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SAFETY, RESPECT AND DIGNITY FOR ALL

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Technical Criteria for

Correctional Institutions

SECTION SU – SITE UTILITIES

Canada

SU-1 SITE UTILITIES – STORM AND SANITARY SEWERS

SU-2 SITE UTILITIES – WASTEWATER (SEWAGE) TREATMENT

SU-3 SITE UTILITIES – WATER UTILITY

SU-4 SITE UTILITIES – POWER SUPPLY AND ELECTRICAL POWER DISTRIBUTION

SU-1 SITE UTILITIES – STORM AND SANITARY SEWERS

1. SCOPE

This section sets out technical guidelines and criteria for storm and sanitary sewers serving CSC Institution properties.

2. RELATED SECTIONS

SP–1 – Site Planning and Development
SP–5 – Traffic Circulation & Parking
SU–2 – Wastewater (Sewage) Treatment
SU–3 – Water Utility
M–2 – Plumbing Requirements

3. DESIGN CONSIDERATIONS

3.1 General

Design of storm and sanitary sewers shall be based on good engineering practice and conform with all applicable codes, regulations and standards in the specific locality of the work. In addition, the following requirements of CSC shall be given special consideration:

3.1.1 Imminent and future development plans

3.1.2 Project specific security requirements

3.1.3 Operation and maintenance aspects as related to the special requirements of a C.S.C. institution.

Institution sewerage systems are often used by inmates to dispose of contraband, clothing and other bulky items which may block sewer pipes, manholes, pumps and treatment equipment.

Screening or comminution equipment must be installed at suitable locations in the collection system. Such equipment shall be power operated, automated (requiring minimum operator manipulation).

3.1.4 Separate sanitary and storm sewer systems will be used and, insofar as is feasible, sewers will be at such a depth as to admit contributing flows by gravity.

3.1.5 Pumping Stations

3.1.5.1 Consider the implications of power failure and of exceeding the pumping capacity.

3.1.5.2 Provide high and low sewage level alarms properly identified to the technical services work station and if this station is not manned on a 24 hour day basis, to the Main Communication Control Post (MCCP).

3.2 Estimation of Flow Quantities

Determine the quantity of wastewater based on the following as appropriate:

3.2.1 Storm - select a storm frequency consistent with the actual or anticipated land use, suggested:

3.2.1.1 50 year maximum for main conduits and high value areas

3.2.1.2 10 year for upstream connecting conduits.

3.2.2 Sanitary

3.2.2.1 The average daily domestic water consumption shall be based on the monitoring data collected by each institution. Where data is not available, the consumption shall be based on 550 ℓ/day/user. The total users shall be the total inmate population plus one third of the total institution staff.

Water requirements for food preparation and dishwashing are included in this allowance.

3.2.2.2 Water requirements for laundry and industrial shall be based on accepted practice,historical data and manufacturers' recommendations. Estimate the minimum and maximum flows where they cannot be measured using the following relationships:

- Maximum daily: Average daily x 2.50
- Minimum daily: Average daily x 0.75
- Peak: Mean rate during the maximum 15 minutes for any 12 month period. For CSC Institutions take at 4 times the average daily.

3.2.2.3 The population and industry estimates should be those anticipated during the design period, which should not be less than 25 years for sewer mains.

3.2.2.4 The above consumption may be modified in accordance with reliable historical data from existing similar institutions.

4. SECURITY CONSIDERATIONS

4.1 Surface Drainage

4.1.1 Inside Perimeter Fence

Minimize the use of open channels in areas within the perimeter. In general, surface drainage will be by buried storm sewers. The use of culverts must be submitted to C.S.C. for approval.

4.1.2 Outside Perimeter Fence

For the area 100 m outside the perimeter fence, open channels, wide and shallow rather than narrow and deep shall be used whenever practical. Where culverts are required they shall not permit the entry of an inmate as a possible hiding place. This may be achieved by the use of multiple small culverts rather than a single large size or the installation of metal bars at outlet.

4.2 Manhole Covers

In Medium and Maximum institutions all manholes and catch-basins within the perimeter fence shall be secured with special fastenings to prevent unauthorized entry. Specify standard covers and frames to be modified as follows: (See Figure SU-1-1)

4.2.1 Covers: Drill three equidistant 20 mm holes near the perimeter to receive 16 mm stainless steel hexagon head bolts. Countersink for washers and bolt heads to ensure a flush installation.

4.2.2 Frame: Drill and tap frame to receive the bolts from the cover. Specify lugs if necessary for this purpose.

4.3 Perimeter Fence Crossings

4.3.1 To prevent possible escape routes, minimize the number of sewer pipes larger than 350 mm OD within the perimeter fence by locating larger mains outside the fence with branch connector lines from within.

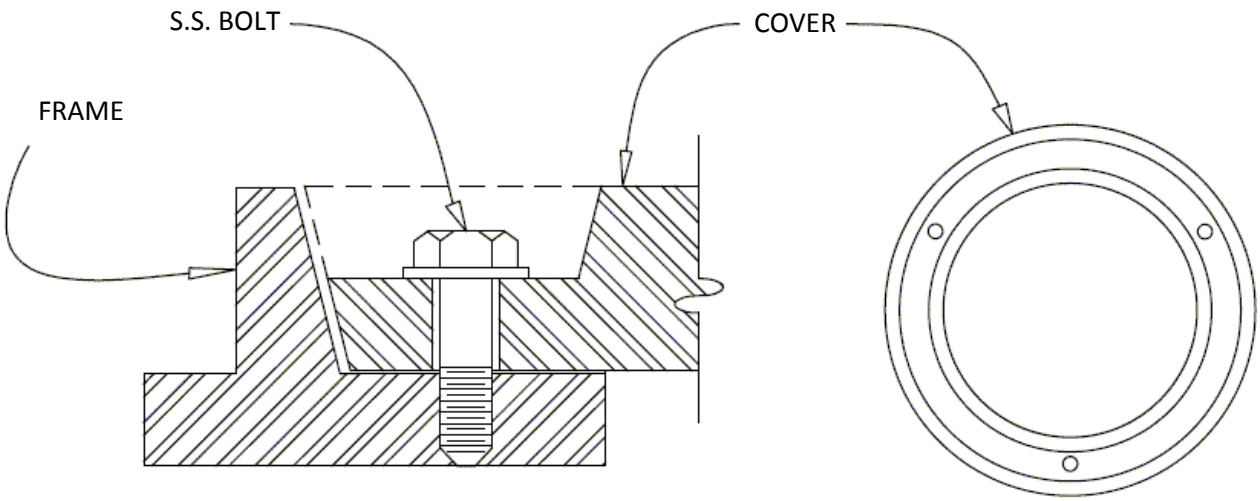
4.3.2 For a Medium and Maximum institution, if a sewer line larger than 350 mm OD is required to cross the perimeter fences, insure that it cannot be used as an escape route. An acceptable solution is to provide distributing manholes on both sides of the fences and run the required number of 350 mm OD (or smaller) pipes joining the two manholes. Refer to Plates SU-1-2 and SU-1-3 and table 1 for details.

4.4 Perimeter Intrusion Detection System (PIDS)

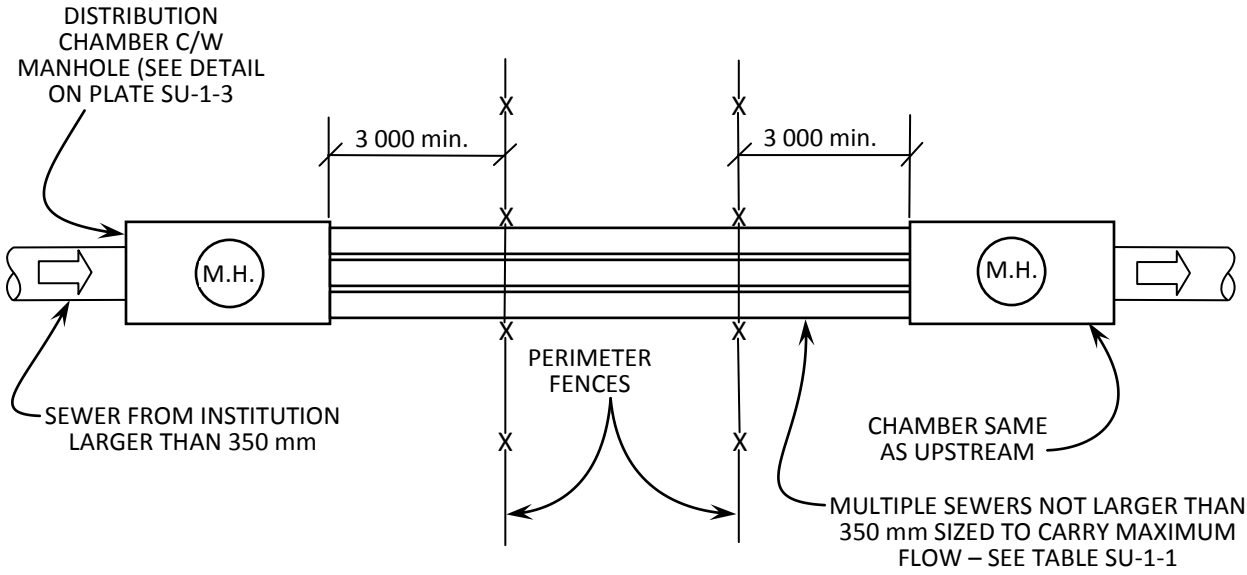
Requirements

4.4.1 Since the PIDS (Motion detection in-ground system) may be affected by both metal pipes and variable flowing liquids, all pipes crossing the perimeter fence for Medium and Maximum institutions shall be a minimum of 1.5 m below grade. This requirement need not be followed at the sally port.

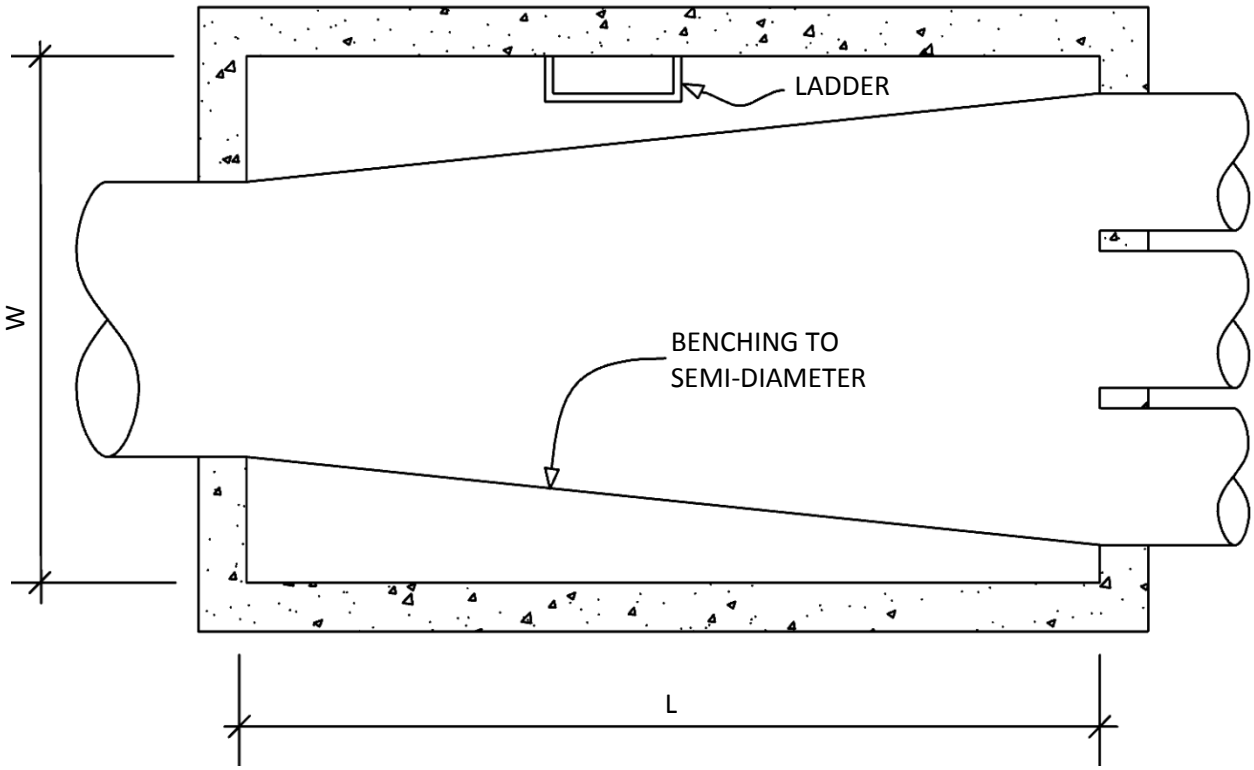
4.4.2 Any liquid flow with changing mass, such as varying flow in partly filled sewer or storm drainage pipes, must also be a minimum of 1.5 m below grade even if the pipes are non metallic.



SU–1–1 – SECURITY MANHOLE COVER



SU–1–2 – LARGE SEWERS CROSSING PERIMETER FENCES – GENERAL LAYOUT PLAN



SU–1–3 – LARGE SEWERS CROSSING PERIMETER FENCES – DISTRIBUTION CHAMBER DETAIL

TABLE SU–1–1 – DISTRIBUTION CHAMBER DIMENSIONS

INLET DIAMETER mm OD	NO. OUTLET PIPES	H mm	W mm			L mm
			1 Tier	2 Tier		
350 to 500	2	30	1 100			2.0 W
600	3	30	1 600			2.0 W
700	4	30	2 000			2.0 W
750	5 (3 + 2)	40		1 600		2.5 W
800	6 (3 + 3)	40		1 600		2.5 W
900	7 (4 + 3)	45		2 000		2.5 W

H = Difference in invert levels between inlet and lowest tier outlet
W = Chamber width internal
L = Chamber length internal

SU-2 SITE UTILITIES – WASTEWATER (SEWAGE) TREATMENT

1. SCOPE

The intent of this section is to set out technical guidelines and criteria for wastewater treatment facilities serving CSC Institution properties.

2. RELATED DOCUMENTS

This section should be read in conjunction with the following as applicable:

SP–1 – Site Planning and Development
SU–1 – Storm and Sanitary Sewers
SU–3 – Water Utility
M–2 – Plumbing Requirements

3. DESIGN CONSIDERATIONS

3.1 This section deals with property sanitary wastewater treatment systems including pre-treatment, (screening, comminution and grit removal), primary treatment, secondary treatment and the disposal of the products of treatment.

3.2 Storm water will not be treated unless there are exceptional environmental requirements.

3.3 All drainage infrastructure and wastewater treatment facilities shall be designed and constructed in accordance with CSC's CD 318-6[1], all applicable Federal, Provincial and local legislation, regulations codes and standards.

3.4 The quantity of wastewater to be treated shall be determined from potable water use data for each institution or from reliable data from existing similar institutions. The design period should not exceed 20 years.

3.5 All treatment plant shall be designed with a level of redundancy in each treatment components to allow for repair and maintenance without requiring bypass or shut down.

3.6 Loadings forecasts wastewater treatment systems may be based on reliable historical data from existing similar institutions or in the absence of such data use the following:

	Allowance per person	
	BOD	SS
Inmates/Patients	0.175 kg/day	0.20 kg/day

3.7 The minimum criteria for wastewater treatment shall meet the requirements as set out in CSC's Management of Wastewater Treatment Systems Guideline CD318-06, the Environment Canada Wastewater Systems Effluent Regulations and local (provincial/ municipal) discharge criteria.

3.8 Sewage systems discharging to on site lagoons shall include screening and will not rely solely on comminution.

3.9 High and low level sewage alarms shall be installed and properly transmitted to a station that is manned on 24 hours a day.

[1] CD 318 – Guidelines 318-6 – Management of Wastewater Treatment Systems (2003-06-11)

4. SECURITY

4.1 Treatment plant installations shall be designed so as to prevent unauthorized entry.

4.2 Suitable remote monitoring and warning devices shall be provided at the technical services work station and if this is not manned on a 24 hour basis critical alarms shall be run to the Main Communication Control Post (MCCP).

4.3 Assess the implications of power failure and where warranted connect to emergency standby power facilities. Redundant pump and other critical components shall have control systems that provide for automatic lead lag rotation and engagement in the event of failure of the primary unit.

4.4 It cannot be stressed too strongly that wastewater treatment at CSC Institutions is not the same as wastewater treatment under normal municipal circumstances. Inmate behaviour may lead to deliberate vandalism and misuse of system and must be considered. As such wastewater treatment technology used should be able to effectively deal with significantly higher plastic and fabric loads; shall be industry standard with wide industry usage and local serviceability.

SU-3 SITE UTILITIES – WATER UTILITY

1. PURPOSE

1.1 The intent of this section is to set out technical guidelines and criteria for domestic and fire protection water supplies serving CSC Institution properties.

1.2 This criterion is to be used to supplement Public Works Canada, , applicable plumbing, building and Fire code requirements. In particular, potable water systems shall be designed and constructed to meet Health Canada's Drinking Water Guidelines and to support the applicable system requirements specified in the most recent version Health Canada's publication *Guidance for Providing Safe Drinking Water in Areas of Federal Jurisdiction*[1].

1.3 Departures from this Document shall be supported by explanation and data satisfactory to CSC and all authorities having jurisdiction.

1.4 Design of the site fire protection systems are subject to the approval of CSC Engineering and Maintenance, Chief Fire Protection Engineer. All codes should be respected, but the Chief Fire Protection Engineer has the final decision.

2. RELATED DOCUMENTS

2.1 This section should be read in conjunction with the following TCD sections as applicable:
SP–1 – Site Planning and Development
SP–5 – Traffic Circulation and Parking
SU–1 – Storm and Sanitary Sewers
SU–2 – Wastewater Treatment
M–2 – Plumbing
M–3 – Fire Protection

2.2 In addition the following will be observed as applicable:
2.2.1 PWGSC Design and Construction Branch Standards and Guidelines
2.2.2 Government of Canada Master Specifications
2.2.3 Canadian Guidelines for Drinking Water Quality
2.2.4 Provincial Drinking Water Guidelines
2.2.5 Guidance for Providing safe drinking water in areas of federal jurisdiction
2.2.6 Local applicable codes and requirements

3. SCOPE

The scope of the design work of project water utility systems includes the following:

- Connections to the building systems 2 m outside the building
- Site distribution and metering
- Connections to public utility main(s)
- CSC owned and operated water supply and treatment system
- Domestic and fire protection water storage.

4. INSPECTION

Establish responsibility regarding payments and inspectional requirements to obtain final approvals by the authorities having jurisdiction.

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[1] Health Canada – Guidance for Providing Safe Drinking Water in Areas of Federal Jurisdiction - Version 1 – 2005, ISBN: H128-1/05-440E, Cat. No.: 0-662-41691-0
http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/guidance-federal-conseils/index-eng.php

5. EMERGENCY POWER

All water treatment and supply equipment, alarm, controls, and accessories requiring electrical power should be supplied with emergency secondary power supply.

6. BASIC DESIGN REQUIREMENTS

Establish contact with local utility company, municipality environmental protection agency, and municipal fire department to obtain the following information:

6.1 Existing water main(s) location, size and elevation

6.2 Utility water residual pressure for the Project flow requirements.

6.3 Allowable, water capacity supplied by the utility company, and security of supply

6.4 Requirements relating to water metering system

6.5 Requirements relating to the division of responsibility with regard to the extent of work to be provided by the Utility and/or User.

6.6 Requirements relating to the type and quality of the materials utilized for the site water systems.

6.7 Requirements relating to the acceptable minimum and maximum sizes of the Project water connection(s) to the utility main(s).

6.8 Requirements relating to the acceptable type and process system of the water treatment and make up facilities, if required.

6.9 Requirements relating to the water disinfection system.

6.10 Location of the existing fire hydrants.

6.11 Thread standards for the site fire hydrant and fire department connections.

7. WATER DISTRIBUTION AND FIRE HYDRANT

7.1 Consider separate domestic and fire protection water distribution systems.

7.2 Site water distribution system should be designed forming sectionalized loops and providing at least two service connections to each major building.

7.3 Water meter assemblies should be located in pits or buildings, accessible to the utility company generally outside the perimeter fence.

7.4 Site distribution loop used for domestic water system only should be of the size required by consumption, but should not be smaller than 100 mm in diameter.

7.5 Site distribution loop used for domestic and fire protection water should be at least 200 mm in diameter. Give justification for any recommendation of main sizes larger than 250 mm.

7.6 Water pressure in the site distribution loop should not be less than 50 PSIG.

7.7 Design and specify adequate number of loop sectionalizing valves, as required by the building and loop layout.

7.8 All bends, fire hydrants and branch 'tees' in the underground distribution lines should be designed with the required trust blocks.

7.9 Valves controlling water supply, including sectional valves, with the exception of those controlling an individual hydrant, shall be the “Post Indication Type” sectional valves and shall be designed so that the majority of hydrants may remain in service during a water outage caused by a break or maintenance.

7.10 Except as otherwise stated in this document, hydrants (including associated piping and valves) shall be designed and installed per the requirements of NFPA 24 “Standard for the Installation of Private Fire Service Mains and their Apparatus”.

7.11 Fire department connections shall be located in supervised areas and accessible to fire department apparatus at all times.

7.12 Fire department connections shall be located so that the distance from a fire department connection to a hydrant does not exceed 45 m and is unobstructed.

8. WATER QUANTITIES

8.1 Domestic Water Consumption shall be based on the following:

8.1.1 The average daily domestic water consumption shall be based on existing potable water use data for the institution or existing similar institutions. Data must be verified for specific locations / institutions. A range for consumption may vary between 300-600 litres/day. The total users shall be the total inmate population plus one third of the total institution staff. Water requirements for laundries, food preparation and dishwashing are included in this allowance.

8.1.2 Water requirements for large scale laundry facilities, industrial and irrigation shall be added to the above amount and shall be based on accepted practice, historical data and manufacturers' recommendations.

8.1.3 Estimate the minimum and maximum flows where they cannot be measured using the following relationships:

- Maximum daily: Average daily x 2.50
- Minimum daily: Average daily x 0.75
- Peak: Mean rate during the maximum 15 minutes for any 12 month period. For CSC Institutions take at 4 times the average daily.

8.1.4 The above consumption may be modified in accordance with reliable historical data from existing similar institutions.

8.2 Water required for fire protection shall be as outlined in M-3:6 – SPRINKLER SYSTEM.

9. WATER SUPPLY

To guard against interruption of service the water supply shall meet the following requirements:

9.1 When available the water supply shall consist of two separate connections to different municipal utility mains with adequate quantity to meet fire protection requirements.

9.2 Where only one connection is practical from a municipal supply or if the quantity is not adequate to meet the fire requirements, supplement municipal supply with on site storage tanks or reservoirs and pumping system. See M-3:9 – FIRE PUMPS for fire pump requirements.

9.3 Where no municipal supply is available, provide a private supply and on site storage with pumping systems.

10. WATER TANK

10.1 The capacity of the water storage tank shall meet the requirements of both the domestic water supply and fire protection water unless non potable water supply is used for fire protection.

10.2 Domestic water storage shall be not less than 24 hours reserve of the average calculated water consumption.

10.3 Fire protection water quantity shall be as specified in M-3:6 – SPRINKLER SYSTEM.

10.4 Design system with at least two tanks or compartments and a separate pump well so that one compartment or tank can be cleaned or repaired while the other can continue to provide water service.

10.5 Water storage tanks shall include, as a minimum, flow through operations and consideration will be given to including active mixing technologies.

10.6 Any pumps or fittings in storage tanks, shall be designed and installed such that they may be serviced or replaced without having to drain or enter the tank.

10.7 All potable water storage tanks shall have securely locking access doors or lids. The lock shall be such that tampering will leave an indication.

10.8 Storage tanks located outside shall be located inside a chain link security fence with Bollards on all four corners.

11. PRIVATE WATER SUPPLY

11.1 General

11.1.1 Where a municipal water supply is not available, a private supply must be found and a thorough survey of all possible sources shall be made by a qualified hydrogeologist and certified well driller.

11.1.2 Where adequate supply of non potable water is available consider separate fire protection and domestic water supply and storage systems.

11.1.3 Prior to undertaking any groundwater investigations, the local authority responsible for granting groundwater permits shall be consulted

11.2 Wells

11.2.1 Prior to undertaking any groundwater investigations, communication with local authority responsible for granting groundwater permits is required.

11.2.2 All local (municipal or provincial) well drilling requirements, including reporting requirements, shall be followed.

11.2.3 The design and construction of a well shall follow the recommendations in Health Canada's *Guidance for Providing Safe Drinking Water in Areas of Federal Jurisdiction* (see footnote 1) in addition to applicable best management practices.

11.2.4 The design and construction of the well(s) shall be adapted to the geologic and the ground water conditions existing at the site of the well in order to provide a sufficient and safe water supply, and to conserve the ground water resource.

11.3 Water Treatment

11.3.1 Water treatment technologies will be designed based on the raw water analysis and results from a vulnerability assessment.

11.3.2 Treatment should aim to reduce corrosion in the distribution system while ensuring final water quality conforms to the Canadian Drinking Water Quality Guidelines.

11.3.3 Water sampling taps will be provided between each treatment technology to allow monitoring of treatment efficiency.

11.3.4 Disinfection will be applied to all finished water such that a disinfection residual in the distribution system conforms to the requirements listed in CD 318-10[2].

Water softening should be considered when calcium carbonate ($CaC0_3$) concentrations in the water exceed 150 parts per million or where required by authorities having jurisdiction.

[2] CD 318 – Guidelines 318-10 – Drinking Water Quality Management (DWQM) (2009-10-28)

11.3.5 When water softening is required consider designing a dual distribution system throughout the building, each with header type mains, i.e. a hard water and a soft water system. Connect water closets and urinals to the hard water system. Connect domestic hot water tank, boiler feed water, humidification systems, make up and fill, etc. to the soft water system.

SU-4 SITE UTILITIES – POWER SUPPLY AND ELECTRICAL POWER DISTRIBUTION

1. SCOPE

This section outlines the performance requirements and design guidelines for the electrical power supply and distribution system.

2. RELATED DOCUMENTS

2.1 This section should be read in conjunction with the following TCD sections as applicable:

SP–1 – Site Development
SP–4 – Site - Exterior Lighting
E–1 – General Electrical Engineering & Electrical Distribution

2.2 In addition, the Canadian Electrical Code Part I[1] will be observed as applicable:

2.2.1 Where this document is more stringent or contradicts a code or standard this document shall override. Approval from CSC must be obtained before any variations from this document are incorporated into any designs.

2.2.2 For the purpose of this document, "High Voltage" is 750 volts and above.

3. POWER SUPPLY AUTHORITY

3.1 The following details regarding the power supply available and point of connection shall be obtained from the local Power Authority.

3.1.1 System Data:

- Voltage, configuration, insulation level and neutral grounding arrangement.
- Available system short circuit present and ultimate future. Values should be both 3 phase bolted fault and line to ground fault.

3.1.2 System operating information:

- Voltage regulation.
- Operating procedures, capacitor switching
- Determine if re-closures are used and whether single or 3 phase.
- Restrictions or requirements with regard to maximum relay settings or fuse sizes at customers service for co ordination.
- Available records concerning history of failures, repair times, duration of power outages.

3.1.3 System connection information:

- Location and type of connection overhead or underground.
- Whether transformer vault required or desirable.

3.1.4 Metering information:

- Preferred method of metering primary or secondary.
- Rate structures, with allowances for high voltage connection, customer owned transformation.
- Special demand charges and power factor penalty.
- Acceptability of additive metering at more than one point on low voltage side of service, such as for dual or triple transformer station.
- Related additional charges, if any.

[1] CSA C22.1-09 – Canadian electrical code (21st edition), part I, safety standard for electrical installations

3.2 In addition to the above details, the following shall be investigated:

3.2.1 The availability of alternate supply connection.

- alternate feeder same route
- alternate feeder alternate route
- alternate feeder alternate station
- Identify power supply authority charges for any other of the above arrangements which are available.
- If available, obtain historical data concerning failure rates and repair times.

3.2.2 Study economics of customer owned versus utility owned transformer and connection voltages.

3.3 Obtain approval of the following from the local Power and Inspection Authorities having jurisdiction:

- Proposed service entrance equipment,
- Switchgear,
- Duct manhole systems,
- Direct buried or overhead systems,
- Transformers and associated equipment.

4. LOAD DETERMINATION

4.1 Carry out preliminary load study, including location of major load distribution centres.

4.2 Allow for 100% lighting load plus an appropriate demand factor on the remaining load, based on operating characteristics.

5. SERVICE LOCATION AND CONFIGURATION

5.1 Underground service is preferred.

5.2 For medium, maximum and multi security level projects underground service must be considered for voltages less than 50 kV.

5.3 Underground service is to start at least 75 meters from the compound fence. Overhead service should be limited to buildings outside the compound.

5.4 For minimum security level projects, service may be underground or overhead.

- Underground service should always be considered for voltages less than 35 kV.

5.5 High voltage main service switchgear and related distribution with or without large station transformation should be configured to recognize the following criteria:

- Minimize steps of transformation as governed by economics.
- Underground distribution is preferred between buildings and service points within the project.
- Medium, maximum and multi security level projects require all power distribution between buildings to be underground.
- in minimum security level projects, where long runs to load centre connection points occur, overhead distribution at high voltage should be considered, as dictated by economic factors.

5.6 Underground services from power supply connection to service location shall be conductors in reinforced concrete encased duct banks.

- In medium, maximum and multi security level projects, an underground distribution within the compound shall consist of conductors in reinforced concrete encased duct banks.

- Conductors shall be installed in reinforced concrete encased duct banks under all hard surfaces such as asphalt or concrete.
- Where practical, for long runs in "soft" landscaped areas of medium security projects, distribution feeder conductors between buildings or service connection points may be direct buried with suitable bedding.
- Spare ducts for future growth are a mandatory requirement. Minimum size of underground ducts should be 78 mm, with pull in ropes.
- Provide one spare duct for each pair of ducts required.
- Whenever services for medium, maximum and multi security level installations are routed under security fences, such services must be minimum 2 meters below ground level.
- Drainage of ducts and pull boxes is extremely important. Pull boxes should be connected to storm sewer drainage system.
- Underground Pull Box requirements for Power and Communications distribution should be outlined. Identify sizes, concrete, galvanized steel lids suitable for vehicular traffic, padlock able lids, identification. Wherever possible locate in non-vehicular areas.

5.7 Where service tunnels are provided for other utilities they should be used for electrical distribution wherever possible.

6. LINE CONSTRUCTION

6.1 Design and specify construction of underground service and distribution facilities and overhead lines in accordance with Canadian Electrical Code Part 3 "Outside Wiring Rules" which consist of the following CSA Standards:

- CSA C22.3 No. 1-10 – Overhead Systems
- CSA C22.3 No.3-98 (R2007) – Electrical Coordination
- CSA C22.3 No. 4-1974 (R2004) – Control of Electrochemical Corrosion of Underground Metallic Structures
- CSA C22.3 No. 7-10 – Underground systems

6.2 For wood poles reference CSA Specification Series:

- CAN/CSA-O15-05 (R2009) – Wood Utility Poles and Reinforcing Stubs
- CAN/CSA-O80 Series-08 – Wood Preservation

7. ELECTRICAL EQUIPMENT VAULTS

7.1 Where vaults for electrical equipment are required, design and specify in accordance with Canadian Electrical Code Part I and to suit local requirements of the electrical Inspection Authority.

7.2 Locate vaults for ease of access and equipment maintenance. Consider special security requirement for openings doors, vents, fences, etc.

8. EXISTING CONDITIONS

8.1 Consult available documents provided by Correctional Service Canada and locate all existing buried services shown such as electrical, telephone lines, water and sewer lines, gas mains, etc.

9. CABLES FOR OUTSIDE SERVICE

9.1 For underground, References are:

- CSA C22.2 No. 1 – Overhead Systems and Underground Systems (ie)
- CSA C68.2 – Concentric Neutral Power cables
- CSA C68.3 – Power cable with Thermoset Insulation
- CSA C22.2 No. 131 – Type Teck cable
- CSA C22.2 No. 124 – Mineral Insulated copper or aluminium Sheathed cables
- CSA C22.2 No. 51 – Armoured cables (2a, 1c)
- XLPE insulation preferred.

9.2 For overhead lines consult with the local power authority as to their specific requirements and also consider copper conductor, bare and weather resistant for low voltage, A.C.S.R. for high voltage.

9.3 References:

- I.C.E.A. P 51 432 – Copper conductor, bare and weather resistant.
- CSA C49.1 – Aluminium conductor steel reinforced (ACSR)
- CSA C49.2 – Compact aluminium conductor steel reinforced (ACSR)
- CSA C22.3 No.1-10 – Overhead systems and underground systems (ie)

10. CONDUCTOR TERMINATIONS

10.1 Specify compression connectors with bolted pad for interface to bus or aerial lug.

10.2 For high voltage cable specify outdoor type porcelain body factory produced slip on terminators, complying with *IEEE Standard 48-2009*[2].

11. CONDUCTOR TESTING

11.1 Specify that the following certified reports be supplied for all type of cables rated between 5kV and 46kV.

11.1.1 Partial discharge extinction level in accordance with *CSA Standard C68.3-97 (R2006)*[3].

11.1.2 Five minute high voltage AC test to be done in the factory in accordance with *CSA Standard C68.3-97 (R2006)* and *C22.2 No. 0.3-09*[4].

11.1.3 Insulation resistance test in accordance with C68.3-97 (R2006) and C22.2 No. 0.3-09 (see footnotes 3 and 4).

11.1.4 High voltage D.C. acceptance test for fifteen minutes after installation and before the cable is placed in regular service in accordance with C68.3-97 (R2006) and C22.2 No. 0.3-09.

11.2 Apart from the above test all conductors up to 46 kV shall undergo the other tests in accordance to their respective CSA Standard.

12. HIGH VOLTAGE SERVICE EQUIPMENT

12.1 For all high voltage service equipment specify:

- Metal enclosed switchgear assemblies in a switchboard or switchboards in accordance with CSA Standard *C22.2 No. 31-04 (R2009)*[5].

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[2] 48-2009 – IEEE Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500kV

[3] CAN/CSA-C68.3-97 (R2006) – Shielded and Concentric Neutral Power Cables Rated 5-46 kV

[4] C22.2 No. 0.3-09 – Test methods for electrical wires and cables

[5] C22.2 No.31-04 (R2009) – Switchgear assemblies

- For more detailed definitions of components and assembly types refer also to *ANSI/IEEE C37.100-1992*[6].
- *Definitions for Power Switchgear*.

12.2 For large main station type configuration specify:

- Full compartmentalization for *Metal Clad Switchgear*.
- Draw out power circuit breakers.
- Copper bus.
- Main incoming switching devices un-fused load interrupter type.
- Provisions for high voltage (primary) metering by utility if agreed.
- Customer metering to include voltmeter, ammeter. Provision for connection of portable monitoring and/or metering in the field for kW (kilowatt), kWh (kilowatt-hour), Power factor, harmonics, etc.

12.3 Ensure adequate space, ventilation cleanliness and moisture free to ensure against tracking.

NOTE: Special treatment for bus will be required where run through compartment walls, i.e.: high voltage insulated sleeves or grommets.

12.4 For voltages 15kV and lower, where specifying dry type high voltage main transformers "Unit Substation" type construction is preferred.

- Refer to "Unit Substation" definition in *ANSI/IEEE C37.100-1992* (see footnote 6) and *EEMAC Standard G13-1, 1978*[7].

12.5 For high voltage breakers, preference is for:

- solid state type relaying with low power requirements in trip actuating circuit thus permitting effective use of current transformer output as source of tripping power and avoiding station battery.
- also consider manual operation.
- 15kV and below specify air circuit breaker or minimum oil type. Above 15kV use minimum oil.

12.6 For small distributed type services, consider fused load interrupter type switchgear and;

- Indoor unit substation configuration up to 15kV.
- If outdoor specify full height full voltage class equipment and ensure flexible high voltage connection between switchgear and transformer.
- Outdoor switchgear and transformer installed on concrete pad, surrounded with crushed stone.
- High voltage fuses, specify "Power Fuses" as defined in *ANSI C37.100-1992*[8] and in accordance with *ANSI C37.46-2000*[9], also refer *ANSI/IEEE C37.40-2003*[10] and *ANSI/IEEE C37.41-2008*[11].
- Use E rated fuses.

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6 C37.100-1992 – IEEE Standard Definitions for Power Switchgear

7 EEMAC G13-1, 1978 – EEMAC Standard for Unit Substations

8 C37.100-1992 – IEEE Standard Definitions for Power Switchgear

9 C37.46-2000 – American National Standard for High Voltage Expulsion and Current-Limiting Type Power Class Fuses and Fuse Disconnecting Switches

10 C37.40-2003 – IEEE Standard Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories

11 C37.41-2008 – IEEE Standard Design Tests for High-Voltage (>1000 V) Fuses, Fuse and Disconnecting Cutouts, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Fuse Links and Accessories Used with These Devices

NOTE: For grounding and fencing requirements refer to *CSA C22.2 No. 0.4-04 (R2009)*[12]

12.7 For station grounding design refer to Canadian Electrical Code Part I[13] and *IEEE Standard 80-2000*[14].

12.8 For all installations provide surge arrestors to protect power cable, switchgear and transformers. Select arrestor class and rating to suit system and voltage. Consult utility. Base selection on:

- *ANSI C62.2-1987*[15].
- Specify manufacture and testing in accordance with *ANSI/IEEE C62.1-1989*[16].

12.9 Allow for future expansion by using adequate space and access for addition of future equipment.

13. HIGH VOLTAGE TRANSFORMERS

13.1 For distribution within buildings for systems 400 kVA and over, secondary voltage normally preferred is 600 volt - 3 phase grounded wye.

- Secondary system may be 4 wires or 3 wires.

(NOTE: 4th wire or neutral should always be taken to main service switchboard and grounded. Some utilities may require the neutral for metering.)

Smaller systems may be lower voltage such as 208/120V 3 phases 4 wires subject to restrictions imposed by motor loads, etc. Unless clearly impractical 3 phase systems are preferred

13.2 When applying high voltage transformers refer to and specify in accordance with the following standards.

- Power Transformers: *CAN/CSA-C60044-5:07*[17]
- Distribution Transformers *CAN/CSA-C2.1-06* and *CAN/CSA-C2.2-06*[18]
- Dry type Transformers *C9-02 (R2007)*[19]

Apply transformer types in accordance with the following table:

Configuration	H.V. (primary)	L.V. (secondary)	Indoor	Outdoor
Main Stn.	Below 15kV	600V	Dry type C9	Power type C88
Dist. Stn.	Below 15kV	600V or lower	Dry type C9	Dist. Type C2
Main Stn.	15kV to 46kV	600V	LNAN C88	ONAN C88
Dist. Stn.	15kV to 46 kV	600V or lower	LNAN C2	ONAN C2
Main Stn.	15kV to 46 kV	600V or lower	LNAN C88	ONAN C88

[12] CAN/CSA-C22.2 No. 0.4-04 (R2009) – Bonding of Electrical Equipment
[13] CSA C22.1-09 – Canadian electrical code, part I (21st edition), safety standard for electrical installations
[14] 80-2000 – IEEE Guide for Safety in AC Substation Grounding
[15] C62.2-1987 – IEEE Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems
[16] C62.1-1989 – IEEE Standard for Gapped Silicon-Carbide Surge Arresters for AC Power Circuits
[17] CAN/CSA-C60044-5:07 – Instrument Transformers – Part 5: Capacitor Voltage Transformers
[18] CAN/CSA-C2.1-06 – Single-Phase and Three-Phase Liquid-Filled Distribution Transformers
CAN/CSA-C2.2-06 – Pole-mounted, Single-phase Distribution Transformers for Electric Utilities
[19] C9-02 (R2007) – Dry-Type Transformers

13.3 Transformer winding and connection arrangement generally preferred is:

- H.V. primary – Delta
- L.V. secondary – grounded wye

However, refer to *ANSI/IEEE C57.105-1978 (R2008)*[20]. Particularly note and Review possibility of Ferro resonance for each application. Where necessary to guard against Ferro resonance use connections and winding arrangements such as:

- H.V. primary – grounded wye
- L.V. secondary – grounded wye

with common ground point for both windings.

NOTE: Requirement for additional loop in magnetic circuit to compensate for negative sequence current due to unbalanced loads and specify 4 or 5 legged core.

13.4 Select transformer size to suit load

- main service configuration
- distribution system size and configuration

For 600 volt secondary, transformer size should be selected to limit maximum let through RMS symmetrical short circuit current to 34,000 amperes which implies a maximum 2500 kVA transformer with 6.5 to 7.0% impedance.

Fan cooled rating would be 3300kVA.

Refer to details for distribution system size and configuration under Section E-2 Electrical Distribution.

13.5 Specify copper windings for high voltage and low voltage. Specify temperature rise tests on all transformers. Specify BIL tests on all dry type transformers.

13.6 Ensure transformers are installed with adequate ventilation.

Oil filled transformers should be installed in a secure enclosure constructed to protect for explosion and fire.

For liquid filled transformer installation refer to *IEEE C57.93-2007*[21] (filling the transformer *IEEE C57.91-1995*[22] and *IEEE C57.91-1995/Cor-2002*[23].

For dry type transformer installation refer to *CSA C9-02 (R2007) Appendix A* [24] .

[20] ANSI/IEEE C57.105-1978 – Guide for Application of Transformer Connections in 3-phase Distribution Systems
[21] C57.93-2007 – IEEE Guide for Installation and Maintenance of Liquid-Immersed Power Transformers
[22] C57.91-1995 – IEEE Guide for Loading Mineral-Oil-Immersed Transformers
[23] C57.91-1995/Cor 1-2002 – IEEE Guide for Loading Mineral-Oil-Immersed transformers Corrigendum 1
[24] C9-02 (R2007) – Dry-Type Transformers

14. COMMISSIONING

14.1 Specify preparation of a load study as part of the contract. The load study is to be reviewed and commented on by the design engineer. The study is then to be submitted to CSC.

14.2 The load study is to contain full load current readings of all feeders connected to 50 ampere circuit interrupting devices and larger. Currents are to be read at the line side of the feeders if possible.

14.3 The load study is to contain voltage readings taken at the load side of the feeders. Transformer taps shall be adjusted within 2% of rated voltage of equipment.

14.4 The load study is to identify loads i.e. are they motors, lighting or heating.

14.5 Specify balancing of loads.

14.6 Specify for contractor to demonstrate that systems operate as design intended them to operate and that contractor must be prepared to operate each device, such as switches, relays etc., to the satisfaction of CSC and PWGSC personnel involved in the acceptance procedure.