fire water tank, and to an existing 50,000 gallon potable water tank. Water from these two tanks is then provided to the North Portal through gravity feed. Modifications to this water supply system will be required to accommodate the estimated future consumption at the North Portal. The modifications to the existing water supply for the North Portal is discussed in Section 7.1.8.

The control system for the water systems fed through the Utility Building, i.e., potable, softened, deionized, chilled water, and hot water, is located in the control room of the Utility Building.

Primary controls are located in the Utility Building, and secondary controls are remote. System operational parameters and status are transmitted over the control LAN to the central control center.

7.1.1 Potable Water

Potable water (sanitary water) is provided throughout the complex for drinking, cooking, washing and showering. Potable water will be supplied to the facilities at the North Portal from the existing Potable Water Storage Tank (50,000 gallon) as identified in Drawing No. YMP-025-1-CIVL-C110, Rev. 00 (Reference 5.28). A new 4-in. PVC potable water supply main will be extended from the present 8-in. main line, just external to the radiological control area (RCA), to the Utility Building (N221-2). Figure 1, Attachment II, shows the routing of this new line. The sizing of the new 4-in. potable water line is discussed in Section 7.1.8 Overall Water Supply Demand.

The potable water fed to the North Portal through the existing system is chlorinated. It is assumed that no additional water treatment for potable water is required, and that chlorine levels in the water are sufficient to maintain required chlorine levels at the demand point in all facilities served. (Assumption 4.3.1.1.2).

7.1.1.1 Flowrates and Consumption

The estimate of potable water consumption is based on the projected manpower loadings for the North Portal as presented in Table 6-2 in the *Repository Surface Design Engineering Files Report,* BCB000000-01717-5705-00009 Rev 00 (Reference 5.4). Additional data identifying the anticipated occupant loadings, on a position-by-position basis, for the various facilities located at the North Portal is provided by Enclosure 4, Reference 5.5. Table 7.1.1-1 presents summary estimates of the anticipated occupant loadings and water consumption on a shift-by-shift basis for the Monday through Friday work week.

Table 7.1.1-1 Potable Water Consumption (Monday through Friday)

Employee Type	Empl. Shift 1	Water/ Employee (gpd)	Potable Water Shift 1 (gpd)	Emply. Shift 2	Water/ Emploee (gpd)	Potable Water Shift 2 (gpd)	Emply. Shift 3	Water/ Employee (gpd)	Potable Water Shift 3 (gpd)
Showering	228	30	6840	144	30	4320	119	30	3570
Non-Showering	197	15	2955	53	15	795	44	15	660
Totals	425	---	9795	197	---	5115	163	---	4230

Employees are classified as either showering or non-showering employees per Assumptions 4.3.1.1.3 and 4.3.1.1.4. Showering employees consume 30 gpd of potable water per Assumption 4.3.1.1.5, and non-showering employees consume 15 gpd of potable water per Assumption 4.3.1.1.6. The total water for showering employees for Shift 1 is calculated by multiplying the total number of showering employees by the water/employee (228 employees X 30 gpd/employee = 6840 gpd). The total water for showering employees for Shifts 2 and 3 is calculated in like manner.

The total water consumption for non-showering employees for Shift 1 is calculated by multiplying the total number of non-showering employees by the water/employee (197 employees x 15 gpd/employee = 2955 gpd). The total water for non-showering employees for Shifts 2 and 3 is calculated in like manner.

The total employees for Shift 1 is calculated by adding the number of shower employees and the number of non-showering employees (228 + 197 = 425). The total employees for Shifts 2 and 3 is calculated in a like manner.

The total potable water consumed for Shift 1 is calculated by adding the total water consumed by showering employees (Shift 1) and the total water consumed by non-showering employees (Shift 1), this total is (6840 gpd + 2955 gpd =) 9795 gpd. The total potable water consumed for Shifts 2 and 3 is calculated in a like manner.

The total water consumed per day is calculated by adding the water consumed for the three shifts, this total is (9795 gpd + 5115 gpd + 4230 gpd =) 19,140 gpd.

Table 7.1.1-2 presents summary data on the anticipated occupant loadings and water consumption on a shift-by-shift basis for Saturdays and Sundays.

Table 7.1.1-2 Potable Water Consumption (Saturday and Sunday)

Employee Type	Empl. Shift 1	Water/ Employee (gpd)	Potable Water Shift 1 (gpd)	Emply. Shift 2	Water/ Emploee (gpd)	Potable Water Shift 2 (gpd)	Emply. Shift 3	Water/ Employee (gpd)	Potable Water Shift 3 (gpd)
Showering	141	30	4230	118	30	3540	113	30	3390
Non-Showering	55	15	825	43	15	645	43	15	645
Totals	196	---	5055	161	---	4185	156	---	4035

The total water consumption for showering employees for Shift 1 is calculated by multiplying the total number of showering employees by the water/employee (141 employees x 30 gpd/employee = 4230 gpd).

The total water consumption for showering employees for Shifts 2 and 3 is calculated in a similar manner.

The total water consumption for non-showering employees for Shift 1 is calculated by multiplying the total number of non-showering employees by the water/employee (55 employees x 15 gpd/employee = 825 gpd). The total water for non-showering employees for Shifts 2 and 3 is calculated in a similar manner.

The total employees for Shift 1 is calculated by adding the number of showering employees and the number of non-showering employees (141 + 55 = 196). The total employees for Shifts 2 and 3 is calculated in a similar manner.

The total potable water consumed for Shift 1 is calculated by adding the total water consumed by showering employees (Shift 1) and the total water consumed by non-showering employees (Shift 1) (4230 gpd + 825 gpd = 5055 gpd). The total potable water consumed for Shifts 2 and 3 is calculated in a similar manner.

The total water consumed per weekend day is calculated by adding the water consumed for the three shifts (5055 gpd + 4185 gpd + 4035 gpd = 13,275 gpd).

Estimated annual consumption of potable water is calculated by: 1) multiplying the daily weekday consumption by the scheduled number of weekday workdays; 2) multiplying the daily weekend consumption by the scheduled number of weekend workdays; 3) multiplying weekend consumption by the number of scheduled holidays (10); and, 4) adding these three products together. The projected number of workweeks for normal operations is 50 (TBV) (Reference 5.7, page 5-17). This indicates that there are 10 scheduled holidays. The projected number of weekends that will be staffed is 52 (TBV) (Reference 5.7). The total estimated consumption is therefore calculated as [(50 weeks x 5 days/week x 19140 gpd) + (52 weeks x 2 weekend days/weekend x 13,275 gpd) + (2 holiday weeks x 5 days/week x 13,275 gpd)] = 6.30 million gallons/year. Due to the conceptual level of understanding in regard to the anticipated staff loadings, a contingency factor of 20% is added to this projected potable water consumption to bring the total annual estimated potable water consumption to (1.2 x 6.30 million gallons/year =) 7.56 million gallons/year.

Evaluation of the data in Table 7.1.1-1 and 7.1.1-2 indicates that the maximum projected water consumption will occur on Shift 1 during the normal Monday through Friday work week; i.e., 9795 gallons. A 20% contingency applied to this number due to the present level of uncertainty in regard to the final workforce size, brings this maximum eight hour demand to (1.2 x 9120 =) 11,754 gallons for an 8-hour shift. This translates into a hourly demand of (11,754 gallons/8 hours =) 1469 gallons/hr. Since water demand is not constant during a given shift, a design factor for peaking water demand needs to be applied for the purposes of sizing equipment and pipelines. As identified in Assumption 4.3.1.1.7, the peaking demand factor is 3.0. This brings the maximum (design) flowrate for potable water to (3.0 x 1469 gallons/hr =) 4407 gallons/hr, which rounds to 4400 gallons/hour. Using 60 minutes/hr, this translates into gpm flowrate of (4400/60 =) 73.3 gpm, or approximately 73 gpm.

7.1.1.2 Equipment Requirements and Brief Description

The potable water system consists of sufficient storage, pump capacity, and piping to provide potable water to users at the various facilities at the North Portal. The potable water supply system is comprised of the following major components:

- Day tank with capacity to supply one-day potable water consumption. As discussed above, the anticipated daily potable water consumption (with 20% contingency) is estimated at (19140 gpd x 1.2 =) 22,968 gpd, or approximately 23,000 gpd. An allowance of 10% is placed on this tank for head space, bringing the total capacity of this tank to (23,000 x 1.1 =) 25,300 gallons, rounded to 25,000 gallons. Materials of construction for this tank will be epoxy lined carbon steel. The storage tank will be located outside the Utility Building; therefore, freeze protection will be required for this tank. If it later becomes necessary to augment chlorination of potable water, this tank will provide residence time for that process.

- Redundant pumps, capable of delivering 73 gpm with a minimum water pressure of 50 psig at the furthest facility served (Assumption 4.3.1.1.8).

The major design consideration for pump sizing is the required delivered pressure and the hydraulic head requirement necessary to overcome the elevation difference between the defined location for the Utility Building, as illustrated in Figure 7 of Reference 5.17, and the highest elevation facility to be served with potable water. A topographic representation of the North Portal complex is presented in Figure 7.2.1-3, Reference 5.7. This figure shows the Utility Building (N221-2) at an approximate elevation of 3640 ft. Further inspection of the figure shows that the highest facility to be provided potable water service is Building 215-2, the Carrier Preparation Building, formally called the Carrier Staging Shed (CSS) which is at an elevation of 3700 ft above sea level. This results in a pressure head of the difference between the two elevations of (3700-3640 =) 60 ft. This 60 ft head is translated to psig through the use of Bernoulli's equation (Reference 5.29, Flow of Fluids, Crane Technical Paper No. 410, page 1-5),

$$Z + 144\, P/\varrho + v^2/2\, g = H$$

where: H = total head, in feet of liquid
Z = potential head or elevation, in feet
P = pressure, psig
ϱ = density, lb/ft^3 (62.4 lb/ft^3 for water)
v = velocity, ft/sec
g = acceleration of gravity, 32.2 ft/sec/sec

Since the velocity is zero, this equation is transformed to $P = (H\text{-}Z)\ \varrho/144$
or $P = (3700 \text{ ft} - 3640 \text{ ft})(62.4 \text{ lb/ft}^3)/144 \text{ in}^2/\text{ft}^2 = 26.0$ psig.

Total pressure requirements for the pumps will be equal to the required residual pressure at the building (50 psig) plus the hydraulic head pressure (26.0 psig) plus pressure losses in the water pipeline due to friction loss. Friction loss for the main header for the potable water system cannot be performed in a rigorous manner at this time due to insufficient data on actual water consumption rates at the various facilities supplied potable water. A bounding approach is taken which assumes maximum flow between the Utility Building (N221-2) and the WHB (211). Inspection of Figure 7, Reference 5.17, places these two buildings approximately 1150 ft apart at their closest point. The National Standard Plumbing Code, 1993, Section B.6.3 recommends flowrates in the 4 to 8 ft/sec range for water lines to minimize erosion/corrosion. Utilizing a maximum of 4 ft/sec (Assumption 4.3.1.1.9) and Table B-14, Flow of Water Through Schedule 40 Steel Pipe, of Crane (Reference 5.29) indicates that for a water flowrate of 73 gpm a 3-inch pipe will yield a flowrate of approximately 3.17 ft/sec. At 3.17 ft/sec, this table also indicates a pressure drop of approximately 0.58 psig/100 ft of pipe. Utilizing a distance between the Utility Building and the WHB of 1150 feet, a maximum pressure drop due to friction can be calculated at (0.58 psig/100 ft x 1150 ft =) 6.7 psig. Adding the pressure drop for friction (6.7 psig) to the pressure drop due to hydraulic head (26.0 psig), plus the required residual pressure of 50 psig at the building, yields a total required pumping pressure of (6.7 psig + 26.0 psig + 50 psig =) 82.7 psig, or approximately 90 psig. Therefore the water pumps for the potable water system have to be capable of delivering 73 gpm at 90 psig. The main header for potable water will be below grade in a common pipe trench with other utility services. Because the pipe trench will not be insulated, freeze protection will be required for this main potable water supply header.

Because potable water is used for safety showers and eye wash stations, it is required to maintain potable water pressure in the event of an electrical outage (RDRD 3.2.5.1.4). For this reason, the potable water pumps will be connected to the standby power system.

7.1.1.3 Header Line Sizing

For the potable water main header supply line, as discussed above, a 3-inch schedule 40 line will be adequate. Because actual water consumption rates on a facility-by-facility basis cannot be determined at this time, this header size will be utilized throughout the North Portal.

Figure 1, in Attachment III depicts the flowsheet for the potable water system.

7.1.1.4 Utility Building Space Requirements

The potable water day tank and potable pumps will be located outside the Utility Building. The control room in the Utility Building will provide space for the water system control system.

7.1.2 Chilled Water System - (CHW)

7.1.2.1 Introduction

For large cooling systems (campus-type application), a central chilled water plant is deemed to be an appropriate cooling system. (See Section 7.1.3, Reference 5.6). A central cooling plant at the Utility Building provides the chilled water system to the North Portal Surface Facilities. The central cooling plant consists of chillers, primary (chiller loop) pumps, secondary (distribution loop) pumps, controls and ancillary equipment. The chiller loop pumping system is a constant-flow type (chillers are generally constant flow machines). The operation of the chillers is sequenced by the temperature of the CHW return temperature to handle the variation of cooling loads. The distribution loop pumping system is of variable-flow type. The CHW system utilizes 2-way control valves for modulation. The chilled water is distributed throughout the facility utilizing a pipe trench for pipe mains. (See Chilled Water Schematic Flow Diagram, Attachment I, Figure 1a).

The control system for HVAC systems (CHW, CW, and HW) is in the control room of the Utility Building. Primary controls are in the Utility Building, and secondary controls are remote, e.g., cooling tower. System parameters are transmitted over the control LAN to the computer control center (CCC).

7.1.2.2 Material Balance

A. System Capacity

The size of the CHW system is based on the following estimated cooling peak demands:

USERS		Load, MBH
1. Building HVAC Systems:		
Waste Handling Building (WHB)	=	31,500 (page I-34, Reference 5.6)
Waste Treatment Building (WTB)	=	5,500 (page II-18, Reference 5.6)
Balance of Plant (BOP)	=	10,800 (See Attachment I, Table T-1a)
Subtotal	=	47,800
2. Process Users:		
Waste Water Condenser	=	2,400 (Page 38, Reference 5.30)
3. Others (Allowance, approx. 15%)	=	7,500
Overall Total	=	57,700 MBH
USE	=	58,000 MBH

B. Pipe Sizing (Distribution Loop)

CHW flowrate, gpm = Q / (8.02 x D x SH x TD) (page 12.2, Ref. 5.11)

= (58,000,000 Btu/hr) / (8.02 ft^3-min/hr-gal x 64.64 lb/ft^3 x 0.904 Btu/lb-°F x 12 °F)

= 10,300 gpm

where: Q = Total cooling load, Btu/hr
D = density (lb/ft^3), 20% glycol at 42 °F (Attachment I, Table T-3b)
SH = specific heat (Btu/lb-F), 20% glycol at 42 °F (Attachment I, Table T-3a)
TD = water temp. differential, °F(Assumption 4.3.1.2.1)
8.02 , constant = 60 min/hr / 7.481 gal/ft^3.

C. Pipe Sizing (Chiller Loop)

CHW flowrate, gpm = Q / (8.02 x D x SH x TD) (page 12.2, Ref. 5.11)
= (58,000,000 Btu/hr) /
(8.02 ft^3-min/hr-gal x 64.64 lb/ft^3 x 0.904 Btu/lb-°F x 10 °F)
= 12,400 gpm

where: Q = Total cooling load, Btu/hr
D = density (lb/ft^3.), 20% glycol at 42° F (Attachment I, Table T-3b)
SH = specific heat (Btu/lb-F), 20% glycol at 42° F (Attachment I, Table T-3a)
TD = water temp. differential, ° F (Assumption 4.3.1.2.1)
8.02, constant = 60 min/hr / 7.481 gal/ft^3.

Notes:
1. For CHW design assumptions, See Section 4.3.1.2
2. See Attachment I, Figures 1a, 1b and 1c for pipe sizes and flowrates for the CHW piping system.
3. For pipe sizing, see Assumption 4.3.1.2.2.
4. The CHW system will be designed with 20 % glycol solution. (See Attachment I, Table T-3c) (Assumption 4.3.1.2.8)

7.1.2.3 Equipment Sizing

A. Chillers:

The central plant chilled water system will consist of multiple number of electric-driven centrifugal chillers. The total peak cooling design requirements will be handled equally by the chillers.The chilled water system will consist of electric-driven, water-cooled, centrifugal-type liquid chillers utilizing environmentally acceptable refrigerant (R134 or equal). (Assumption 4.3.1.2.9)

Overall Cooling Load Capacity = 58,000 MBH
Nominal Chiller Capacity = 60,000 MBH
= 5,000 TR
where:1 ton of refrigeration(TR) = 12,000 Btu/hr (See p. 35.1, Ref. 5.10)

Chiller Leaving CHW temperature = 42° F (See Assumption 4.3.1.2.1)
Water temperature differential, TD = 10° F (See Assumption 4.3.1.2.1)
Chiller Entering CHW temperature = 42° F + 10° F

	=	52° F
CHW Flowrate, gpm	=	12,400 (See Chiller Loop- CHW Pipe Sizing Flowrate, Sect. 7.1.2.2C)

Unit Selection:

Number of units	=	4 operating (Assumptions 4.3.1.2.3 and 4.3.1.2.4)
Nominal Cooling Capacity	=	5,000 TR / 4 units
	=	1,250 TR
Ent / Lvg CHW temperature	=	52 / 42 ° F
Ent / Lvg CW temperature	=	85 / 95 ° F
CHW Flowrate	=	12,400 gpm / 4 units
	=	3,100 gpm
Power input, kW	=	0.70 kW/TR x 1250 TR (Assumption 4.3.1.2.5)
	=	875 kW

B. Primary (Chiller Loop) Pumps

The primary CHW pumping system will consist of multiple pumps, one pump per chiller with a spare unit serving as standby. The primary CHW piping will be looped inside the chiller room with piping drop connections to the pumps and chillers. The piping length was based from an estimated chiller room size (See Section 7.5.1). The estimated pump head is calculated as follows:

Length of CHW Piping	=	400 ft	(Estimated)
Equiv. Length of Fittings (50%)	=	200 ft	(Assumed)
Total Pipe Length	=	600 ft	
Ave. Pressure Drop @ 1.5 ft / 100 ft	=	9 ft	(18" dia. ave. pipe size)
Equipment press. drop	=	30 ft	(Assumption 4.3.1.2.4)
25% Safety factor	=	10 ft	(Assumed)
Total Pump Head	=	49 ft	
USE	=	50 ft	

Unit Selection

Number of units	=	4 operating, 1 standby (Assumptions 4.3.1.2.3 and 4.3.1.2.6)
Flow Capacity, gpm	=	12,400 gpm / 4 units
	=	3,100 gpm
Total Dynamic Head (TDH)	=	50 ft.-H_2O

Brake HP	=	gpm x TDH x SG / (3960 x E) (derived from page 38.6, Reference 5.12)
	=	(3100 gpm x 50 ft x 1.04) / (3960 ft-gal/min-hp x 0.70)
	=	58 bhp
Nominal Motor HP	=	75 hp

where:

SG	=	specific gravity of 20% glycol at 42° F (See Attachment I, Table T-3b)
3960, constant	=	(33,000 ft-lb/min-hp) / 8.33 lb/gal
E (Pump eff.)	=	70% (Assumption 4.3.1.2.6)

C. Secondary (Distribution Loop) Pumps

The secondary CHW pumping system will consist of multiple pumps (assume to be the same number as the primary pumps) with a spare unit serving as standby. The secondary CHW piping will start from the chiller plant and extend around the site to all the CHW users. The piping run from the Utility Building to the Waste Handling Building (including building distribution piping) appears to have the longest run or highest pressure drop and is selected for the pump head calculation (See Attachment I, Figure 4). The estimated pump head is calculated as follows:

Length of CHW Piping	=	4,500 ft	(Estimated)
Equiv. Length of Fittings (10 %)	=	450 ft	(Assumed)
Total Pipe Length	=	4,950 ft	
Ave. Pressure Drop @ 1.5 ft/100 ft	=	74 ft	(18"dia. ave. pipe size)
Equipment and control valve press.drops	=	30 ft	(Assumption 4.3.1.2.7)
25% Safety factor	=	26 ft	(Assumed)
Total Pump Head	=	130 ft	

Unit Selection:

Number of units	=	4 operating, 1 standby (Assumptions 4.3.1.2.3 and 4.3.1.2.6)
Flow Capacity, gpm	=	10,300 gpm / 4 units
	=	2,575 gpm
Total Dynamic Head (TDH)	=	130 ft.-H_2O
Brake HP	=	gpm x TDH x SG / (3960 x E) (derived from page 38.6, Reference 5.12)
	=	(2575 gpm x 130 ft x 1.04) / (3960 ft-gal/min-hp x 0.70)

	=	126 bhp
Nominal Motor HP	=	150 hp

where:

SG	=	specific gravity of 20% glycol at 42° F (See Attachment I, Table T-3b)
3960, constant	=	(33000 ft-lb/min-hp) / 8.33 lb/gal
E (Pump eff.)	=	70% (Assumption 4.3.1.2.6)

D. Ancillary Equipment

Ancillary equipment will include controls, compression tank, air separator, chemical pot feeder system and make-up water system. Capacity, size and requirements will be determined in the design stages. The primary CHW controls are located in the Utility Building and secondary controls, i.e. cooling towers, are remote. System parameters are transmitted over the control LAN to the CCC.

E. Space Requirements

A space will be provided inside the Utility Building for four (4) chillers, five (5) primary pumps, five (5) secondary pumps, and required ancillary equipment. Additional space will be provided for future chillers, primary pumps and secondary pumps (two of each equipment). A 5000 TR chiller measures approximately 16-ft long by 10-ft wide by 13-ft high. Each chiller will be provided with a tube pull-out space equivalent to its length and with a minimum vertical clearance of 2-ft. Each CHW primary and secondary pump (with motor and base) measures approximately 6-ft long by 3-ft wide. All equipment will be provided sufficient space between components to allow pipe and valve access, and to facilitate ease of maintenance. Space will also be allocated for the CHW system ancillary equipment. The total space allocated to the chiller room is 100-ft by 80-ft (8000 ft^2), with a height of 20-ft. See Section 7.5 for total Utility Building space requirements.

7.1.3 Cooling Tower Water System - (CW)

7.1.3.1 Introduction

A central cooling tower (condenser) water system will provide the condenser water to the chillers. The condenser water system will consist of cooling towers, circulation pumps, controls and ancillary equipment. Capacity control based on water temperature in the tower sump will be done by any one or combination of the following: cycling the cooling tower fans,bypassing the cooling tower return to the tower sump and/or shutting down a set of a cooling tower and its associated pump. The cooling tower water will be piped to the central cooling plant at the Utility Building (See Cooling Tower Schematic Flow Diagram, Attachment I, Figure 2).

The control system for HVAC systems (CHW, CW, and HW) is in the control room of the Utility Building. Primary controls are in the Utility Building, and secondary controls are remote, e.g., cooling tower. System parameters are transmitted over the control LAN to the computer control center (CCC).

7.1.3.2 Material Balance

A. System Capacity:

The size of the CW system is based on the following estimated cooling peak loads:

Chiller Cooling Capacity	=	60,000 MBH
Heat of Compression (25%)	=	15,000 MBH (See p. 36.2, Ref. 5.11)
Total Heat Rejection Capacity	=	75,000 MBH

B. Pipe Sizing

CW flowrate, gpm = Q / (8.02 x D x SH x TD) (page 12.2, Ref. 5.11)
= (75,000,000 Btu/hr) / (8.02 ft^3-min/hr-gal x 62.15 lb/ft^3 x 0.998 Btu/lb-°F x 10° F)
= 15,100 gpm

where:

Q	=	Total cooling load, Btu/hr
D	=	density (lb/ft^3.), water at 85° F (Attachment I, Table T-3b)
SH	=	specific heat (Btu/lb-F), water at 85° F (Attachment I, Table T-3a)
TD	=	water temp. differential, ° F (Assumption 4.3.1.3.1)
8.02, constant	=	60 min/hr / 7.48 gal/ft^3.

Notes:

1. For CW design assumptions, See Section 4.3.1.3.
2. See Attachment I, Figure 2 for pipe sizes and flowrates for the CW piping system.
3. For pipe sizing, see Assumption 4.3.1.3.2. The 30-in dia. is obtained by extrapolation.

C. Make-up Water

For the information used below, see Chapter 36, Reference 5.12.

Make-up Water = evaporation rate + drift rate + blowdown rate
= 0.01 x 15,100 gpm + 0.001 x 15,100 gpm + see calculation of blowdown rate below
= 151 gpm + 15 gpm + 15 gpm
= 181 gpm

where:

Evaporation Rate	=	1 % of water circulation
Water Circulation, gpm	=	15,100 (See CW Pipe Sizing Flowrate, Sect. 7.1.3.2B)
Drift Rate	=	Range of 0.002 to 0.2% water circulation
	=	0.1% (average)
Cycles of concentration	=	<u>Evaporation + Drift + Blowddown</u> Drift + Blowdown
	=	6 (Assumption 4.3.1.3.3)
Blowdown Rate	=	15 gpm

7.1.3.3 Equipment Sizing

A. Cooling Tower:

The central plant cooling tower water system will consist of a multiple number of mechanical- draft type, cross-flow or counter-flow cooling towers. The total peak cooling design requirements will be handled equally by these units.

Total Heat Rejection Capacity	=	75,000 MBH
Nominal Cooling Tower Capacity	=	5,000 TR
where: 1 ton of refrigeration (TR)	=	15,000 Btu/hr (See p. 36.2, Ref 5.11)
Leaving CW temperature	=	85° F (Assumption 4.3.1.3.1)
Water temperature differential, TD	=	10° F (Assumption 4.3.1.3.1)
Entering CW temperature	=	85° F + 10° F
	=	95° F
Ambient Wet Bulb temperature	=	65° F
CW Flowrate, gpm	=	15,100 (See CW Pipe Sizing Flowrate, Sect. 7.1.3.2C)

<u>Unit Selection</u>:

Number of units	=	4 operating (Assumption 4.3.1.3.4)
Cooling Capacity	=	75,000 MBH / 4 units
	=	18,750 MBH (1,250 TR)
Ent / Lvg Water temperature	=	95° / 85° F
Ambient Wet Bulb temperature	=	65° F
CW Flowrate	=	15,100 gpm / 4 units
	=	3,775 gpm

Fan HP	=	40 (See Attachment I, Table T-4; Unit is selected by extrapolation)

B. Cooling Tower Water Pumps

The primary CW pumping system will consist of multiple pumps, one pump per cooling tower with a spare unit serving as standby. The CW piping will be looped around the chillers and the cooling towers with drop connections to the pumps, chillers and cooling towers. chillers. The piping length was based from an estimated chiller room size (See Section 7.5.1) and location of cooling towers relative to the Utility Building (See Attachment I, Figure 4) . The estimated pump head is calculated using Table T-2b, Attachment I as follows:

Length of CW Piping	=	600 ft	(Estimated)
Equiv. Length of Fittings (50%)	=	<u>300 ft</u>	(Assumed)
Total Pipe Length	=	900 ft	

Ave. Pressure Drop @ 1.0 ft/100 ft	=	9 ft	(24-in dia. ave. pipe size)
Equipment press.drop	=	30 ft	(Assumption 4.3.1.2.4)
Cooling Tower Lift and Nozzle	=	17 ft	(Assumption 4.3.1.3.5)
25% Safety factor	=	<u>14 ft</u>	(Assumed)
Total Pump Head	=	70 ft	

<u>Unit Selection</u>:

Number of units	=	4 operating, 1 standby (Assumptions 4.3.1.2.3 and 4.3.1.2.6)
Flow Capacity, GPM per unit	=	15,100 gpm / 4 units
	=	3775 gpm
Total Dynamic Head (TDH)	=	70 ft.-H_2O
Brake HP	=	(gpm x TDH x SG) / (3960 x E) (derived from page 38.6, Reference 5.13)
	=	(3775 gpm x 70 ft. x 1.0) / (3960 ft-gal/min-hp x 0.70)
	=	95 bhp
Nominal Motor HP	=	100 hp

where:

SG	=	specific gravity of water at 85° F (See Attachment I, Table T-3b)
3960, constant	=	(33,000 ft-lb/min-hp) / 8.33 lb/gal
E (Pump eff.)	=	70% (Assumption 4.3.1.2.6)

C. Ancillary Equipment

Ancillary equipment will include controls, a sand filtration system, a chemical treatment system, and a make-up water system. Capacity, size and requirements will be determined or verified in the design stages. The primary CHW controls are located in the Utility Building and secondary controls, i.e. cooling towers, are remote. System parameters are transmitted over the control LAN to the CCC.

The cooling tower sump will be provided with water heating for freeze protection. (DOE 6430.1A, Section 1550-2.1.4) (Assumption 4.3.1.3.6)

E. Space Requirements

A pad, outside the Utility Building, will be provided for four (4) cooling towers, and five (5) cooling tower water pumps and the required ancillary equipment. Additional space will be provided for future towers and pumps (two of each equipment). Each 75,000 MBH cooling tower measures approximately 16-ft long by 20-ft wide by 19-ft high. All equipment will have sufficient space between components to allow pipe and valve access and to facilitate maintenance.

7.1.4 Heating Water System - (HW)

7.1.4.1 Introduction

A central heating plant at the Utility Building will provide the heating water system to the North Portal surface facilities. The central heating plant will consist of boilers, distribution loop pumps, controls and ancillary equipment. The temperature of the supply heating water will be reset automatically by representative building heating loads or by outside air. The distribution loop pumping system will be the constant-flow type. The HW users will utilize 3-way control valves for modulation. The heating water will be distributed throughout the facility utilizing a pipe trench for pipe mains. (See Heating Water Schematic Flow Diagram, Attachment I, Figure 3a). (Assumption 4.3.1.4.1) The major load of the heating system is the HVAC's space heating. No requirement for a large steam supply has been identified within the present understanding of North Portal operations. Any steam requirement will be provided locally where it is needed either by an electric steam boiler or an oil-fired boiler. (Assumption 4.3.1.4.5)

The control system for HVAC systems (CHW, CW, and HW) is in the control room of the Utility Building. Primary controls are in the Utility Building, and secondary controls are remote, e.g., cooling tower. System parameters are transmitted over the control LAN to the computer control center (CCC).

7.1.4.2 Material Balance

A. System Capacity

The size of the HW system is based on the following estimated heating peak demands:

USERS		Load, MBH
1. Building HVAC Systems:		
Waste Handling Building (WHB)	=	31,000 (page I-35, Reference 5.6)
Waste Treatment Building (WTB)	=	6,700 (page II-17, Reference 5.6)
Balance of Plant (BOP)	=	12,400(See Attachment I, Table T-1b)
Subtotal	=	50,100
2. Others (Allowance, approx. 15%)	=	7,500
Overall Total	=	57,600 MBH
USE	=	60,000 MBH

B. Pipe Sizing

HW flowrate, gpm = Q / (8.02 x D x SH x TD) (page 12.2, Ref. 5.11)
= (60,000,000 Btu/hr) /
(8.02 ft^3-min/hr-gal x 62.64 lb/ft^3 x 1.0 Btu/lb-°F x 30° F)
= 4,000 gpm

where: Q	=	Total heating load, Btu/hr
D	=	density (lb/ft^3.), 20% glycol at 170° F (Attachment I, Table T-3b)
SH	=	specific heat (Btu/lb-F), 20% glycol at 170° F (Attachment I, Table T-3a)
TD	=	water temp. differential, ° F (Assumption 4.3.1.4.2)
8.02, constant	=	60 min/hr / 7.48 gal/ft^3.

Notes:

1. For HW design assumptions, See Section 4.3.1.4.
2. See Attachment I, Figures 3a, 3b and 3c for pipe sizes and flowrates for the HW piping system.
3. For pipe sizing, see Assumption 4.3.1.2.2.
4. The HW system will be designed for 20 % (wt) glycol solution (Assumption 4.3.1.2.9)

7.1.4.3 Equipment Sizing

A. Hot Water Boilers:

The central plant hot water system will consist of a multiple number of oil-fired, water boilers. The total peak heating design requirements will be shared equally by these units.

Overall Boiler Heating Load, Q	=	60,000 MBH
Boiler Leaving HW temperature	=	200° F (Assumption 4.3.1.4.2)
Water temperature differential, TD	=	30° F (Assumption 4.3.1.4.2)
Boiler Entering HW temperature	=	200 - 30° F
	=	170° F
HW Flowrate	=	4,000 gpm(See HW Pipe Sizing Flowrate, Sect. 7.1.4.2B)

Unit Selection:

Number of units	=	2 operating (Assumption 4.3.1.4.3)
Heating Output Capacity	=	60,000 MBH / 2 units
	=	30,000 MBH
Boiler Efficiency	=	75% (Assumption 4.3.1.4.3)
Heating Input Capacity	=	30,000 MBH / 0.75
	=	40,000 MBH
Ent / Lvg Water temperature	=	170 / 200 ° F
HW Flowrate Capacity	=	4,000 gpm / 2 units
	=	2,000 gpm

B. Hot Water Pumps

The primary HW pumping system will consist of multiple pumps, one pump per boiler with a spare unit serving as standby. The HW piping will start from the chiller plant and extend around the site to all the HW users.The piping run from the Utility Building to the Waste Handling Building (including building distribution piping) appears to have the longest run or highest pressure drop and is selected for the pump head calculation (See Attachment I, Figure 4). For HW (boiler piping) schematic flow diagram, see Attachment I, Figure 3a. The estimated pump head is calculated Table 2A, Attachment I, as follows:

Length of HW Piping	=	4,500 ft	(Estimated)
Equiv. Length of Fittings (10 %)	=	450 ft	(Assumed)
Total Pipe Length	=	4,950 ft	
Ave. Press. Drop @ 2.0 ft /100 ft	=	100 ft	(12" dia. ave. pipe size)
Equipment and control valve press. drops	=	20 ft	(Assumption 4.3.1.4.4)
25% Safety factor	=	30 ft	(Assumed)
Total Pump Head	=	150 ft	

Unit Selection:

Number of units	=	2 operating, 1 standby (Assumptions 4.3.1.2.3 and 4.3.1.2.6)

Flow Capacity, gpm	=	4,000 gpm / 2 units
	=	2,000 gpm
Total Dynamic Head (TDH)	=	150 ft.-H_2O
Brake HP	=	gpm x TDH x SG / (3960 x E) (page 38.6, Reference 5.12)
	=	(2,000 gpm x 150 ft x 1.00) / (3960 ft-gal/min-hp x 0.70)
	=	108 bhp
Nominal Motor HP	=	150 hp

where:

SG	=	specific gravity of water at 170° F (See Attachment I, Table T-3b)
3960, constant	=	(33,000 ft-lb/min-hp) / 8.33 lb/gal
E (Pump eff.)	=	70% (Assumption 4.3.1.2.6)

C. Ancillary Equipment

Ancillary equipment will include controls, compression tank, air separator, chemical pot feeder system and make-up water system. Capacity, size and requirements will be determined in the design stages. The primary HW controls are located in the Utility Building. System parameters are transmitted over the control LAN to the CCC.

D. Space Requirements

A space, inside the Utility Building, will be provided for two (2) boilers, three (3) hot water pumps, and required ancillary equipment. Additional space will be provided for future boilers and pumps (one of each type of equipment). A 30,000 MBH boiler measures approximately 33-ft long by 13-ft wide by 15-ft high. Each of the HW circulating pumps (including motor and base) measures approximately 6-ft by 3-ft. All equipment will have sufficient space between components to allow access to valves and pipes, and to facilitate maintenance. Space will also be provided for the HW system ancillary equipment.

Total space allocation within the Utility Building for the Boiler Room is 70-ft by 80-ft (5600 ft^2) with a height of 20-ft.

7.1.5 Water Softening and Supply System

Untreated well water presently comes to the North Portal area from the existing fire water storage tank (200,000 gallon) as identified in Drawing No. YMP-025-1-CIVL-C110, Rev. 00 (Reference 5. 28). A new 8-in. potable water supply main will be extended from the present 12-in. main line, just external to the radiological control area (RCA), to the Utility Building (N221-2). This new line will provide well water for feed to the water softening and supply system, and to the deionized water treatment and supply system. Figure 1 (Attachment II) shows the routing of this new line. The sizing of this new 8-in. line is discussed in Section 7.1.8 Overall Water Supply Demand.

The primary use for this well water will be for the production of softened water for makeup water to the cooling tower. To minimize the potential of hard water deposit formation on components within the cooling tower system, the water is softened, i.e., calcium and magnesium ions are replaced with sodium ions. The net result of this water softening is water conservation. If the water going to the cooling tower were to not be softened, the amount of recycle of that water within the cooling tower system would have to be decreased sufficiently enough to minimize hard water scale deposit formation. Softened water will also be available for use as utility water for such activities as facility washdown and housekeeping.

7.1.5.1 Flowrates and Consumption

Table 7.1.5-1 provides the estimated consumption of water to be utilized in the washdown and housekeeping of the North Portal facilities.

There is no accurate way of predicting the timing of this usage, although, washdown activities would probably occur on a weekday, Shift 1. If it is assumed that a maximum of eight hoses are in use at a given time and each hose is delivering 5 gpm (Assumption 4.3.1.5.3), the maximum water flowrate would be (8 hoses x 5 gpm/hose =) 40 gpm.

The major consumption of softened water will be for makeup to the cooling tower. From Section 7.1.3.2, above, the maximum cooling water makeup requirement is 180 gpm which correspondence to a maximum heat rejection capacity of 75,000 MBH. Adjustment of this number is required to

Table 7.1.5-1 Estimated Annual Consumption of Utility Water for Housekeeping Purposes

Facility	Sq. Ft. (Table 4-2 of Reference 5.4)	Gal/Sq. Ft. (Assumption 4.3.1.5.1)	Frequency (Assumption 4.3.1.5.2)	Annual Consumption (gallons)
Fire Station	7600	1	1/month	91,200
Central Shops	28800	1	3/year	86,400
Motor Pool	1200	1	1/month	14,400
Utility Building	5500	1	1/month	66,000
Total				258,000

determine actual water consumption for cooling tower usage on an annual basis. Assuming an average use factor of 0.4 for HVAC cooling loads (Assumption 4.3.1.5.4), an average utility water consumption rate can be determined as (180 gpm x 0.40 =) 72 gpm. Annual consumption of cooling tower water would then be (72 gpm x 60 minutes/hour x 24 hours/day x 365 days/yr =) 37.8 million gallons of water/year.

7.1.5.2 Equipment Size

The water softening system is a multiple bed system. The number of beds is defined such that at maximum flow rate through the softening system at least one bed will either be regenerating or on standby. To minimize the amount of water and salt consumption for regeneration purposes, the system will monitor hardness, and automatically transfer between beds prior to breakthrough of an operating bed. A simple flowsheet for the water softening system is presented in Figure 2, Attachment III.

Maximum daily cooling water consumption is (180 gpm x 60 minutes/hour x 24 hours/day =) 259,200 gallons/day. A reasonable amount of surge capacity and holdup for this water is four hours. This requires a surge tank with a capacity of (180 gpm x 60 minutes/hour x 4 hours =) 43,200 gallons. Allowing 10% for head space, the surge tank size is (1.1 x 43,200 gallons =) 47,520 gallons, rounded to 48,000 gallons. The water used in washing down of floors is not considered in the sizing of the surge capacity because it represents such a small and irregular flow.

This tank would be placed immediately adjacent to the Utility Building. The tank will be constructed of carbon steel, and will have a recirculating heater system to prevent the water in the tank from freezing.

Two pumps will be utilized to move softened water from the Soft Water Surge Tank through the softened water distribution system. Both pumps will be sized sufficient to move the maximum flowrate of softened water. The maximum anticipated flowrate for the pumps will be sum of the maximum cooling tower water flowrate and the maximum floor washdown flowrate, (180 gpm + 40 gpm =) 220 gpm. Allowing 20% for contingency and pump performance uncertainty, the pumps will be sized to deliver (1.2 x 220 =) 264 gpm, rounded to 260 gpm. Maintaining a flow velocity below 4 fps (Assumption 4.3.1.1.9) for this flowrate would require a utility main of at least 5-in. schedule 40 (Reference 5.29). Because 5-in. lines are atypical and pipe and valving is more expensive, a 6-in. water main is utilized. The design pressure of discharge for these pumps is set at 60 psig. A pressure of 60 psig will provide for a residual pressure at the end user of at least 50 psig (Assumption 4.3.1.1.8) (See Section 7.1.5.3 for discussion on pressure drop).

A water balance around the water softening system shows that total water consumed is equal to the product softened water plus an amount of water utilized in the regeneration of the ion exchange resins. It is assumed that the amount of water consumed during regeneration is equal to 7% of the softened water product (Assumption 4.3.1.5.5). The flowrates vary during regeneration, and are a function of actual resin performance with the chemistry of the water being treated.

From Reference 5.19, page 369, water softening flowrates/ft^2 of bed vary between 4 to 8 gpm/ft^2. For equipment sizing, a 4 gpm/ft^2 flowrate is used. (Assumption 4.3.1.5.6) Using a flowrate of 220 gpm and a flowrate factor of 5 gpm/ft^2 , the cross-sectional area of the bed is (220 gpm/5 gpm/ft^2 =) 44.0 ft^2. In practice, water softener systems typically use several smaller beds to accomplish this large a cross-sectional area.

Using the area of a circle as A = pi x d^2/4 (Reference 5.26, page 2-6),

where: A = area, in ft^2
d = diameter, in feet
pi = 3.14159

If the diameter of a given water softener bed is 3 ft (Assumption 4.3.1.5.7), using six water softener beds yields a total cross-sectional area of [6 x pi x (3)^2/4 =] 42.4 ft^2. This is close enough to the 44.0 ft^2 to be acceptable. An additional bed is required to ensure maximum flow rate through the system is available while a bed is regenerating; therefore, the total number of water softener beds will be seven.

Review of the water quality data for Well J-13 indicates a silica content of approximately 40 mg/liter (References 5.20 and 5.21). A silica content in this range presents some concern over potential deposition of silica within the water softening beds. To minimize the impact of silica deposition, a high backwash flowrate and column head space sufficient for 100% bed expansion during backwash is used.

For the purpose of this conceptual effort, it is assumed that the highest flowrate during regeneration occurs during fast rinse, and that this flowrate is equal the design flowrate through the bed. (Assumption 4.3.1.5.8) Using this assumption, the peak flowrate to the water softening system would be equal to the rate of softened water being produced plus the flow of one of the beds being fast rinsed. Because the flow of water is equally distributed through the six operating beds, the flow through a given bed is (220 gpm/6 beds =) 36.7 gpm/bed. Therefore the maximum flow rate of well water to the water softening system will be (220 gpm + 36.7 gpm =) 256.7 gpm, or 260 gpm.

The height of the ion exchange resin bed is assumed to be four (4) ft (Assumption 4.3.1.5.9). Using a 100% factor for bed expansion during backwash, the total column height is (2 x 4 ft =) 8 ft.

A brine tank is required to produce salt brine for use in regeneration of the water softener. The brine tank cross-section is assumed to be equal to the sum of the resin bed cross-sections, this equates to an approximate 8-ft 3-in diameter, and the height of this tank is assumed to be 8 ft. (Assumption 4.3.1.5.10) This tank is accessible from a platform to allow for operators to load dry salt into the brine tank. Brine solution from the brine tank is aspirated through the resin bed using a venturi valve system which is part of the bed regeneration system.

The maximum waste water flowrate from regeneration of the water softening system will occur during the summer months when the cooling tower is operating at peak demand of 180 gpm. Using the 180 gpm, the peak daily flow will be approximately (180 gpm x 60 min/hr x 24 hr/day =) 259,200 gpd. An additional amount of water will be utilized in the washdown of facilities, this is approximately (258,000 gal/yr / 250 operating day/yr =) 1032 gpd. The total peak softened water flow will therefore be approximately (259,200 gpd + 1032 gpd =) 260,232 gpd. Using the 7% factor for waste water generation during the regeneration process (Assumption 4.3.1.5.5), the peak waste water flow rate from the water softening system going to the evaporation pond is approximately (0.07 x 260,232 gpd =) 18,216 gpd, rounded to 18,200 gpd.

The average waste water from the water softening system in the winter months is based on the assumption that the base load cooling requirement during the winter months is 20% of peak load (Assumption 4.3.1.5.12). Using the peak cooling tower water flow rate of 180 gpm and multiplying by 20% yields the average cooling tower water flow in the winter months of approximately (180 gpm x 0.2 =) 36 gpm. The daily flow would then be approximately (36 gpm x 60 min/hr x 24 hr/day =) 51,840 gpd. Adding to this number the average daily flow of softened water used in the washdown of facilities yields the total daily softened water flow in the winter months of approximately (51,840 gpd + 1032 gpd =) 52,872 gpd. The average waste water flow is then approximately (0.07 x 52,872 gpd =) 3701 gpd, rounded to 3700 gpd.

7.1.5.3 Header Line Sizing

From Crane, (Reference 5.29), with a flow of 220 gpm, and a pipe size of 6-in. Schedule 40, the anticipated pressure drop/100 ft for this line would be approximately 0.16 psig/100 ft. Actual distance between these tanks and the cooling tower, the major user cannot be determined, but assuming the distance is 300 ft (Assumption 4.3.1.5.11), the anticipated pressure drop would be (300 ft x 0.16 psig/100 ft =) 0.5 psig. The distribution line for softened water to the remaining facility is sized to deliver (1.2 x 40 gpm =) 48 gpm. Using 1150 ft. of pipe (Section 7.1.1), a 2.5 inch schedule 40 pipe is reasonable. The delivered pressure, under maximum flow, to the WHB would be approximately [60 psig - (0.77 psig/100 ft x 1150 ft) =] 51.1 psig.

7.1.5.4 Utility Building Space Requirements

The water softening equipment, softener(s), brine tank, and pumps, will be housed within the Utility Building. The seven resin beds will be manifolded together, with sufficient space between the beds to allow maintenance, and resin replacement if required. A reasonable amount of minimum space between beds is three feet, and a space between a bed and a outside wall is 2-1/2 ft. The brine tank, approximately 8-ft in diameter, will require approximately 3 - 4 feet clearance around its perimeter. The loading of the brine tank will be from a platform, with top elevation equal to the height of the brine tank, 8-ft. The space allocation for this equipment is 15 ft by 20 ft (300 ft^2), with an overhead height of 20 ft.

The softened water storage tank and supply pumps will be located outside the Utility Building. The tank, pumps, and lines (above surface) will be heat traced (electric) and covered.

7.1.6 Deionized Water Treatment and Supply System

The primary use of deionized water within the North Portal Surface Facilities will be for the short-term storage of fuel rods in fuel pools within the WHB. This short-term storage will allow for consolidation of fuel prior to loading into waste packages, thereby minimizing the total number of waste packages.

7.1.6.1 Flowrates and Consumption

The fuel storage pools within the WHB require deionized water for fuel storage. A specific water quality requirement for this deionized water in the fuel storage pools has not been established. Water quality within fuel storage pools at electrical utilities must be maintained below 20 micro-seimens, 10 CFR 50.3663 (Reference 5.22). To provide the initial fill of the storage pool water and to provide makeup water for evaporation to the storage pools, it is assumed that the required water quality from the deionization system is 2 micro-seimens (Assumption 4.3.1.6.1).

There are three pools in the WHB. The total volume of these three pools is 182,760 ft^3, reference Table 7.2-1 Assembly Handling Pool Volume, *Surface Nuclear Facilities Space Program Technical report,* DI:BCBD00000-01717-0200-00012 Rev 00 (Reference 5.31). Using 7.481 gallons/ft^3, the volume of water is (182,760 x 7.481 =) 1.367 million gallons.

Estimating the quantity of water evaporated from one pool is performed by the following series of calculations:

1) The cells housing the storage pools are supplied with controlled HVAC air entering at 26,700 ACFM (total), and 16,400 ACFM for the first twenty feet of elevation. The conditions of this air is 65° F, and with a dew point (at dryest conditions) of 15° F. (Reference 5.6). Because actual airflow patterns within the cells are unknown, a bounding case is made by having the airflow longitudinal across the pool's surfaces, which yields the highest evaporation rate. The longitudinal cross-section near the water surface where the air is moving at 16,400 ACFM is estimated by the following calculation.

The cell dimensions are approximately 40 ft wide by 90 ft long by 70 ft high. The longitudinal cross-section is then 40 ft wide by 20 ft high or approximately (40 ft x 20 ft =) 800 ft^2.

The velocity of air is then equal to the volumetric flowrate divided by the cross-sectional area or (16,400 ft^3/min / 800 ft^2 =) 20.5 fpm.

2) Estimating the evaporation rate of water is performed utilizing an empirical correlation developed for evaporation rate from indoor swimming pools (ASHRAE Handbook, Applications, 1995, page 4.7) (Reference 5.13).

$$w_p = A (p_w - p_a) (95 + 0.425 V)/Y$$

where: w_p = evaporation rate of water, lb/hr
A = area of pool surface, ft^2
V = air velocity over the pool surface, fpm
Y = latent heat of vaporization at water surface temperature BTU/lb
p_w = saturation pressure at room air dew point, in. Hg
p_a = saturation vapor pressure taken at the surface water Temperature, in. Hg

The surface area of the pools (A) exposed to air is the Cask Unloading Pool (450 ft^2) plus the Spent Fuel Storage Pool (504 ft^2), i.e., (450 + 504 =) 954 ft^2. Reference 5.31, Table 7.2-1, page 48.

The actual wet bulb temperature of the incoming air is undefined. The design low dry bulb temperature is 22.5° F. It is assumed that the lowest dew point temperature is 15° F. (Assumption 4.3.1.6.2). From *Basic Principles and Calculations in Chemical Engineering, 2nd edition,* D. M. Himmelblau, 1967, Figure 5.11 (b) Humidity Chart, (Reference 5.33) a dew point temperature of 15° F correlates to a saturation pressure for water of approximately 0.103 in. Hg (corrected to an elevation of 3700 ft above sea level). The saturation vapor pressure for the pool water taken at 55° F (Reference 5.33) taken from this same Figure 5.11 (b) and corrected to an elevation of 3700 ft above sea level is approximately 0.437 in. Hg. The latent heat of vaporization for water at 55° F is (1085.6 Btu/lb - 23.059 Btu/lb =) 1062.5 Btu/lb, Reference 5.26, Table 3-276. Correcting this latent heat of vaporization for elevation, from Figure 5.11 (b), Reference 5.33, yields a latent heat of vaporization of approximately (1062.5 Btu/lb - 1.5 Btu/lb =) 1061.0 Btu/lb.

Therefore,

w_p = 954ft^2 (0.437 - 0.103)in-Hg [95 + 0.425 (20.5 ft/sec)]/1061.0 Btu/lb = 31.1 lb/hr per pool. (Note: this is a correlation of empirical observance, the units are non-consistent).

Since there are three pools, the total water loss by evaporation is estimated at (3 x 31.1 =) 93.3 lb/hr. Using 8.34 lb/gallon of water, this is equal to (93.3/8.345 =) 11.2 gal/hr, rounded to 11 gal/hr.

Additional deionized water users in the North Portal facilities are:

Miscellaneous Laboratory Use	5000 gal/yr (Assumption 4.3.1.6.3)
Refill for Loss to Closed Loop Water Systems	6000 gal/yr (Assumption 4.3.1.6.4)
Subtotal	11000 gal/yr

The major use of deionized water will be for the initial fill of the storage pools, and, in the unlikely event, total refill of those pools. It is assumed that it is reasonable to allow 30 (thirty) days to fill the storage pools (Assumption 4.3.1.6.5). This will require a flowrate of (1,367,000 gallons/30 days/24 hr/day/60 min/hr =) 31.6 gpm, rounded to 32 gpm.

A water balance around the deionization system shows that total water consumed is equal to the product deionized water plus an amount of water utilized in the regeneration of the ion exchange columns. It is assumed that the amount of water consumed during regeneration is equal to 7% of the deionized water product (Assumption 4.3.1.5.5). The flowrates vary during regeneration, and are a function of actual resin performance with the chemistry of the water being treated. For the purpose of this conceptual effort, it is assumed that the highest flowrate during regeneration occurs during fast rinse, and that this flowrate is equal the design flowrate of 32 gpm (Assumption 4.3.1.5.8). Using this assumption, the peak flowrate to the deionization system would be equal to the rate of deionized water being produced in one column (32 gpm) plus the fast rinse water (32 gpm), 64 gpm.

The average daily quantity of waste water resulting from the regeneration of the deionization system is calculated by multiplying the average daily deionized water consumption by 7 % (Assumption 4.3.1.5.5). The average flow rate of deionized water is approximately (11 gal/hr x 24 hr/day + 11,000 gal/yr / 365 day/yr =) 294 gpd. The approximate waste water flow is (0.07 x 294 =) 20.6 gpd, rounded to 21 gpd.

7.1.6.2 Equipment Requirements

The ion exchange system uses two parallel sets of ion exchange beds. One set of beds is in operation while the other set of beds is either being regenerated or in standby. A set of beds consists of two ion exchange beds, cation exchange followed by anion exchange, i.e., the water will first be passed through a cation bed and then passed through an anion bed. A simple flowsheet for the deionization system is presented in Figure 3, Attachment III. From Reference 5.19, page 369, water flowrates/ft^2 of bed vary between 4 to 8 gpm/ft^2. A 4 gpm/ft^2 flowrate is assumed through the water deionization beds. (Assumption 4.3.1.6.6) Using a flowrate of 32 gpm and a flowrate factor of 4 gpm/ft^2 , the cross-sectional area of an ion exchange bed is (32 gpm/4 gpm/ft^2 =) 8 ft^2. Using the area of a circle as A= pi x $d^2/4$, where d is the diameter (Reference 5.26). The diameter of the bed is((4 x 8/pi) ^{½} =) 3.2 ft, or approximately 3-ft 3-in.

Review of the water quality data for Well J-13 indicates a silica content of approximately 40 mg/liter (References 5.20 and 5.21). A silica content in this range presents some concern over potential deposition of silica within the deionization beds. To minimize the impact of silica deposition, a high backwash flowrate and column head space sufficient for 100% bed expansion during backwash is used. The height of the ion exchange resin within the bed is assumed to be six (6) ft (Assumption 4.3.1.6.7). Using a 100% factor for bed expansion during backwash, the total column height is (2 x 6 ft =) 12 ft.

An acid and a caustic tank are required to produce dilute acid for cation bed regeneration and dilute caustic for anion bed regeneration. These tanks will be 8500 gallon lined tanks, located outside the

Utility Building. Small chemical feed pumps will be used for feeding regeneration acid or base to the appropriate ion exchange column.

The storage (surge capacity) of deionized water is set at four hours at maximum flowrate. This will allow for continued flow of deionized water from the system in the event that one set of beds cannot be regenerated due to equipment failure. This will require a surge tank with a capacity of (4 hr x 32 gpm x 60 minutes/hr =) 7680 gal. Allowing 10% for head space, the tank will have a volume of (1.1 x 7680 gal.=) 8448 gal., rounded to 8500 gal. The tank will be epoxy lined carbon steel.

Two, redundant, pumps will be utilized to deliver deionized water. To compensate for uncertainty in pump performance and eventual wear, the pumps will be sized with a 20% contingency. The pumps will be capable of delivering (32 gpm x 1.2 =) 38 gpm at 60 psig. The pumps will be stainless steel. Because the deionized water is used to provide cooling for fuel in the WHB storage pools, it is important to maintain water flow in the event of a long term power outage, for this reason, the two pumps will be provided with standby power.

7.1.6.3 Header Line Size

Using Crane Table B-14 (Reference 5.29) the required line size to deliver 32 gpm at a flowrate less than 4 fps (Assumption 4.3.1.1.8), is 2-in schedule 40. The deionized main piping will be constructed of flanged Teflon lined pipe.

7.1.6.4 Utility Building Space Requirements

The deionized water system, deionizer columns, deionized water surge tank, and pumps will be housed within the Utility Building. The 8500 surge tank will take up approximately a 20-ft by 20-ft area. The tank will be approximately 12-ft in diameter, and just over 10-ft high. Walk space around the tank will be approximately 4-ft. The two deionized water pumps will be contained in a space of approximately 10-ft by 10-ft. The ion exchange columns, two cation beds and two anion beds, will be in a space approximately 16-ft by 20-ft. The columns have sufficient space between them to allow piping and automatic valves. The total space required inside the Utility Building is 56 ft by 20 ft (1120 ft^2) with an overhead ceiling height of 20 ft to accommodate the 12-ft columns and piping.

The acid and base tanks and their feed pumps will be located outside the Utility Building. A neutralization tank, 8500 gallons, will also be located outside the Utility Building. This tank will be used to collect regeneration water. The water will be analyzed to ensure that the pH is within discharge requirements prior to draining to the evaporation pond. Acid or base will be added as necessary to achieve the required pH.

7.1.7 Fire Water System and Supply

The existing fire water supply system was designed to support exploratory operations at the North Portal. This system has insufficient capacity to support the future North Portal Surface Facilities.

Certain provisions, e.g., the main supply line coming to the North Portal will be re-utilized. In general though, a new fire water supply and distribution system will be installed to meet fire protection requirements for the North Portal Surface Facilities.

The fire pump control system for the fire pump will be installed in the pump houses. System status will be transmitted over the control LAN to the computer control center and over the fire alarm system to the fire house. Sprinkler system status will be monitored at each building and status will also be transmitted.

7.1.7.1 General System Description

A conceptualized configuration of the fire water based fire protection systems (sprinkler system, fire hydrants, fire mains, and pump houses is depicted in Figure 5, Attachment III. The layout includes the requirements of DOE 5480.7A, 6430.1A, and those of the "improved risk" insurance companies. Figure 5 shows two fire water sources (fire pumps and tanks)[1], fire main loops, and minimal section valves, and that essentially all facilities at the North Portal will have fire protection. The lead-ins to the WHB and WTB (non-reactor nuclear facilities) are arranged to prevent both systems from being impaired in the event of a main break. Either fire pump station will be capable of supplying the WHB or WTB sprinkler systems in the event of a main break.

The layout of the fire hydrants is based on approximately 300 ft between hydrants to ensure that total hose length in the fighting of a fire is no greater than 300 ft. The hydrants will be located 50 ft or more from the building, per DOE Orders, and NFPA 24 requirements. Post indicator valves (PIV) for section valves and sprinkler system control valves will be provided. The sprinkler system control valves will be located 40 ft or more from the building in accordance with NFPA 13. From this layout it is estimated that 21 fire hydrants will be required to support North Portal Surface Facilities.

The number of sprinkler systems (zones) is based on the gross square footage of the various facilities. Buildings with less than 52,000 ft^2 will have a single sprinkler system. Larger buildings will have one sprinkler system for each 52,000 ft^2 or portion thereof.

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[1] The presented concept shows two tanks and two pump houses to provide necessary water storage and supply for fire protection. An alternative to this conceptualized layout would be to take advantage of the elevation gradient, and locate one of the fire protection storage tanks on the hill northwest of the facilities. Because detailed engineering has not been performed, it cannot be definitively stated that sufficient head is available through the use of the elevation increase appreciated by locating a firewater tank on the hill. An additional pump may be required to raise the required 125 psig. Figure 5, Attachment III also shows a potential location for a tank on the hill. In either case, sufficient space between the two storage tanks is recommended to prevent the imposition (under NRC requirements) of having to seismically harden tanks and/or pump houses.

Water for fire fighting activities for both manual and automatic suppression systems will be provided by two sources with sufficient flow and pressure. It is expected that the maximum sprinkler demand will be in the Central Warehouse Building (Building 220-7). Storage occupancy is anticipated to be palletized and rack storage of less than 12-ft height. This type of system will require that the sprinklers be designed in accordance with NFPA 13 for an extra hazard group 2 occupancy. This protection will require a density of 0.4 gpm/ft^2 over the remote 2500 ft^2. The inside hose allowance is 250 gpm and the outside allowance is 500 gpm. DOE and NRC guidelines require that the flow to the sprinkler system be available for two hours. DOE requires that a 500 gpm hose stream allowance be included in the calculation. NFPA 231, *Standard for General Storage*, 1995, and NFPA 231C, *Standard for Rack Storage of Materials,* 1995, require the installation of an inside hose station and an allowance for them in the calculations. The flow for the sprinkler system is expected to be (0.4 gpm/ft^2 x 2500 ft^2 =) 1000 gpm. An additional 25% is added to allow balance of sprinklers, this brings the total flow to (1000 gpm x 1.25 =) 1250 gpm. Total flow is therefore (1250 gpm + 250 gpm + 500 gpm =) 2000 gpm (Assumption 4.3.1.7.1). The pressure requirement is based on the flow to the sprinklers in the highest building. It takes 0.433 psig to raise water one foot in elevation.

For a 120 ft high building, it will take (120 ft x 0.433 psig/ft =) 52 psig. The end head pressure of an operating sprinkler system is typically about 20 psig. The friction loss through the sprinkler system at the required flowrate is typically designed to about 25 psig. Friction loss in the mains and pumping station is typically designed to about 15 psig at the required flowrate. This requires a total pressure of approximately (52 psig + 20 psig + 25 psig +15 psig =) 112 psig to allow the system to operate as designed. The closest listed or approved fire pump to this value is 125 psig. The tank size is calculated by multiplying the required flow rate of 2000 gpm (Assumption 4.3.1.7.1) by the two hour requirement for flow (Section 4.2.1.2.6), (2000 gpm x 60 min/hr x 2 hr =) 240,000 gallons. The nearest listed or approved tank is 250,000 gallon[2]. Each pumping source will have two fire pumps rated at 2000 gpm at 125 psi (one diesel and one electric) taking suction from a 250,000 gallon tank. A jockey pump will be provide at each location. The suction tank will be refilled by the site process water system. The suction tanks can supply the automatic sprinkler and hose stream demand flows for two hours as required by DOE and NRC guidelines.

The existing 200,000 gallon tank (Assumption 4.3.1.7.2) which provides feed to the fire water storage tanks is approximately 2000 ft away, and approximately 210 ft higher in elevation. This will give a head pressure of approximately (0.433 psig/ft x 210 ft =) 90 psig. The friction loss in a 6-in at a flowrate of 520 gpm is 0.014 psig/ft, Reference 5.34, *Factory Mutual Loss Prevention Data Sheet 2-89*. The friction loss in a 6-inch pipe is therefore estimated at (0.014 psig/ ft x 2000 ft =) 28 psig. With an elevation head pressure of 90 psig, a 6-in main fill line will be required.

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[2] NUREG 0800 (Reference 5.32) does not apply to the design presented. If, at a future date, a determination is made requiring adherence to NUREG 0800, the only significant impact to the conceptual design presented would be an increase in the firewater storage tanks from 250,000 gallons to 300,000 gallons.

Each fire pump in either location will be able to provide the required fire protection water. Pressure will be maintained in the system by either jockey pump. The electrical fire pump will start when the required pressure cannot be maintained by the jockey pump(s), indicating a sprinkler system has activated or a hose is being utilized. The diesel pump or pumps will start on power failure to the pump house.

Each pump house, will be heated, provided with an automatic fire suppression system, and contain the heating system for the suction tanks as required by NFPA 22 Chapter 13. The pump houses are sized at 26 ft by 20 ft (520 ft^2). Tank heating will be provided by a pump that will circulate hot water into the tank from a diesel fired hot water boiler. The tank fill line, as discussed above, will need to be a minimum of 6-inches in size. The required flowrate to refill the 250,000 gallon tank in 8 hrs is (250,000 gallons/ 8 hrs/ 60 min/hr =) 520 gpm.

The operation of the fire pumps and tank levels and temperatures will be monitored by the fire alarm system. Alarms from the pumps or tanks will be transmitted to the Central Alarm Control System in the Fire Station.

Water mains for fire protection use will be separated from other plant water systems. These mains will be 12-inches in size, 12-inch mains are selected to keep friction loss to a minimum. Sectional valves will be provided such that either pumping source can be isolated without affecting the other.

Each sprinkler system for the nuclear facilities will be provided with its own lead-in which can be isolated from other systems. Dual feeds, sectional valves and separate lead-ins will allow the sprinkler systems to remain in operation even with a main break. Manual fire fighting activities are provided by fire hydrants and small diameter hose stations.

Equipment that will be used for the fire system will be Factory Mutual approved or UL listed for the intended purpose. The underground mains will be polyvinyl chloride (PVC) type piping. Reduced friction loss is important in meeting the sprinkler demands with the fire loop impaired or as the mains age. The low friction losses in the 12-inch mains will allow the sprinkler demand to be met in the high bay areas. The design of fire mains will be in accordance with NFPA 24.

Each fire pump house will be arranged such that each pump has its own discharge into the loop and so that either pump can supply water to the loop through either discharge line. Pump testing will be provided using a flow meter that discharges back into the tank. This will allow for the recycling of the water used for testing.

7.1.7.2 Water Consumption

The amount of water consumed in the unlikely case of a fire is discussed above in Section 7.1.7.1. Additional water is consumed by the fire water supply system during the performance of routine system testing. A conceptual level assessment of the fire protection system indicates that an approximate total of 21 fire hydrants will be required within the boundaries of the North Portal. These hydrants have to be tested once/yr with an approximate flow of 5000 gallons/test (Assumption

4.3.1.7.3), (21 tests x 5000 gal/test =) 105,000 gallons/year. An additional assessment of the number of fire sprinkler zones indicated that approximately 26 sprinkler systems will be required. These sprinkler systems are tested once every two months at approximately 1,000 gallons/test (Assumption 4.3.1.7.4). This will consume (26 systems x 6/year x 1000 gal/test =) 156,000 gallons/year. The maximum instantaneous flowrate from this testing is approximately 500 gpm from the sprinkler systems and 1500 gpm from the fire hydrants.

7.1.8 Overall Water Supply Demand

Water comes to the North Portal through existing water supply lines, one for raw well water used utility and fire water purposes, and one for potable (sanitary) water. Potable water is only used for potable water purposes, e.g., drinking, showering, etc.. Well water is used for the following purposes: 1) initial supply and makeup to the fire water system; 2) feed to the softened water system; and, 3) feed to the deionized water system. It is assumed that sufficient well water will be available for all water demands for operations at the North Portal Surface Facilities through modifications to the existing well water system, pumping, tankage, and water lines. (Assumption 4.3.1.8)

Figure 4, Attachment III, provides a blockflow diagram of the water systems for the North Portal and presents the anticipated flows for the various utility water streams. From Section 7.1.1.2, the maximum flowrate for potable water, stream 1 on Figure 4, is estimated at 73 gpm.

Potable water is fed by gravity flow from an existing 20,000 gallon potable water tank (Reference 5.28) located N 764000 and (approximately) E 569400, Figure 7.2.1-2 of the MGDS Advanced Conceptual Design Report, Volume 2 of 4 (Reference 5.7). The approximate elevation of these two water tanks, also taken from this figure, is 3860 ft above sea level. The approximate elevation where the existing water lines enter the North Portal area is 3670 ft above sea level. The elevation at the presently identified location for the Utility Building is 3640 feet (Section 7.1.1.2).

Utilizing Bernouli's equation, see Section 7.1.1.2,

$$Z + 144\ P/\varrho + v^2/2\ g = H$$

where:
- H = total hydraulic head in feet
- Z = potential head in feet
- P = pressure, psig
- ϱ = density, lb/ft^3 (64.4 lb/ft^3 for water)
- v = velocity, ft/sec
- g = acceleration of gravity, 32.2 ft/sec/sec

Since the velocity is zero, this equation is transformed to $P = (H\text{-}Z)\ \varrho/144$

$$\text{or } P = (3860 - 3640)(64.4)/144 = (220)(64.4)/144 = 98.4 \text{ psig.}$$

Utilizing Table B-14 from Crane (Reference 5.29), a flowrate of 73 gpm and a velocity < 4 ft/sec, a three inch schedule 40 pipe will have a pressure drop of 0.584 psig/100 ft. Utilizing Figure 7.2.1-1 from the MGDS Advanced Conceptual Design Report, and the proposed routing for the new potable water service connection, Figure 1, Attachment II, the distance between the storage tank on the hill and the Utility Building is approximately 5000 ft. Therefore, a calculated pressure drop for potable water between the tank and the Utility Building would be (0.584 psig/100 ft x 5000 ft =) 29.2 psig. The existing line from the tank to the edge of the North Portal is 8 in., therefore, an even lower pressure drop would be anticipated.

The normal[3] maximum flowrate for raw water, stream 11, (Figure 4, Attachment III) is equal to the sum of the maximum flowrate for makeup to the fire water system, stream 10, 125 gpm, plus the flow to the deionization system, stream 9, 64 gpm, plus the flow to the water softening system, stream 5, 260 gpm. The total of this flow is (125 gpm + 64 gpm + 260 gpm =) 449 gpm. Using Crane Table B-14, Reference 5.29, an 8-in. Schedule 40 pipe will supply this amount of water at about 4 ft/sec, with a pressure drop of approximately 0.15 psig/100 ft of pipe. From above, the anticipated pressure drop would be (0.15 psig/100 ft x 5000 ft =) 7.5 psig. Since the hydraulic head from the water storage tank on the hill is about 98.4 psig, an 8-in line will be sufficient to allow for gravity feed of the raw well water to the Utility Building.

7.1.9 Water Recycle Systems

There are no water recycle systems identified for the utility water systems. A detailed engineering analysis has not been performed to determine the potential economic viability of recycling water from the two liquid discharge sources, sanitary waste or cooling tower blowdown. It is recommended that additional analysis be performed to determine the potential viability of water recycle.

7.1.10 Sanitary Waste System

The installed sanitary wastewater system was designed for a daily flow of 20,000 gpd (Reference 5.38). Current population estimates indicate that the daily flow will be 22,300 gpd which includes a 20% contingency. It is assumed that the amount of discharge going to the sanitary waste system is equal to the amount of potable water consumed by employees, both showering and non-showering. A 20 % contigency is placed on this number due to the uncertainty of future site population (Assumption 4.3.1.10). The design basis for the existing system is NAC 444.750 through NAC 444.840 and the Uniform Plumbing Code.

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[3]Normal maximum flow of fire water makeup (for purposes of defining normal maximum raw consumption) is defined as the makeup required to accommodate testing of the fire protection system. The initial fill of the fire water system or water supplied to the fire water system during a fire occurrence is considered a non-normal occurrence.

7.1.11 Evaporation Pond

Collection System - Gravity collection lines will be installed from the point of discharge of water to be evaporated to the evaporation pond. These lines will be 8" PVC, ASTM D3034 pipe with manholes installed at angle points and required grade breaks. Eight inch pipe will handle 90+ gpm at a minimum grade flowing 1/3 full at 2 ft/sec (Reference 5.15).

Evaporation Pond - The pond will dispose of the blowdown water from the cooling tower system and the regeneration waters from the water softening system and the deionized water system. Surface precipitation and runoff from the RCA and BOP will be collected and disposed by a separate system. The pond will be lined to prevent leaching of dissolved solids into the soil column. Therefore the pond must be sized to permit total evaporation. The sizing of the evaporation pond is an iterative process. The discussion presented is the culmination of that iterative process, which indicates that a 4.25 acre pond will provide sufficient retainage for evaporation, i.e. the pond can periodically dry up, but never overflow. Table 7.1.11-1 presents the results of the 4.25 acre pond evaluation. The 4.25 acre pond is evaluated against water inflow and evaporation starting with discharge into an empty pond on September 1, after the peak evaporation rate of summer has past. The depth of the pond is set at 36-in. A three year cycle is used to determine the suitability of the selected size. Evaporation and precipitation data was utilized from Reference 5.23 (Assumption 4.3.1.11.1). Two water inflow rates from North Portal operations are defined, one for the hot months and the other for the cold/wet months.

Daily peak hot month flow is determined as follows:

Cooling Tower Blowdown	15 gpm x 1440 min/day	= 21,600 gpd
Water Softener Backwash	(from Section 7.1.5.1)	= 18,220 gpd
Deionized Water Backwash	(from Section 7.1.6.2)	= 12 gpd
Building Washdown Water	(from Section 7.1.5.1)	= 1,032 gpd
Total Daily Flow		40,873 gpd

Daily peak cold/wet month flow is determined as follows:

Cooling Tower Blowdown	15 gpm x .2[4] x 1440 min/day	= 11,232 gpd
Water Softener Backwash	(from Section 7.1.5.1)	= 3,700 gpd
Deionized Water Backwash	(from Section 7.1.6.2)	= 21 gpd
Building Washdown Water	(from Section 7.1.5.1)	= 1,032 gpd
Total Daily Flow		9,073 gpd

[4] The average waste water from the water softening system in the winter months is based on the assumption that the base load cooling requirement during the winter months is 20% of peak load. This value assumes that the winter cooling load is 50% of the average load of 40%. (Assumption 4.3.1.5.12)

Table 7.1.11-1 Water Evaporation Pond

Year	Month	Inflow (in/month)	Precipitation (in/month)	Evaporation (in/month)	Pond Depth (in)
1	Sept	10.62	0.33	9.77	1.18
	Oct	2.36	0.26	5.89	0.00
	Nov	2.36	0.43	2.81	0.00
	Dec	2.36	0.49	1.71	1.14
	Jan	2.36	0.55	0.85	3.20
	Feb	2.36	0.62	2.09	4.09
	Mar	2.36	0.49	5.21	1.73
	Apr	10.62	0.32	6.94	5.73
	May	10.62	0.24	10.08	6.51
	June	10.62	0.19	13.15	4.17
	July	10.62	0.35	13.92	1.22
	Aug	10.62	0.28	13.50	0.00
2	Sept	10.62	0.33	9.77	1.18
	Oct	2.36	0.26	5.89	0.00
	Nov	2.36	0.43	2.81	0.00
	Dec	2.36	0.49	1.71	1.14
	Jan	2.36	0.55	0.85	3.20
	Feb	2.36	0.62	2.09	4.09
	Mar	2.36	0.49	5.21	1.73
	Apr	10.62	0.32	6.94	5.73
	May	10.62	0.24	10.08	6.51
	June	10.62	0.19	13.15	4.17
	July	10.62	0.35	13.92	1.22
	Aug	10.62	0.28	13.50	0.00
3	Sept	10.62	0.33	9.77	1.18
	Oct	2.36	0.26	5.89	0.00
	Nov	2.36	0.43	2.81	0.00
	Dec	2.36	0.49	1.71	1.14
	Jan	2.36	0.55	0.85	3.20
	Feb	2.36	0.62	2.09	4.09
	Mar	2.36	0.49	5.21	1.73
	Apr	2.36	0.32	6.94	5.73
	May	10.62	0.24	10.08	6.51
	June	10.62	0.19	13.15	4.17
	July	10.62	0.35	13.92	1.22
	Aug	10.62	0.28	13.50	0.00

The square footage of the pond is equal to approximately (4.25 acres x 43,560 ft^2/acre =) 185,130 ft^2.

These flows are converted to depth of water increase in the pond per month as follows:

Hot month: (40,873 gpd x 30 days/month x 12 in/ft)/(7.481 gal./ft^3 x 185,130 ft^2) = 10.62 in/month

Wet month: (9073 gpd x 30 days/month x 12 in/ft)/(7.481 gal./ft^3 x 185,130 ft^2) = 2.36 in/month

Table 7.1.11-1 presents the resulting pond depth over the three year period

The selected 4.25 acre pond will provide adequate evaporative surface to prevent significant accumulation of liquid over an extended period. The values used for precipitation and evaporation are averages. Thus the pond design depth is adequate to contain the liquid for several consecutive wet years. Historically, wet years are followed by normal and dry years.

The process water will carry a minute quantity of dissolved solids. The build up of dissolved solids is considered insignificant compared to the pond size (Assumption 4.3.1.11.2). Determination of the total pond depth did not consider dissolved solids accumulation.

7.1.12 Storm Water Surface Drainage

Collection System - Gravity collection lines will be installed to connect catch basins and roof drains for transport of rain water to the retention pond.

7.2 Compressed Air Systems

The compressed air systems will be located in the Utility Building. Controls for the system will be in the control room. System status will be transmitted over the control LAN to the central control center. System status and local control will be performed at the WHB and WTB.

7.2.1 Breathing Air System

Breathing air is provided in the WHB and WTB for the purpose of allowing personnel access into the cell areas for the performance of non-routine maintenance or to correct off-normal occurances. It is assumed that the breathing air systems will be designed per the requirements of ANSI Z88.2-92; *Practices for Respiratory Protection;* 29 CFR 1910, (OSHA) *Selected General Industry Safety and Health Standards;* and Compressed Gas Association (CGA), ANSI/CGA G-7.1-1966, *Commodity Specification for Air* (Assumption 4.3.2.1.2). The air quality to be provided is identified in ANSI/CGA (Compressed Gas Association) G-7.1.

Breathing compressors and equipment is designed to meet the criteria identified in OSHA 29 CFR 1910.134 - Respirator Protection.

To maintain operator comfort, the breathing air temperature at the respirator will be maintained between 45° - 80° F. If cooling or heating of the air is required, the equipment will be provided by the WHB and WTB to maintain the air temperature between 45° - 80° F. The design capacity for the breathing air supply equipment and piping distribution systems will be equal to the maximum number of outlets anticipated to be in use at one time multiplied by 15 SCFM/outlet (Assumption 4.3.2.1.3).

The maximum number of breathing air outlets in use at one time in the WHB has been assumed at 20, and the maximum number of breathing air outlets in use at one time in the WTB has been assumed at 10 (Assumption 4.3.2.1.4). Since breathing air may need to be utilized in the WHB and the WTB at the same time, the total maximun number of outlets which may be required is (20 + 10 =) 30. Multiplying the number of outlets by the required amount of capacity per outlet yields the total required capacity of (30 outlets x 15 SCFM/outlet =) 450 SCFM. The operating pressure for the receiver has been set at 150 psig. Delivered air pressure at the entrance to either the WHB or the WTB has been set at 135 psig. This allows a maximum pressure drop between the compressor receiver and the receiving facilities of (150 psig - 135 psig =) 15 psig. The distance between the Utility Building as discussed in Section 7.1.1.2 is 1150 ft.

Utilizing the empirical data from the table on page 33-81 of *Compressed Air and Gas Data, third edition, 1982, A.W. Loomis, editor,* Reference 5.35, the pressure drop per 100 ft of 2 in. schedule 40 pipe, with a flowrate of 500 CFM at 150 psig, is 1.05 psig/100 ft. Using this pressure drop per 100 ft. and the distance between the facilities of 1150 ft., the anticipated pressure drop in the main will be (1150 ft x 1.05 psig/100 ft =) 12.1 psig. This is within the required 15 psig margin.

Sufficient reserve capacity is required to allow personnel egress from areas where there is an immediate hazard to life due to the atmosphere. It is assumed that a maximum of three air connections would be necessary to meet this requirement. (Assumption 4.3.2.1.5). It is assumed that a five minute minimum reserve capacity is required (Assumption 4.3.2.1.6) to allow for this emergency egress. Utilizing 3 air outlets, and 15 scfm per outlet, the air reserve capacity is (3 x 15 x 5 =) 225 scf. It is required to supply 90 psig at an air mask (Assumption 4.3.2.1.7). The compressor system is designed to supply 150 psig. Assuming ideal gas behavior (Boyle's Law), where $P_1V_1 = P_2V_2$ (Reference 5.36, page 7), and setting V_2 (V_{min})as the compressor receiver volume:

$V_{min} = 225\ (90/150) = 135\ ft^3 = 7.481 gallons/ft^3 \times 135\ ft^3 = 1010$ gallons, rounded to 1000 gallons.

To minimize costs, this volume can be made by manifolding four 250 gallon, 150 psig air receivers together.

The air compressors are two (redundant) water cooled, non-lubricated screw compressors, with dual air purifiers and a single carbon monoxide detector. The motors are 150 HP, and will be connected to standby power to provide breathing air in the event of a lengthy power outage.

7.2.2 Instrument and Shop Air System

Instrument and shop air is required for certain minimal activities within the WHB/WTB and in the Central Shops Building. Present level of design for process systems within the WHB/WTB or in other facilities is insufficient to specifically identify the number of pneumatically controlled valves. For the purpose of this technical report, it is assumed that the total number of pneumatic control valves will be less than 100(Assumption 4.3.2.2.2). Assuming, the consumption of air per pneumatic control valve is 2 SCFM (Assumption 4.3.2.2.3), the total air consumption would be (100 valves x 2 SCFM/valve =) 200 SCFM.

If it is assumed that the shop has two air driven tools in operation at the same time, and it is assumed that the air consumption per tool is 50 SCFM/tool (Assumption 4.3.3.6). The total air consumption for the shop would be (2 tools x 50 SCFM/tool =) 100 SCFM.

Summing the maximum air consumption for instrument/shop air yields (200 SCFM + 100 SCFM =) 300 SCFM.

Since this air consumption is well within the capacity of the compressor system for breathing air, and because the breathing system will have extremely low actual utilization. It is appropriate to use the same compressor system to provide both breathing and instrument/shop air. The only requirement is that the air receivers and distribution systems be totally independent and that the breathing air system be isolated through double check-valves from the instrument air system (Reference 5.37).

The receiver for instrument/shop air is sized to allow for a reasonable shutdown of equipment in the event of compressor failure(s). The same receiver size of 1000 gallons (four 250 gallon tanks) as for the breathing air is sufficient.

7.2.3 Utility Building Space Requirements

The air compressor system is a packaged system which will be delivered to the North Portal skid mounted. The compressor and necessary air cleaning and monitoring systems will be mounted on the skid. The space required for the compressor system is 12-ft by 20-ft (240-ft^2). The tanks for storage of both the breathing air and the instrument/shop air will be located outside of the Utility Building.

7.3 Industrial Gas Systems

Industrial gases are consumed in the process of receiving and repackaging wastes for the repository. There are no significant consumers of industrial gases other than those associated with this receiving and repackaging, therefore the rate of consumption of industrial gases is based on the waste handling schedule.

Table 7.3.-1 presents the present established schedule for the receiving and repackaging of waste shipments (Key 001, Reference 5.8).

Table 7.3-1 Schedule of Waste Repackaging

Year	Cask/Carrier Handling			Assembly Transfer Line				Canister Transfer Lines			Total DCs
	Truck	Rail	Total	Casks	DPCs	Assys.	DCs	Casks	DISPs	DCs	
2010	32	28	58	57	25	1037	37	1	1	1	38
2011	32	78	110	109	6	2317	75	1	1	1	76
2012	49	167	216	213	2	4233	149	3	3	3	152
2013	74	277	351	345	24	6496	245	6	6	6	251
2014	95	453	548	540	10	10403	365	8	8	8	373
2015	86	570	656	519	14	10069	363	137	626	140	503
2016	117	579	696	551	22	10405	368	145	659	156	524
2017	100	571	671	533	43	9977	367	138	609	125	492
2018	114	578	692	541	48	10399	367	151	678	157	524
2019	115	570	685	532	96	9987	366	153	644	141	507
2020	109	544	653	499	123	10197	368	154	645	142	510
2021	89	536	625	471	161	10182	363	154	645	142	505
2022	110	526	636	496	177	10095	378	140	585	123	499
2023	108	515	623	483	179	10043	362	140	585	123	485
2024	93	509	602	457	199	10261	367	145	605	128	495
2025	124	545	689	519	250	11007	377	150	625	133	510
2026	0	578	578	429	411	12250	381	149	613	127	508
2027	0	565	565	418	381	11425	369	147	605	123	492
2028	0	523	523	376	347	10867	356	147	605	123	479
2029	0	545	545	364	347	10457	350	181	765	143	493
2030	0	539	539	352	319	10646	363	187	801	150	513
2031	0	526	526	345	302	9962	350	181	781	149	499
2032	0	427	427	284	6	10040	360	143	548	113	473
2033	0	276	276	171	1	6388	223	105	379	89	312
Max	124	579	696	551	411	12550	381	187	801	157	524
Total	1447	11023	12470	9604	3493	219144	7667	2866	12022	2546	10213

Truck refers to cask waste shipments received by truck and **Rail** refers to cask waste shipments received by rail. The total waste shipments received in a given year is determined by adding the

number of truck shipments and the number of rail shipments. For example, in the year 2016, 117 truck shipments will be received, and 579 rail shipments will be received. The total shipments received in the year 2016 will, therefore, be (117 + 579 =) 696. The next to last row of the table identifies the maximum quantity for a given row. Inspection of this row shows that the year 2016 will have the largest number of waste packages received. The casks which are received are handled in different ways depending upon the waste package contents, and on the cask construction. There are two handling schemes: 1) casks will be opened and the contained fuel assemblies will be processed through the pool system; or, 2) casks will be opened, and the contents will be placed directly into a Disposal Canister (DC) or waste package. Table 7.3-1 identifies those casks which will processed through the pool system as the columns under the subheading Assembly Transfer Line. The first subcolumn under this heading, "Casks," identifies the total number of casks which will be processed through the pool system. The second subcolumn, "DPC's," identifies casks which contain an internal canister which must also be opened prior to actually accessing the fuel. The third subcolumn, "Assys.," identifies the total number of fuel assemblies to be packaged. The fourth subcolumn, "DCs," identifies the number of waste packages produced for the repository from the pool processing. The second subheading, Canister Transfer Line, refers to those casks received which will have their contents placed immediately into waste packages, and not go through the pool system. The final subheading of Table 7.3-1, "Total DCs," identifies the total number of waste packages from both the pool processing, and those which are not processed through the pool. Inspection of this column shows that the maximum number of waste packages will be produced during year 2016.
As is discussed below, this data will be utilized in defining the consumption of industrial gases. There are four types of industrial gases which are used in the WHB for the production of waste packages, nitrogen, argon, argon/helium blend, and helium.

7.3.1 Nitrogen

Nitrogen is used for purging of casks and waste packages and to facilitate the drying of fuel after is removed from the pool.

The first step in the processing of waste casks is to sample the gas within the cask to ensure that the cladding on the enclosed fuel elements is intact. To accomplish this gas sampling, nitrogen gas is passed through the cask and then fed through radiological monitoring equipment.

The amount of nitrogen consumed in this sampling operation is determined by the maximum number of casks with bare fuel assemblies which will be processed in a given year, and by the size and type of the various casks to be opened. HLW casks and DSNF casks do not need to be analyzed because this material is placed in sealed canisters prior to shipment to the repository, nor will they be processed through the fuel storage pools. Therefore, no nitrogen consumption for the processing of HLW or DSNF is included in the estimated consumption. If at a later date it is determined that sampling of this material is required, sufficient capacity is designed into the system to accommodate this activity. Inspection of Table 7.3-1 shows that the maximum number of casks received to be sampled occurs in year 2016. The total casks is 551.

It is assumed (Assumption 4.3.3.1.1) that four void volumes of nitrogen at standard conditions are used in sampling the void space. It is also assumed (Assumption 4.3.3.1.2) that the void space within a cask is equal to 50% of the cask volume as defined by the cask outer dimensions. The volume of gas consumed (SCF) would therefore be equal to

$$V_{nitrogen\ (purging)} = 4\ (0.50) V_{cask}\ .$$

Volume of the cask is calculated by using the equation for calculating volume of a right-cylinder, Perrys, 4th edition, page 2-7, Reference 5.27, V= pi x $d^2/4$ x height. The largest (volume) cask to be received, taken from Table 7.2-2 of Reference 5.8, has dimensions of 193 in. length and 99 in. diameter. This volume is approximately [(V= 3.14159(99 in/12 in/ft)^2 (193 in/12 in/ft)/4 =)] 859.75 ft^3.

Therefore, the maximum volume of nitrogen consumed in sampling a cask is

$$V_{nitrogen\ (purging)} = 4\ (0.50)\ (859.75\ ft^3) = 1719.5\ ft^3.$$

The sampling of a cask involves: 1) connecting the gas sampling lines to the cask; 2) purging the cask with nitrogen and sampling the purge gas; and, 3) disconnecting the gas sampling lines from the cask. Assuming that it takes 5 minutes to sample a cask (Assumption 4.3.3.1.3), Reference 5.25, dividing this volume of nitrogen used in sampling by the sampling time yields the design nitrogen flowrate of (1719.5 ft^3/5 minutes =) 344 ft^3/min.[5]

For the purpose of this technical report, the reference year will be the year 2016, which receives the maximum number of transportation casks, 551 casks . Design assumption Key 001, Reference 5.8, also suggests that actual throughput may be a factor of 20% higher for a reasonable period of time. Therefore, a 20% contingency should be placed on the 551 cask/yr number to bring it up to (551 x 1.2 =) 661 casks/year.

The total volume of nitrogen consumed in the sampling of all casks in year 2016 is presented in Table I-IV Attachment IV at 670,509 SCF, rounded to 670,000 SCF. This number is generated by the same method as above applied to all the various sizes of casks to determine the volume of nitrogen for a cask, multiplying by the number of casks to be received of a given dimension, and then summing the total nitrogen. Assuming an amount of nitrogen loss during the making and breaking of sampling lines of 10% (Assumption 4.3.3.1.4), the total projected nitrogen consumed in year 2016 would be (1.1 x 670,000 =) 737,000 SCF.

The second operation which consumes nitrogen is the drying of fuel assemblies contained in handling baskets after their removal from the fuel storage pool. The basket containing fuel assembleys, after being removed from the pool, and washed down with deionized water is dried by placing inside a drying chamber. This chamber is closed, and then evacuated. After

[5]This flowrate represents an impractical value for flow rate through the cask connections. It is recommended that review of the time allocation for gas sampling be made to solve this issue.

evacuation, the chamber is pressurized with nitrogen gas to atmospheric pressure. The chamber is then sequenced between evacuation and nitrogen pressurization a total of three additional times (Assumption 4.3.3.1.5). The drying chamber is then opened and the basket placed inside the DC. The volume of the dryer is assumed at 1100 ft^3(Assumption 4.3.3.1.6). The maximum total number of baskets to be processed in a given year, from Table 7.3.1 above, is in the year 2026, this number is 381. The HLW packages and the DSNF packages are not placed in the storage pools, because they are received in sealed containers, therefore, they do not go through the drying operation. Actual detailed scheduling for the processing of these drying operations has not been performed, nor has detailed technical analysis been performed on the actual amount of time it takes to dry a basket containing the fuel assemblies. For the purposes of this engineering technical report, it is assumed that it takes 10 minutes to fill an evacuated drier chamber with nitrogen to atmospheric pressure (Assumption 4.3.3.1.7). Dividing the volume of 1100 ft^3 by this ten minute period yields a flowrate of (1100 ft^3/10 min =) 110 ft^3/min. The total volume of nitrogen consumed in this operation during the year 2026 is calculated by multiplying the number of times the drier is filled by the drier package and then multiplying by the total number of drying operations; i.e. $1100 \times 4 \times 381 = 1.68 \times 10^6$ ft^3.

The third operation which uses nitrogen is the inerting of the DC after the dried fuel assemblies have been placed within the DC and the DC mechnically sealed. This operation is accomplished by again alternately evacuating and then pressurizing with nitrogen a total of four DC void volumes. This operation is applied to all DCs processed. Therefore, from Key Assumption 003, Table 3-9, Reference 5.8, this operation is performed a total of 524 times during year 2016. The void volume of the DC is assumed to be 50% of the total volume of the DC as defined by the external dimensions (Assumption 4.3.3.1.8).

The dimension of the largest[6] DC is 210 in. long by 65 in. diameter. Using the equation for the volume of a right cylinder, as referenced above, the volume (Reference 5.27) of a DC is ($V = 3.14159 \times (210/12) \times (65/12)^2 /4 =$) 403.26 ft^3, rounded to 403 ft^3. Therefore, 50% of the volume is (403 ft^3 x 0.5 =) 201.5 ft^3, rounded to 202 ft^3. The total volume of nitrogen consumed is calculated by multiplying the void volume by four and then by the total number of casks to be processed in year 2016. This calculates to (202 ft^3 x 4 x 524 =) 4.23×10^5 ft^3. Assuming that it takes twenty minutes to fill a cask with nitrogen (Assumption 4.3.3.1.9), the flowrate for nitrogen used in this purging process is (202 ft^3 x 4/20 minutes =) 40.4 ft^3/min, rounded to 40 ft^3/min..

The maximum flowrate for nitrogen would be found by assuming that the cask purging, drying, and DC inerting were occurring simultaneously. This maximum flowrate would equal (344 ft^3/min + 110 ft^3/min + 40 ft^3/min =) 494 ft^3/min, rounded to 490 ft^3/min..

The maximum total amount of nitrogen consumed in a year is (7.37×10^5 ft^3 + 1.68×10^6 ft^3 + 4.23×10^5 ft^3 =) 2.84×10^6 ft^3.

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[6] The size of the DC for the storage of Navy fuel will be approximately 2 meters (6.56-ft) in diameter by 6.2 meters (20.3-ft) in length (Reference 5.8, EBORD 3.7.1.5.1). Gas systems will be capable of handling this larger DC.

Nitrogen will be supplied to the WHB from a dewar (storing liquefied nitrogen) located near the WHB. A truck carrying liquid nitrogen will replenish this dewar with off-site manufactured nitrogen as required.

7.3.2 Argon

Argon cover gas is used during the welding of the inner lid of the DC and the outer lid of the DC. The flowrate of the argon used during the welding of the inner lid is 100 SCFH for 4 hours per DC (Assumption 4.3.3.2.1).

The flowrate of the argon used during the welding of the outer lid is 100 SCFH for 20 hours per DC. (Assumption 4.3.3.2.2). The total amount of argon consumed in the welding of a DC is therefore [(100 x 4) + (100 x 20) =] 2400 SCF. Using the total number of DCs to be welded in 2016, the total amount of argon consumed in 2016 is (2400 SCF x 524 =) 1.26 x 10^6 SCF. The cited reference suggests that a contingency of 25% be used for the gas consumed during the period prior to and post welding. This brings the total gas consumed in year 2016 to (1.26 x 1.25 =) 1.58 x 10^6 SCF.

Argon will be supplied to the WHB from high-pressure cylinder trucks (rentals) located near the WHB. Argon supply will be replenished by replacing the cylinder trucks as required.

7.3.3 Argon/Helium Blend

Argon/Helium blend (25%/75%, respectively) torch gas is used during the welding of the inner lid of the DC and the outer lid of the DC. The flowrate of the argon/helium blend used during the welding of the inner lid is 92 SCFH for 4 hours per DPC. (Assumption 4.3.3.3.1)

The flowrate of the argon/helium blend used during the welding of the outer lid is 92 SCFH for 20 hours per DC. (Assumption 4.3.3.3.2). The total amount of argon/helium blend consumed in the welding of a DC is therefore [(92 x 4) + (92 x 20) =] 2208 SCF. Using the total number of DCs to be welded in 2016, the total amount of argon/helium blend consumed in 2016 is (2208 SCF x 524 =) 1.16 x 10^6 SCF.

Argon and helium will be supplied to the WHB from high-pressure cylinder trucks (rentals) located at the WHB. Argon and helium supply will be replenished by replacing the cylinder trucks as required. A mixer will be utilized at the WHB to provide the proper mix of argon/helium as it enters the building.

7.3.4 Helium

Helium gas is used to provide an inert heat transfer gas for the DC. This gas is placed in the DC before welding of the outer lid of the DC. Assuming that it takes 20 minutes to fill the DC with helium (Assumption 4.3.3.1.9), and the void volume of the DC, as calculated above in Section 7.3.1, is 202 ft^3, flowrate of helium is (202 ft^3/20 min =) 10.1 ft^3/min, rounded to 10 ft^3/minute.

The total amount of helium consumed during this filling process in the year 2016 is calculated by multiplying the volume of helium used in one DC by the total number of DCs. This calculates to (201.6 ft^3 x 524 =) 1.06 x 10^5 ft^3.

Assuming some line losses due to connection and disconnection of fill line, and a line loss volume of 10%, the total amount of helium consumed during 2016 would be (1.1 x 1.06 x 10^5 ft^3 =) 1.17 x 10^5 ft^3 (Assumption 4.3.3.4.1).

The helium will be supplied to the WHB from high-pressure cylinder trucks (rentals) located near the WHB. Helium supply will be replenished by replacing the cylinder trucks as required.

7.4 Fuel Oil System

7.4.1 Fuel Oil Consumption

Fuel oil is utilized for proving thermal energy for process systems. An evaluation was made of the potential of using natural gas for providing this thermal energy. Discussions with area natural gas suppliers indicates that the availability of natural gas at the North Portal should be discounted for economic reasons. Liquid petroleum gas, i.e., propane, is considered too dangerous a fuel for the large scale use required.

The major consumption of fuel oil will be as fuel for the hot water system (Section 7.1.4). Additional and significantly smaller consumers will be the emergency generator sets, back-up diesel driven pumps for the fire water system, and tank heaters associated with the fire water system. Fuel distribution to these smaller consumers will be through the use of a tank truck which will deliver fuel oil from the main fuel oil storage tank (onsite). Although the hot water boiler could utilize various qualities of fuel oil, it is important to ensure that the fuel oil will be pumpable at the design temperature of 22.5° F. No. 2 (API) fuel oil can be both stored and pumped and mechanically atomized down to about 0° F (Reference 5.26, Figure 9-4, Perry's Chemical Engineering Handbook, fifth edition). No. 1 fuel oil would also provide this feature, but it is more expensive. This allows the use of No. 2 fuel oil without having to heat trace lines or heat fuel oil storage tanks. This is especially important to ensure the ability of fuel oil flow to emergency diesel engines (emergency generators, standby generators, and diesel-driven firewater pumps) in the event of tank heater or pipe tracing failure. This technical report is based on using No. 2 fuel oil for all fuel consumers (Assumption 4.3.4.1). The viscosity of No. 2 fuel oil at 20° F is approximately 20 centistokes (same reference Table 9-4).

The consumption of fuel for the hot water system is a function of the heating demand. From Section 7.1.4.3, the maximum heating demand is 80,000,000 BTU/hr (assuming a boiler efficiency of 75%). It is assumed for this technical report that the lower heating value of No. 2 Fuel Oil is 130,000 BTU/gallon (Assumption 4.3.4.2) (Reference 5.26, Table 9.11 and Figure 9-3). No. 2 fuel oil has an index of 33° A.P.I. (Table 9.11). From Figure 9-3, the lower heating value is between approximately 126,000 and 132,000 BTU/gal depending on the sulfur content.

Because No. 2 fuel oil has a required sulfur content of about 0.2 %, the 130,000 BTU/gal is a reasonable assumption.

Using the maximum total heating demand of 80,000,000 BTU/hr, and a lower heating value of 130,000 BTU/gal, the flowrate of heating oil is (80,000,000 BTU/hr / 130,000 BTU/gal =) 615.4 gallons/hr, or 10.3 gpm.

7.4.2 Equipment Size

Fuel oil is to be delivered to the North Portal through the use of rail tanker cars, a reasonable frequency of delivery is about every two weeks (Assumption 4.3.4.3). A two week supply of oil, during maximum consumption, would be (615.4 gallons/hr x 24 hr/day x 14 days =) 206,774 gallons. Assuming an allowance for 20% head space (Assumption 4.3.4.4) the tank size is (206,774 gallons x 1.2 =) 248,129 gallons, rounded to 250,000 gallons.

Fuel oil will be pumped from the main storage tank to a day tank located at the Utility Building. A days supply of fuel oil at maximum flowrate would be (615.4 gallons/hr x 24 hr =) 14,770 gallons. Assuming a head space of 20%, the tank size would be (1.2 x 14,770 gallons =) 17,724 gallons, rounded to 18,000.

Two (redundant) pumps will be utilized to pump the fuel from the main storage tank to the day tank. The location of the main fuel oil storage tank has not been defined. Assuming that it is located just inside the RCA and immediately south of the railroad tracks near N 766000, the approximate distance between the oil storage tank and a day tank located at the Utility Building would be approximately 1200 ft. A reasonable flowrate for oil transfer between the main storage tank and the day tank is 250 gpm. This would allow for filling the tank in (18000 gallons / 250 gpm =) 72 minutes. Using a 6-in. schedule 40 pipe to transfer the oil between the storage tank and the day tank, the pressure drop is calculated by the following method:

Reynolds No. = $N_R = D\ u_b\ \varrho/v$,(Reference 5.29, Equation 3.3, page 3-2)

where:
- D = pipe diameter in feet
- u_b = bulk velocity in ft/sec
- ϱ = density, lb/ft^3
- v = viscosity in centipoise, 1×10^{-2} grams/cm-second

The internal diameter of a 6-in schedule 40 pipe is 6.065 in., or (6.065 in./12 in./ft =) 0.505 ft, and has a cross-sectional area of 0.2006 ft^2 (Reference 5.26, Table 6-15).

The bulk velocity is equal to the volumetric flow divided by the cross-sectional area, (250 gpm/7.481 gallons/ft^3/0.2006 ft^2 =) 166.6 ft/min, or 2.78 ft/sec.

From above Figure 9-4. Reference 5.26, the viscosity of No. 2 fuel oil at 22.5° F is approximately 20 centistokes. A centistoke is defined as the viscosity (in centipoise) / density (in grams/cm^3), Reference 5.26, page 5-3.

The specific gravity at 60°/60° F (density in cgs) of No. 2 fuel oil is approximately 0.84, Figure 9-3. Reference 5.26.

The thermal expansion coefficient for A.P.I. gravity 33 is approximately 0.00040, Reference 5.26 page 9-11. Using this thermal expansion coefficient, the specific gravity of No. 2 fuel oil at 22.5° F is approximately [0.84/(1-(60°F - 22.5°F)(0.00040) =] 0.853, rounded to 0.85.

Therefore,

$$v = (20 \text{ centistokes}) (0.85) = 17 \text{ centipoise}$$

The density, ϱ, is equal to (62.4 lb/ft3 x 0.85 =) 53.0 lb/ft^3.

$N_R = D\, u_b\, \varrho/v$ = 0.505 ft x 2.78 ft/sec x 53.0 lb/ft3/ 17 centipoise x 6.72 x 10^{-4} lb/ft-sec/centipoise) = 6513, rounded to 6500. (This is turbulent flow).

Using the chart for friction factor on page 3-9 of Reference 5.29, a Reynolds Number of 6500 and a pipe diameter of 6-in, correlates to a friction factor of approximately 0.015.

Using the nomograph on page 3-11 of Reference 5.29, a friction factor of 0.015, a density of 53 lb/ft^3, and a flow rate of 250 gpm, a pressure drop of approximately 0.14 psig/100 ft of pipe is determined.

The pressure drop for 1200 ft of pipe is estimated at (1200 ft x 0.14 psig/100 ft =) 1.7 psig.

Setting the pump pressure to 50 psig (a nominal pump pressure) will provide sufficient pressure to pump the No. 2 fuel oil at the coldest design temperature of 22.5°F.

Oil is pumped from the day tank to the hot water boiler, the pump is required to provide sufficient pressure to both move the oil to the boiler, and to also atomize the oil at the boiler for combustion. Utilizing a pump delivering 60 psig, a 1-in. line approximately 100-ft in length, and a flowrate of fuel (from Section 7.4.1, above) of 10.3 gpm.

From Table 6-15., Reference 5.26, a 1-in. schedule 40 pipe has an internal diameter of 1.049 in., and a cross-sectional area of 0.006 ft^2. This indicates a bulk flow rate (u_b) for 10.3 gpm of approximately (10.3 gpm/(7.481 gal/ft^3 x 0.006 ft^2)/60 seconds/min. =) 3.82 ft/sec, rounded to 3.8 ft/sec. Assuming the temperature is 22.5°F, the viscosity and density, from above, is 17 centipoise, and 53.0 lb/ft^3, respectively.

$N_R = D\, u_b\, \varrho/v$ = 0.087 ft x 3.8 ft/sec x 53.0 lb/ft^3/(17 centipoise x 6.72x10^{-4} lb/ft-sec/centipoise) = 1534. (This is laminar flow).

The pressure drop can be calculated using equation 3-6, page 3-2 of Reference 5.29.

Pressure drop = $0.000668 \; v \; L \; u_b / D^2$

where: v = viscosity, in centipoise
L = length, in feet
u_b = bulk velosity, in ft/sec
D = diameter, in inches

Pressure drop = 0.000668 x 17 centipoise x 100 ft x 3.8 ft/sec/(1.049 in.)^2 = 3.92 psig, rounded to 3.9 psig.

From above, the pump pressure is 60 psig, therefore, the residual pressure for atomization of the fuel oil is approximately (60 psig - 3.9 psig =) 56.1 psig. From Reference 5.27, page 18-65, Table 18-16, this is sufficient pressure for atomization of the oil at the burner.

Primary controls for the fuel oil system will be located in the control room of the Utility Building. Secondary controls will be at the main storage tank and the day tank. System status will be transmitted over the control LAN to the computer control center.

7.5 Utility Building

The Utility Building will house most of the major components associated with providing utility services to the North Portal Surface Facilities. Certain pumps and tanks will be located external and adjacent to the Utility Building. The cooling tower system will be located reasonably close to the Utility Building to minimize pipe run lengths.

Gas storage, i.e., nitrogen, argon, and helium, will be provided at the WHB. The WHB is the only large consumer of these gases.

7.5.1 Space Requirements

The following main utility systems will be housed within or adjacent to the Utility Building:

- chillers
- hot Water Boilers
- water softening system
- deionized water system
- compressed air system

The internal square footage required for these utility system components are as follows:

Room Description		Length	Width	Sq Ft	Height
Chiller Room (Section 7.1.2.3 E)	=	100 ft	80 ft	8000	20 ft
Boiler Room (Section 7.1.4.3 D)	=	70 ft	80 ft	5600	20 ft
Water Softening (Section 7.1.5.4)	=	15 ft	20 ft	300	20 ft
Deionized Water (Section 7.1.6.4)	=	56 ft	20 ft	1120	20 ft
Air Compressor (Section 7.2.3)	=	12 ft	20 ft	240	< 20 ft
Subtotal				15260	

Utility operations will require support areas for essential operational functions and to house operational personnel. Listed below are these support areas:

- Chemical storage is required to store NaCl for water softening, small amounts of glycol for chilled and hotwater system makeup, and a small supply of various analytical chemicals used in water chemistry analysis. The estimated space for this area is (10 ft x 20 ft =) 200 ft.

- Analytical laboratory space is required to perform water chemistry analyses for potable water, softened water, and deionized water to ensure proper system performance. This laboratory will be a 10-ft by 20-ft (200 ft^2) laboratory module. The module will contain one fume hood and sufficient counter space for the various analytical instruments.

- Control room to house the control systems for the utility systems. The control room will be 20-ft by 20-ft (400 ft^2). The control room will provide control of the potable water, softened water, deionized water, chilled water system, cooling tower system, and the heating water system. It will also provide status of the fuel oil system.

- Office space will be provided for the assumed 3 supervisor personnel assigned to the Utility Building. (Assumption 4.3.5.1, based on Reference 5.5). The square footage for these offices is estimated at (3 offices x 100 ft^2/office =) 300 ft^2.

- Record storage area of 100 ft^2 is allocated for the Utility Building to house operational records. This area is based on 10 cabinets at 7-ft^2/cabinet plus 30 ft^2 for personnel circulation around the cabinets.

- Restroom/change room space is allocated based on the assumed maximum number of operational personnel/shift (Assumption 4.3.5.1) and the assumed gender mix of 3:2, men to women, respectively (Assumption 4.3.5.2). The total area for lockers space is[(16 ft^2 /locker x 6 lockers(1 + 2/3) =] 160 ft^2. Restroom space is 10-ft by 20-ft, for men and women, each, or a total of 400 ft^2. This provides sufficient space for 2 showers and 3 fixtures for each restroom. Total space is (160 ft^2 + 400 ft^2 =) 560 ft^2.

- Breakroom/lunchroom space is provided at 200 ft^2.

Room Description		Length	Width	Sq Ft	Height
Chemical Storage	=	10 ft	20 ft	200	20 ft
Laboratory	=	10 ft	20 ft	200	10 ft
Control Room	=	20 ft	20 ft	400	10 ft
Offices (3)	=	30 ft	10 ft	300	10 ft
Storage	=	10 ft	10 ft	100	10 ft
Restrooms/ Change rooms	=			560	10 ft
Break room	=			200	10 ft
Subtotal				1960	

Additional space is required for electrical/mechanical space to support utility system components. This space is based on a percentage of the total space allocated to the utility system components, 15,260 ft^2, from above. A percentage of 5 % is applied for electrical/mechanical room. This calculates to (0.05 x 15,260 ft2 =) 763 ft^2.

Space is provided to allow general circulation and appropriate emergency egress from the facility. This space is 16% of the total space allocated to the utility system components, 15,260 ft^2 plus the support systems space of 1960 ft^2, from above. This calculates to [0.16 x (15,260 ft^2 +1960 ft^2) =] 2755 ft^2.

Space is allocated for a janitor room, receiving, etc. of 1262 ft^2.

Total space for the Utility Building is:

Total system components	15260 ft2
Total support area	1960 ft^2
Mechanical and Electrical (15260 x 0.05)	763 ft^2
Operations Circulation (15260 x 0.16)	2755 ft^2
Support (Janitor Room, Receiving, etc.)	1262 ft^2
Total Building Area	22000 ft^2

7.5.2 Building Construction

The Utility Building will be a pre-engineered metal-sided building set on a concrete slab on grade. The facility will have roll-up doors located for receiving of chemicals, and other supplies, and to facilitate equipment changeout as required.

8. CONCLUSIONS

This report identifies quantities and flowrates for the various liquid and gas utility services to be provided throughout the North Portal Surface Facilities. The report also presents conceptual equipment sizes necessary to provide the utility services. In some cases, due to insufficient prior definition, the quantity of a utility service was estimated. It is believed that in those cases where estimates were generated, that the estimates represent reasonable bounding values for the purposes of VA. There is presently insufficient definition of water and air (breathing or instrument) consumption for subsurface North Portal operations to identify demand requirements on North Portal utility services for water and air. Potable water will be made available for subsurface use at the Utility Building through the use of dedicated transportable tanks. It is assumed that the demand of potable water for North Portal subsurface use is within the engineering contingency placed on North Portal Surface Facility potable water consumption.

Raw well water will be available through existing system connections for use in North Portal subsurface operations. This water will continue to be utilized through the use of transportable tanks. The addition of lithium bromide (LiBr) used as a tracer for subsurface water is not included in the scope of this report.

The potential quantity of instrument air requirements for North Portal subsurface operations has not been quantified. It is assumed that sufficient capacity of instrument air exists within the engineering contingency placed on the North Portal instrument/shop air system.

It is assumed that sufficient capacity is present with the engineering contingency placed on North Portal Surface Facility breathing air for incidental use of breathing air by North Portal subsurface operations. If it becomes evident, after detailed definition of subsurface breathing air consumption requirements, that additional capacity for North Portal Surface Facility breathing air is required to support subsurface operations, a noticeable cost impact to the breathing air system will occur.

The conclusions drawn in this report are for the purposes of supporting the Viability Assessment (VA) of the North Portal Surface Facilities. The design assumptions, design parameters, design criteria, and applicable codes and standards, presented in this report should be re-evaluated prior to the start of definitive design, procurement activities or construction.

8.1 Water Systems

A new 3-in. line will be installed to connect potable water from the existing potable water supply to the Utility Building. The total potable water consumption is estimated at 7.56 million gallons per year, with a maximum flow rate of 73 gpm.

A new day tank with a capacity of 24,500 gallons will be installed. Two redundant pumps will be installed to supply potable water throughout the North Portal Facilities. These pumps will deliver 73 gpm at 90 psig. The potable water pumps will be connected to standby power to ensure potable water supply for emergency showers and eye washes in the event of a power outage. Present definition of electrical systems does not include provisions for standby power for the potable water pumps, the deionized water pumps, or the breathing air compressor and system components. It is recommended that evaluation of this requirement be carrried over into the North Portal Surface Facility electrical system.

The Utility Building will supply chilled water service throughout the North Portal Facilities. This water will be used for HVAC cooling and process cooling. The total estimated cooling load is 58,000 MBH (58 x 10^6 Btu/hr).

Five primary pumps (four operating and one standby) will supply up to 12,400 gpm at a head of 50 ft. Five secondary pumps (four operating and one standby) will supply up to 10,300 gpm at a head of 130 ft. The chilled water temperature will be 42° F delivered and 52° F returned.

A central cooling tower will supply cooling to the chillers used to cool the chilled water. The maximum water flow to the cooling tower will be 180 gpm. Maximum blowdown from the cooling tower to the evaporation pond will 15 gpm.

The evaporation pond will evaporate cooling tower blowdown water and waste water from the regeneration of the water softener and the water deionization system. Maximum flow to the evaporation pond will be 156 gpm, average flow will be just over the 16 gpm cooling tower blowdown. The size of the evaporation pond is 4.25 acres.

The Utility Building will provide a central source of hot water for HVAC heating and process heating. Overall maximum heat duty is 60,000 MBH (60 x 10^6 Btu/hr). Two boilers will be utilized to provide the required heat duty.

Softened water will be provided for feed to the cooling tower. Softened water will also be provided for facility use as utility water. A 48,000 gallon surge tank will provide softened water throughout the facility. Water will be pumped utilizing two pumps (redundant) each capable of delivering 260 gpm at 60 psig.

Deionized water will be provided for initial fill and makeup for the spent fuel storage pools in WHB. Deionized water will be available for laboratory use or other specialty users. The system will be capable of delivering 32 gpm. Deionized water quality will be 2.0 micro-seimens.

Fire water will be supplied from two 250,000 gallon storage tanks. A pump house will be located at each storage tank. The pump house will contain an electric pump and a diesel-driven emergency pump each capable of delivering 2000 gpm at 125 psig. A jockey pump will be located at each pump house to maintain system pressure under no load conditions.

8.2 Air Systems

Breathing air will be provided by a compressor located at the Utility Building. The compressor will be capable of delivering 450 SCFM at 150 psig. The system will be capable of producing Type D breathing air. The compressor and system components are attached to standby power.

Instrument/Shop air will be provided by the same compressor providing breathing air. The receiver/reservoir for the instrument/shop air will be separate from and isolated from the breathing air reservoir.

8.3 Industrial Gas Systems

Nitrogen will be provided to the WHB from a dewar containing liquid nitrogen. The estimated consumption of nitrogen is 2.84 million SCF/year. Present time allocations for the sampling of incoming casks does not allow sufficient time for the use of four nitrogen volumes in the sampling process. It is recommended that the sampling requirements be reevaluated in the definition of waste package receipt and handling operations.

Helium and argon will be provided to the WHB from rental cylinder trucks located at the WHB. The helium/argon blend used for welding will be blended on site with a mixer station located at the WHB.

8.4 Fuel Oil

Fuel oil will be stored in a 250,000 gallon storage tank located near the railroad to permit delivery of fuel oil by railcar. Fuel will be pumped from the main storage tank to a day tank located at the Utility Building. Other smaller users of fuel oil will be serviced through the use of a tank truck which will be filled from the main storage tank.

8.5 Utility Building

The Utility Building will be a 22,000 ft^2 pre-engineered metal-sided building set on a slab on grade. The facility will have roll-up doors located for receiving of chemicals, and other supplies, and to facilitate equipment changeout as required.

9.0 ATTACHMENTS

ATTACHMENT	NO. OF PAGES	TITLE
I	16	HVAC Data and Flow Diagrams
II	1	Potable and Raw Water Tie-Ins Figure
III	5	Water Systems Figures
IV	1	Total Nitrogen for Sampling in Year 2016
V	1	Cooling/Heating Systems Usage Factors

ATTACHMENT II

Potable and Raw Water Tie-Ins Figure

Cooling Energy Requirements
(Balance of Plant area Facilities)

Building (Note 1)	Floor Area sq. ft. (note 1)	SF per ton (note 2)	Multiplier (note 3)	Corr. sq. ft. per ton (note 4)	Capacity Ton (note 5)
Security Station 1 (Main BOP portal)	8,000	320	0.79	252.8	31.6
Security Station 2 (RCA/BOP portal)	3,000	320	0.79	252.8	11.9
Security Station 3 (RCA truck/rail portal)	2,800	320	0.79	252.8	11.1
Administration Building	44,000	320	0.79	252.8	174.1
Food Service Facility	11,000	200	0.79	158.0	69.6
Training Auditorium	1,000	300	0.79	237.0	4.2
Medical Center	8,200	425	0.79	335.8	24.4
Fire Station	7,600	320	0.79	252.8	30.1
Computer center	4,000	85	0.79	67.2	59.6
Central Warehouse	57,000	350	0.79	276.5	206.1
Central Shops	28,800	350	0.79	276.5	104.2
Motor Pool and Facility Service Sta.	1,200	350	0.79	276.5	4.3
Mockup Building	9,800	300	0.79	237.0	41.4
Utility Building	5,500	350	0.79	276.5	19.9
Visitor Center	19,800	300	0.79	237.0	83.5
Total	211,700				876
				USE:	900
				MBH (note 6)	= 10,800

Notes:

1. Input — From Table 7.2.7-2, Ref. 5.7
2. Input — MEANS Building Construction Cost Data, 1996, section R155-020, page 542
3. Formula — Air density correction factor x high temperature correction factor (0.874 x 0.90=0.79), Ref. 5.6
4. Formula — S.F. per ton x Multiplier
5. Formula — Capacity=Floor Area x Corr. sq. ft. per ton.
6. Formula — MBH = (Ton x 12,000 Btu/hr)/1000

Table T-1a

Heating Energy Requirements
(Balance of Plant area Facilities)

Building (Note 1)	Floor Area sq. ft. (note 1)	Clg Height ft. (note 2)	Volume cu. ft. (note 3)	Loss Factor (note 4)	Temp. Corr. factor (note 5)	Corr. Loss factor (note 6)	Est. heat loss (BTUH) (note 7)
Security Station 1 (Main BOP portal)	8,000	10	80,000	4.6	0.68	3.13	250,240.0
Security Station 2 (RCA/BOP portal)	3,000	14	42,000	6.9	0.68	4.69	197,064.0
Security Station 3 (RCA truck/rail portal)	2,800	14	39,200	6.9	0.68	4.69	183,926.4
Administration Building	44,000	9	396,000	4.6	0.68	3.13	1,238,688.0
Food Service Facility	11,000	8.5	93,500	5.7	0.68	3.88	362,406.0
Training Auditorium	1,000	10	10,000	4.7	0.68	3.20	31,960.0
Medical Center	8,200	8.5	69,700	6.9	0.68	4.69	327,032.4
Fire Station	7,600	15	114,000	5.7	0.68	3.88	441,864.0
Computer center	4,000	8.5	34,000	6.9	0.68	4.69	159,528.0
Central Warehouse	57,000	23	1,311,000	5.1	0.68	3.47	4,546,548.0
Central Shops	28,800	14	403,200	5.7	0.68	3.88	1,562,803.2
Motor Pool and Facility Service Sta.	1,200	28.8	34,560	5.7	0.68	3.88	133,954.6
Mockup Building	9,800	45	441,000	5.5	0.68	3.74	1,649,340.0
Utility Building	5,500	25	137,500	5.7	0.68	3.88	532,950.0
Visitor Center	19,800	10	198,000	5.7	0.68	3.88	767,448.0
Total	211,700		3,403,660				12,385,753
						USE:	12,400,000

Notes:

1. Input — From Table 7.2.7-2, Ref. 5.7
2. Input — From miscellaneous section drawings, Ref. 5.7
3. Formula — Volume=floor area x Clg. Height
4. Input — MEANS Building Construction Cost Data, 1996, table 1-building type all walls exposed, section R155-050, page 541.
5. Input — MEANS Building Construction Cost Data, 1996, @ 22.5 deg. F outdoor temperature, Ref. 5.6
6. Formula — Loss Factor x Temp. Corr. Factor
7. Formula — Volume x Corr. Loss Factor

Table T-1b

ALLOWABLE FLOW RATES FOR CLOSED SYSTEM PIPING

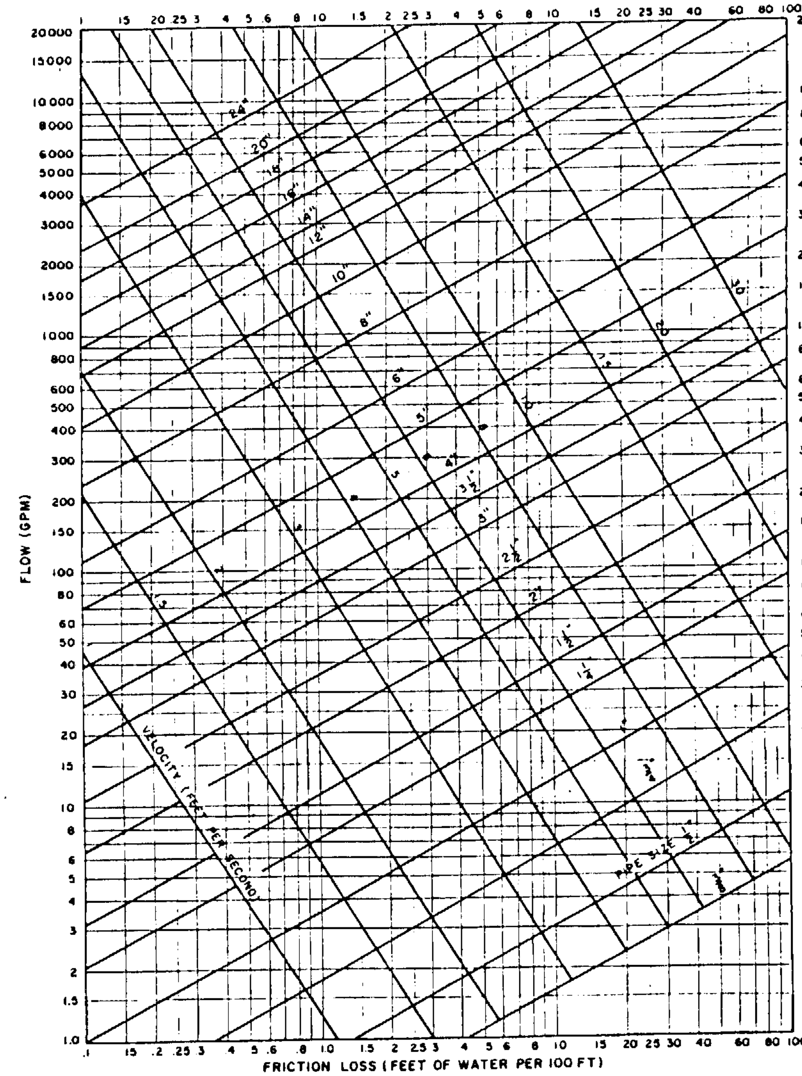
STANDARD WEIGHT STEEL PIPE

PIPE SIZE	FLOW RANGE	PRESSURE DROP RANGE
1/2"	0 - 2 GPM	0 - 4 ft/100
3/4"	3 - 4 GPM	2.5 - 4 ft/100
1"	5 - 7.5 GPM	2.0 - 4 ft/100
1-1/4"	8 - 16 GPM	1.25 - 4 ft/100
1-1/2"	17 - 24 GPM	2 - 4 ft/100
2"	25 - 48 GPM	1.25 - 4 ft/100
2-1/2"	49 - 77 GPM	2 - 4 ft/100
3"	78 - 140 GPM	1.5 - 4 ft/100
4"	141 - 280 GPM	1.25 - 4 ft/100
5"	281 - 500 GPM	1.5 - 4 ft/100
6"	501 - 800 GPM	1.75 - 4 ft/100
8"	801 - 1700 GPM	1.0 - 4 ft/100
10"	1701 - 2500 GPM	1.25 - 2.75 ft/100
12"	2501 - 3600 GPM	1.25 - 2.25 ft/100
14"	3601 - 4200 GPM	1.25 - 2.0 ft/100
16"	4201 - 5500 GPM	1.0 - 1.75 ft/100
18"	5501 - 7000 GPM	0.9 - 1.50 ft/100
20"	7001 - 9000 GPM	0.8 - 1.25 ft/100
24"	9001 - 13000 GPM	0.6 - 1.00 ft/100

Note: The above capacities are based on a maximum pressure drop of 4 feet per 100 and a maximum velocity of 10 feet per second.

FLOW GRAPH FOR CLOSED SYSTEM PIPING

STANDARD WEIGHT STEEL PIPE



HEATING, VENTILATION, AND AIR CONDITIONING DESIGN MANUAL

Table T-2a

...ATES FOR COOLING TOWER PIPING

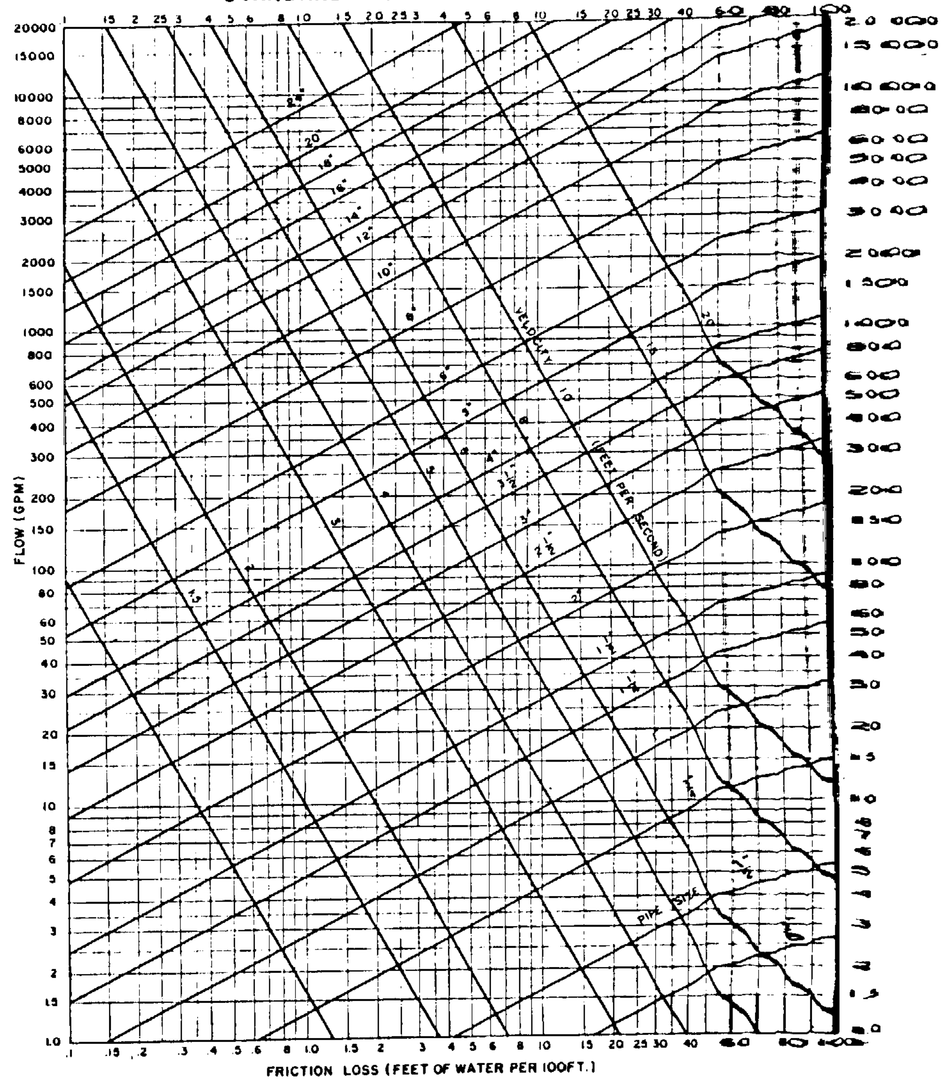
...D WEIGHT STEEL PIPE

...HARGL	PUMP SUCTION PIPING *	TONS @ 3 GPM/TON
	1-1/4"	0 - 2
	1-1/2"	2 - 5
	2"	5 - 7
	2-1/2"	7 - 13
	3"	13 - 22
	3-1/2"	22 - 40
	4"	40 - 55
	5"	55 - 70
	6"	70 - 120
	8"	120 - 200
	10"	200 - 300
	12"	300 - 500
	14"	500 - 700
	16"	700 - 900
	18"	900 - 1100
	20"	1100 - 1500
	24"	1500 - 1800
	30"	1800 - 2600

...ble to make water flow from sump of cooling tower ... tower sump must always be above condenser water

FLOW GRAPH FOR COOLING TOWER SYSTEM PIPING

STANDARD WEIGHT STEEL PIPE



...TION, AND AIR CONDITIONING DESIGN MANUAL

Table T-2b

Specific Heat (Btu/(lb·°F)) of Aqueous Solutions of DOWTHERM *SR-1 Fluid*

Temp. °F	Volume Percent Ethylene Glycol 0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
-30							0.680	0.625	0.567	
-20						0.739	0.686	0.631	0.574	0.515
-10						0.744	0.692	0.638	0.581	0.523
0					0.799	0.749	0.698	0.644	0.588	0.530
10				0.849	0.803	0.754	0.703	0.651	0.595	0.538
20			0.897	0.853	0.808	0.759	0.709	0.657	0.603	0.546
30		0.940	0.900	0.857	0.812	0.765	0.715	0.664	0.610	0.553
40	1.004	0.943	0.903	0.861	0.816	0.770	0.721	0.670	0.617	0.561
50	1.001	0.945	0.906	0.864	0.821	0.775	0.727	0.676	0.624	0.569
60	1.000	0.947	0.909	0.868	0.825	0.780	0.732	0.683	0.631	0.576
70	0.999	0.950	0.912	0.872	0.830	0.785	0.738	0.689	0.638	0.584
80	0.998	0.952	0.915	0.876	0.834	0.790	0.744	0.696	0.645	0.592
90	0.998	0.954	0.918	0.880	0.839	0.795	0.750	0.702	0.652	0.600
100	0.998	0.957	0.922	0.883	0.843	0.800	0.756	0.709	0.659	0.607
110	0.998	0.959	0.925	0.887	0.848	0.806	0.761	0.715	0.666	0.615
120	0.998	0.961	0.928	0.891	0.852	0.811	0.767	0.721	0.673	0.623
130	0.999	0.964	0.931	0.895	0.857	0.816	0.773	0.728	0.680	0.630
140	0.999	0.966	0.934	0.898	0.861	0.821	0.779	0.734	0.687	0.638
150	1.000	0.968	0.937	0.902	0.865	0.826	0.785	0.741	0.694	0.646
160	1.001	0.971	0.940	0.906	0.870	0.831	0.790	0.747	0.702	0.654
170	1.002	0.973	0.943	0.910	0.874	0.836	0.796	0.754	0.709	0.661
180	1.003	0.975	0.946	0.913	0.879	0.842	0.802	0.760	0.716	0.669
190	1.004	0.978	0.949	0.917	0.883	0.847	0.808	0.766	0.723	0.677
200	1.005	0.980	0.952	0.921	0.888	0.852	0.813	0.773	0.730	0.684
210	1.007	0.982	0.955	0.925	0.892	0.857	0.819	0.779	0.737	0.692
220	1.008	0.985	0.958	0.929	0.897	0.862	0.825	0.786	0.744	0.700
230	1.010	0.987	0.961	0.932	0.901	0.867	0.831	0.792	0.751	0.708
240	1.012	0.989	0.964	0.936	0.905	0.872	0.837	0.799	0.758	0.715
250	1.014	0.992	0.967	0.940	0.910	0.877	0.842	0.805	0.765	0.723

- Above atmospheric boiling point

Densities (lb/ft³) of Aqueous Solutions of DOWTHERM SR-1 Fluid (lb/gal = 0.1337 x lb/ft³)

Temp. °F	Volume Percent Ethylene Glycol									
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
-30							69.03	69.90	70.75	
-20						68.05	68.96	69.82	70.65	71.45
-10						67.98	68.87	69.72	70.54	71.33
0					66.97	67.90	68.78	69.62	70.43	71.20
10				65.93	66.89	67.80	68.67	69.50	70.30	71.06
20			64.83	65.85	66.80	67.20	68.56	69.38	70.16	70.92
30		63.69	64.75	65.76	66.70	67.59	68.44	69.25	70.02	70.76
40	62.42	63.61	64.66	65.66	66.59	67.47	68.31	69.10	69.86	70.59
50	62.38	63.52	64.56	65.55	66.47	67.34	68.17	68.95	69.70	70.42
60	62.34	63.42	64.45	65.43	66.34	67.20	68.02	68.79	69.53	70.23
70	62.27	63.31	64.33	65.30	66.20	67.05	67.86	68.62	69.35	70.04
80	62.19	63.19	64.21	65.17	66.05	66.90	67.69	68.44	69.15	69.83
90	62.11	63.07	64.07	65.02	65.90	66.73	67.51	68.25	68.95	69.62
100	62.00	62.93	63.93	64.86	65.73	66.55	67.32	68.05	68.74	69.40
110	61.84	62.79	63.77	64.70	65.56	66.37	67.13	67.84	68.52	69.17
120	61.73	62.63	63.61	64.52	65.37	66.17	66.92	67.63	68.29	68.92
130	61.54	62.47	63.43	64.34	65.18	65.97	66.71	67.40	68.05	68.67
140	61.39	62.30	63.25	64.15	64.98	65.75	66.48	67.16	67.81	68.41
150	61.20	62.11	63.06	63.95	64.76	65.53	66.25	66.92	67.55	68.14
160	61.01	61.92	62.86	63.73	64.54	65.30	66.00	66.66	67.28	67.86
170	60.79	61.72	62.64	63.51	64.31	65.05	65.75	66.40	67.01	67.58
180	60.57	61.51	62.42	63.28	64.07	64.80	65.49	66.12	66.72	67.28
190	60.35	61.29	62.19	63.04	63.82	64.54	65.21	65.84	66.42	66.97
200	60.13	61.06	61.95	62.79	63.56	64.27	64.93	65.55	66.12	66.65
210	59.88	60.82	61.71	62.53	63.29	63.99	64.64	65.24	65.81	66.33
220	59.63	60.57	61.45	62.27	63.01	63.70	64.34	64.93	65.48	65.99
230	59.38	60.31	61.18	61.99	62.72	63.40	64.03	64.61	65.15	65.65
240	59.10	60.05	60.90	61.70	62.43	63.10	63.71	64.28	64.81	65.29
250	58.82	59.77	60.62	61.40	62.12	62.78	63.39	63.94	64.46	64.93

∙ = Above atmospheric boiling point

$$\text{Specific Gravity} = \frac{\text{density of solution}}{\text{density of water @ 60 F}}$$

CHW : Specific Gravity (20% glycol @ 42 F) $= \frac{64.64}{62.34} = 1.04$

HW : Specific Gravity (20% glycol @ 170 F) $= \frac{62.64}{62.34} \cong 1.00$

Table T-3b

SELECTING THE PROPER CONCENTRATION OF DOWTHERM FLUID

The concentration of glycol-based heat transfer fluid required in a system depends on the kind of protection needed in winter, or the operating temperature if the system involves refrigeration. There are two basic types of protection available: "burst protection" and "freeze protection."

Burst protection

Burst protection is sufficient if the system will remain dormant when the temperature is below the freezing point of the solution. In HVAC applications, burst protection is considered an appropriate safeguard in systems where there is adequate space to accommodate the expansion of an ice/slush mixture *and* the system is inactive during the winter.

Inhibited glycol-based fluids provide burst protection in the following manner: As the temperature drops below the solution's freezing point, ice crystals begin to form. Because water in the solution freezes first, the remaining glycol solution becomes further concentrated and remains fluid. The combination of ice crystals and fluid results in a flowable slush. Fluid volume increases as this slush forms, with the extra volume flowing into available expansion volume in the system. If the concentration of glycol is sufficient, system damage will not occur.

For burst protection, a 30 percent (by volume) solution of ethylene glycol (31.4 percent DOWTHERM SR-1 or 32.5 percent DOWTHERM 4000) is usually adequate. See Table 3 for typical ethylene glycol concentrations required to achieve burst protection at various temperatures.

Freeze protection

Freeze protection is required in systems where fluid must be pumped at the lowest anticipated temperature. Freeze protection is essential in cases where no ice crystals can be permitted to form or where there is inadequate expansion volume available to accommodate ice/slush formation.

For freeze protection, the required concentration of inhibited glycol fluid in the system depends on the operating conditions of the system and the lowest expected ambient temperature. HVAC systems that are subject to prolonged winter shut-down—but which must start-up again while the weather is still cold—may require freeze protection. Freeze protection is also appropriate for closed-loop systems that must be protected in the event of power or pump failure.

To obtain adequate freeze protection, the glycol solution must maintain a freezing point at least 5°F below the lowest anticipated ambient temperature. Table 3 lists typical concentrations of DOWTHERM fluids required to provide freeze protection. Refer to Table 2 for a complete list of the concentrations of inhibited ethylene glycol to be added for freeze protection.

Table 3—Typical Concentrations of DOWTHERM Fluids Required to Provide Freeze and Burst Protection at Various Temperatures

Temperature °F	Percent (vol.) DOWTHERM Fluid Concentration Required			
	For Freeze Protection		For Burst Protection	
	Volume % DOWTHERM SR-1	Volume % DOWTHERM 4000	Volume % DOWTHERM SR-1	Volume % DOWTHERM 4000
20	16.8	17.3	11.5	11.9
10	26.2	27.1	17.8	18.4
0	34.6	35.7	23.1	23.8
-10	40.9	42.2	27.3	28.1
-20	46.1	47.6	31.4	32.5
-30	50.3	51.9	31.4	32.5
-40	54.5	56.3	31.4	32.5
-50	58.7	60.6	31.4	32.5
-60	62.9	64.9	31.4	32.5

NOTE: These figures are examples only and may not be appropriate to your situation. Generally, for an extended margin of protection, you should select a temperature in this table that is at least 5°F lower than the expected lowest ambient temperature. Inhibitor levels should be adjusted for solutions of less than 30% glycol. Contact Dow for information on specific cases or further assistance.

ATTENTION: These are typical numbers only and are not to be regarded as specifications. As use conditions are not within its control, Dow does not guarantee results from use of the information or products herein; and gives no warranty, express or implied.

ATTACHMENT I
PAGE 8 OF 16

B.A.C. INDUSTRIAL MODULAR COOLING TOWERS

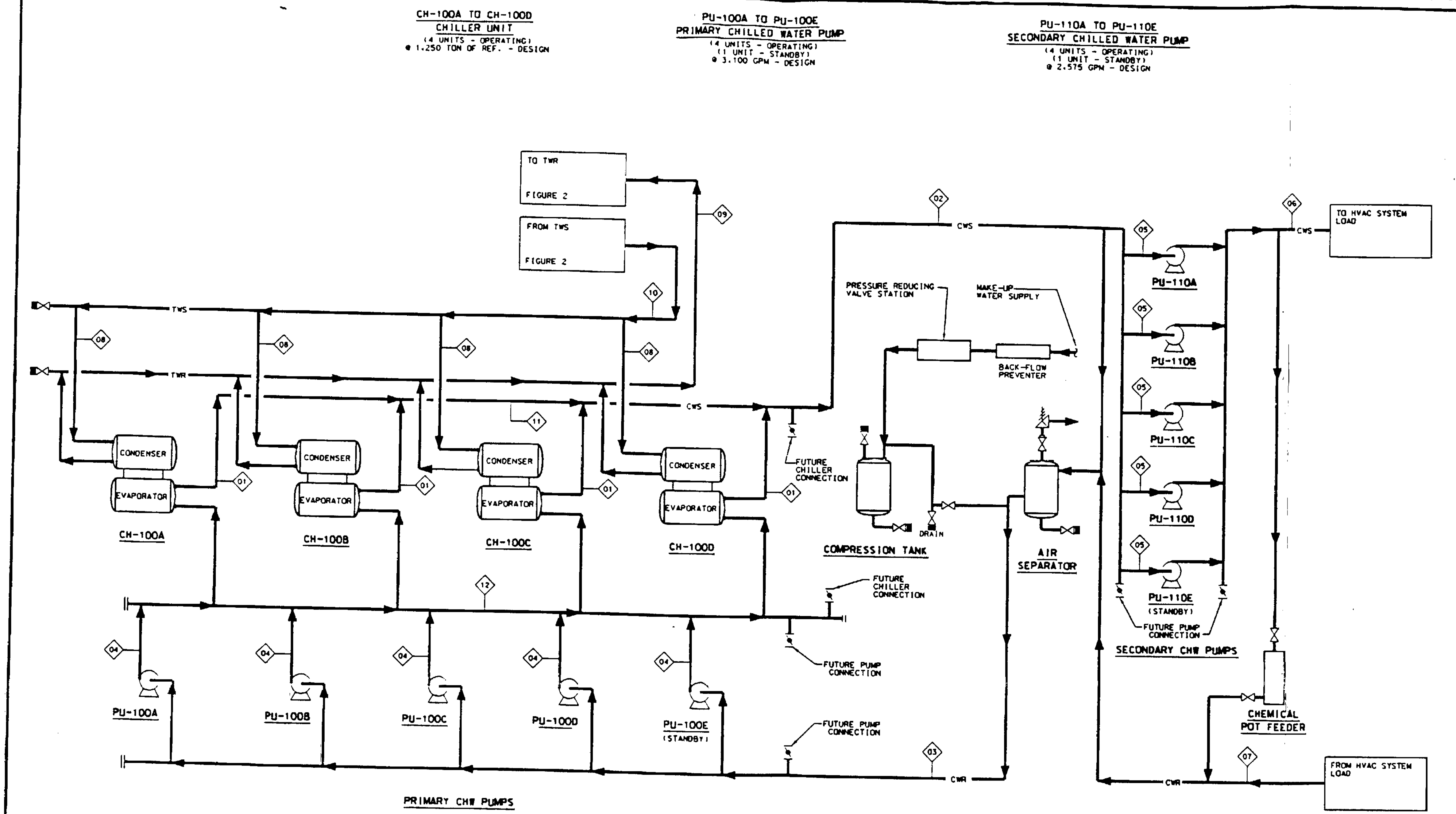
SELECTION TABLES

IMT model numbers represent approximate nominal tonnage capacity at standard cooling tower conditions (3 GPM/ton, 95°F/85°F/78°F WB). For exact performance capability at various common conditions consult the table below. For conditions not shown, consult your BAC-Pritchard Representative or the factory.

SINGLE CELL CAPACITY / 4 SIDED AIR INLET

WET BULB		70				75				78				80			
TEMPERATURE CONDITIONS (°F)		95/85	100/85	100/90	105/90	95/85	100/85	100/90	105/90	95/85	100/85	100/90	105/90	95/85	100/85	100/90	105/90
MODEL NO.	MOTOR HP																
IMT 420-1	20	1838	1467	2355	1859	1493	1215	2034	1627	1250	1035	1815	1468	1066	986	1656	1350
IMT 450-1	25	1968	1574	2516	1990	1601	1305	2176	1744	1342	1113	1944	1574	1145	964	1774	1449
IMT 470-1	30	2080	1666	2654	2103	1694	1382	2298	1844	1422	1180	2054	1666	1214	1023	1876	1534
IMT 520-1	40	2266	1819	2882	2291	1850	1513	2500	2012	1555	1293	2238	1819	1330	1118	2046	1677
IMT 525-1	20	2327	1858	2980	2353	1890	1539	2574	2060	1583	1312	2298	1858	1350	1136	2096	1710
IMT 570-1	25	2491	1993	3184	2519	2027	1653	2754	2208	1700	1410	2461	1994	1451	1222	2246	1836
IMT 600-1	30	2633	2110	3359	2662	2145	1752	2908	2335	1801	1495	2600	2110	1539	1297	2375	1944
IMT 660-1	40	2868	2304	3648	2900	2342	1917	3164	2548	1970	1639	2833	2304	1686	1422	2591	2125
IMT 700-1	50	3061	2465	3883	3096	2505	2044	3374	2723	2110	1731	3024	2465	1792	1491	2768	2273
IMT 650-1	25	2958	2320	3838	2987	2365	1887	3291	2590	1949	1578	2916	2316	1633	1341	2642	2114
IMT 685-1	30	3136	2460	4068	3167	2509	2002	3489	2746	2067	1675	3092	2456	1732	1424	2802	2243
IMT 750-1	40	3440	2700	4459	3474	2753	2197	3825	3013	2269	1839	3391	2695	1902	1564	3074	2462
IMT 800-1	50	3695	2901	4788	3732	2958	2362	4109	3237	2439	1978	3643	2897	2045	1682	3303	2646
IMT 850-1	30	3824	3004	4952	3863	3062	2446	4250	3351	2525	2047	3770	2999	2117	1741	3417	2739
IMT 900-1	40	4192	3295	5426	4235	3358	2684	4659	3675	2770	2248	4133	3290	2324	1912	3748	3005
IMT 975-1	50	4502	3540	5825	4548	3608	2885	5003	3948	2977	2416	4439	3534	2498	2056	4026	3229
IMT 1050-1	60	4773	3711	6174	4813	3807	2997	5303	4146	3112	2494	4706	3691	2592	2110	4257	3359
IMT 1025-1	40	4678	3673	6062	4725	3745	2990	5202	4099	3087	2503	4612	3667	2588	2128	4180	3349
IMT 1100-1	50	5025	3947	6508	5075	4024	3214	5586	4403	3318	2691	4954	3940	2782	2288	4491	3599
IMT 1175-1	60	5327	4185	6898	5380	4267	3409	5921	4669	3519	2855	5252	4179	2952	2428	4762	3817
IMT 1250-1	75	5722	4453	7407	5776	4568	3596	6360	4975	3734	2992	5642	4429	3110	2533	5108	4030
IMT 1225-1	50	5689	4468	7369	5746	4554	3638	6324	4985	3755	3045	5608	4461	3149	2589	5084	4074
IMT 1325-1	60	6031	4738	7809	6091	4830	3859	6703	5286	3983	3231	5945	4730	3340	2748	5390	4321
IMT 1425-1	75	6477	5091	8384	6542	5189	4147	7198	5678	4281	3474	6386	5083	3591	2955	5791	4644
IMT 1500-1	100	6928	5344	9092	6931	5481	4315	7723	5970	4481	3591	6799	5315	3732	3039	6130	4836
IMT 1450-1	60	6599	5179	8554	6664	5280	4215	7338	5780	4352	3527	6505	5171	3648	2999	5896	4722
IMT 1550-1	75	7088	5565	9184	7158	5674	4531	7881	6210	4678	3793	6988	5556	3922	3225	6334	5075
IMT 1700-1	100	7773	6106	10067	7850	6225	4973	8641	6812	5135	4164	7664	6096	4306	3542	6948	5569

Table T-4



LINE NUMBER	CAPACITY (GPM)	PIPE SIZE (DIA. INCHES)
01	3,100	12"Ø
02	12,400	24"Ø
03	12,400	24"Ø
04	3,100	12"Ø
05	2,575	12"Ø
06	10,300	24"Ø
07	10,300	24"Ø
08	3,775	14"Ø
09	15,100	30"Ø
10	15,100	30"Ø
11	12,400	24"Ø
12	12,400	24"Ø

CHILLED WATER SYSTEM

FIGURE 1a
CHILLED WATER
SCHEMATIC FLOW DIAGRAM (CHILLER PIPING)

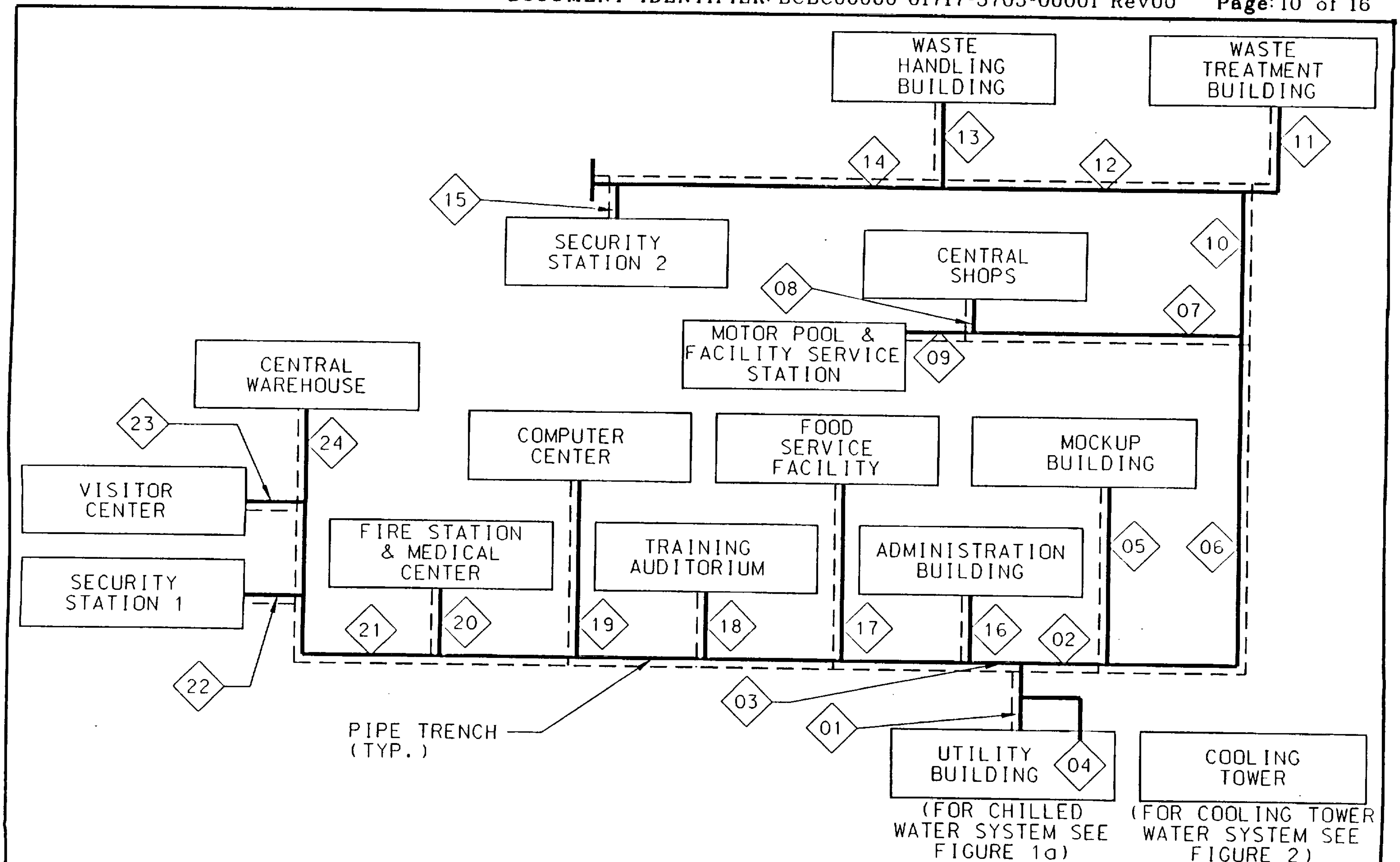


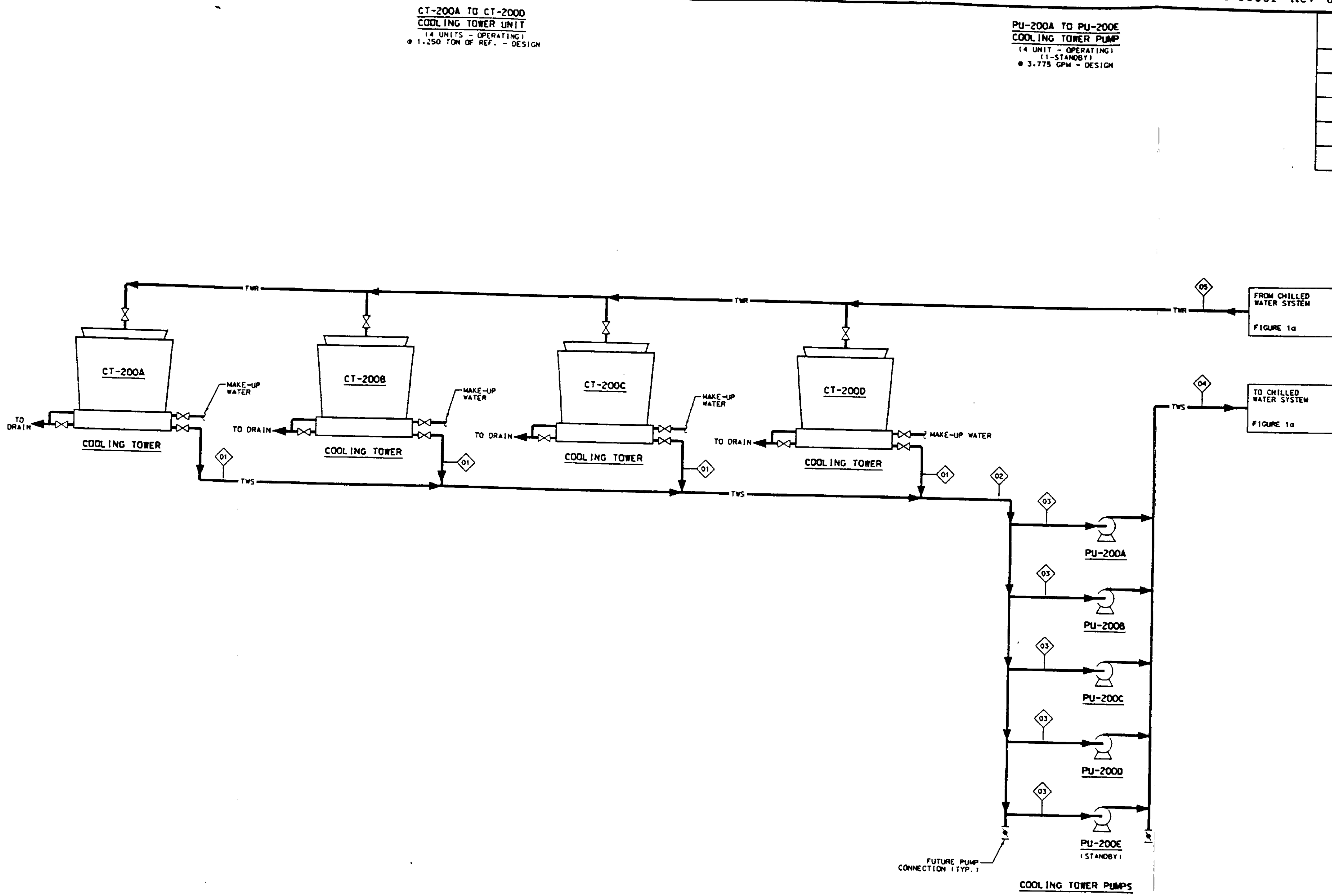
FIGURE 1b
CHILLED WATER
SCHEMATIC FLOW DIAGRAM

LINE NUMBER	FLOW RATE (GPM)	SIZE DIA. (IN.)
01	10,300	24
02	8,455	20
03	1,795	10
04	50	3
05	90	3
06	8,365	20
07	280	6
08	270	6
09	10	2
10	8,085	20
11	1,195	8
12	6,890	18
13	6,855	18
14	35	4
15	35	2
16	460	6

LINE NUMBER	FLOW RATE (GPM)	SIZE DIA. (IN.)
17	185	4
18	65	3
19	165	4
20	75	3
21	845	8
22	85	3
23	215	4
24	545	6

FIGURE 1c
CHILLED WATER
SCHEMATIC FLOW DIAGRAM

LINE NUMBER	CAPACITY (GPM)	PIPE SIZE (DIA., INCHES)
01	3,775	14"Ø
02	15,100	30"Ø
03	3,775	14"Ø
04	15,100	30"Ø
05	15,100	30"Ø



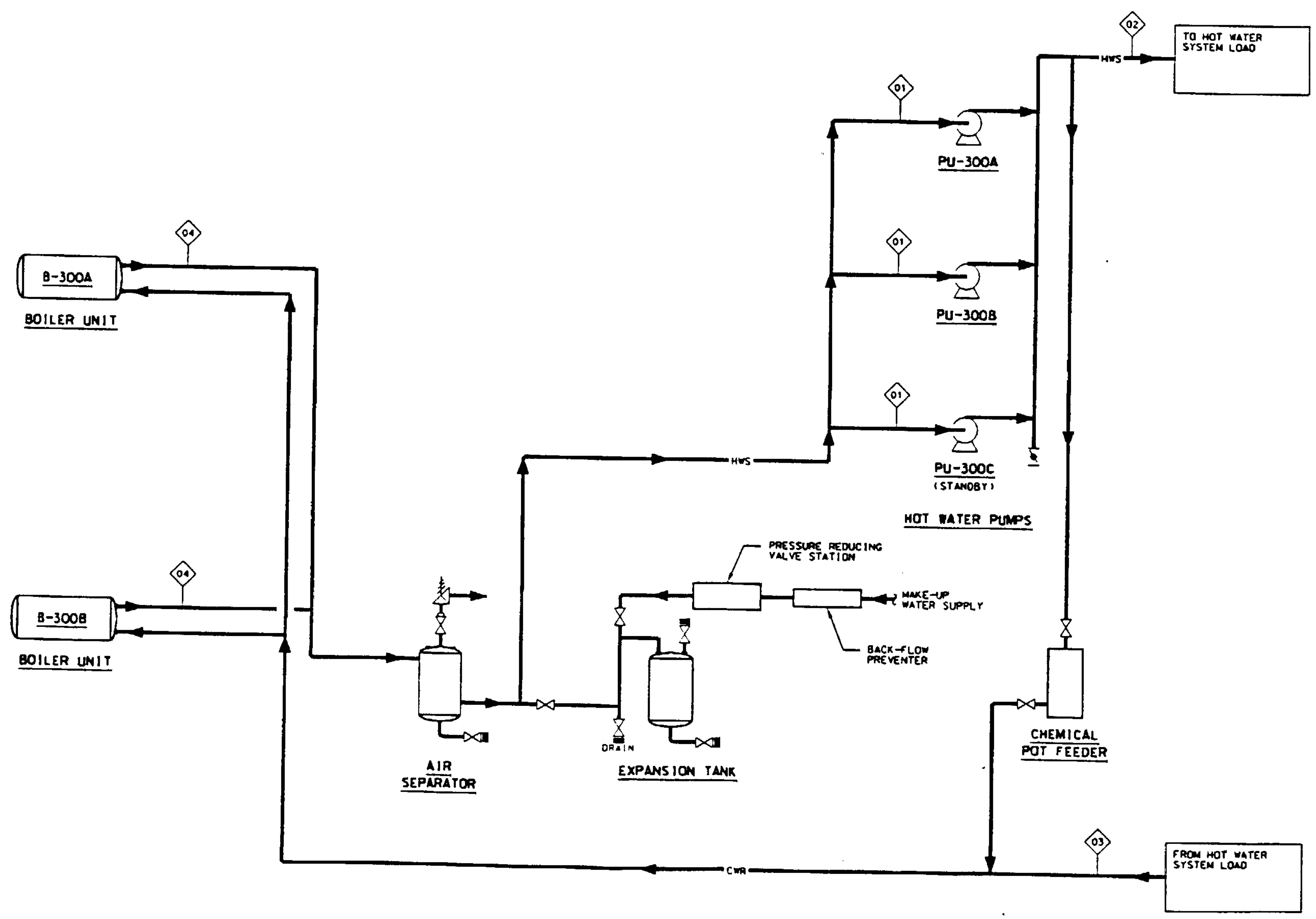
COOLING TOWER WATER SYSTEM

FIGURE 2
COOLING TOWER
WATER SCHEMATIC FLOW DIAGRAM

B-300A AND B-300B
HOT WATER BOILER UNIT
(2 UNITS - OPERATING)
@ 30,000 MBH - DESIGN

PU-300A TO PU-300C
HOT WATER PUMP
(2 UNITS - OPERATING)
(1 UNIT - STANDBY)
@ 2,000 GPM - DESIGN

LINE NUMBER	CAPACITY (GPM)	PIPE SIZE (DIA., INCHES)
01	2,000	10"Ø
02	4,000	16"Ø
03	4,000	16"Ø
04	2,000	10"Ø



HOT WATER SYSTEM

FIGURE 3a
HEATING WATER
SCHEMATIC FLOW DIAGRAM (BOILER PIPING)

reyese t:*reps*hvac*dgn*srh-fig98.dgn 26-FEB-1998 14:56

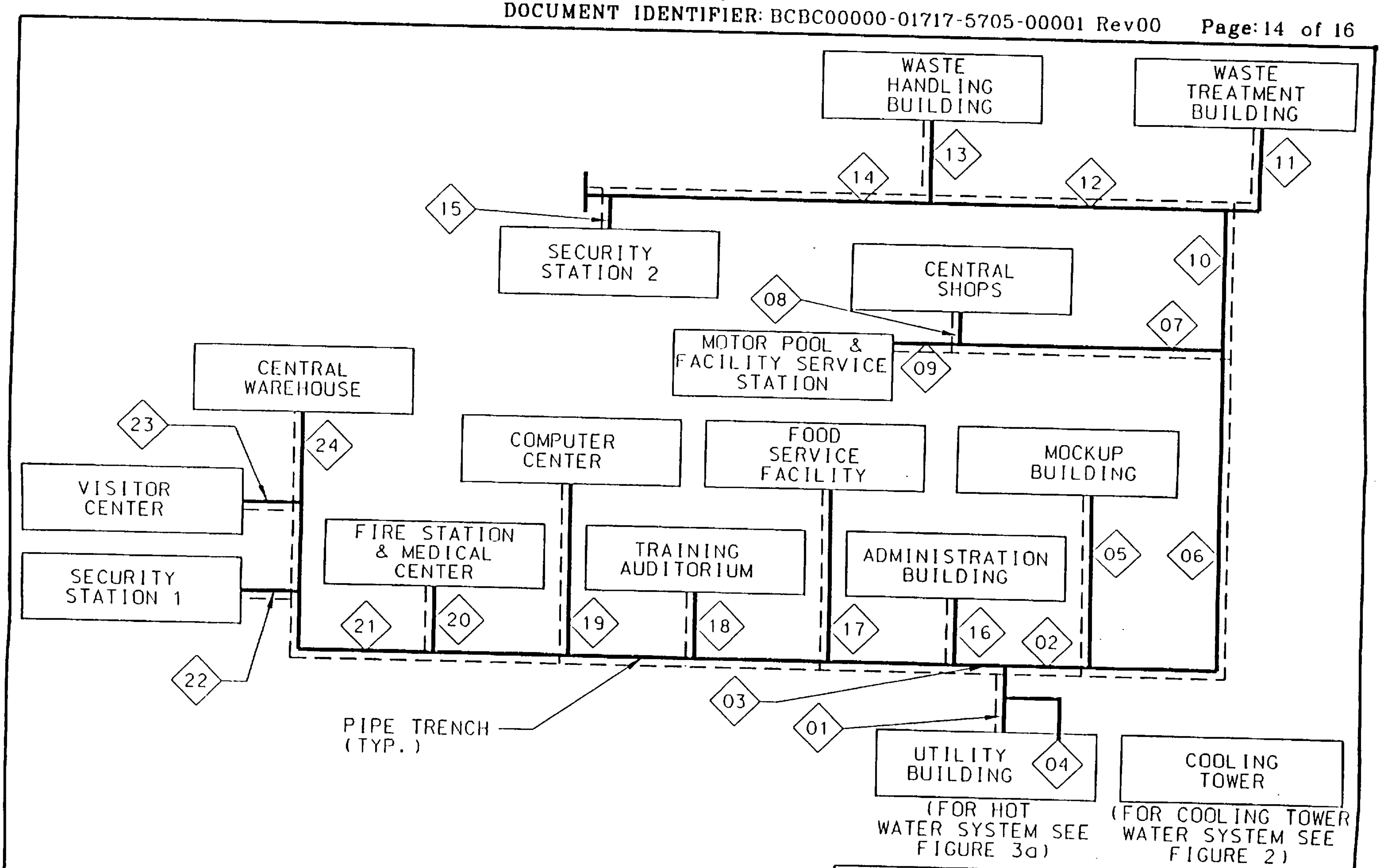


FIGURE 3b
HEATING WATER
SCHEMATIC FLOW DIAGRAM

LINE NUMBER	FLOW RATE (GPM)	SIZE DIA. (IN.)
01	4,000	16
02	3,270	14
03	680	6
04	50	3
05	20	2
06	3,250	14
07	150	4
08	135	3
09	15	2
10	3,100	14
11	550	6
12	2,550	12
13	2,530	12
14	20	4
15	20	2
16	110	3

LINE NUMBER	FLOW RATE (GPM)	SIZE DIA. (IN.)
17	35	2
18	30	2
19	15	2
20	40	2
21	450	6
22	20	2
23	65	3
24	365	6

FIGURE 3c
HEATING WATER
SCHEMATIC FLOW DIAGRAM

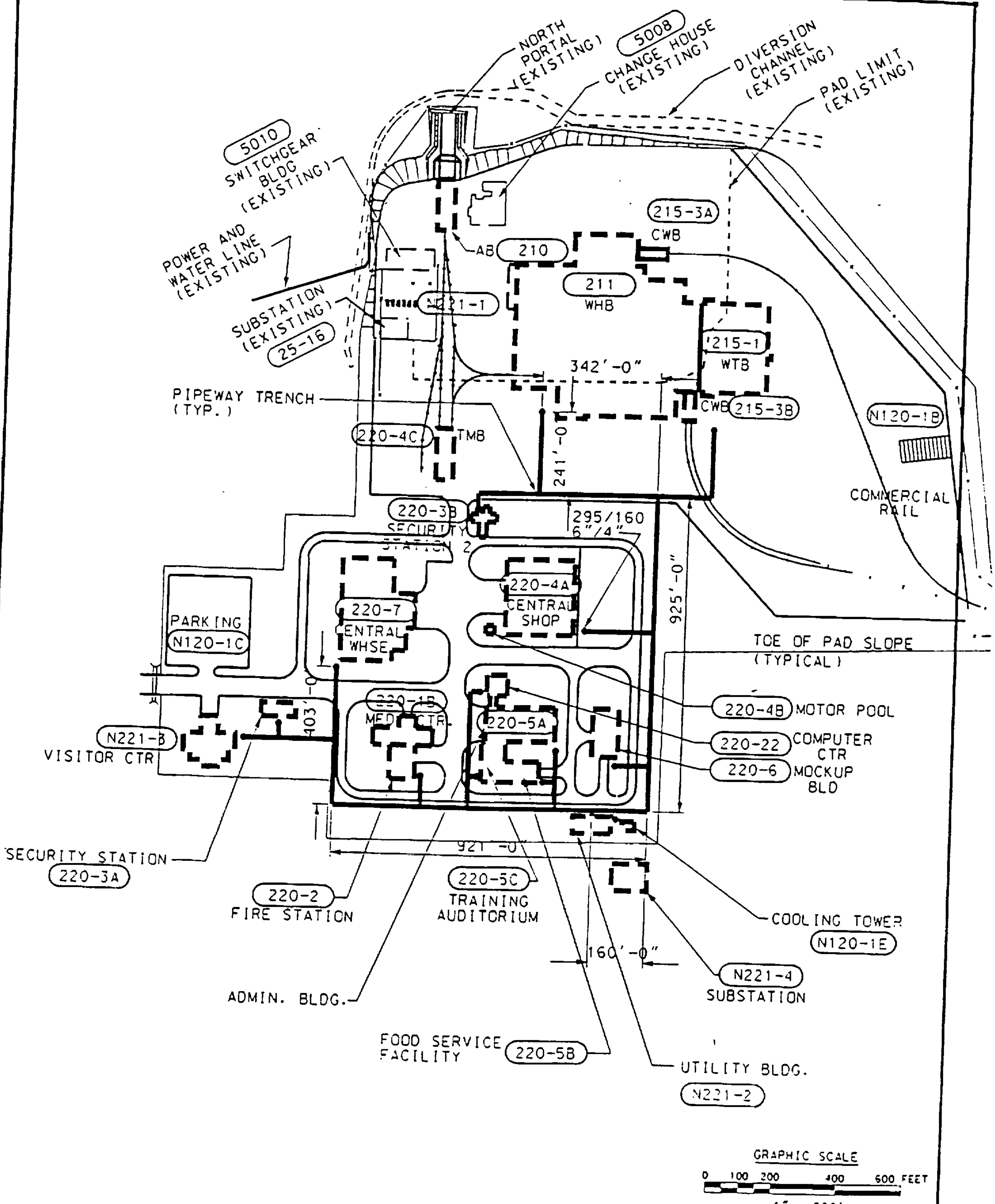


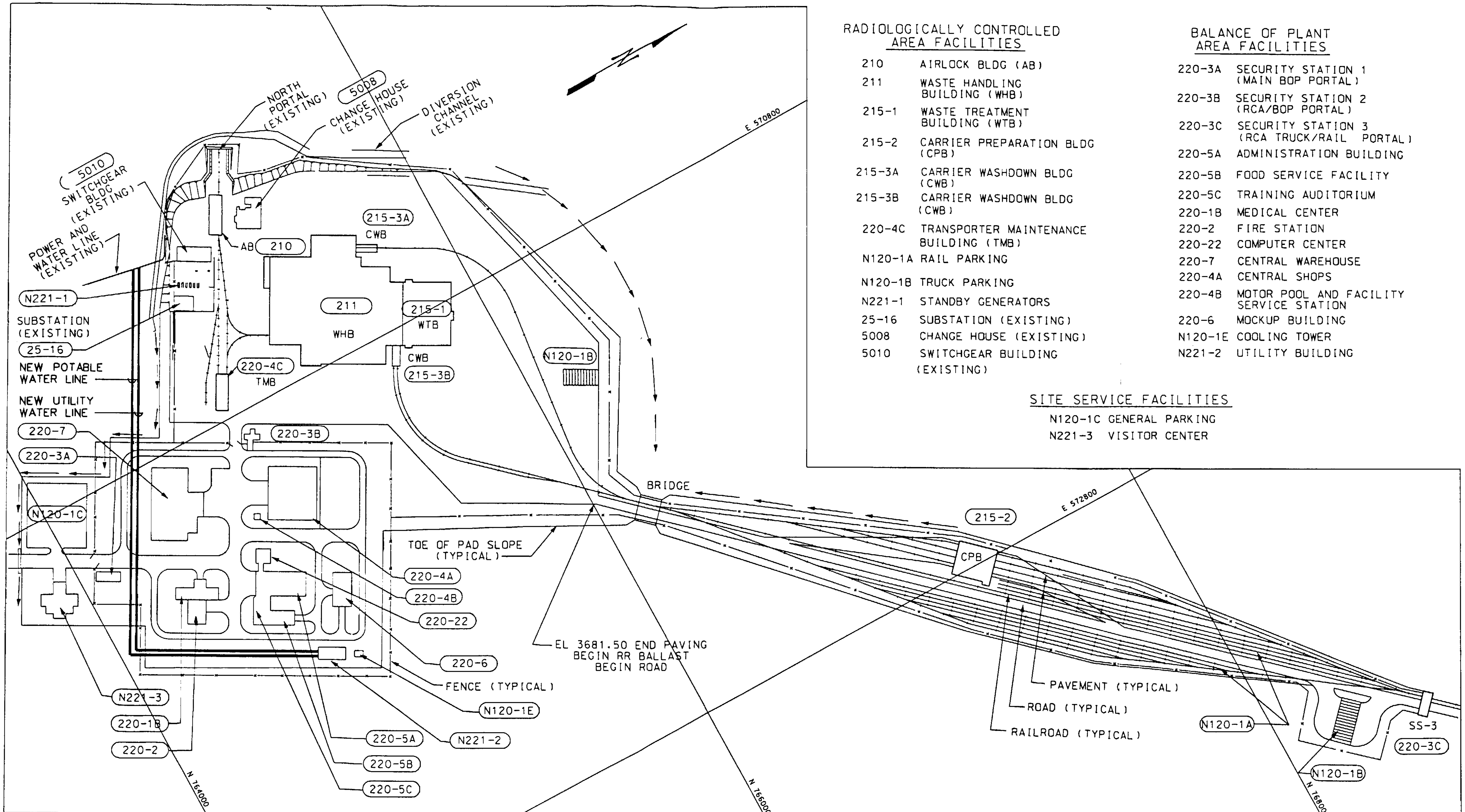
FIGURE 4
CHW/HW SYSTEM
PIPING DISTRIBUTION

26-FEB-1998 14:58

CAD FILE: t:*reps*hvac*dgn*srn-fig92.dgn

ATTACHMENT I

HVAC Data and Flow Diagrams



NOTES:

1. THIS FIGURE DEPICTS CONCEPTUAL DESIGN AND IS PRESENTED FOR INFORMATION ONLY. THE INFORMATION IS NOT INTENDED FOR PROCUREMENT, FABRICATION, OR CONSTRUCTION

Figure 1
POTABLE AND RAW WATER TIE-INS

ATTACHMENT III

Water Systems Figures

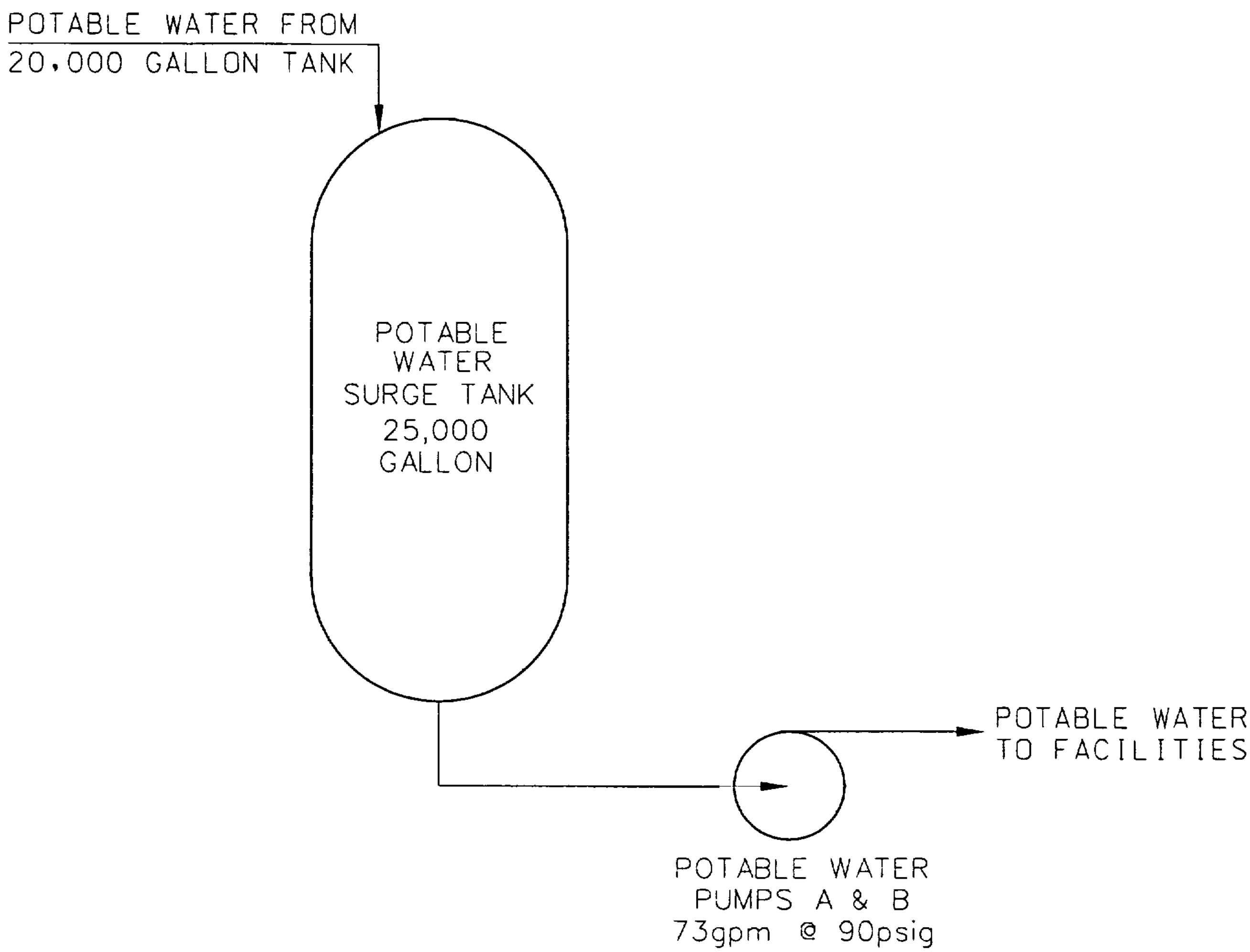


Figure 1
POTABLE WATER
FLOW DIAGRAM

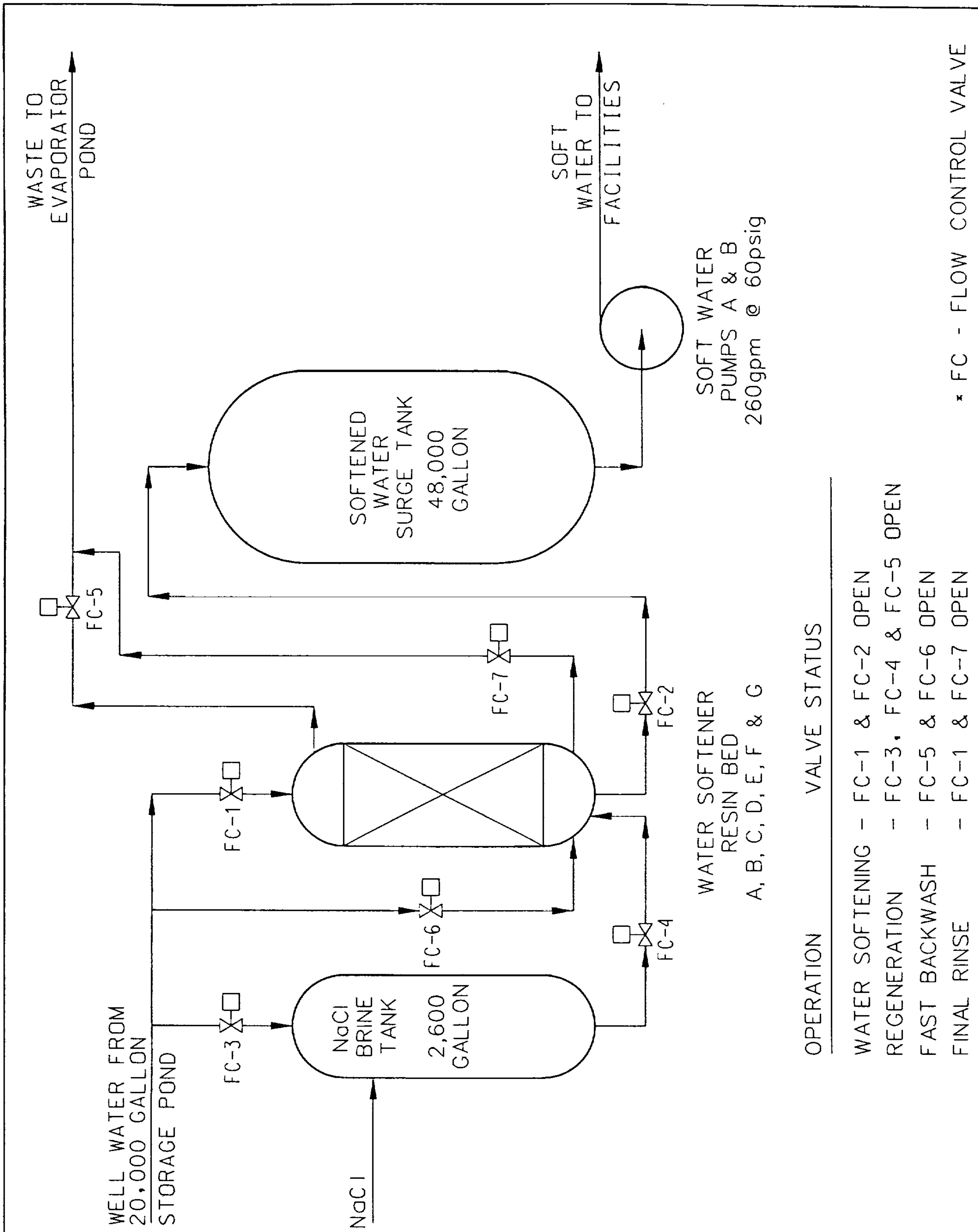


Figure 2
SOFT WATER
FLOW DIAGRAM

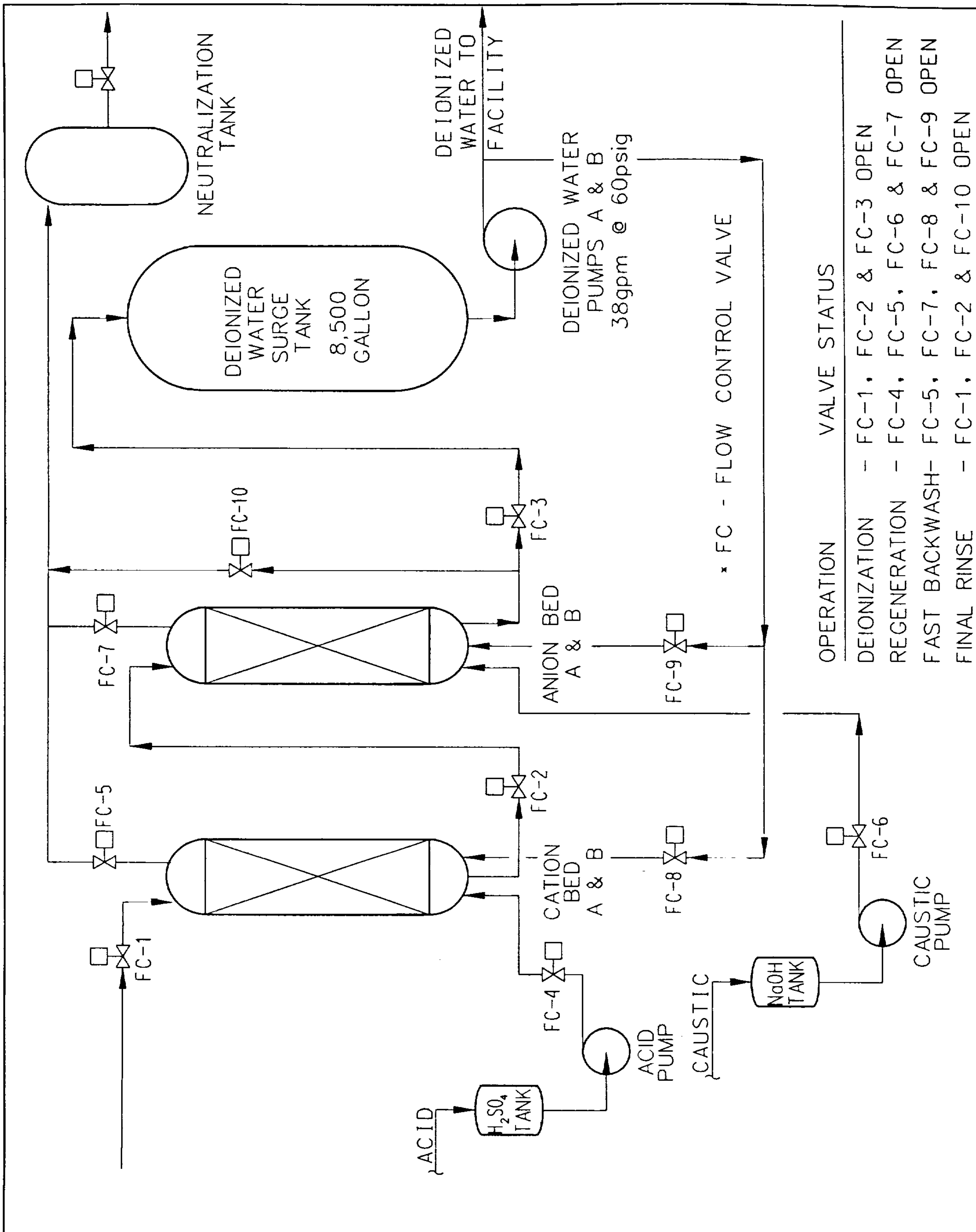
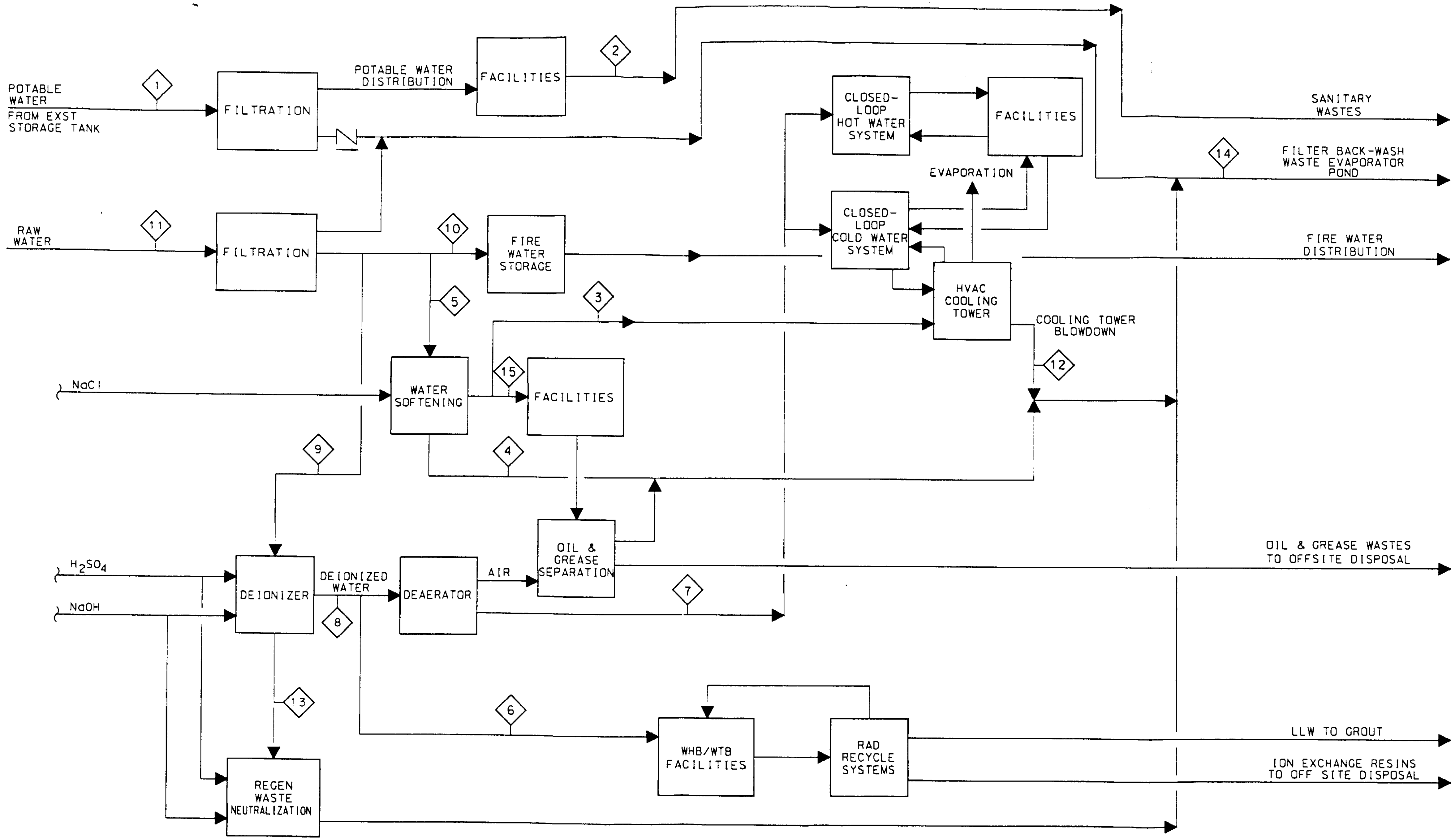


Figure 3
DEIONIZED WATER
FLOW DIAGRAM



Stream No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	POTABLE WATER FEED	SANITARY WASTES	COOLING TOWER FEED	SOFT WATER REGEN WASTE	RAW WATER TO SOFTENER	DI-WATER TO WHB	DI-WATER TO LOOPS	TOTAL DI-WATER	RAW WATER TO DE-IONIZER	FIRE WATER MAKEUP	TOTAL RAW WATER	COOLING TOWER BLOWDOWN	DE-IONIZER REGEN WASTE	TOTAL EVAP. WASTE	SOFT WATER TO BOP
Max. gpm	73	N/A	180	37	260	32	32	32	64	125	449	15	32	156	40
gpd (wkday)	23.000	23.000	103.700	7.800	111.600	240	N/A	270	289	N/A	112.500	11.232	18.9	45.827	N/A
gpy x 10^6	7.56	7.56	37.8	2.8	40.7	0.096	0.006	0.1	0.11	0.26	41.1	4.1	0.007	16.73	0.26

Figure 4
WATER SYSTEMS
FLOW DIAGRAM

RADIOLOGICALLY CONTROLLED AREA FACILITIES

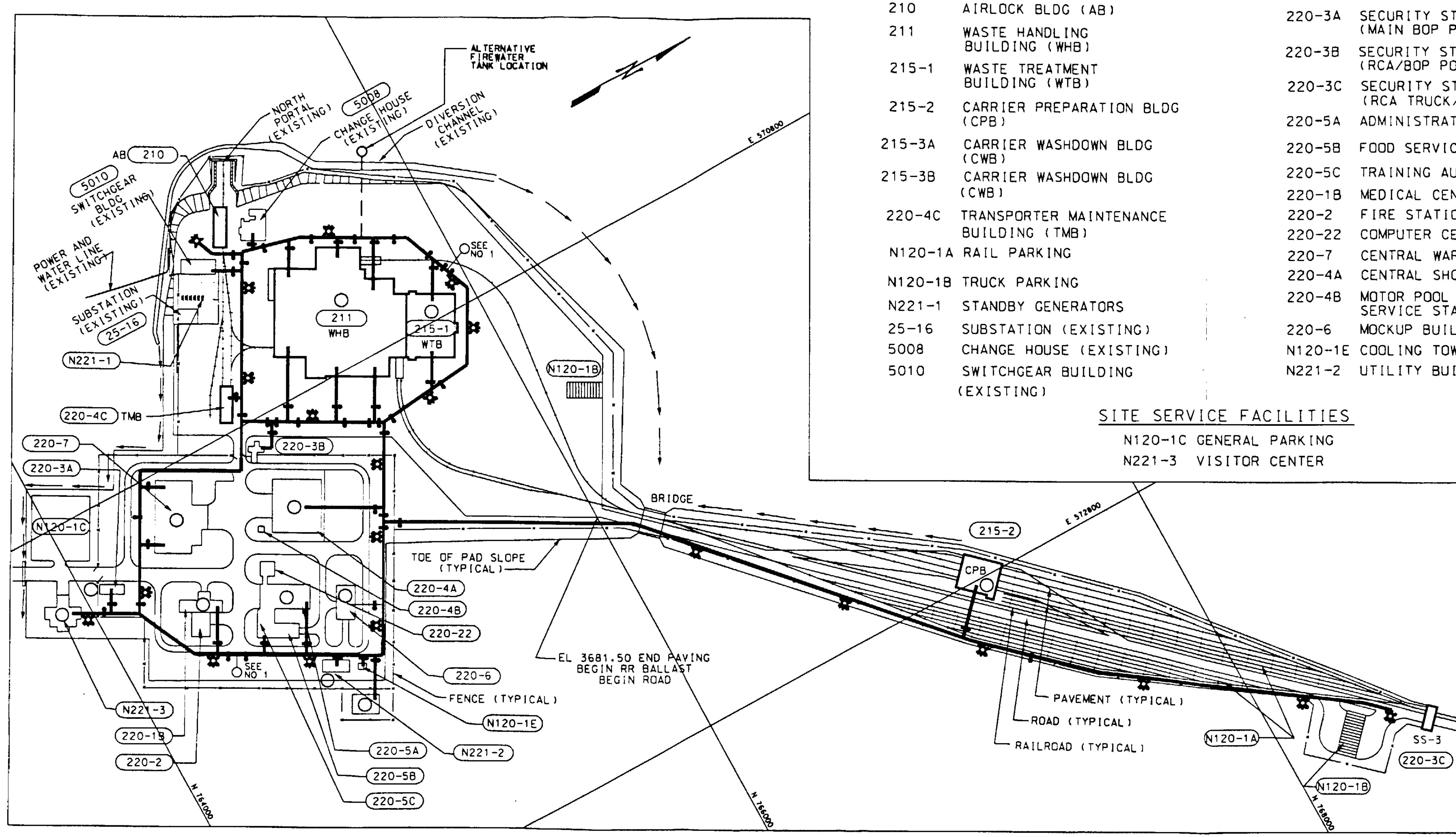
210	AIRLOCK BLDG (AB)
211	WASTE HANDLING BUILDING (WHB)
215-1	WASTE TREATMENT BUILDING (WTB)
215-2	CARRIER PREPARATION BLDG (CPB)
215-3A	CARRIER WASHDOWN BLDG (CWB)
215-3B	CARRIER WASHDOWN BLDG (CWB)
220-4C	TRANSPORTER MAINTENANCE BUILDING (TMB)
N120-1A	RAIL PARKING
N120-1B	TRUCK PARKING
N221-1	STANDBY GENERATORS
25-16	SUBSTATION (EXISTING)
5008	CHANGE HOUSE (EXISTING)
5010	SWITCHGEAR BUILDING (EXISTING)

BALANCE OF PLANT AREA FACILITIES

220-3A	SECURITY STATION 1 (MAIN BOP PORTAL)
220-3B	SECURITY STATION 2 (RCA/BOP PORTAL)
220-3C	SECURITY STATION 3 (RCA TRUCK/RAIL PORTAL)
220-5A	ADMINISTRATION BUILDING
220-5B	FOOD SERVICE FACILITY
220-5C	TRAINING AUDITORIUM
220-1B	MEDICAL CENTER
220-2	FIRE STATION
220-22	COMPUTER CENTER
220-7	CENTRAL WAREHOUSE
220-4A	CENTRAL SHOPS
220-4B	MOTOR POOL AND FACILITY SERVICE STATION
220-6	MOCKUP BUILDING
N120-1E	COOLING TOWER
N221-2	UTILITY BUILDING

SITE SERVICE FACILITIES

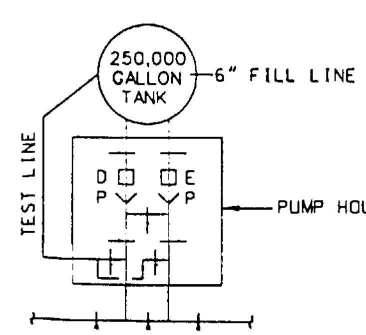
N120-1C	GENERAL PARKING
N221-3	VISITOR CENTER



GRAPHIC SCALE

0 100 200 400 600 FEET

1" = 200'



NO 1

NTS

NOTES:

1. THIS FIGURE DEPICTS CONCEPTUAL DESIGN AND IS PRESENTED FOR INFORMATION ONLY. THE INFORMATION IS NOT INTENDED FOR PROCUREMENT, FABRICATION, OR CONSTRUCTION

LEGEND

- HYDRANT WITH MAINTENANCE VALVE
- PIV
- OS & Y
- FIRE PUMP
- CHECK VALVE
- NUMBER OF SPRINKLER SYSTEMS IN BUILDING
- AUTOMATIC SPRINKLER SYSTEM WITH PIV

12 INCH - LOOP

8 INCH - LEAD-INS TO SPRINKLER'S AND BLDG 215-2

6 INCH - HYDRANT LINES

Figure 5
FIRE WATER LOOP

ATTACHMENT IV

Total Nitrogen for Sampling in Year 2016

Table I - IV
Total Nitrogen for Sampling in Year 2016

Cack Type	Cask Length (inches)	Cask Diam (inches)	Volume = [pi*(L/12)*(D/12)**2]/4 (ft3)	1/2 Volume (ft3)	four purges (ft3)	2016 Waste Cann Rcvd	Total N_2 SCF/year
9 BWR	198	47	198.80	99.40	397.59	23	9145
7 BWR	227	68	477.08	238.54	954.16	3	2862
4 PWR	188	48	196.87	98.44	393.75	62	24412
3 PWR	218	68	458.16	229.08	916.33	7	6414
7 BWR	227	68	477.08	238.54	954.16	0	0
3 PWR	218	68	458.16	229.08	916.33	27	24741
3 PWR	218	68	458.16	229.08	916.33	11	10080
61 BWR	210	92	807.87	403.93	1615.74	34	54935
26 PWR	193	99	859.75	429.88	1719.51	91	156475
24 BWR	205	96	858.70	429.35	1717.40	81	139110
24 PWR	205	96	858.70	429.35	1717.40	120	206088
17 BWR	210	64	390.95	195.48	781.91	1	782
7 PWR	210	64	390.95	195.48	781.91	19	14856
17 BWR	210	64	390.95	195.48	781.91	0	0
7 PWR	210	64	390.95	195.48	781.91	0	0
44 BP	181	94	726.91	363.45	1453.82	0	0
12 PWR	205	96	858.70	429.35	1717.40	12	20609
					Total Nitrogen (SCF)		670509

ATTACHMENT V

Cooling/Heating Systems Usage Factors

Table I-V

Title: COOLING/HEATING SYSTEMS USAGE FACTOR
Building: SURFACE FACILITIES - REPOSITORY

System	Type	CFM Note 1	Cooling Peak MBH Note 2	Annual Cooling Energy, MBtu/Yr Note 3	Heating Peak MBH Note 4	Annual Heating Energy, MBtu/Yr Note 3
Primary/Secondary Confinement System	100% OSA 90/65	314,000	13,900	29,300,000	14,300	32,800,000
Tertiary Confinement System	41% OSA 76/72	282,000	10,100	30,000,000	7,200	20,100,000
HVAC Equip. Room	100% Recir 76/72	161,000	2,340	19,400,000	0	0
Non-rad Areas	20% OSA 90/65	112,900	3,850	25,200,000	5,750	12,000,000
Cold Support Area	20% OSA 76/72	57,000	1,280	6,800,000	3,400	7,200,000
WHB	Sub-Total	926,900	31,470	110,700,000	30,650	72,100,000
Balance of Plant * Use Cold Support Area Percentages	20% OSA 76/72	270,000	10,800	28,500,000 *	12,400	13,000,000 *
	TOTAL	1,196,900	42,270	139,200,000	43,050	85,100,000

* Use 50% of of Cold Support Area percentages with 24 hours occupancy.
Balance of Plant buildings are assumed to have 12 hours occupancy.

Cooling Usage Factor = Cooling Peak,MBH * 8760 hrs per year
= 0.40

Heating Usage Factor = Heating Peak,MBH * 8760 hrs per year
= 0.20

Notes:
1. Input — Copy from Air Handling list
2. Input — Copy from cooling requirements calc. sheet
3. Input — Copy from htgclgfactor(annual energy consumption)
4. Input — Copy from heating requirements calc. sheet
Reference 5.6