Chapter 360 Electrical

360.01 General

This chapter provides general design criteria for the electrical design of WSF facilities. Refer to Chapter 610 (Vehicle Transfer Span) and Chapter 620 (Passenger Overhead Loading) for more detailed information on the electrical design criteria Vehicle Transfer Spans and Passenger Overhead Loading facilities.

Chapter	Subject
350	Buildings
610	Vehicle Transfer Span
620	Passenger Overhead Loading

360.02 References

Unless otherwise noted, any code, standard, or other publication referenced herein refers to the latest edition of said document.

(1) Federal/State Laws and Codes

Federal, State and Local Building Codes

Life Safety Code, NFPA-101

National Electrical Testing Association (NETA)

The Occupational Safety and Health Act (OSHA)

WAC 296-45 *Washington Safety Standards for Electrical Workers*

WAC 296-46B *Washington Safety Standards – Installing Electrical Wires and Equipment*

WAC Title 51, *Enterprise services, department of (building code council)*

Washington Industrial Safety and Health Act (WISHA)

Washington State Energy Code

(2) Design Guidance

Standard Plans M 21-01, WSDOT

Standard Specifications M 41-10, WSDOT

Plans Preparation Manual M 22-31, WSDOT

National Electric Code (NEC)

360.03 Design Considerations

(1) Materials Specification

Utilize materials that are in accordance with the requirements of the WSDOT *Standard Specifications*, WSDOT *General Special Provisions*, WSF *General Structural Notes*, and *Regional General Special Provisions*. Consider the material requirements of federally funded projects including Buy America requirements.

Electrical specifications and special provisions which are project specific shall be edited to contain only requirements relevant to the project they are provided for. Use WSDOT and *Regional General Special Provisions* whenever possible

Provide electronic copies of the specifications, in the file format which the specifications were developed, for each required project deliverable (e.g. 30 percent, 60 percent, 90 percent, and Final).

(2) Design Drawings

Electrical drawings for WSF Terminal Engineering shall be arranged in the order given in Section 816 of Division 8. If additional drawings are needed in a category, the sheet number should remain the same on the left side of the decimal and increase sequentially on the right side of the decimal (see the first two sheets as an example).

Provide electronic copies of the drawings, in the file format which the drawings were developed, for each required project deliverable (e.g. 30 percent, 60 percent, 90 percent, and Final).

(a) Electrical Symbols and Abbreviations

The Electrical Symbols and Abbreviations sheets shall be project specific and show only items relevant to the project they are provided for.

(b) Electrical Onelines

On power distribution onelines, in addition to showing the equipment ratings, show equipment location and interconnecting conduit and wire sizes.

(c) Site Power Distribution Block Diagram

The onelines for demolition and new work on projects that include site power distribution shall include block diagrams showing conduit interconnections of equipment, junction boxes, and manholes that are part of the work done on the project.

(d) Site Communications Block Diagram

The onelines for demolition and new work on projects that include site communication system shall include block diagrams showing the conduit interconnections of equipment, junction boxes, and manholes for the work done on the project.

(e) Communications Drawings

Communications drawings shall include telephone, paging, IT networks, radio, and other similar communications systems that are included in the project.

(3) UL Label

All electrical components shall be approved or listed and labeled by Underwriters Laboratories Inc. (UL) or other testing laboratory accredited by the State of Washington.

(4) Power Outages and Temporary Power

Power outages are defined as interruptions in normal power for longer than 15 minutes. Anticipate the number and length of power outages required for the project. If possible, specify in the Special Provisions the number, length and time of day when power outages can occur. Outages and interruptions must be coordinated with WSF Operations at all locations, and US Customs at Anacortes and Friday Harbor, to determine the need for temporary power. Projects at Terminals where facilities are to remain open during all or part of construction often require temporary power.

(5) Network and Communications Systems

Interruptions in network and communications service must be coordinated with WSF Operations, IT, and Security in advance. At Ferry Terminals open to the public during construction, the electrical design shall indicate interruptions in network and communications service shall occur during non-business hours and shall be coordinated a minimum of 48-hours in advance.

(6) Proprietary Items

WSF uses competitively acquired products to fulfill the requirements of a contract wherever feasible to help achieve the lowest price, the best quality, and the most efficient use of resources. There are instances in which competitive bidding may not or cannot be provided and a specific proprietary product is allowed. Refer to Section 220.07(2) for limitations on the use of proprietary items.

(7) Electrical Identification

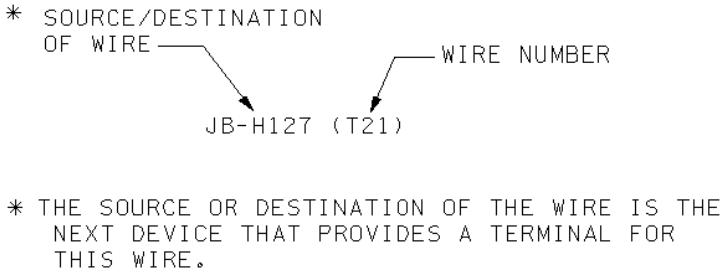
(a) Conduit

A metal conduit identification tag, stamped or engraved with the raceway number from the Contract Drawings, shall be installed on both ends of all accessible conduits. The tags shall be located in vaults and junction boxes for underground conduits and adjacent to each termination point for above ground conduits. Underground conduits shall have a continuous line warning tape located directly above the conduit(s).

Inside buildings, conduits that terminate at surface mounted equipment shall have identification tags. Conduits concealed above ceilings or in walls are not required to have conduit tags. Conduits for auxiliary systems (e.g. Fire alarm, telecommunications, etc.) shall have wraparound colored bands to identify the system.

(b) Wire and Cable

Heat shrink tubing wire and cable markers shall be installed on each conductor in panelboards, switchboards, transformers, gutters, pull boxes, outlets and junction boxes, etc. and at load connections. Identify with panelboard or switchboard designation and branch circuit or feeder number for power and lighting circuits. Identify control wiring with source/destination of wire or cable and the control wire number indicated in the schematic and interconnection diagrams. All identifications shall be typewritten.



Control Wire and Cable Labeling
Exhibit 360-1

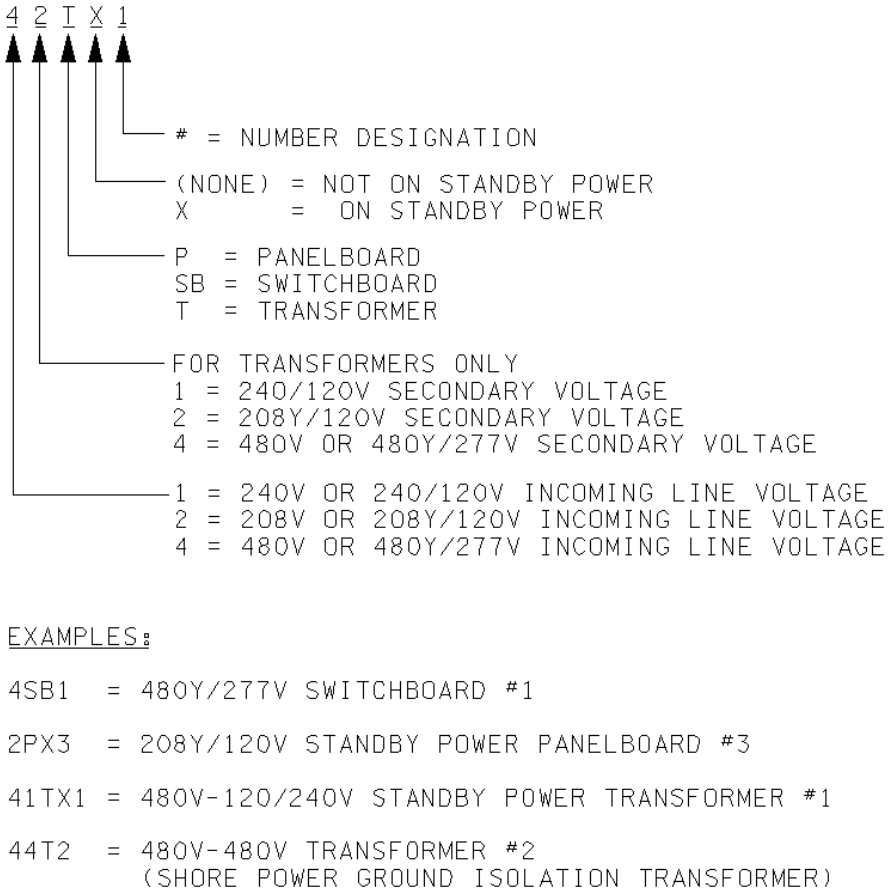
(c) Boxes and Vaults

Engraved nameplates shall be installed on all above ground junction and pull boxes and welded bead labels on all in-ground junction, pull boxes, and vaults. Box labels and nameplates shall denote the box number as indicated in the Plans and box type. Box types shall be “PWR” for power, “COMM” for communications and “CTRL” for control.

In buildings, junction box, pullbox or outlet boxes covers shall have adhesive plastic labels when mounted below 8-feet and permanent waterproof marker when mounted above 8-feet.

(d) Equipment

Equipment identification labels shall be developed following the convention shown in Exhibit 360-2.



Electrical Equipment Labeling Convention
Exhibit 360-2

Engraved nameplates with the device or equipment designation, voltage, power source designation and Contract Number shall be provided for all major electrical equipment. The following is an example of an electrical equipment nameplate:

PANEL 4P1
VOLTAGE: 480Y/277V
SOURCE: SWITCHBOARD 4SB1
CONTRACT: 5555

360.04 Wiring and Protection

(1) Calculations

The following calculations are required for all electrical designs for WSF Terminal Engineering projects. Include the final calculation in the Design File and submit to WSF Terminal Engineering in printed format. Provide all calculations with sufficient documentation so that it is clear how each result was derived.

Provide electronic copies of all project calculations, in the file format which the calculations were done, for each required project deliverable (e.g. 30 percent, 60 percent, 90 percent, and Final).

(a) Load Studies

Complete load studies for each new power distribution component (i.e., panelboards, switchboards, engine-generators, etc.) provided as part of the design and for each existing power distribution component where new load is added.

Load studies can be calculated using recorded peak demand information as permitted by NEC 220.35.

(b) Arc Flash and Short Circuit Current

Model the electrical system using SKM PTW Arc Flash software. Calculate incident energy and flash boundary values and select appropriate PPE. Provide Arc Flash labels for all panels. Provide fault reports for each bus. Provide SKM PTW Arc Flash electrical system model software files for the project.

(c) Voltage Drop

Prepare steady-state voltage drop calculations for each feeder and branch circuit over 100 feet in length. The maximum allowable voltage drop on any single feeder or branch circuit is 3 percent. The maximum total voltage drop for any load including feeder and branch circuit is 5 percent. Use the load calculated in the load study for the load used in the calculation of voltage drop. It is acceptable to assume that voltage is adjusted to normal on the secondary of transformers using taps.

Prepare motor starting voltage drop calculations for all motors 5-horsepower and above. The maximum acceptable voltage dip from any motor starting is 15 percent. Provide solid-state reduced voltage motor starters to limit voltage dip as required.

(d) Lighting

Prepare light level calculations for all new lighting provided as part of the design. Take into consideration any existing light fixtures that are to remain. Include in the light level calculation report all the information and calculation results necessary to verify the design complies with the lighting criteria. Lighting calculations shall be performed using AGI32. Provide AGI32 lighting calculation software files for the project.

(2) Services

The information in this section supplements Article 230 of the National Electrical Code and Section 9-29.24 Service Cabinets of the *Standard Specifications*. Additional requirements and information are provided that pertains specifically to WSF Terminal Engineering work.

(a) Service Ratings

For WSF work, use electrical services rated 480Y/277V, 3-phase, 4-wire unless otherwise permitted by the WSF Terminal Engineering Electrical Supervisor.

(b) Modified Type E Service Cabinets (600 Amperes and Below)

Use a Modified Type E Service Cabinet for services rated less than or equal to 600 amps. A Type E Service Cabinet detailed on WSDOT Standard Plan for 240/480V service rated up to 200A. The WSDOT Type E Service Cabinet is modified for WSF Terminal Engineering work so that it is compatible with 480Y/277V, 3-phase, 4-wire services up to 600 amps.

Modified Type E Service Cabinets house the following components:

- Power utility revenue meter base
- I-Line panelboard, service rated
- The following items are optional depending on project conditions:
- 120/240V or 208Y/120V panelboard
- Strip heater and thermostat
- Lighting contactor
- Convenience receptacle

(c) Service Equipment (Above 600 Amperes)

Provide service equipment above 600 amps as an indoor switchboard unless otherwise permitted by the WSF Terminal Engineering Electrical Supervisor.

(d) Ground-Fault Protection of Equipment

Provide ground-fault protection of equipment solidly grounded wye electrical services with service disconnect rated 1000 amps or more in accordance with Section 230.95 of the NEC.

When ground-fault protection of equipment is required on the main circuit breaker, furnish all feeder breakers in the same panel with an overcurrent trip rating greater than the ground fault trip rating of the main circuit breaker with ground fault protection. Coordinate the ground fault protection on the main and feeder breakers so that a ground fault on a feeder circuit will not trip the main unless there is a failure of the ground fault protection on that feeder circuit.

(3) Grounding

The information in this section supplements Article 250 of the NEC. Additional requirements and information is provided that pertains specifically to WSF Terminal Engineering work.

The purpose of grounding is to protect people, property, and equipment from short-circuits, ground-faults, insulation failure, lightning strikes, overvoltages, etc. Provide grounding for electrical services and separately derived systems, with the exception of shore power systems.

(a) Services

Bring the neutral conductor to the service cabinet or service disconnect enclosure and terminate on a neutral bus or lug. Ground the neutral at the service disconnect by a "main bonding jumper" between the neutral bus or lug and the ground bus.

Ground the neutral at the transformer if required by the serving utility.

(b) Grounding Electrode System

Provide a grounding electrode system for each service, separately derived system, and building. Locate the grounding electrode system as close as possible to the source of the system being grounded. Separately derived systems may share a grounding electrode system only if they are immediately adjacent, in the same building, or if they are located on the trestle.

The minimum requirements for a grounding electrode system are as follows:

- Copper-clad ground rods, 1/2 inch in diameter and 10 feet long or 3/8 inch in diameter and 8 feet long, installed in accordance with the NEC.
- Grounding electrode system for services with at least four ground rods installed around the perimeter of the service equipment.
- Grounding electrode system for separately derived systems consisting of at least two ground rods.
- Provide separation between ground rods of 6 feet minimum.
- Install each ground rod in a ground well. Ground wells are to be WSDOT Type 1 junction boxes in accordance with WSDOT Standard Plan Section J.
- Interconnect ground rods with #4/0 bare copper cable, direct buried not less than 30 inches below finished grade.
- Grounding electrode conductors are to be stranded copper with type XHHW or USE insulation.

The grounding electrode conductor between the grounding electrode system and the service equipment or separately derived system ground bus is to be an insulated conductor, installed in conduit and sized not smaller than indicated in Exhibit 360-3. Do not consider the exceptions permitted in the NEC when sizing service and derived system ground electrode conductors.

2 or smaller	8
1 or 1/0	6
2/0 or 3/0	4
Over 3/0 through 350	2
Over 350 through 600	1/0
Over 600 through 1100	2/0

Grounding Electrode Conductor for Alternating Current Systems
Exhibit 360-3

(c) Grounding Separately Derived Systems on Over Water Structures or in Buildings

Multiple separately derived systems located on the trestle and transfer spans or in buildings may be grounded from a common grounding electrode conductor. Size the common grounding electrode conductor in accordance with Exhibit 360-3, based on the largest derived phase conductor of the systems being grounded.

(d) Equipment Ground Conductor

An equipment ground conductor is to be installed in all conduits. Specify stranded copper equipment ground conductors with type XHHW insulation outdoors and THHN/THWN insulation in buildings. Design the equipment ground conductor to ground all metal that encloses electrical conductors or equipment such as cabinets, boxes, and raceway. Size equipment ground conductors according to Table 250.122 of the NEC.

(e) Grounding Boxes and Enclosures

Design all junction boxes, pull boxes, equipment enclosures, etc. with copper ground lugs or terminals for a bonding jumper to ground the box or enclosure sized according to Table 250.122 of the NEC.

(f) Raceway Grounding

Ground all metallic raceways. Ground conduits using grounding end bushings.

(g) Supplemental Grounding for Light Standards

Provide supplemental grounding at light standards. Foundations for these standards are to be installed with a bare #6 copper wire that is connected to the reinforcing cage with an approved acorn clamp or cadweld and routed to connect to the pole at the grounding lug. Size the light standard foundation based on the site soil conditions in addition to the height of the standard, quantity, weight and configuration of the luminaires.

(h) Shore Power Systems

When ferries are connected to shore power, the shipboard electrical distribution system is ungrounded to prevent highly corrosive leakage currents from seeking a path back to a grounded service transformer through the underwater body. Ground isolation is provided by a 480V to 480V, delta-delta transformer. The shore power receptacle side of the transformer is to be ungrounded. Run the ungrounded shore power feeds through a readable network connected meter and equip with ground fault detection relays providing alarm indication of ground faults. Check with the WSF Terminal Engineering Electrical Supervisor for the current ground fault detection design.

360.05 Wiring Methods and Materials

(1) Conductors for General Wiring

The information in this section supplements Article 310 of the National Electrical Code. Additional requirements and information are provided that pertain specifically to WSF Terminal Engineering work.

(a) Conductor Material

All conductors are to be stranded copper.

(b) Insulation

Use Exhibit 360-4 to determine conductor insulation requirements. Where any part of a wire run is installed underground, provide the conductors with USE insulation for the entire length of the cable run, from terminal to terminal.

Installation Type and Location	Insulation Type
Secondary Distribution Wiring	
Underground	USE
Aboveground Outdoors	XHHW
Indoors	THHN/THWN
Control Wiring	
Underground	XHHW
Aboveground Outdoors	XHHW
Indoors	THHN/THWN
Signal Wiring	
All Locations	Flame Retardant PVC
Internal Wire for Custom Panels and Cabinets	
Outdoors	XHHW
Indoors	THHN/THWN
Multi-Conductor Power and Control Cable Installed for Flexibility	
Exposed	SOOW
In Conduit	Flexible Type TC

Conductor Insulation Requirements
Exhibit 360-4

(c) Signal Cable

Cable for electronic circuits to instrumentation, metering, and other signaling and control equipment is to be two or three conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield.

(d) Splices

1. **600V Cable**

   Make splices using a compression type butt splice, copper or high conductivity copper alloy sleeve, insulated with 600-volt rated heavy wall or medium wall heat shrinkable tubing with adhesive liner to provide a watertight seal.

2. **Control Wiring**

   Splice control wiring on terminal blocks.

(e) Terminations

1. **Terminals**

   Terminations on terminals are to use solderless copper, single-cycle compression, ring type cable lugs. Cable lugs for 250 kcmil and larger wire are to be two hole flat.

2. **Circuit Breaker**

   Terminations on circuit breakers are to be directly on the circuit breaker lugs.

3. **Motor Leads**

   Connections on 480V motors are to consist of crimp-on lugs bolted together and insulated with 600V heat shrink caps.

4. **Spares**

   Spare conductors are be terminated with heat shrink caps, coiled, and identified as spares.

(2) Junction Boxes

This section covers requirements for junction and pull box installations on WSF Terminal Engineering projects.

(a) Size

Size boxes in accordance with Article 314 of the NEC. Oversize boxes with terminals, if required, to provide wire bending space at the terminals in accordance with Article 312 of the NEC.

(b) In-Ground Junction Boxes

In-ground junction boxes are to conform to WSDOT Standard Plan Section J and Section 8-20.3(6) and 9-29.2 of the *Standard Specifications* except as listed below:

- Junction boxes placed in the roadway, roadway shoulders, parking areas, and other areas subject to vehicular traffic are to be traffic bearing with a bolt down lid and rated for HS-25 loading. In all other areas, boxes are to be rated for H-20 loading.
- Type 3 junction boxes are to be furnished with a two-door lid.

(c) Vaults

Use pre-cast vaults as manufactured by Utility Vault Company or approved equal. Vaults placed in the roadway, roadway shoulders, parking areas, and other areas subject to vehicular traffic are to be rated for HS-25 loading. Vaults in all other locations are to be rated for H-20 loading. Access lids are to be bolt down type and have spring assisted galvanized diamond plate cover with locking latch for vaults in non-vehicular traffic areas. Access lids for vaults in vehicle traffic areas are to be round cast iron type.

(d) Exposed Outdoor Junction Boxes

Junction and pull boxes over water or facing a roadway or driveway are to be NEMA Type 4 cast iron. Equip cast iron boxes with overlapping covers, external mounting lugs, internal mounting buttons for back plates or grounding lugs/bars, a neoprene gasket, and a stainless steel retention cable for the cover.

Outdoor junction and pull boxes not required to be cast iron are to be NEMA 4X Stainless Steel.

(e) Indoor Junction Boxes

Indoor boxes (larger than switch, receptacle, or fixture type) are to be constructed of sheet steel and galvanized after fabrication.

Indoor, dry, finished locations use NEMA 1.

Indoor, dry, unfinished locations or areas designated for maintenance use NEMA 12.

Indoor, wet or damp locations use NEMA 4X.

(3) Raceways

This section covers requirements for electrical raceway installations on WSF Terminal Engineering projects.

(a) Underground Conduit

PVC conduit is to be installed for underground conduit. Specify schedule 40 conduit, with the exception that where trenching is permitted for roadway crossings, or where service lateral runs are installed, specify schedule 80 conduit. The same schedule and type of conduit is to be used for the entire length of the run from outlet to outlet.

Use Rigid Metal Steel Conduit (RMC) for all underground bends and elbows. Conduit stub-ups are to be Rigid Metal Steel Conduit from the exposed portion to and including the underground bend or elbow that turns the conduit horizontal. For conduit that enters the ground at a slope or bulkhead where there is no elbow or bend that turns the conduit horizontal, install at least 3-feet of Rigid Metal Steel Conduit underground

before transitioning to PVC Conduit. Paint Rigid Metal Steel Conduit emerging from underground with a protective coating of bitumastic, asphalt-based paint or a PVC coating extending from the transition (PVC to steel) coupling to 6 inches above grade.

(b) Exposed Outdoor Conduit

Rigid Metal (Steel) Conduit (RMC) is to be installed for exposed outdoor installations on shore. All conduit bodies, device boxes, and conduit fittings are to be steel or malleable iron with a hot-dipped galvanized finish. Support material and fittings are to be hot-dipped galvanized steel. Anchors, nuts, bolts, washers, and other hardware are to be stainless steel.

Rigid Metal Steel Conduit PVC-Coated (RMCP) are to be installed for all exposed outdoor installations on offshore structures. All conduit bodies, device boxes, and conduit fittings connected to RMCP conduit are to be PVC-coated steel or PVC-coated cast iron. Support material and fittings in direct contact with RMCP conduit are to be PVC-coated steel. Anchors, nuts, bolts, washers, and other hardware are to be stainless steel.

Liquidtight Flexible Metal Conduit (LFMC) are to be installed for all exposed outdoor installations where flexibility is needed. All fittings for LFMC conduit are to be PVC-coated steel or PVC-coated cast iron. Support material and fittings in direct contact with LFMC conduit are to be PVC-coated steel. Anchors, nuts, bolts, washers, and other hardware are to be stainless steel.

(c) Indoor Conduit

Electrical Metallic Tubing (EMT) conduit is to be used indoors in finished areas.

In areas where maintenance work is performed or other such areas where conduit may be subject to physical damage, RMC (Steel) is to be used.

Flexible metal conduit may be used indoors only. Flexible metal conduit may be used in locations requiring flexibility, for wiring between light fixtures, and fished between studs in interior wall, but is to not be used for general purpose raceways.

(d) Metal Wireway

Metal wireway and gutters may be used outdoors and indoors in unfinished areas. Outdoor wireway are to be NEMA 4X, indoor wireway are to be NEMA 1 in finished areas and NEMA 12 in unfinished areas.

(e) Surface Metal Raceway

Surface metal raceway may be used in toll booths. It is not to be used in other locations.

360.06 Equipment

(1) Switches

The information in this section supplements Article 404 of the National Electrical Code. Additional requirements and information are provided that pertains specifically to WSF Terminal Engineering work.

(a) Wall Switches

Wall switches are to be heavy-duty industrial grade.

(b) Disconnect Switches

Disconnect switches are to be Heavy Duty Safety Switches, 600V rated, non-fusible.

(c) Circuit Breaker Disconnects

Circuit breaker disconnects are to be enclosed molded case circuit breakers.

(d) Manual Transfer Switches (MTS)

Manual transfer switches are to be Double Throw Safety Switches, 600V rated, non-fusible, Type DTU.

(e) Enclosures

Enclosures for disconnect switches, circuit breaker disconnects, and manual transfer switches are to be NEMA Type 1 indoors in finished areas, NEMA 12 indoors in unfinished areas and NEMA Type 4X stainless steel outdoors.

(2) Automatic Transfer Switches (ATS)

This article covers automatic transfer switches (ATS) for connection of a utility provided power source and a standby engine-generator power source to designated loads.

(a) Enclosures

Enclosures for ATSs are to be NEMA Type 12 indoor and NEMA Type 4 outdoor.

(b) Neutral

ATSs are to be solid neutral or switched neutral depending on the power distribution system in which it is applied.

(c) Optional Features

ATSs are to include the following optional features:

- Auxiliary contacts consisting of one contact that is closed when the ATS is connected to the normal source and one contact that is closed when the ATS is connected to the standby source.
- ATSs installed outdoors are to be furnished with a strip heater and thermostat, wired to load terminals.
- Remote annunciation.

(3) Receptacles

The information in this section supplements Article 406 of the National Electrical Code. Additional requirements and information is provided that pertains specifically to WSF Terminal Engineering work.

(a) Convenience Receptacles

Convenience receptacles are to be heavy-duty specification grade, duplex grounding type rated 15A at 125V, NEMA 5-15R, ivory in color.

Indoor GFCI receptacles are to be heavy duty grade, 15A, 125VAC, NEMA 5-15R, ivory in color.

Outdoor and wet location GFCI receptacles are to be marine product, 15A, 125 VAC, GFCI receptacle, gray with PVC weatherproof while-in-use cover plate.

Isolated ground receptacles are to be similar to duplex receptacles except with the ground terminal insulated from the mounting yoke, hospital grade and orange in color.

(b) Shore Power Receptacles

Shore power receptacles are to be 200A, 600 VAC, 3-wire, 3-pole pin and sleeve receptacle with shell grounding, rain tight construction with clamp cover.

(4) Switchboards and Panelboards

The information in this section supplements Article 408 of the National Electrical Code. Additional requirements and information are provided that pertain specifically to WSF Terminal Engineering work.

(a) Bus Work

All bus work is to be copper.

Neutral busses should not be less than 100 percent rated.

Isolated ground panels are to have a 200 percent rated neutral bus.

(b) Switchboards

Main and feeder devices in switchboards are to be circuit breakers. All switchboards are to have a main circuit breaker unless otherwise permitted by the WSF Terminal Engineering Electrical Supervisor.

When ground fault protection is required on the main circuit breaker, all feeder breakers with trip rating greater than the ground fault trip rating of the main circuit breaker are to be furnished with ground fault protection. The ground fault protection on the main and feeder breakers are to be coordinated so that a ground fault on a feeder circuit will not trip the main unless there is a failure of the ground fault protection on that feeder circuit.

Distribution sections are to consist of group mounted circuit breakers.

Switchboard enclosures are to be NEMA 1 indoor and NEMA 3R outdoor on shore. Switchboards should not be installed outdoors on over water structures. For new construction, when a switchboard is to be installed on the trestle it should be installed in a ventilated electrical room inside a building.

(c) Panelboards

Panelboard enclosures are to be NEMA 1 indoor in finished areas, NEMA 12 indoor in unfinished areas and NEMA 4X stainless steel outdoors.

(5) Pipeline Freeze Protection (Heat Trace)

The information in this section supplements Article 427 – "Fixed Electric Heating Equipment for Pipelines and Vessels" of the National Electrical Code. Additional requirements and information are provided that pertain specifically to WSF Terminal Engineering work.

(a) Heat Trace Cable

Heat trace cable is to be self-regulating type with tinned copper braid.

(b) Heat Trace Monitoring and Control

A Heat Trace Monitoring and Control Panel are to be provided for heat trace installations. The Monitoring and Control Panel are to be a microprocessor-based unit with programmable heater ON, OFF and ALARM set points and indication for Low Temperature, High Temperature, Low Heater Current, High Heater Current, Ground Leakage Current, and Damaged RTD.

(c) Temperature Sensors

Temperature input to the Heat Trace Monitoring and Control Panel are to be from pipe wall sensing RTD(s).

(6) Motors and Motor Starters

The information in this section supplements Article 430 of the National Electrical Code. Additional requirements and information are provided that pertain specifically to WSF Terminal Engineering work.

(a) Motors

Efficiency – All motors are to be of the "energy efficient" or "energy saver" type when available. Design A and B polyphase motors are to comply with the minimum efficiencies required by the Washington State Energy.

Motor Enclosures – Motors installed outdoors or indoors in areas where maintenance activities are performed are to be Totally Enclosed type.

Motors – Motors in indoor finished areas are to be Open Drip-proof type.

(b) Motor Starters

Motor starters are to be combination type with Motor Circuit Protector (MCP) overcurrent protection device.

Motor starters are to be across the line starting type unless reduced voltage starting is necessary to reduce motor starting voltage dip. Across the line motor starters are to be NEMA rated.

The maximum acceptable voltage dip from any motor starting is 15 percent. Solid-state reduced voltage motor starters are to be provided to limit voltage dip as required.

Motor starters installed outdoors are to have NEMA 4X stainless steel enclosures.

Motor starters installed indoors are to have NEMA 12 painted steel enclosures.

(7) Generators

The information in this section supplements Article 445 of the National Electrical Code. Additional requirements and information are provided that pertain specifically to WSF Terminal Engineering work.

(a) Equipment

Generators are to be standby rated packaged engine-generator systems with diesel engine drives.

The installation shall be designed as an optional standby system as defined in Article 702 in the National Electrical Code.

Due to long lead times for procurement, consider advance purchase of the generator.

(b) Ratings

Generators are to be rated 480 Volts, 3-phase, 4-wire and sized to power all terminal facility loads; with the exception of the vessel shore power. Size the generator with a 10 percent surplus capacity. Prepare a generator sizing technical memorandum as the basis for design. The technical memorandum must receive the concurrence of the WSF Terminal Engineering Electrical Engineering Supervisor.

(c) Enclosures

Enclosures are to be outdoor, weather-protective, sound attenuating type. The overall sound rating (combined mechanical and exhaust noise) are not to exceed 75 dBA at 23 feet.

(d) Fuel Tanks

Fuel tanks are to be integral base type sized for 24-hour continuous full load operation of the engine-generator.

(e) Remote Annunciator Panel

A Generator Remote Annunciator Panel is to be provided for each engine-generator. Panels are to comply with NFPA 110, Level 1. Typically, the Generator Remote Annunciator Panel will be located in the Terminal Supervisor Office. Coordinate exact location with WSF Operations.

(f) Grounding

The generator neutral is to be connected to a grounding electrode system in accordance with Section 360.04.

(8) Transformers

The information in this article supplements Article 450 of the National Electrical Code. Additional requirements and information are provided that pertain specifically to WSF Terminal Engineering work.

(a) Windings

All transformers are to have copper windings.

(b) Outdoor, Dry-Type Transformers

Dry-type transformers installed outdoors are to have encapsulated core and coil assemblies.

(c) Temperature Ratings

For transformers 10kVA and below, the temperature rise is to be 115-degree C rise above a 40-degree C ambient. For transformers above 10kVA, the temperature rise is to be 150 degrees C above a 40-degree C ambient. The maximum temperature of the top of the enclosure is to not exceed a 35-degree C rise above a 40-degree C ambient.

(9) Mini Power-Zone

The information in this section covers Mini Power-Zone packages, which is a packaged power supply consisting of an incoming line main circuit breaker, a transformer section, and secondary power distribution panelboard.

Mini Power-Zone packages are to be provided with the following options:

- Bolt-on branch circuit breakers.
- NEMA 3R painted stainless steel enclosure for outdoor installations

360.07 Lighting

(1) General Requirements

The design of lighting systems shall be developed to provide:

- Safe working conditions, safe passage, and the identification of any hazards or obstruction, indoors and outdoors.
- Comfortable visibility conditions.
- Adequate light levels and color for safe and effective accomplishment of tasks to be performed.
- The most efficient and economical system practicable.
- Minimal light trespass and glare.

General illumination shall conform to the recommendations of *The Illumination Engineering Society of North America (IESNA) Lighting Handbook* except as modified by this article.

(2) Indoor Lighting Design Criteria

(a) Indoor Illumination

Indoor illumination shall be provided in accordance with Exhibit 360-5.

Light Level Chart			
Area Description	**Minimum Average Horizontal Illuminance (Footcandles)**	**Minimum Maintained Illuminance (Footcandles)**	**Distance Above Finished Floor (Inches)**
Agent's Office	30		30
Bicycle/Kayak Staging	10		0
Building Entrance		5	0
Communications	50		30
Computer	30		30
Conference Room	30		30
Corridors	5	1.2	0
Counting/Safe Room	50		30
Crew Quarters	20		30
Crew Room	30		30
Customs Check-In	30		30
Customs Offices	30		30
Deli/Pub	30		30
Dining	30		30
Electrical	30		30
Employee Break Room	15		30
Espresso/Fast Food	30		30
Food Storage	15		0
Lockers	15		0
Mechanical	20		0
News/Books/Gifts/ATM	50		30
Office/Admin/Training	30		30
Parking (Indoor)	5		0
Receiving/Service	20		0
Restrooms	General: 5 Vanity: 15 Plumbing: 15		General: 0 Vanity: 30 Plumbing: at top of fixture
Security Control	30		30
Service	20		30
Stairways	5		0
Storage/Janitors/Supply	10		30
Tickets	30		30
Travel Desk	50		30
Waiting	15		30
Water Valve	20		0

Indoor Illumination Requirements
Exhibit 360-5

(b) Uniformity

For indoor lighting, the maximum maintained horizontal illuminance level shall not be more than six times the average level and the minimum horizontal illuminance shall not be less than one-sixth the average level.

(c) Exit and Emergency Lighting

Exit and emergency lighting shall be provided in accordance with the Life Safety Code (NFPA 101). Emergency lighting shall also be provided on the outside of building to light steps or ramps for safe egress.

Emergency lighting shall be provided to operate in the event of failure of the normal power source. Emergency lighting fixtures provided to illuminate the means of egress shall be arranged to provided initial illumination that is not less than an average of 1 foot-candle and, at any point, not less than 0.1 ft-candle, measured along the path of egress at floor level. A maximum-to-minimum illumination uniformity ratio of 40-to-1 shall not be exceeded.

Exit signs shall be provided to mark each means of egress and shall use LED type lamps.

Key communications and Operations areas shall have emergency lighting sufficient to allow work to continue. Coordinate with the WSF Terminal Engineering Electrical Supervisor to determine which areas fall into this category.

Electrical Equipment rooms shall have emergency lighting to provide 3 ft-candles average at 30 inches above the floor with an average-to-minimum uniformity of 6-to-1.

Exit and emergency lighting shall provide a minimum operating time of 90 minutes. Additional operating time may be required at some locations. If batteries are used as the emergency lighting power source, they shall be long-life Nickel-Cadmium batteries.

(3) Outdoor Lighting Design Criteria

Outdoor illumination shall be provided in accordance with Exhibit 360-6.

Light Level And Uniformity Ratio Chart			
Area Description	Minimum Average Horizontal Illuminance (Footcandles)	Minimum Horizontal Illuminance (Footcandles)	Target Uniformity Ratio (Avg/Min)
Pedestrian walkways (flat)	3	1	
Pedestrian walkways (sloped, uneven, steps, or obstacles)	5		3:1
Transfer span pedestrian walkway (at Terminals without overhead loading)	5		3:1
Traffic ways	1		3:1
Traffic holding area	0.8		4:1
Traffic holding area where WSF personnel direct traffic		1	
Gangways	10	3	

Outdoor Illumination Requirements
Exhibit 360-6

Luminaires at locations accessible by vehicles shall not be mounted at heights greater than 40-feet so that WSF Maintenance is able to perform maintenance on the luminaires.

Luminaires at locations not accessible by vehicles shall not be mounted at heights greater than 16-feet so that maintenance can be performed from a step ladder.

If Generator power is available, Exit signs, site lighting and egress lighting shall be connected to standby panels in addition to Battery powered Emergency Lighting.

(4) Lighting Calculations

The light level calculation report, as described in Section 360.04(1)(d), shall include all the information and calculation results necessary to verify the design complies with the lighting criteria.

Average light levels for areas shall not be less than the values given in the above lighting criteria. Where a minimum maintained light level is listed for an area, the light levels shall not be lower than the value given at any point in the calculation point grid for that area.

The lighting system shall be designed to be as close as practical to the target uniformity ratio (typically within 5 percent). Lighting designs where the uniformity exceeds the target uniformity ratio require approval of the WSF Terminal Engineering Electrical Supervisor.

The location, arrangement, size, and spacing of all calculation point grids require approval of the WSF Terminal Engineering Electrical Supervisor.