Appendix C
Water System Design Criteria

C.1 Minimum Design Standards

C.1.1 Introduction

The following design standards are the minimum allowable by the District for any and all water improvement projects, whether designed by the District or by another engineering firm/agency. The intent is that all projects be designed to the same standard to ensure uniformity of final product and of cost to the financier. The sections that follow indicate incorporated standards, DOH and District approval requirements, and general, urban and rural design standards. Standard material and installation specifications (for construction contracts) are included in District's Water System Plan.

Good design of projects is a goal of the District. Although these standards are intended to apply to physical development within the District, the standards may not apply for all situations. Compliance with these standards does not relieve the designer of the responsibility to apply conservative and sound professional judgment. These are minimum standards and are intended to assist, but not substitute for, competent work by design professionals. The District may at its sole discretion for any reason place more stringent requirements on a project than would normally be required under these standards.

Waiver of specific design criteria indicated in this Plan must be requested in writing and may be approved only by the District's General Manager. The decision to grant, deny or modify the standards will be based upon evidence that the request can meet the following criteria:

a. The change will achieve the intended result in a comparable or even superior design and a better quality of improvement; and

b. The change will not adversely affect safety and/or operation; and

c. The change will not adversely affect maintainability.

C.1.2 Incorporation of Other Standards

The latest edition of the existing standards listed below is hereby incorporated by reference, as modified herein:

- Minimum Design Standards, Chapter IV, Regional Supplement, Skagit County Coordinated Water System Plan
- Standard Specifications for Road, Bridge and Municipal Construction (WSDOT/APWA) including APWA Supplement

- Standards of the American Water Works Association
- IAPMO Uniform Plumbing Code and Installation Standards
- ICBO Uniform Building Code
- International Building Code
- Water System Design Manual, Washington State Department of Health
- Recommended Standards for Water Works, Great Lakes - Upper Mississippi River Board of State Sanitary Engineers
- Cross Connection Control Requirements, AWWA Pacific Northwest Section

C.2 Design Standards

The following standards apply to all areas served by the District, regardless of local government or land use policies. In cases of conflict between the standards and any District regulation, the District regulations shall govern.

C.2.1 Ownership

All water lines and appurtenances when accepted shall be and remain the exclusive property of the District for future operation, maintenance and service responsibilities. The point of District ownership and responsibility shall end at the meter or detector check valve, unless otherwise stated in the District's letter of final acceptance. District ownership and responsibility for double check valves and double check detector backflow assemblies shall end at the gate valve on the water main at the point the fire service line is connected (on easements on private property) or at the property line (on public rights-of-way).

C.2.2 Design Responsibility

Water plant plans and specifications shall be prepared under the supervision of and signed by a professional engineer registered in the state of Washington, and shall comply with the design standards of the District. Plans shall indicate new water plant in bold, existing water plant in normal weight, and all other utilities in half-tones, all on one drawing. The designer shall confirm design requirements and criteria with the District's Engineering Department. The District may develop plans and specifications for a customer as the District's workload allows. For design by a private engineer, the Applicant shall deliver a copy of the final design, acceptable to the District, to the District prior to commencement of work, then a photocopy mylar and compact disk (CD) of the final record drawings to the District upon completion of work.

C.2.3 Design Review and Approval

Per WAC 246-290-110 and -120, the designer of any new water system, water system extension, or improvement to be accepted by the District must submit a project report and

construction documents (plans and specifications) to competent authority for review and approval.

C.2.3.1 Distribution Improvements

a. Per WAC 246-290-125(1), the following types of projects are not required to receive approval of DOH prior to installation:

   1. Installation of valves, fittings and meters, including backflow prevention assemblies;
   2. Installation of hydrants under WAC 246-290-230;
   3. Repair of a system component or replacement with a component of similar capacity and materials in accordance with the original design; and
   4. Maintenance or painting of surfaces not contacting potable water.

b. Per the approval of the District's Water System Plan by DOH, the District is authorized to construct new distribution mains (or replace existing with new mains of larger capacity) for its own water systems without prior approval of DOH, PROVIDED the District maintains a copy of the completed ***Construction Completion Report*** on file for each project. The ***Report*** forms are found as Figure 4-2 Design Standard in the DOH Water System Design Manual.

c. For each distribution improvement indicated in paragraphs a. and b. above, the District shall ensure:

   1. the project is designed per the District's design criteria, whether designed in-house or by a consultant; and
   2. the project is completed per District's standard construction specifications, whether installed by in-house staff or a private contractor.

C.2.3.2 Distribution-Related Improvements

Per the approval of the District's Water System Plan by DOH, the District is authorized to review and approve distribution-related improvements (water plant facilities appurtenant to distribution mains) for its own water systems, including but not limited to: booster pump stations, distribution reservoirs (tanks), transmission pipelines, repainting of potable water facilities, etc. but **not** including source or treatment facilities.

For each distribution-related improvement project approved by the District, the District shall:

- have a professional engineer (licensed in Washington state, on District staff, separate from the designer) review the project reports and construction documents for each such distribution-related improvement, and complete an ***Engineering Design Report*** form for such project's file;
- have a professional engineer (licensed in Washington state, on District staff, separate from the design engineer) complete a ***Construction Completion Report For***

Submittal Exception Process for each such project. Submit a copy of the ***Report*** to DOH for each project that includes new storage tanks or booster pump stations; and

- when necessary, submit a revised Water Facility Inventory (WFI) to DOH per WAC 246-290-100.

The ***Engineering Design Report*** and ***Construction Completion Report For Submittal Exception Process*** forms are found as Figures 4-3 and 4-4 in Design Standards in the DOH Water System Design Manual.

C.2.3.3 Source of Supply and Treatment Improvements

The District shall submit to DOH for review and approval a project report and construction documents for each District project relating to source of supply or treatment facilities.

C.2.4 Added Source of Supply Considerations

Source water and facilities for District water systems shall conform to the requirements of DOH. The District will pay special attention to:

- Surface Water/GWI: water rights, water quality, water quantity, instream flow requirements, treatment system, and watershed control/wellhead protection (GWI).
- Groundwater: water rights, water quality, water quantity, geologic study showing confining layers and relation to neighboring wells, pump test(s), treatment system, and wellhead protection. Wells to serve the District's water systems shall be drilled and cased and shall be in conformance with WAC 173-160 and RCW 18.104. Casings shall be vented and shall include a port and tubing for checking static water level.

The District reserves the right to place additional requirements on source development to ensure adequate water quality.

C.2.5 Urban vs. Rural Standards

The majority of these design criteria apply to both urban and rural areas of the District's service areas. These design standards may specify different criteria for specific facilities in urban and rural areas. Urban design standards shall apply to District water systems within City limits, urban growth areas and rural villages per adopted Skagit County Comprehensive Plan(s). Rural design standards shall apply to all areas outside City limits, urban growth areas and rural villages per adopted Skagit County Comprehensive Plan(s). Exceptions to downgrade from these urban/rural criteria require the written approval of the General Manager of the District; the District reserves the right to coordinate such exceptions with County and city agencies.

C.3 Water Distribution Mains

C.3.1 Pipe Sizing

All main extensions and replacements shall be sized by the District based on District hydraulic and pressure requirements, using domestic and fire demands which may be reasonably expected over the life of the pipe, to comply with the District's basic water policy outlined in this section. Final approval of water pipe sizing shall rest solely with the District. In all cases, pipe size shall meet Washington State Department of Health (DOH) minimum standards. (1626)

All elements of the District's system shall be sized: (1626)

a. to provide a minimum of 30 psi and preferably 40 psi, during peak hourly design flow conditions, at every service connection (meter) in the projected pressure zone; or (1626)

b. to provide at least 20 psi, during fire flow and peak hourly design flow conditions, at every service connection in the projected pressure zone (fire flow shall be as required by the Fire Marshal having jurisdiction); or (1626)

c. to flow water no faster than 10 fps in ferrous pipe and 8 fps in non-ferrous pipe under the conditions stated in conditions (a) and (b) above,

whichever is more stringent. (1626)

The District, the Applicant for new service, or existing Customer requesting increase in service capacity, shall provide such line extensions and/or replacements required to satisfy its flow and velocity requirements and/or minimum pipe size as delineated in this Section. The District reserves the right to increase the pipe diameter for present or future needs of the District. The District will make this determination. If the District chooses to implement this option, the District may pay the difference in cost between the Applicant's flow requirements and/or minimum pipe size as delineated in this Section.. The financing method and approval of increased pipe sizes will require Commission approval. (1626)

Urban Area. Water mains shall be a minimum of 8-inches in diameter, unless otherwise hydraulically justified and approved by the District. Water mains shall be sized to provide the fire flow required by the Fire Marshal having jurisdiction, but not less than the values indicated in Table C-1. Fire flow velocities and pressures will normally govern pipe sizing, rather than domestic flow requirements. The use of buried 3-inch pipe is not authorized as it has minimal installed-cost benefit over 4-inch pipe.

Rural Area. Water mains shall be sized as hydraulically justified based on source pressure, future gridding, peak hour demands, fire flow (if required by the Fire Marshal) and flushing requirements, with a minimum size of 2-inches in diameter. The use of buried 3-inch pipe is not authorized as it has minimal installed-cost benefit over 4-inch pipe.

C.3.2 Materials (1626)

The District's minimum pipe standard is AWWA C151 Thickness Class 50 ductile iron pipe with push-on gasketed joints. All ductile iron pipe installed in soil shall be encased in 8-mil thick polyethylene per ANSI/AWWA C105/A21.5 prior to backfill. Should soil testing determine that the surrounding soils are corrosive, or that stray electrical current is present, the District may determine that AWWA C-900 PVC or C-906 HDPE will be required. Buried PVC mains shall use gasketed joints wherever practical. HDPE mains shall be flanged or butt-welded. Solvent-welded PVC slip joints shall be minimized; where used, solvent welds shall comply with manufacturer's installation requirements. Pipe used above grade or in vaults shall be Thickness Class 53 ductile iron, brass, or Schedule 80 PVC; PVC shall be joined with Ford PAK-JOINTs unless otherwise approved by the District. Tracer wire shall be used over all water mains and water service lines. Tracer wire shall be No. 10 solid copper wire and shall be brought up in each valve box, water service box and connected at all tees, crosses and service saddles. (1626)

PVC and HDPE pipe shall not be used in soils with existence of or potential for hydrocarbon contamination. Ductile iron pipe used in such soils shall use gaskets of Viton or Fluorel, or other FPM gaskets acceptable to the District.

All mains 4-inches in diameter and larger shall be at least Thickness Class 50 ductile iron, unless otherwise allowed; flanged iron pipe shall be of at least Thickness Class 53. PVC mains 4-inches in diameter and larger where allowed shall be AWWA C-900 PVC Pressure Class 200 (DR 14). All mains 2-inches in diameter shall be at least pressure rated 200 psi (SDR21) PVC or 200 psi HDPE. Ductile iron fittings shall be used on all water mains 4-inch and larger; 2-inch water mains shall use FORD Pak-Joint connectors and brass fittings.

Should a District project be paid for in part with federal funds or financed with federal funds, federal specifications may supersede the District standard for pipe materials. The federal requirements will not be considered precedent-setting and will not be applicable to non-federal funded or financed projects. The remaining provisions of this Code shall not be affected. (1626)

C.3.3 System Layout

Water pipe shall be designed to lie in a public road right-of-way, or if not available, on a dedicated, recorded ingress-egress utility easement. Permanent easements shall be a minimum of 20 feet in width. Pipe shall be designed for maximum trench depth of 48 inches and an average depth to top of pipe of about 3 feet. All pipe shall maintain a positive or negative slope between respective high and low points in the waterline; high points shall be fitted with air-vacuum release assemblies and low points shall be fitted with flushing assemblies as determined necessary by the District. All layout by private consultants shall be coordinated with and reviewed by the District for conformance with these and other requirements prior to issuance of final construction documents.

C.3.4 Length of Water Main Installation Requirements (1626)

C.3.4.1 Rural Unplatted Areas

In "rural unplatted" areas the water line shall be extended one length of pipe beyond the structure of the residence or the structure of the commercial establishment. (1410)."

C.3.4.2 Urban Areas and Rural Platted Areas

The Applicant will be required to install pipe across its entire front footage of its lot/land in urban growth, city and platted areas. When more than one dwelling or establishment is to be served by a water main, and a public road, street, or private roadway provides access to the dwellings or establishments, the District will require a water main to be installed in front of the dwellings or establishments to the far edge of the property being served.

C.4 Water Services (1626)

C.4.1 General

All water services shall be metered. To obtain a meter, the Applicant must apply for and pay all fees associated with a water service prior to installation of the meter. Fees include, but are not limited to, water service/meter installation fee, system development fee, customer deposit, and latecomer's fee (if applicable). All fees shall be based on the current schedule for each fee in effect at the time of payment. Meter size shall be based on Uniform Plumbing Code fixture count criteria. Costs associated with waterline extension(s)/replacement(s) must also be paid in full prior to installation of a water service on the waterline.

The minimum meter size available shall be a 5/8-inch meter. Meters shall be sized per the most current Uniform Plumbing Code/International Plumbing Code. (1626)

C.4.2 Domestic Water Services

Water mains constructed in platted areas shall include the installation of water service lines to common or individual lot corners. New services in nonplatted areas may be located by the Applicant. Water service installation shall include all materials indicated on the appropriate standard detail. Service lines that are part of a water main extension shall be installed concurrently with the water main installation. Services shall be connected to the water mains and extended to the Applicant's lot line, with a tailpiece extended above the ground, prior to pressure and bacteriological testing of the water main, if applicable. A meter box shall not be installed until frontage grades are established and all water service fees are paid. The cost of service lines installed as part of a water main extension shall be borne by the Applicant as part of the water main installation cost.

C.4.3 Irrigation Water Services

Designers of each new large irrigation system shall submit Blaney-Criddle Water Balance calculations and other data required to justify demands to the District for review before the new irrigation service is approved and installed. The new irrigation customer shall complete an Irrigation Agreement with the District as a condition of service.

C.4.4 Water Service Lines.

Service lines for 1-inch or smaller water services will normally be 1-inch polyethylene pipe, rated for 200 psi service, with a copper tracer wire. Service lines in soils with potential for or existence of hydrocarbons shall use 1-inch diameter Type K soft copper pipe, with compression fittings suitable for Type K copper pipe for 1-inch and smaller water services.

One and one-half inch and two inch services shall use 200 psi polyethylene pipe or Schedule 80 PVC on short side and less than 20'-0" in length (PUD note: this should be shown on details. They can be revised when changes are made). Service lines in soils with potential for or existence of hydrocarbons serving 1-1/2 and 2-inch water services shall use 2-inch diameter soft type K copper pipe. Three inch and larger services shall use class 53 ductile iron pipe. (1626)

Water service lines within platted areas shall be installed across streets and to common lot corner locations concurrent with the water main installation. The service lines will be connected to the pipelines and extended to lot lines with a tailpiece extended above the ground. Meter boxes shall not be installed until lot frontage grades are established and water service actually applied for. Water service stubouts to property corners shall be in place prior to pressure and bacteriological testing of the water main. Water service stubouts from the water line to the property corner(s) shall be part of the pipe installation cost to be borne by the Applicant. (1626)

Water services should not exceed 300 feet from the meter to the point of use, in order to maintain adequate pressure. Services over 300 feet in length are permitted, however, the District cannot assure adequate pressure for these services. In areas where static pressures are low or the service line will be unusually long, the District/Applicant should consider upsizing the service line to minimize frictional pressure losses and water velocity. (1626)

C.4.5 Meter Costs (1626)

An Applicant must apply and pay for a water service with meter prior to installation of the meter. In addition to the metered service cost, new water services are required to pay a System Development Fee to the District (See Appendix A, Table A-6). The Applicant will be required to pay the System Development Fee and applicable meter installation fee as required by the regulation(s) in effect at the time a water meter is paid for. Water meters and related appurtenances will be installed by the District, the District's contractor, or by the Developer's contractor under District supervision. (1626)

C.4.6 Pressure Reducing Valves at Water Services (1626)

The Applicant may (PUD Note) install pressure-reducing valves on water services when static line pressures exceed 80 psi. At the Applicant's request, the District will calculate or measure the water pressure at the Applicant's point of delivery as an aid to determining whether a reducing valve is required. Pressure reducing valves, when required, shall be installed and maintained by the Applicant. Pressure reducing valves are not to be installed in the meter box. (1626)

C.5 Control Valve Stations

A control valve station (pressure reducing, pressure sustaining, etc.) shall be installed at the interface between pressure zones; the District shall select the final location of each control valve station. Control valves shall be sized based on anticipated fireflows at projected peak hour demand conditions. If the receiving pressure zone contains a storage reservoir, the control valve station shall contain a single control valve with slow-acting pilot; if the receiving pressure zone contains no storage reservoir, the control valve station shall contain duplex control valves (6x2, 8x3, etc.) and a pressure relief valve. Control valve stations shall normally be on a bypass to the main waterline, shall be located below grade in a concrete vault, and shall include a mainline meter. The pressure relief valve shall discharge visibly above grade to a catch basin or other appropriate structure and drain away to a non-environmentally sensitive area.

On high pressure transmission lines, a pressure and/or flow control valve, and a pressure relief valve for high volume connections, shall be installed between the transmission line and the customer's water service/distribution line connection.

C.6 Mainline Meters

Mainline meters shall be located along transmission lines, between pressure zones, and at urban growth area boundaries to record the transfer of water between areas. Each mainline meter station shall normally be below grade in a concrete vault. The station shall include the meter and a test tee. The meter shall be located in-line, with uninterrupted flow upstream and downstream as recommended by the manufacturer, and shall be sized for maximum projected demands during the life of the meter. The mainline meter shall also, if required by the District, have a waterline bypass around the meter vault.

C.7 Backflow Prevention

The District is responsible for protecting its water systems from actual and potential contamination. Current State and federal laws prohibit any cross-connection, actual or potential, between a system furnishing potable water and a system furnishing non-potable water. The District's Construction Department shall ensure the prevention of back flow using cross-connection control assemblies is in conjunction with Cross Connection requirements listed in Section 2.5.5. Cross-connection control assemblies shall be installed by the Applicant when deemed necessary by the District or when required. The entire cost of the installation shall be borne by the customer and shall remain the Applicant's ownership and responsibility. Annual

testing of such assemblies shall be made by a Washington State Certified Backflow Assembly Tester. The District shall receive the original test results document. Each customer shall maintain its cross-connection control assembly(ies) in a fully functioning condition. All DOH and District conditions shall be satisfied as a condition of District water service.

C.8 Storage (Tanks)

The District's goal is to provide standby storage in each local area of at least 800 gallons per service. This is equivalent to two days of peak residential use and four times the residential planning figure of 200 gpsd. Storage shall include operational storage, equalization storage, standby storage and fire storage, as required, and shall be sized for the projected number of services in the water system, or area of the water system to be served by the storage, over the water system's useful life. Each developer with a substantial project requiring new storage facilities as part of the project shall be responsible for the storage capacity for the project; the District may elect to increase the capacity of a new reservoir(s) and bear the incremental increase in cost. Each new storage reservoir shall incorporate the following essential design considerations:

1. Design each reservoir per the most current version of AWWA tank design standards (D-100, Welded Steel Tanks; D-103, Bolted Steel Tanks; D-110, Wire Wound Circular Prestressed-Concrete Water Tanks), using the pseudodynamic effective mass procedure. Cast-in-place concrete reservoirs shall be designed per ACI 318, Building Code Requirements for Reinforced Concrete and Circular Concrete Tanks without Prestressing, Portland Cement Association. All reservoirs shall be designed for wind speed of 120 mph, seismic zone 3, and roof live load of 125 psf. Design the reservoir foundation based on the recommendations of a geotechnical engineer, including soil bearing, drainage, settlement potential and stability of the soils under design seismic conditions.
2. Design each reservoir with adequate freeboard. Freeboard shall be measured from the high water level (top of the overflow pipe) to the top of the reservoir wall, and shall be sized to allow for sloshing of the reservoir in an overflow condition, including for water treatment plant clarifiers and filter units, to ensure that walls and roof structures will not be adversely affected during the design seismic event.
3. Measure reservoir capacity from the normal operating hi-pool level (a point 12-inches below the overflow elevation) to the low water level (at the top of the outlet pipe or silt stop, whichever is higher).
4. Cover each reservoir and fit with water-tight, insect proof hatch(es), manway(s) and atmospheric vent(s). Furnish each vent with woven stainless steel insect screen, minimum 24 ga., secured gap-free with stainless steel straps; roof slope shall be minimum 1/4-inch per foot.
5. Furnish each reservoir with lightning arrestor(s) and electrical grounding, as appropriate.
6. Furnish separate floor penetrations for inlet, outlet, overflow, and drain piping. Locate all floor penetrations within 5 feet of the reservoir wall. Design the floor to slope to the outlet and drain pipes, with the high point near the center of the reservoir floor.

7. Fit all inlet, outlet and drain piping with flanged isolation gate valves to permit isolating the reservoir from the water system. Locate reservoir isolation gate valves five (5) feet outside the reservoir foundation line.
8. Specify all underground piping penetrating the reservoir floor to be of welded Schedule 40 SS304 stainless steel to five (5) feet outside the reservoir foundation line; use of restrained joint or flanged Class 53 ductile iron or welded steel as material alternatives requires prior written authorization by the District. Fit all pipelines penetrating through steel floor decking with reinforcing rings welded to the pipeline and floor. Fit all penetrating pipelines through concrete flooring with water stops welded to each pipe, centered within the concrete floor slab. Fit inlet and overflow piping with flanges approximately one foot above the reservoir floor. Design drain and outlet lines to be flush with the reservoir floor.
9. All reservoir pipes passing more than one (1) foot beyond the reservoir foundation shall be connected to outside piping with restrained joint flexible connectors (EBAA double ball Flex-Tend or approved equal). Locate each flexible connector outside the reservoir foundation, starting at the flanged pipeline or valve.
10. Lay out the outlet pipeline with a minimum of fittings to flow directly to the distribution system, with a minimum of fittings. Fit the outlet with an externally weighted or spring-loaded check valve to prevent inadvertent filling of the reservoir through the outlet. On reservoirs fed by gravity (not a pump system), the inlet line shall be fitted with an altitude valve (one-way delayed opening); connect the altitude valve sensing line to the outlet line (upstream of the check valve) or the drain line (upstream of the gate valve). For pumped systems, provide no control valve on the reservoir inlet line. Locate any inlet altitude valve and outlet check valve in a vault outside the reservoir foundation. Drain the vault to daylight.
11. Fit the outlet with a removable 6-inch high silt stop inside the reservoir.
12. Size the drain to empty the full contents of the reservoir without causing damage to the water distribution system or inducing erosion at the drainage outlet. Lay out the reservoir drain line(s) to drain to daylight to a County-approved stormwater detention facility or, if approved, directly to storm sewers, sanitary sewers, or overflow pond. Each reservoir drain line connection shall contain at least a 12-inch air gap and such devices as are required to prevent animals and insects from entering the reservoir drain system.
13. Overflow piping shall each be sized with the hydraulic capacity to discharge 125 percent of maximum inflow capacity. Air vent(s) shall each be sized with the pneumatic capacity to discharge 125 percent of maximum inflow capacity and 125 percent of the maximum drainage rate.
14. Inlet and overflow pipe risers within the reservoir may be of ductile iron, PVC or painted steel. Inlet piping shall extend from the inlet flange approximately 2/3 of the reservoir height and shall be fitted with an 45° angled nozzle to assist circulation within the reservoir. Overflow piping shall be fitted with a flare on top. Support all inlet and overflow pipes with suitable bracing or struts from the adjacent reservoir wall.
15. Fit all painted reservoirs with drain plate, scuppers and downspouts, or other suitable rainwater “streak protection”.

16. All interior bracing, fittings and fasteners shall be of SS316 stainless steel. Interior ladder shall be of SS316 stainless steel or 300#-rated fiberglass. Exterior ladder and all exterior fittings shall be G-60 hot-dipped galvanized and painted.
17. Locate a sample tap on the reservoir side of the outlet check valve.
18. Coat steel reservoirs with interior coatings of an NSF-approved epoxy paint (TNEMEC Pota-Pox or equal) and exterior coatings of a polyurethane paint (TNEMEC or equal). Provide cast-in-place concrete reservoirs with an interior coating of NSF-approved waterproof material to prevent water migration through the concrete.
19. Locate an alarm system on the reservoir site for high level and low level conditions, annunciating through a suitable SCADA communication system to District Operations personnel. Provide a pressure transducer on the reservoir side of the drain valve (or the outlet check valve) and a float switch at the overflow pipe, each connected to the SCADA system.
20. Provide local level indication as part of the SCADA system and, if required by the District, provide a pressure gauge measured in "feet".
21. Provide BEST brand padlocks on all roof access hatches, vents, ladder guards, and fence gates to prevent unauthorized entry and/or vandalism. All locks shall be keyed to match the District's factory registered keying system.
22. Provide the District safe, legal permanent access to the reservoir site, including but not limited to: roads of adequate width, grade and condition for District construction equipment, keys to private gates or space for District locks in series, and ingress-egress-utility easements for vehicle access, pipelines and related utilities to support the reservoir site.
23. Provide deeded title for the reservoir site to the District; a dedicated permanent easement may by acceptable if segregation of the reservoir site lot would create a substandard parent lot.
24. Specify leakage testing, cleaning and disinfection per AWWA standards. The District will provide specific direction for each individual reservoir project.
25. Provide specific details and construction specifications per Appendix F of the District's Water System Plan, unless otherwise modified by the District.

C.9 Pump Stations

1. Size pump systems serving an area with reservoir storage to refill the reservoir(s), in 72 hours while meeting maximum day demands; the District has found that its maximum day demands are approximately 75 percent of its peak hour demands. Size pump systems serving an area without storage to provide at least peak hour demands.
2. Base maximum day demands and peak hour demands on the buildout of the area to be served, as determined by the District in coordination with the local land use authority.
3. Design all District pump stations to include the following items, as a minimum:
   a. Minimum 4-inch reinforced concrete floor (2,500 psi minimum 28-day strength). Provide cast-in-place reinforced concrete inertia block for each pump, minimum 18-inches high

above finished floor. Provide looped ferrule threaded inserts for securing each pump to base.

b. Floor drain with grate, properly plumbed away from the building to daylight or an approved storm sewer system. Size floor drain to be a minimum of 6-inch diameter.

c. Separate rooms for electrical and pump equipment, with exterior access to each.

d. Interior and exterior paint, color and number of coats per District selection.

e. Lockable doors (hollow metal doors and frames; BEST cylinder, core and keyway to match existing District factory registered key system).

f. Standing seam metal roofing material approved by District, over plywood sheathing system acceptable to roofing manufacturer; minimum 24-inch overhang all four sides.

g. Adequate pump house venting (eaves, wall dampers, doors, etc.).

h. Commercial wiring installed per National Electric Code (NFPA 70).

i. Thermostat-controlled wall heater, 1500W minimum, (no heat lamps) in each room.

j. Suitable interior and exterior lighting. Interior lighting shall be suitable for damp location, with hand switch in respective room. Exterior lighting to be operable by photocell, with override switch inside pumphouse.

k. Manual electrical power transfer switch (in electrical room) and emergency power wiring box (exterior, near power entrance); auxiliary suction and discharge connections for a portable pump, if approved by the District.

l. All interior and underslab water piping shall be sized for potential buildout of the area to be served.

m. Interior piping: 4-inch and larger of minimum Class 53 ductile iron with ductile iron fittings; 2-inch and smaller of Schedule 80 PVC with FORD Pak joints, Type L copper with sweated fittings, or threaded brass with brass fittings. Pump manifold(s) shall be secured. Flexible connections required for pump(s).

n. Pipe and fittings under the floor slab shall be of Class 53 ductile iron, restrained with Grip-Rings or Mega-Lugs. Pipe penetrations through the floor (or wall) shall be sleeved or wrapped with a thin bond breaker (e.g. 1 wrap of #15 roofing felt).

o. Furnish pump(s), plumbed and secured to inertia block. Provide duplex/replacement pump if required by District. Motor(s) shall meet NEMA 12.6C (high efficiency). Booster pumps shall be ANSI end-suction type; Goulds or approved equal. Test pumps through full range of conditions prior to project completion.

p. Provide flanges and valves at pressure tank(s), booster pump(s), etc. to allow removal of equipment.

q. Telemetry-SCADA-Control Systems-See Section C.13

r. Master (source) meter installed within the pump house. Meter must be accurate to 99 percent through full range of flow through the pump system, and provide a 4-20mA signal or pulse output to the SCADA system.

s. Bladder tank(s), if required.

t. On well systems (well casing shall be located outside well house or booster pump station):

- System documentation (restrictive covenant, water right, geologic report, wellhead protection plan, 4 and 72 hour pump tests, etc.)
- Raw water tap in wellhouse installed minimum 6-inches above floor.
- Disinfection/treatment system inside wellhouse, as required.
- Groundwater surface level measurement system.

u. Motor control(s) shall be either solid state reduced voltage starter or variable frequency drive, as selected by the District. Reduced voltage starters for 20 hp and larger pumps shall include a pump algorithm for soft start and stop. For pumps serving a pressure zone with a storage reservoir, a PRV shall be plumbed to allow water to return to the suction pressure zone for fire demands; the associated gate valve may be normally closed, at the District's discretion. There shall also be a valved bypass between pressure zones; the valve shall be normally closed.

v. Skid-mounted pump/pressure tank units may be allowed for temporary service to a small portion of a service area (pressure zone) that will expand within the life of the pump station.

w. Telemetry/SCADA & Control Systems See Section C.13

Comply with additional requirements of Urban and Rural Standards indicated below, as applicable.

1. Minimum Urban Standards. Permanent pump station structures shall be of fully grouted reinforced concrete masonry unit (CMU) construction. Unless otherwise dictated by the building department of the local government having jurisdiction, design the exterior of the building to be split-face CMU, the roof to be wood framed with standing seam metal roofing with matching gutters and downspouts; all colors to be as selected by the District. Mount a W-section monorail and chain-lift trolley within the pump room, above the door, centered over the pump base(s).

2. Minimum Rural Standards. Design permanent pump station structures of insulated 2x6 wood framed construction meeting UBC. Set wall framing on a minimum 3-1/2-inch high concrete curb, integral with the concrete floor slab. Specify pressure treated floor plates. Design exterior sheathing to be at least shop grade T-1-11 plywood, minimum 1/2-inch thickness. Design interior sheathing to be 1/2-inch ACX plywood. Provide gutters and downspouts on front fascia only. All color selection(s) to be by the District.

C.10 Fire Protection

C.10.1 General

Fire protection by fire hydrants and/or other means shall be required as determined by the Fire Marshal for the County or respective City. Spacing of fire hydrants shall be as determined by the Fire Marshal, using Table C-1 as a minimum standard. The cost of each hydrant installation requested by a customer shall be borne totally by that customer.

The cost of each hydrant installation required by the Fire Marshal for a District-sponsored waterline replacement project shall be borne by the District; the cost of each additional hydrant beyond this requested by another party shall be borne by that party. Final ownership of a hydrant shall be transferred to the District, except on private property when not accessible to the public. (1626)

Rural Standards. Fire protection is not required in rural areas except at cluster developments, per Chapter IV of the Skagit County CWSP and Table C-1 above. Tanker-truck-filling hydrants will be installed in rural areas during system upgrade and expansion at major roadway intersections, whenever practical. The distance between tanker truck filling hydrants shall not exceed one mile. More frequent spacing is optional and subject to approval of the General Manager or funding by parties other than the District.

C.10.2 Commercial (1626)

a. Fire protection by fire hydrants and/or other means shall be required as determined by the person designated as "fire chief" for the jurisdiction involved. The District will not allow installation of fire hydrant(s) on water mains wherein the potential demand of the hydrant will exceed safe operating velocities as established in Section C.3.1(c). (1626)

Table C-1
Minimum Fire Flow Design Standards For New And Expanding Water Systems[1]

Land Use Designations Or Densities	Minimum Fire Flow (Gallons Per Minute)	Minimum Duration (Minutes)	Maximum Hydrant Spacing (Feet)
Urban Growth Areas [2]			
Industrial	1500	60	[3]
Commercial	1500	60	[3]
Multi-Family Residential	1500	60	500
Single-Family & Duplex Residential	1000	60	500
Non-Urban Growth Areas			
Commercial / Industrial	1500 [4]	60 [4]	[4]
1 Dwelling Unit Per Lot Less Than 2.5 Acres	500 [5]	30 [5]	900 [5]
1 Dwelling Unit Per Lot 2.5 Acres Or Larger	NONE [5]	NONE [5]	NONE [5], [6]
Natural Resource Lands	NONE [5]	NONE [5]	[5], [6]

[1] The design standards may be amended to reflect changes to Comprehensive Plan land use designations and/or their densities. Proposed amendments will be presented to the Skagit County CWSP WUCC for approval.

[2] These criteria establish a minimum water system design standard. Each water system in an urban growth area must comply with the standards of the local government with jurisdiction. When there are different or conflicting standards, the most stringent standard shall apply. Prior to the issuance of a development permit, the approving authority shall establish fire flow, duration and hydrant spacing requirements.

[3] As determined by the appropriate fire official.

[4] Fire flow for individual buildings or groups of buildings is to be determined by the Skagit County Fire Marshal per Uniform Fire Code Appendix IIIA and the Skagit County Fire Marshal policy on fire flow. The application of lesser or alternative standards shall be in accordance with Section 4.3.5 (Interpretation of Standards).

[5] Fire flow will be required for a Conservation and Reserve Development (CaRD) land division as follows.

CaRD Characteristics	Fire Flow Requirement	
5 or more lots	Option 1:	Fire flow of 500 gpm for 30 minutes with hydrant spacing of 900 ft. or,
	Option 2:	Fire Marshal approved fire prevention water system that provides adequate pressure and flow to support NFPA 13D sprinkler systems is required for all residential dwellings. In addition, if the property is located in an Industrial Forest, Secondary Forest, or Rural Resource designated land the fire protection requirements as listed in Skagit County Code 14.04.190(14)(b)(iii)(b-e) also apply.
4 or fewer lots	None required, unless the property is located in an Industrial Forest, Secondary Forest, or Rural Resource designated land. If the property is located in such designated land the fire protection requirements as listed in Skagit County Code 14.04.190(14)(b)(iii)(b-e) apply. However, NFPA 13D sprinklers are only applicable to residential dwellings.	

As of the effective date of the CWSP, where in-fill development or extension of an existing water system occurs to serve an existing platted lot, the Skagit County Fire Marshal may limit the requirement for fire flow or fire suppression in accordance with Table C-1 to the newly developed lot only. Group B public systems may choose to separate the fire flow from water flow. Separate tank and hydrant(s) location is subject to Skagit County Fire Marshal approval.

(6) Hydrants shall be installed when water lines are installed or replaced and are capable of supplying a tanker truck with a minimum of 500 gallons per minute at a minimum residual pressure of 20 psi. Tanker truck filling hydrants are to be located at major roadway intersections and along roads at a spacing not to exceed one mile to assist in fire protection.

b. Application shall be made by completing and signing a standard application form. (1626)

c. Service charge for new fire protection service connection: (1626)

1. The Applicant shall pay the total installation cost of all fire service lines from the Applicant's point of use to an existing or new District main with adequate capacity to provide the required fire flows. (1626)

2. The Applicant shall pay the cost of the detector check meter plus the cost of installation.

3. Notwithstanding the provisions as contained in these schedules for commercial fire protection service, or for other metered service, including water furnished to any fire hydrant or other equipment used, or which may be used for fire protection service connection, it is understood that the District cannot guarantee any minimum quantities of water or pressure of the water to be furnished to any such hydrants or outlets, and the District shall not be liable in any manner for any loss or claim by reason of the quantity of water, or pressure of the same furnished to such hydrant or outlet. (1626)

C.10.3 Residential (1626)

The installation of fire hydrants in residential areas shall be according to City, County and State regulation. The District will refer to the applicable WAC provisions (WAC 248-57) and/or to the person designated as the "fire chief" to the particular jurisdiction for applicable requirements. The District encourages fire hydrant installation on mains large enough and with adequate supply to provide sufficient fire protection. The District will not allow installation of fire hydrant(s) on water mains wherein the potential demand

of the hydrant will exceed safe operating velocities as established in Section C.1.3(c). (1626)

C.10.4 Interface with Fire Jurisdictions

C.10.4.1 General

The District shall develop and implement a long-term program to ultimately meet the CWSP recommendation for fire hydrants and fire protection devices throughout the district under the following criteria: (draft 1542)

a. New Water line Extensions. New water line extensions to the District's system that are provided for the benefit of new customers, including new "stand alone water systems" that are owned and operated by the District, will include hydrants; (draft 1542)

b. Replacement of Existing District Water Lines. Replacement of the District's existing water lines and water line installed by the District to complete grids and for water quality purposes will include fire hydrants as a part of the District's system upgrade program. (draft 1542)

C.10.4.2 Uniform Policy on Installation of Hydrants

The District will utilize the program outlined in this regulation to implement an equitable and uniform policy consistent with the objectives defined within the CWSP. For each Fire Jurisdiction that has executed a Memoranda of Understanding with the District that conform to this Code, this program will include: (draft 1542)

a. An annual District budget allocation to upgrade or add new fire hydrants with consideration of existing conditions within the various cities and fire districts serviced by the District. (draft 1542)

b. a provision allowing Fire Districts and cities to request the District to upgrade or add new fire hydrants or fire flow on an expedited schedule provided the fire district or city provide the additional funds required to meet the District budget requirements. (draft 1542)

c. a provision allowing the District to annually identify the proposed system upgrades and budget for fire hydrants and request input from the cities and fire districts on prioritizing the location and expenditure of the funds identified for fire protection enhancement. (draft 1542)

d. respective responsibilities between the District fire jurisdictions for the operation and maintenance of fire hydrants and private fire system connected to the District water system.. (draft 1542)

C.10.4.3 Hydrant Standards

a. Hydrant Standard. The hydrant standard shall be as specified by the Skagit County Water System Design Standards developed by the CWSP. (draft 1542)

d. Hydrant Spacing. The hydrant spacing and location shall be as specified by the CWSP and adopted by reference by the District. A city or Fire District may request additional hydrants subject to full payment by the requesting customer or agency. (draft 1542)

e. Public Right-of-Way/Utility Elements. All fire hydrants and detector check valves shall be located on public right-of-way or utility easements unless otherwise approved in writing by the District. (draft 1542)

f. Detector Checks and Gate Valve. The District may require detector check valves or gate valves as a part of a fire hydrant or fire service installation. The cost of such facilities shall be paid by the customer. (draft 1542)

g. Minimum Pressure and Flow/Hydrant Code. The District will not install a new fire hydrant on a water line with inadequate flow or pressure except when the installation is part of a scheduled capital improvement program that anticipates hydraulic improvements. The District will provide pressures and flow availability to color-code hydrants. (draft 1542)

h. There may be circumstances where improvements may furnish a hydrant in an area without the current ability to provide adequate pressure. The District will notify the fire marshal(s) affected thereby and will not be liable for any loss or claim based in whole or in part on the installation. (draft 1542)

C.10.4.4 Hydrants on District-Replaced Water Mains.

a. As a part of the District's water main replacement program, the District will seek to relocate existing hydrants and install new hydrants, to upgrade the District system to meet the CWSP criteria. Installation spacing will be as specified within the CWSP. Should a city or fire district desire additional hydrants over the CWSP minimum requirements at the time of a water line replacement, the District will install additional hydrants, at the agencies written request, provided that the requesting agency reimburses the District for all the material costs necessary for the requested hydrant installation. These costs shall include the hydrants and other necessary appurtenances. (draft 1542)

   The District will notify and coordinate with the fire department or district with jurisdiction before hydrant relocation or new hydrant installation is performed. (draft 1542)

b. Mains without adequate flows or pressures. If the water main being replaced does not have pressures or flows that meet minimum CWSP or Department of Health standards, the District will not install fire hydrants or fire hydrant line tees unless system improvements are scheduled. A replacement water main will be retrofitted to include hydrants per the CWSP spacing when the water main can provide adequate

flows and pressures. Scheduling of retrofitting will be at the discretion of the District. (draft 1542)

C.10.4.5 Upgrading Fire Protection Within The District's Existing System

a. The District may install hydrants on replacement lines and other locations at District discretion for public safety and community needs. Hydrants of this nature will be installed as part of the District's capital improvement plan. (draft 1542)

b. To upgrade facilities to meet CWSP recommendations, District will budget to a specified number of (minimum of one) fire hydrants to each of the fire districts' coverage area each year beginning in the calendar year 2005. The District will budget to add additional (minimum of 3) fire hydrants within each of the cities of Burlington, Mount Vernon, and Sedro-Wool1ey's city limits each calendar year beginning in 2005. If fire departments request fire hydrant installation in addition to the established formula, the requesting fire department's request will be deemed advisory unless the requesting agency pays for the additional fire hydrant installation. (draft 1542)

c. Assigned Operation and Maintenance Responsibilities. Table C-2 below outlines the major tasks and assigned shared responsibilities to maintain and operate the fire hydrants. These responsibilities shall be confirmed in writing prior to the District proceeding with the addition of new hydrants as a part of the system upgrade program or accepting ownership of new hydrants. Fire District/Department and District responsibilities for Operation and Maintenance of fire hydrants shall be as follows unless otherwise agreed to in writing. (draft 1542)

   The District shall be the sole judge of when a hydrant is in satisfactory condition. The District shall not consider hydrants with hose ports only (no pumper port) for replacement, providing the hydrant otherwise is mechanically functional. The District desires input from fire departments, however, will consider the input advisory. (draft 1542)

d. Cost Sharing. The customer will be responsible for the cost of all new installations unless the District has included the cost of the hydrant as a part of the District annual budget process. The city or fire district will be responsible for their share of the cost of implementing the operation and maintenance agreement. (draft 1542)

Table C-2		
Task		**Agency**
A.	Inspection of new installation	Fire Department
B.	Review of installation and type of hydrant, ports, and valves	Fire Department
	Testing and flow pressure	Fire Dept/District
	Operation of tee valve	District
	Private/Building system (Wet and Dry)	Fire Department
C.	Clearing Vegetation and Brush for visibility	Fire Department
D.	Location of Hydrants (per CWSP)	Fire Department
E.	Mechanical maintenance and repair	
	Public Property	District
	Private Property	Hydrant Owner
F.	Regulations (per CWSP)	Fire Dept/District
G.	Painting and coding:	
	Application of paint (initial installation)	Fire Department
	Purchase and specification of paint	Fire Department
	Color and coding	Fire Department
	Repainting fire hydrants	Fire Department
	Numbering	Fire Dept/District
H.	Notification of District's personnel in case of major fires, when hydrants are used for fire fighting training, or testing purposes.	Fire Department
I.	Communication (Emergency alert, system, etc.)	Fire Dept/District
J.	Hydrants that have been damaged or need replaced because of being damaged beyond repair.	District
K.	Notification of hydrants out of service	Fire Dept/District

C.11 Cathodic Protection

Impressed current is commonly used in Skagit County by gas and other utilities to protect their ferrous pipe from corrosion. Unprotected ferrous (iron or steel) water mains adjacent to these protected pipes can deteriorate if sufficient stray current is present. When 5 mV/ft or more of stray electrical current is identified in soil to receive a new ferrous waterline (or where one is already installed), the District will require the waterline to be protected. An acceptable method of protection is to make the waterline electrically continuous (have the lengths of pipe bonded together) in the area of high stray current and bond the waterline to the other utility's pipe. If this is not acceptable to the other utility, a sacrificial anode and test station may be wired to the waterline and the anode installed away from the waterline, approximately 24-inches from the protected pipe. The District will monitor these test stations at least annually. At the District's sole discretion, the ferrous waterline may be replaced with PVC C-900 pressure class 200 (DR 14) pipe for that portion influenced by the stray current (see "Pipe Materials" earlier in this section).

C.12 Security

All District above-ground facilities (pump stations, reservoirs, etc.) shall be secured within a 6-foot high WSDOT Type 1 chain link fence with three strands of barbed wire on supports above the fence and gates. At least one operable "magnate" gate shall be installed per site; a vehicle gate is required for each site with vehicle access.

C.13 Telemetry and Control Systems - General

C.13.1 Description

This section specifies general requirements which are applicable to all process Telemetry/SCADA systems consisting of process sensors, monitoring and control instruments, and accessories required to provide a complete and functional monitoring and control system.

The Control System Integrator (CSI) shall provide, calibrate, and assist in the testing of the complete process Telemetry system. The System Integrator shall also place the completed system in operation including tuning loops and making final adjustments to instruments as required during plant start-up and he shall provide the services of instrument technicians for testing and adjustment activities.

This specification is an extension of, and includes all of the requirements of The WSDOT Standard Specifications and all work shall comply with the applicable sections of the Standard Specifications.

C.13.2 Definitions

a. General: The definitions of terminology used in these specifications shall be defined in ISA Standard S51.1, unless otherwise specified.

b. Solid State: Circuitry or components of type which convey electrons by means of solid material such as crystals for which work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, stepping motors, or other devices are not acceptable substitutes for solid state components or circuitry.

c. Integrated Circuit: A number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.

d. Two-wire Transmitter: A transducer which derives operating power supply from the signal transmission circuit and therefore requires no separate power supply connections. As used in this specification, two-wire transmitter refers to a transmitter which produces a 4 to 20 milliampere current regulated signal in a series circuit with a 24 volt direct current driving potential and a maximum circuit resistance of 600 ohms.

e. Galvanic Isolation: Pertaining to an electrical node having no direct current path to another electrical node. As used in this specification, galvanic isolation refers to a device with electrical inputs and/or outputs which are galvanically isolated from ground, the device case, the process fluid, and any separate power supply terminals, but such inputs and/or outputs are capable of being externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.

f. Panel: An instrument support system which may be either a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process

control systems. Panels may provide mechanical protection, electrical isolation, and protection from dust, dirt, and chemical contaminants which may be present in the atmosphere. Panel shall include consoles, cabinets and racks.

g. Data Sheets: Data sheets as used in this specification shall refer to ISA S20.

h. Signal Types: The following types of signals are used in systems specified in this division.

1. Low Level Analog: A signal that has a full output level of 100 millivolts or less. This group includes thermocouples and resistance temperature detectors.
2. Digital Code: Coded information such as that derived from the output of an analog to digital converter or the coded output from a digital computer or other digital transmission terminal. This type includes those cases where direct line driving is utilized and not those cases where the signal is modulated.
3. Pulse Frequency: Counting pulses such as those emitted from speed transmitters.
4. High Level Analog: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4-20 mA transmission.
5. Modulated Signals: Signals emanating from modems or low level audio signals. Normal signal level is plus 4 dBm to minus 22 dBm. Frequency range is 300 to 10,000 hertz.
6. Discrete Events: Dry contact closures monitored by solid state equipment. If the conductors connecting to dry contacts enter enclosures containing power or control circuits and cannot be isolated from such circuits in accordance with NEC Article 725, this signal shall be treated as low voltage control.
7. Low Voltage Control: Contact closures monitored by relays, or control circuits operating at less than 30 volts and 250 milliamperes.
8. High Level Audio Signals: Audio signals exceeding plus 4 dBm, including loud speaker circuits.
9. Radio Frequency Signals: Continuous wave alternating current signals with fundamental frequency greater than 10 kilohertz.

i. Control System Integrator: An organization engaged in the business of detail designing, component purchase, assembly, programming and implementing process control and industrial electronic systems.

C.13.3 Description of System

C.13.3.1 General

The Telemetry and control system shall include the instruments, control devices, programmable controllers, input and output devices, sensors, interfacing devices, cabinets, enclosures and other components indicated and implied by the Drawings and Specifications.

The control system shall be designed, assembled to provide:

a. Control of motor driven pumps, equipment, and processes.
b. Monitoring of operation of motor driven pumps, equipment, and processes.
c. Indication of operating status of motor driven pumps, equipment, and processes

C.13.3.2 Project Specifics

C.13.4 Quality Assurance

C.13.4.1 References

All equipment and materials shall conform to the latest revised editions of applicable standards published by the following organizations:

- American National Standards Institute (ANSI).
- Institute of Electrical and Electronic Districts (IEEE).
- National Electrical Manufacturers Association (NEMA).
- Underwriters' Laboratories (U/L).
- International Society of Measurement and Control (ISA)

All equipment, materials, and the design, construction, installation, and application thereof shall comply with all applicable provisions of the National Electrical Code (NEC), the Occupational Safety and Health Act (OSHA), and any applicable federal, State, and local ordinances, rules and regulations. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the *Electrical Testing Laboratories Accreditation Report* available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

C.13.4.2 Systems Responsibility

All Telemetry and industrial electronic systems shall be provided under the supervision of a single Control System Integrator, chosen by the District, which is regularly engaged in the design and installation of such systems of similar scope and complexity.

C.13.4.3 Control System Integrator's Responsibilities

The Control System Integrator shall be responsible for the following equipment and services:

a. Detailed design of control panels. The Integrator shall prepare and use or use CAD files prepared by the Districts SCADA Consultant and complete to provide detailed schematics and scaled design of all components on and in the control panels and determine specific requirements.

b. The design of all interconnecting wiring of control equipment including remote control panels, packaged equipment panels, mechanical equipment with control components, etc.

c. Coordinate with the Developer, SCADA Consultant and the District for specific requirements and locations of raceway penetrations and field wiring in control panels.

d. The Control System Integrator shall supply the Developer and the District with all necessary detailed installation drawings and/or written instruction for installation of all control components and sensing devices for proper system operation.

e. Provide 16 hours in-shop assistance to test the PLC and communications of the two panels.

f. Provide 16 hours on-site assistance for the SCADA Consultant to test and demonstrate system functions.

C.13.4.4 Developer Responsibilities

The Developer will install all field devices (if any), panels, etc. per the System Integrator's direction.

C.13.5 Environmental Conditions

C.13.5.1 General

Equipment shall be modified, if necessary, to make it suitable for operation in the following ambient conditions.

C.13.5.2 All Areas:

Atmospheric contaminants:

Hydrogen sulfide	0.1 mg/1
Chlorine	0.01 mg/1
Ammonia	0.5 mg/1
Dust	50.0 ug/m3

Electromagnetic radiation:

27/500 MHz	10 volts/m

C.13.5.3 Control Room:

Temperature	35 to 95 degrees F
Humidity	20 to 80 percent

C.13.5.4 Pump Rooms

Temperature	35 to 120 degrees F
Humidity	10 to 100 percent

C.13.5.5 Outdoor Field Locations:

Temperature	-10 to 120 degrees F
Humidity	10 to 100 percent

C.13.6 Functional Requirements

C.13.6.1 General

The Telemetry and control system functions required shall be dependent on the hydraulic requirements of the individual system.

C.13.6.2 Drawings

a. General: The Control System Integrator shall develop all shop drawings required for design, fabrication, assembly and installation of the control system. Shop drawings shall include all drawings required in manufacture of specialized components and for assembly and installation of them.

b. Drawings shall be prepared utilizing a computer based drafting program and printed on 11 inch by 17-inch media. Drawings shall have borders and title blocks identifying the project system, revisions to the drawings, and type of drawing. Each revision of a drawing shall carry a date and brief description of the revisions. Diagrams shall carry a date and brief description of the revisions. Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with panel work wiring, Section 17110.

c. Elementary Diagrams: The Control System Integrator shall provide elementary diagrams for all discrete loops. Loop diagrams shall be prepared in compliance with ISA S5.4 and shall be provided for all analog loops. Elementary diagrams and loop diagrams shall show circuits and devices of a system. These diagrams shall be arranged to emphasize device elements and their functions as an aid to understanding the operation of a system and maintaining or troubleshooting that system. Elementary and loop diagrams shall also show wire numbers, wire color codes, signal polarities, and terminal block numbers.

d. Panel Fabrication and Arrangements Drawings: The Control System Integrator shall provide arrangement drawings of all panel front-and internal-mounted instruments, switches, devices and equipment indicated. All panel mounting details shall be shown. Outer dimensions of all panels shall be included on the drawing. Deviations from approved arrangements require approval prior to installation.

Arrangement drawings shall be drawn to scale using standard Architectural or Districting scales.

A full set of as constructed drawings shall be provided to the District upon competition of the project in AutoCAD R14 electronic format on a CD unless otherwise approved in writing.

C.14 Products

C.14.1 Materials and Quality

C.14.1.1 General

Material shall be new, free from defects, and of the quality specified. All equipment and materials utilized in the system shall be the products of Manufacturers with at least five (5) years experience in the manufacture of similar equipment. Similar items in the system shall be the products of the same Manufacturer. All equipment shall be of industrial grade and of standard construction, shall be capable of long, reliable, trouble-free service, and shall be specifically intended for control and monitoring of operation of motor-driven pumps and equipment. All equipment shall be of modular design to facilitate interchangeability of parts and to assure ease of servicing.

C.15. Execution

C.15.1 Design and Assembly

The system shall be completely assembled in the shop by the Control System Integrator. All components and equipment shall be prewired to the maximum extent possible.

The Control System Integrator shall be responsible for the coordination and integration of control system with the motor control and other related equipment. The Control System Integrator shall communicate directly with the Manufacturer(s) and Supplier(s) of all related equipment to determine all details of the equipment which may influence or affect the control system. The Control System Integrator shall determine all requirements for and shall cause integration of the control system into a unified operating system. The Control System Integrator shall define all requirements for all interfacing equipment and shall supply all appurtenances, accessories and all such devices which may be required for proper interfacing as part of the control system.

The Control System Integrator shall be responsible to obtain submittal information on equipment supplied by other disciplines and to integrate them into the control system to form a complete working package as outlined by the contract documents. This includes but is not limited to the following list of major pieces of equipment.

C.15.2 Installation

C.15.2.1 General

Installation and testing procedures shall be a specified in these and subsequent sections of this division.

The control system shall be installed in accordance with the installation drawings and instructions prepared by the Control System Integrator.

The control system panels shall not be shipped to the site until a suitable environment is available for installation of the equipment. A suitable environment shall be defined as a covered and heated area to maintain a minimum ambient temperature of 60 degrees F. Prior to shipment, the Control System Integrator shall contact the District for field verification of a suitable environment.

Equipment shall be located so that it is readily accessible for operation and maintenance.

C.15.2.2 Field Equipment

Equipment shall be provided as specified on the drawings such that ports and adjustments are accessible for in-place testing and calibration. Where possible, equipment shall be located between 48 inches and 60 inches above the floor with a maximum of 72 inches to the top of panel, or a permanent work platform. Telemetry equipment shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Equipment shall not be mounted where shock or vibration will impair its operation. Support systems shall not be attached to handrails, process piping or mechanical equipment except for measuring elements and valve positioners. Instruments and cabinets supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between instrument and wall.

Steel used for support of equipment shall be hot-dip galvanized after fabrication. Support systems including panels shall be designed in accordance with the UBC for seismic Zone 3 and to prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction.

C.15.2.3 Not Used

C.15.2.4 Signal Connections

Electrical signal connections to equipment shall be made on Intrelec terminal blocks or by locking plug and receptacle assemblies.

C.15.2.5 Tagging

All field instruments shall be labeled with function and instrument number, i.e. (FIT-301/EFFLUENT FLOW METER). Tag shall be 10ga, 316 stainless steel with stamped letters and numbers attached to device with 12ga 316 stainless steel wire.

C.15.3 Tests and Inspections

C.15.3.1 General Requirements

Materials, equipment, and construction included under this specification shall be inspected in accordance with the specifications. Testing shall be performed by the Control System Integrator, in accordance with the Standard Specifications, and this and subsequent sections of this division.

No required test shall be applied without prior notice to the District. Between 20 and 30 days before the commencement of any testing activity, the Control System Integrator shall provide a detailed step-by-step test procedure, complete with forms for the recording of test results, testing equipment used, and identification of the individual performing or, if applicable, witnessing the test.

C.15.3.2 Factory Testing

The completed control system shall be tested in the shop by the Control System Integrator. Testing shall be conducted in two phases. The initial testing shall include, but not be limited to, operation of all input and output (I/O) points, control devices and motor controllers 24 hours per day for a continuous period of at least seven (7) days without failure or interruption.

The initial testing of the control system shall include energizing each discrete input and output and simulating each analog input and output using a loop simulator and calibrator. Circuits not energized shall be tested for continuity. Initial testing of the control system shall be conducted continuously, 24 hours per day, for at least seven (7) days without a failure or interruption.

Upon completion of the initial testing, the Control System Integrator shall conduct testing for inspection by the District. The Control System Integrator shall provide for time, equipment and support in their shop for the Districts consulting engineering to test the functions of the entire control system. All control functions and all status and alarm monitoring and indication will be demonstrated under simulated operating conditions. Simulating equipment shall be provided and wired by the System Integrator the control system for this testing. The Control System Integrator shall revise, modify, and adjust the system as required by the District during the testing period. Testing shall be continued for the time period required by the District to observe and verify any revisions.

C.15.4 Calibration and Start-up

C.15.4.1 Calibration

All components of the control system shall be calibrated by the Control System Integrator after completion of installation. Each component shall be adjusted to be within the Manufacturer's required range and for the specific application.

The Control System Integrator shall calibrate all instruments, indicators, recorders, loops, etc. and complete appropriate test forms provided at the end of this section. Test forms, identifying each instrument to be tested shall be submitted to the District prior to final commissioning.

Components provided by the System Integrator that cannot be properly calibrated or that are found to exceed the Manufacturer's specified range or accuracy shall be removed and replaced at no additional cost to the District.

C.15.4.2 Commissioning

Commissioning shall be accomplished by the Districts Engineering Consultant with the Control System Integrator, with the Owner and/or District present. Commissioning shall include operation and verification of all control components and features of the entire control system.

C.15.5 System Maintenance

The Control System Integrator shall be solely and completely responsible for all hardware maintenance of the system provided by the Integrator from time of start-up to the date of substantial completion of all work under the contract. The Control System Integrator shall correct all deficiencies and defects and make any and all repairs, replacements, modifications, and adjustments as malfunctions or failures occur. The Control System Integrator shall perform all such work required or considered to be required by the District to cause and maintain proper operation of the system and to properly maintain the system.

The Control System Integrator shall make any and all repairs, replacements, modifications and adjustments required to eliminate any and all defects in design, materials and workmanship that are disclosed within the one-year guarantee period. The Control System Integrator shall begin all repairs, replacements, modifications and adjustments within twenty-four (24) hours of notification by telephone by the District and shall complete such repairs, replacements, modifications and adjustments within forty-eight (48) hours of notification. Should the Control System Integrator fail to begin the work within 24 hours or complete the work within 48 hours, the District may proceed to undertake or complete the work. In such event, CSI and its surety shall be liable for all costs incurred by the Owner.

The Control System Integrator shall anticipate that the District may delay acceptance of all work under the contract if, in the judgment of the District, malfunctions or failures in operation of the control system repeatedly occur after start-up. The Control System Integrator shall not be entitled to an extension of time or to any claim for damages because of hindrances, delays or complications caused by or resulting from delay by the District in accepting the work because of malfunctions or failures in operation of the control system.

C.15.6 Operation and Maintenance Training

The Control System Integrator shall conduct specifically organized training sessions in operation and maintenance of the control system for personnel employed by the District. The training sessions shall be conducted to educate and train the personnel in maintenance and operation of all components of the control system. Training shall include, but not be limited to, the following:

a. Preventative maintenance procedures
b. Trouble-shooting
c. Calibration
d. Testing
e. Replacement of components
f. Manual mode operation

At least Two (2) separate training sessions, each at least Four (4) hours in duration, shall be conducted at the District after start-up of the system. The Control System Integrator shall prepare and assemble specific instruction materials for each training session and shall supply such materials to the District at least 14 days prior to the time of the training.

C.15.7 Operation and Maintenance Data

The Control System Integrator shall prepare and assemble detailed operation and maintenance manuals in accordance with the project general requirements. These manuals shall be submitted 14 days prior to training. The manuals shall include, but not be limited to, the following:

a. Preventative maintenance procedures.
b. Trouble-shooting.
c. Calibration.
d. Testing.
e. Replacement of components.
f. System schematics / shop drawings.
g. Record wiring diagrams of cabinet and enclosure contained assemblies.
h. Record wiring diagrams of overall system.

i. Note: Updated system schematics and wiring diagrams shall be included as described in the Shop drawing and Submittal sections of this specification.

j. Catalog data and complete parts list for all equipment and control devices provided by Control System Integrator.

k. Listing of recommended spare parts.

l. Listing of recommended maintenance tools and equipment.

All drawings shall be provided on hard copy and CAD file on CD ROM. CAD drawing files shall be in .dwg 2004 format, bound, with all "xref" links removed.

C.15.8 System Description of Operation and Programming (Not Used)

END OF SECTION

PLC I/O CALIBRATION TEST FORM

ANALOG INPUT MODULE				Page 1 of 3
Project Name: **Panel No.:** _____ **Rack No. and Slot No.:** _____ **Make and Model No.:** _____ **Input:** _____				
Simulate input and measure output with appropriate meter.				
Percent of Range	**Input**	**Expected Register Reading**	**Actual Register Reading**	**Percent Deviation**
Input 1				
0				
50				
100				
Percent Deviation Allowed:				
Input 2				
0				
50				
100				
Percent Deviation Allowed:				
Input 3				
0				
50				
100				
Percent Deviation Allowed:				
Input 4				
0				
50				
100				
Percent Deviation Allowed:				
Input 5				
0				
50				
100				
Percent Deviation Allowed:				

ANALOG INPUT MODULE				Page 2 of 3
Percent of Range	**Input**	**Expected Register Reading**	**Actual Register Reading**	**Percent Deviation**
Input 6				
0				
50				
100				
Percent Deviation Allowed:				
Input 7				
0				
50				
100				
Percent Deviation Allowed:				
Input 8				
0				
50				
100				
Percent Deviation Allowed:				
Input 9				
0				
50				
100				
Percent Deviation Allowed:				
Input 10				
0				
50				
100				
Percent Deviation Allowed:				
Input 11				
0				
50				
100				
Percent Deviation Allowed:				
Input 12				
0				
50				
100				
Percent Deviation Allowed:				

ANALOG INPUT MODULE				Page 3 of 3
Percent of Range	**Input**	**Expected Register Reading**	**Actual Register Reading**	**Percent Deviation**
Input 13				
0				
50				
100				
Percent Deviation Allowed:				
Input 14				
0				
50				
100				
Percent Deviation Allowed:				
Input 15				
0				
50				
100				
Percent Deviation Allowed:				
Input 16				
0				
50				
100				
Percent Deviation Allowed:				

Comments: _____

CERTIFIED: _____ DATE: _____

PLC I/O CALIBRATION TEST FORM

ANALOG OUTPUT MODULE				Page 1 of 2
Project Name:				
Panel No.: _____				
Rack No. and Slot No.: _____				
Make and Model No.: _____				
Input: _____				
Force output point and measure output with appropriate meter.				
Percent of Range	**Input**	**Expected Register Reading**	**Actual Register Reading**	**Percent Deviation**
Output 1				
0				
50				
100				
Percent Deviation Allowed:				
Output 2				
0				
50				
100				
Percent Deviation Allowed:				
Output 3				
0				
50				
100				
Percent Deviation Allowed:				
Output 4				
0				
50				
100				
Percent Deviation Allowed:				
ANALOG OUTPUT MODULE				
Comments: _____				

CERTIFIED: _____ DATE: _____

FIELD SWITCH CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make and Model No.: _____ **Serial No.:** _____

Input: _____

Range: _____

Set Point(s): _____

Simulate process variable (flow, pressure, temperature, etc.) and set desired set point(s). Run through entire range of switch and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

Comments: _____

CERTIFIED: _____ DATE: _____

TRANSMITTER OR INDICATOR CALIBRATION TEST DATA FORM

Tag No. and Description: _____
Make and Model No.: _____ **Serial No.:** _____
Input: _____
Range: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

Percent of Range	**Input**	**Expected Register Reading**	**Actual Register Reading**	**Percent Deviation**
Input 1				
0				
50				
100				
Percent Deviation Allowed:				

Comments: _____

CERTIFIED: _____ DATE: _____

RTD VERIFICATION TEST DATA FORM

Tag No. and Description: _____

Make and Model No.: _____ **Serial No.:** _____

Type: _____

Force output point and measure output with appropriate meter.

Temperature	Expected Output	Actual Output	Percent Deviation

Percent Deviation Allowed:

Comments: _____

CERTIFIED: _____ DATE: _____

VALVE CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make and Model No.: _____ **Serial No.:** _____

Associated Panel/Rack No: _____

Operate valve via PLC control or Jumper and verify operation. Verify limit switch operation if applicable.

Close Operation	**Pass (Y/N)**	**Close Position**	**Pass (Y/N)**

Open Operation	**Pass (Y/N)**	**Open Position**	**Pass (Y/N)**

Limit Switch Operation	**Pass (Y/N)**

Comments: _____

CERTIFIED: _____ DATE: _____

SECTION 16
PANELS

C.16 General

C.16.1 Description

C.16.1.1 Scope

This section specifies requirements for panels, cabinets, consoles, and racks for Telemetry and communication equipment. Additional requirements are specified in sections specifying the various Telemetry and communication systems.

C.16.1.2 Panel Design

Panelboards: Each panel containing 120-volt powered equipment with an aggregate load greater than 1200 watts shall be provided with a panelboard as specified in the Standard Specifications.

Annunciators: Each panel containing alarm points shall be provided with one or more annunciators as specified in section 17120.

Power Supplies: Each panel containing direct current powered instruments or serving as the termination point for transmission loop powered field instruments shall contain direct current power supply system as specified in Section 17130.

C.16.2 Quality Assurance

C.16.2.1 References

All equipment and materials shall conform to the latest revised editions of applicable standards published by the following organizations:

- American National Standards Institute (ANSI).
- Institute of Electrical and Electronic Districts (IEEE).
- National Electrical Manufacturers Association (NEMA).
- Underwriters' Laboratories (U/L).
- International Society of Measurement and Control (ISA).

All equipment, materials, and the design, construction, installation, and application thereof shall comply with all applicable provisions of the National Electrical Code (NEC), the Occupational Safety and Health Act (OSHA), and any applicable federal, State, and local ordinances, rules and regulations. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the *Electrical Testing Laboratories Accreditation Report* available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

C.16.3 Submittals

Submit all catalog data in accordance with the Submittals requirements in Section 17010. Show material information and confirm compliance with these specifications.

C.17 Products

C.17.1 Fabrication

C.17.1.1 General

Panel work shall be designed for the seismic requirements of paragraph 17010. 3.02.B. Structures and equipment shall be braced to prevent damage from specified forces. Equipment shall not be required to function properly during periods of seismic disturbance but shall automatically restart following a disturbance.

Cutouts for future equipment shall be blanked off with suitable covers. Instrument tag numbers shall be identified on the panel rear. Nameplates shall identify face-mounted instruments. Instruments shall be mounted in a manner that allows ease of access to components and ease of removal.

Face-mounted instruments that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb. moment force on the face of the panel shall be supported underneath at the rear by a 1-inch x 1/8-inch thick steel angle.

Face-mounted equipment shall be flush or semiflush with flat-black escutcheons.

Cabinets less than 60 inches high shall be provided with floor stands to raise the top of the panel to 60 inches above the floor or work platform or, if panel weighs less than 100 pounds and wall space is available, wall mounting may be used in lieu of a floor stand.

C.17.1.2 Indoor, Control Panel

Cabinet shall be a NEMA 250, Type 1 enclosure. Cabinet shall be fabricated from 1/8-inch minimum thickness stretcher leveled sheet steel. Cabinet shall be provided with an interior frame or otherwise formed so as to provide a rigid structure. Rear door (s) shall be hung on removable pin hinges and equipped with vault-type latch capable of accepting

a 3/8 inch-shackle padlock. Three-point latch hardware shall be provided for doors exceeding 30 inches height. Where cabinet width exceeds 36 inches, multiple doors no wider than 24 inches shall be provided.

C.17.2 Not Used

C.17.3 Nameplates

Machine engraved laminated white phenolic nameplates with black lettering shall be provided for panel mounted equipment. Nameplate engraving shall be as specified and shall carry the instrument tag number 3/32-inch minimum size lettering on the bottom line Nameplates shall be attached to the panel with a minimum of two self-tapping 316 stainless steel screws. The Control System Integrator shall modify nameplate wording without additional cost or time if changes are made prior to commencement of engraving.

Machine embossed metallic adhesive labels shall identify tag number if instruments inside panels.

Nameplates shall be attached to panel surfaces, not to instruments.

C.17.4 Interconnection Wiring and Electrical Devices

C.17.4.1 Interconnection Wiring

Power and control wiring shall be single conductor stranded copper NFPA No. 70 Type MTW No. 16 AWG minimum. Wiring for analog signals shall be provided with instruments and run continuously from measuring element to receiving instrument without splices.

Wiring shall be supported independently of terminations by lacing to panel support or by slotted flame retardant plastic wiring channels. Wiring channels shall comply with UL 94, Type V. Wiring channel fill shall not exceed 40 percent.

Wiring and terminals in instrument and relay compartments, control panels, instrument panels, field panels and control stations, as well as connections to mechanical equipment shall have reference number and letter in accordance to the following:

h = Control power hot
n = neutral
g = ground
x = PLC output (number shall correspond to the program input number)
y = PLC output (number shall correspond to the program output number)
ax = PLC signal/analog input (no. shall correspond to the program input number)

120 AC wire	Color
Power	Black
Control	Red
Neutral	White
Ground	Green

24V DC wire	Color
Power supply	Black
Signal (pos)	Red
Control - (+)	Violet
Control - (-)	Gray
Signal ground	Black
Equipment ground	Green
External	Yellow

All control wiring in control panels or other enclosures that is powered from an external source and is not disconnected by the control panel disconnect shall be terminated at a disconnecting terminal block (with energization indicator light upon entering the enclosure. The color of the wire shall then be changed to yellow to identify it as being powered from an external source. Provide identification nameplate on exterior of enclosure to indicate sources of external power.

Wiring shall comply with the requirements of NFPA No. 70 as a minimum. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment.

Drawings show general layout of devices and associated wiring space. Final panel design will arrange terminals and wiring so field wiring is separate from internal panel wiring.

C.17.5 Terminal Blocks

Terminal blocks shall be strap screw type, minimum .41" width, rated for 600 volts. Each terminal strip shall have a unique identifying alphanumeric code at one end and a vinyl marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8 inch high. Wire connectors shall be locking fork tongue or ring tongue insulated crimp type terminals. No more than two connections shall be made to one terminal. Connections shall have box type lugs capable of terminating 2 #14 AWG stranded wires. Terminals shall be strip mounted as manufactured by Entrelec or Phoenix Contact.

Fuse terminal blocks shall be hinged disconnect level type with "blown fuse" indicators. Phoenix Contact UK 5 series or equal. Disconnecting terminal blocks shall be knife type with light indicator Phoenix Contact type MTK or equal.

Field connections shall be to separate terminal blocks. Terminal blocks for field termination shall be in a separate part of the panel close to where the field cables enter the panel.

C.17.6 Fuses

Circuits shall be fused. Fuses shall be 1/4 x 1-1/4 inch. Fuses on 120V AC circuits shall be ceramic tube type with 25,000 amperes interrupting capacity at 125 volts and neon blown fuse indicator lamps. Fuses for 24V DC circuits shall be fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops and 1/2 amp for the power supply to individual instruments. Fuse holders for 120V AC shall be drawout type and molded from melamine plastic.

C.17.7 Surge Protection

Surge protectors shall be provided at panel external terminal blocks for type c, d, e, f, and g signal circuits as defined in paragraph 17010-1.01 B.8, which extend outdoors. Surge protectors shall be Joslyn Model 1663-08, Taylor 1020FA, or equal.

Telephone circuit protectors shall include three-element fail-short gas tubes, Cook Electric type 9X, or approved equal. Protectors shall be rated at 400 Vdc and shall be self-restoring. An external spark gap shall be provided for backup protection in accordance with Underwriters Laboratory 497, 4th Edition.

C.18 Execution

C.18.1 General

Control room cabinets shall be mounted on channel irons sills as specified. Sills shall be leveled so panel structures will not be distorted. Panels shall be shimmed to precise alignment so doors operate without binding. Sealant shall be provided under panels not located in dry control or electrical equipment rooms.

Each panel shall have its record connection and interconnection diagrams mounted behind a piece of plexiglass on the inside of one (or more) door(s).

C.18.2 Coating

Metal surfaces of panels, cabinets, and consoles shall be prepared, prime and finish coated in accordance with Manufacturers Standards.

END OF SECTION

SECTION 19
ANNUNCIATOR SYSTEMS

C.19 General

C.19.1 Description

This section specifies requirements for annunciator systems and annunciator light boxes required to support alarm points. Application requirements are specified in the instrument schedule.

C.19.2 References

All equipment and materials shall conform to the latest revised editions of applicable standards published by the following organizations:

- American National Standards Institute (ANSI).
- Institute of Electrical and Electronic Districts (IEEE).
- National Electrical Manufacturers Association (NEMA).
- Underwriters' Laboratories (U/L).
- International Society of Measurement and Control (ISA).

All equipment, materials, and the design, construction, installation, and application thereof shall comply with all applicable provisions of the National Electrical Code (NEC), the Occupational Safety and Health Act (OSHA), and any applicable federal, State, and local ordinances, rules and regulations. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the *Electrical Testing Laboratories Accreditation Report* available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

C.19.3 Submittals

Submit all catalog data in accordance with the Submittals requirements in Section 17010. Show material information and confirm compliance with these specifications.

C.20 Products

C.20.1 Large Case Annunciator Systems. (When Requested)

C.20.1.1 Annunciator Light Boxes

Annunciator light boxes shall contain lamps and structures as specified in Paragraph 17120.2.01.A with logic provide in the PLC. Annunciator light bay shall be Ronan LB2000, or equal

C.21 Execution

Annunciator systems shall be mounted and connected in panels specified in Section 17110. Windows shall be engraved as specified and filled with permanent black ink.

END OF SECTION

SECTION 22
POWER SUPPLY AND CONDITIONING EQUIPMENT

C.22 General

C.22.1 Description

This section specifies requirements for power supply and conditioning equipment required to support the Telemetry and communication systems specified.

C.22.2 References

All equipment and materials shall conform to the latest revised editions of applicable standards published by the following organizations:

- American National Standards Institute (ANSI).
- Institute of Electrical and Electronic Districts (IEEE).
- National Electrical Manufacturers Association (NEMA).
- Underwriters' Laboratories (U/L).
- International Society of Measurement and Control (ISA).

All equipment, materials, and the design, construction, installation, and application thereof shall comply with all applicable provisions of the National Electrical Code (NEC), the Occupational Safety and Health Act (OSHA), and any applicable federal, State, and local ordinances, rules and regulations. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the *Electrical Testing Laboratories Accreditation Report* available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

C.22.3 Electrical Supply System

Electric power for Telemetry and communication systems shall be obtained from the site power distribution system. This power is not regulated, wave forms may be distorted, and significant amounts of electrical noise may be present. The Control System Integrator shall provide all necessary power supply and conditioning equipment to provide electrical power of the required voltages and current capacities and of adequate quality to ensure reliable operation of the Telemetry and communication system. Unless

otherwise specified, the Control Systems Integrator shall assume that the power supply for Telemetry systems is 120 volts plus or minus 15 percent, 60 hertz plus of minus 3 hertz, 5 percent maximum total harmonic distortion.

C.22.4 Submittals

Submit all catalog data in accordance with the Submittals requirements in Section 17010. Show material information and confirm compliance with these specifications.

C.23 Products

C.23.1 General

Except for power supply units which form an integral part of an individual piece of equipment, all power supply and conditioning equipment shall comply with UL 1012 and shall be approved by UL, CSA, or FM for the application. All power supply equipment shall be provided in redundant configurations such that failure of a single unit will not disable all or any part of the Telemetry and communication systems. Diode isolation shall be provided for redundant direct current supply units, and the power supply negative output terminal shall be grounded.

C.23.2 Alternating Current (AC) Voltage Regulators

Regulators shall be of the solid-state tap-changing type, insensitive to line frequency variations between 47 and 63 hertz. Ferroresonant units are not acceptable. Output regulation for input voltage variation from 85 to 125 volts shall not exceed 3.3 percent. Output regulation for load variation from 0 to 100 percent shall not exceed 1.0 percent. Response time shall be 1.0 cycles or less. Voltage regulator serving panelboards and control panels shall have a load capacity not less than 200 percent of the connected load. Voltage regulators serving panelboards and control panels shall have a load capacity not less than 125 percent of the connected load. Power loss in the regulator shall not exceed 2 percent of the regulator capacity, and harmonic distortion introduced by the regulator shall not exceed 0.1 percent. Regulator output shall be fully protected against internal faults, external overloads and short circuits. Three-phase units shall be 4 wire, wye-connected and capable of supporting 100 percent unbalanced load. regulators shall be Topaz, or equal.

C.23.3 Noise-Suppression Isolation Transformers

Isolation transformers shall be provided for AC powered Telemetry loads containing solid state circuitry where such is not included within the instrument. Isolation transformers shall be of the triple box shield type. Each coil shall be completely enclosed in a grounded conductive faraday shield, and the overall transformer enclosed in a faraday shield. Common mode noise attenuation between primary and secondary shall exceed 140 dB at 1.0 kHz. Isolation transformer dielectric strength shall be 2500 volts minimum. Isolation transformers serving panelboards and control panels shall have a load capacity not less than 124 percent of the connected load. Power loss is the isolation transformer shall not exceed 2.0 percent of the maximum load rating. Harmonic

distortion introduced by the isolation transformer shall not exceed 0.1 percent. Three-phase units shall be 4-wire, wye-connected and capable of supporting 100 percent unbalanced load. Isolation transformers shall be Topaz, or equal.

C.23.4 Direct-Current Power Supplies

Direct-current supplies for bulk 24-volt nominal Telemetry power shall be convection-cooled switching type. Line regulation shall be 0.4 percent for line variations from 105 to 132 volts, and load regulation shall be 0.4 percent for load variations from 0 to full load. Ripple and noise shall not exceed 100 mV peak-to-peak. Hold-up time at maximum load shall be not less than 15 milliseconds. Efficiency shall be a better than 70 percent. Power supply shall be rated for continuous duty from 0 to 50 degrees C at rated load. Output shall be electronically current limited, and overvoltage crowbar shutdown shall be provided. Power supply output voltage shall be rated 28 volts DC, adjustable plus or minus 5 percent, and shall be set to provide 26.4 volts on the panel direct current bus. Power supplies shall be Power One, or equal.

C.23.5 Uninterruptible Power Supply (UPS)

UPS shall provide continuous duty protection and complete power conditioning. UPS shall consist of a power conditioner, a battery charger, a battery, and inverter, a system control and a surge suppression network. Total harmonic distortion shall be ±5% maximum (from the batteries) or ±2% maximum added to incoming line distortion (from line voltage). UPS shall UL or CSA labeled and shall meet IEEE 587-80 standards. UPS shall provide surge protection for both itself and the load as defined by ANSI C62.41-80 (6000V peak, 500 nanosecond rise time, 100 kHz damped ring wave). UPS shall also meet the following specifications:

When the power line is absent:

Output voltage - 120VAC ± 3%, sinewave.

When the power line is present:

Voltage Regulation
Input voltage range: 120V ± 20%
Output regulation band: +6% to -8% of nominal for all conditions of line and load.
Correction time: 2 cycles maximum.
Common mode noise attenuation: 100dB at 100 kHz.
Normal mode noise attenuation: 70dB at 100 kHz.
Efficiency 93% minimum.
Transfer time: AC line to inverter: 1 or 4 milliseconds selectable.
Inverter to AC line: No interruption
Transfer Points: Power conditioning to inverter: -8% or +6% of nominal voltage.
Inverter to power conditioning -11% or +13% of nominal voltage.
Input Frequency tolerance: ±5%.
Load Power Factor: 0.9 leading to 0.9 lagging, linear load, 0.6 non-linear load.
Operating Temperature: -29 to +40 degrees C.

The UPS shall be TOPAZ Powermaker, or equal.

C.23.6 Backup Power Supply (BPS)

BPS shall provide continuous duty protection and complete power conditioning. BPS shall consist of a power conditioner, a battery charger, a battery, system control and a surge suppression network. The BPS will provide 12VDC and 24VDC with sufficient wattage to run telemetry and associated equipment..

BPS battery charger shall be voltage regulated, current-limited charger with 3 Amps maximum current and typical recharge time of 6 - 12 hours after full discharge. Batteries shall be sealed Gel-cell, maintenance free type.

The BPS shall be provided with relay contacts rated at 32 Volts, 1 Amp for Battery ON and AC ON signals. The BPS will be provided by the Control System Contractor/Developer/Designer using off the shelf equipment.

C.23.7 Surge Protection

Surge arrestors and capacitors shall be provided on the primary winding of isolation transformers supplying power to solid state systems. Surge protectors shall be mounted in a separate, NEMA 1 enclosure adjacent to the transformer and the incoming line passed through this enclosure. Surge arrestors shall be General Electric 9L15EC or equal. Surge capacitors shall be General Electric 9L18B, or equal.

C.24 Execution

C.24.1 General

Power supply and conditioning equipment shall be mounted and connected in compliance with the manufacturer's instructions unless otherwise specified. Line side disconnect switches shall be provided for power supply and conditioning equipment. Line and load side overcurrent protection shall be provided for power supply and conditioning equipment in compliance with NFPA 70. Disconnect switches shall comply with the Standard Specifications.

Small power supply and conditioning equipment may be mounted in the panel served. Larger units shall be mounted adjacent to the equipment served. Where unconditioned power is brought into control panels, it shall be enclosed in metallic raceways within the panel.

Power supply and conditioning equipment larger than 5 KVA load capacity supported from surfaces other than concrete shall be provided with sound isolators. Final raceway connections shall be a flexible conduit in compliance with the Standard Specifications.

Power supply and conditioning equipment not designed for exposed mounting shall be housed in panels in compliance with Section 17110.

END OF SECTION

SECTION 25
MISCELLANEOUS PANEL INSTRUMENTS

C.25 General

C.25.1 Description

This section specifies requirements for miscellaneous panel mounted instruments used to provide process control and interface between the operator and the process.

C.25.2 References

All equipment and materials shall conform to the latest revised editions of applicable standards published by the following organizations:

- American National Standards Institute (ANSI).
- Institute of Electrical and Electronic Districts (IEEE).
- National Electrical Manufacturers Association (NEMA).
- Underwriters' Laboratories (U/L).
- International Society of Measurement and Control (ISA).

All electrical equipment and materials, and the design, construction, installation, and application thereof shall comply with all applicable provisions of the National Electrical Code (NEC), the Occupational Safety and Health Act (OSHA), and any applicable Federal, State, and local ordinances, rules and regulations. All materials and equipment specified herein shall be within the scope of UL examination services, be approved by the Underwriter's Laboratories for the purpose for which they are used and shall bear the UL label.

C.25.3 Submittals

Submit all catalog data in accordance with the Submittals requirements in Section 17010. Show material information and confirm compliance with these specifications.

C.26 Products

C.26.1 Relays

C.26.1.1 Relays For General Purpose

Relays for general purpose use shall have 10 Amp contacts with the appropriate coil voltage for the application. All relays shall have an integral indicating light to show if there is coil voltage present. They shall have an 8-pin/blade base and matching socket. Units shall be Allen-Bradley 700 type HA, HB, Idec RH Series, or equal. Appropriate relay shall be selected based on application from the control wiring diagrams.

C.26.2 Signal Conditioners

The current to current (I/I) converters shall provide an isolated DC output proportional to the DC input while providing complete electrical isolation between the output and input. The device shall plug into a standard 8-pin relay socket which is capable of being mounted either on a flat surface and track. Provide appropriate scaling as required. Units shall be as manufactured by AGM, Wilkerson Instruments, Action Instruments, or equal.

C.27 Execution

C.27.1 Installation

Instruments shall be installed on panel specified in Section 17110.

END OF SECTION

SECTION 28
MEDIUM CAPACITY
PROGRAMMABLE LOGIC CONTROLLERS (PLC)

C.28 General

C.28.1 Description

C.28.1.1 Scope

This section specifies requirements for PLC (s) capable of performing the same function as relays, latching relays, current trips, shift registers, timers, counters, stepping switches, sequences, multiplexers, or solid state logic systems.

C.28.1.2 Work Included

Under this contract the PLC is provided by the Owner. CSI shall install PLC in new enclosure, and provide additional I/O cards where needed.

C.29 Products

C.29.1 Processor Support Components

C.29.1.1 Network Communications

Fiber optic communications shall be accomplished to execute the same above utilizing Phoenix Digital OCM, or equal fiber optic driver. Fiber to serial transceiver.

Communication over phone line shall be accomplished utilizing Data-Linc or Allen/Bradley modems.

C.29.2 Input/ Output System (I/O)

C.29.2.1 General

The system shall consist of individual plug-in input and output modules or cards. Any number of remote discrete and analog I/O points (up to the system capacity) shall be available. I/O system shall be 25% spare of each type of I/O.

C.30 Execution

C.30.1 Installation

Installation shall be in accordance with Section 17110-3.01. The PLC(s) shall be mounted in control panels as shown on the drawings. Wire terminations shall be at

terminal blocks. Power supplies located in instrument panels shall have an isolation transformer and secondary surge protection.

C.30.2 Programming (By Others)

C.30.3 Start-Up

Contractor shall provide on-site start up of the PLC system in accordance with paragraph 17010-3.04 and 1.02B.

C.30.4 Testing

Testing shall be in compliance with paragraph 17010-3.03 and 1.02B.

C.30.5 Training

A minimum of 16 hours of training shall be provided in accordance with paragraph 17010-3.06 to explain the system operation and how the PLC/OIT controls the system.

END OF SECTION

SECTION 31
ETHERNET RADIO MODEMS

C.31 Overview

C.31.1 It is the intent of this section to outline the requirements for radios used only in line-of-site locations. It is not the intent of this section to state that line-of-site conditions can be met at each intended location.

It is the responsibility of the installer to confirm operability within the parameters of this specification section. If these parameters cannot be achieved in the locations outlined in the contract documents, the installer shall notify the control system integrator in writing within 48 hours of discovery of the exception to the specified conditions.

C.32 Unitary responsibility

C.32.1 In order to unify responsibility for proper operation of the Ethernet radio modems, it is the intent of these Specifications that a single supplier (unitary source) shall furnish all components for the radio system.

C.33 General

C.33.1 All Ethernet radio modems shall not require FCC site license. All radio modems shall have FCC type acceptance as per FCC Part 15-Subclass C.

C.33.2 All Ethernet radio modems shall be license-free direct sequence spread spectrum, operating in the 2.416 to 2.462 GHz Spread Spectrum band.

C.33.3 All Ethernet radio modems shall be compatible with IEEE 802.11b specifications.

C.33.4 All Ethernet radio modems will operate at 1-Watt output power and provide a line-of-site (LOS) range of at least 5 miles.

C.33.5 All Ethernet radio modems will communicate at a radio frequency (RF) data rate of 11 MBPS. The RF data rates will automatically scale from 1-11 MPBS to maintain a reliable communication link based upon received signal strength and data quality. RF data rates lower than 1 MBPS will not be acceptable.

C.33.6 All Ethernet radio modems shall be able to operate in the Ethernet point-to-point and multi-point Bridging Mode.

C.33.7 All Ethernet radio modems shall be able to operate in the Access Point Mode.

C.33.8 All Ethernet radio modems shall be able to function in the EtherStation Mode. This is the ability of the radio modem to function as a Client to an Access Point. The radio modem in the EtherStation Mode shall be able to roam between multiple Access Points.

C.33.9 The radio modems shall have digi-repeater capability to extend the operating range of the Ethernet network.

C.33.10 The radio modem shall be user configurable via its internal web server.

C.33.11 All Ethernet radio modems shall support transfer of Ethernet based data in both UDP and Ethernet II formats. All Ethernet protocols, including but not limited to TCP/IP, will be supported.

C.34.12 All Ethernet radio modems will only pass data for the MAC address attached to the wireless Ethernet modems to reduce wireless network traffic.

C.33.13 All Ethernet radio modems will be housed in a single metal, panel mountable, industrial based enclosure. The Ethernet radio modem shall have a 10BaseT RJ-45 connector for Ethernet interfacing.

C.33.14 All Ethernet radio modems shall support the installation of external antennas that can be remotely located at distances up to one hundred (100') feet from the radio modem using factory recommended feedlines.

C.34 Communications data rate

C.34.1 All Ethernet radio modems will use direct sequence spread spectrum modulation at a RF data rate of 11MBPs.

C.34.2 The RF data rate shall automatically scale from 1-11 MBPS to maintain a reliable communication link based upon received signal strength and data quality. RF data rates lower than 1 MBPS will not be acceptable.

C.35 Electrical

C.35.1 Power input shall be 11.0 - 15.0 VDC or 110-240 VAC with optional switching power supply.

C.35.2 Ethernet radio modems shall have the following front panel indicators: PWR-Power (red), TX-Transmit (red), RX-Receive (red), T/E-Test/Error (red), 10BaseT Link (Amber) and Ethernet activity (Green).

C.36 Transmitter

C.36.1 Ethernet radio modem shall have output power of 1-watt maximum (+30 dBm).

C.36.2 All Ethernet radios will have a maximum rise time of 10µsec.

C.37 Receiver

C.37.1 All Ethernet radio modems shall use auto-squelch circuitry that requires no setting from the user.

C.37.2 Sensitivity shall be at least -93dbm @ 8E-2 Frame Error.

C.37.3 Receiver spurious & image rejection shall be > 80dB.

C.37.4 Receiver adjacent channel rejection shall be > 35dB

C.38 OPERATING ENVIRONMENT

C.38.1 Ethernet radio modems shall be rated for NEMA 1 environments.

C.38.2 Ethernet radio modems shall operate over a range of -30o to +60oC.

C.39 MANUFACTURER

C.39.1 The radio modems shall be 802.11b compatible Spread Spectrum wireless Ethernet radio modem as supplied by ESTeem or pre-approved equal.

END OF SECTION

SECTION 40
UHF RADIO MODEMS

C.40 Overview

C.40.1 It is the intent of this section to outline the requirements for radios used only where line-of-site functionality cannot be met. It is not the intent of this section to state that line-of-site conditions can or cannot be met at each intended location.

It is the responsibility of the installer to confirm operability within the parameters of this specification section. If these parameters cannot be achieved in the locations outlined in the contract documents, the installer shall notify the control system integrator in writing within 48 hours of discovery of the exception to the specified conditions.

C.41 Manufacturer

C.41.1. The wireless modems shall be narrow band, licensed UHF radio modems that operate in the

450-470 MHz frequency band as supplied by ESTeem or pre-approved equal.

C.42 Unitary Responsibility

C.42.1. In order to unify responsibility for proper operation of the UHF radio modems, it is the intent of these Specifications that a single supplier (unitary source) shall furnish all components for the radio system.

C.43 General

C.43.1. All radio modems shall be licensed by the FCC for narrow band operation in the 450 to 470 MHz frequency band.

C.43.2. All radio modems shall be compatible for 25 KHz, 12.5 KHz and 6.25 KHz channel spacing.

C.43.3. All radio modems shall be software frequency agile and adjustable locally or remotely using the remote programming feature.

C.43.4. All radio modems will function as a Base, Repeater, or Remote with the same unit. Changing functions shall be accomplished through software programming locally or remotely over the RF link.

C.43.5. All radio modems will be capable of master to master communications. No radio modem in the system will be limited to function only as a repeater or slave to a master radio modem.

C.43.6. All radio modems shall have Digi-Repeating, which will allow the user to route data through a

maximum of three radios to reach a remote radio node. Digi-Repeating will allow any radio in the network to repeat a data packet from another radio modem.

C.43.7. All radio modems functioning as a remote must to able to function as a Digi-Repeater while simultaneously providing data to its attached device.

C.43.8. The Digi-repeater feature shall be transparent to the User's Device.

C.43.9. All radio modems must have a Grouping feature that will allow multiple devices to share access to a single radio modem.

C.43.10. All radio modems will have the PLC protocol emulation contained in the radio modem firmware. Transparent only operation will not be acceptable.

C.43.11. All radio modems shall have received signal strength and data quality available for diagnostics.

C.43.12. All radio modems shall include a software package for setup and diagnostics at no additional cost.

C.43.13. All radio modems shall have remote programming over the radio link. All configuration functions shall be available through remote programming including programming though repeaters.

C.43.14. All radio modems shall have an infrared (IR) port for remote programming without a physical connection to the unit.

C.44 RF Communications

C.44.1. All radio modems shall use 4-level FSK modulation to provide a RF data rate of 19,200 bps when using a 25 KHz channel spacing and 9,600 bps when using a 12.5 KHz channel spacing.

C.44.2. All radio modems shall have a maximum point to point communications turn around time of < 30 msec. + data using the Acknowledge Feature and <15 msec. + data without the Acknowledge Feature.

C.44.3. All radio modems shall utilize Carrier Sensed Multiple Access with Collision Detection (CSMA-CD) transmission protocol.

a. All radio modems shall use Forward Error Correction and 32 Bit Cyclic Redundancy

END OF SECTION