Minimum Technical Requirements Summary

502.11WG PRESENTATION

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Overview

- Brief Summary of Transmission Substation Minimum Technical Requirements based on documents from 52 ISOs, RTOs and Utility TFOs

ISO/RTOs

The following ISO/RTOs had significant substation connection information on their websites:

- IESO
- ISO-NE
- PJM
- SPP

Baseline Document

- NERC FAC-001-1
- <u>Title</u>: *Facility Connection Requirements*

- 16 Connection Criteria General Categories

- The ISO/RTOs and TFOs expanded the NERC criteria to establish Minimum Requirements

General Requirements (1/2)

- Coordinated joint power system studies & review
- Connection taps to transmission lines of voltages 345kV and higher are not permitted
- Minimum requirements do not replace Regulatory Code Requirements
- Minimum requirements are intended to ensure a safe, effective, and reliable interconnection

General Requirements (2/2)

- Substation design shall minimize animal infestations and wildlife caused outages
- As a design minimum account for (N-1) failures
- Minimize magnitude/duration of system outages in event of a substation component failure
- Design substation to withstand fault current including projected growth & expansion in the future.

Connection Disconnection/Isolation (1/2)

- Automatic isolation of Connection for faults or abnormal conditions.

- Interrupting device must have sufficient capacity to interrupt ultimate fault current

- Manual Isolating device/disconnect switch:
  - Must open all phases simultaneously
  - Must be accessible to TFO
  - Must be lockable in open and closed positions
  - Must be suitable for safe operation under all weather conditions
  - Full physical open position can be visually seen

Connection Disconnection/Isolation (2/2)

- GIS isolation devices shall be equipped with Low Gas alarming/tripping/lockout schemes

- Disconnection/Isolation devices must comply with applicable IEEE C37 collection of standards.

Environmental Factors (1/2)

- The effects of the following must be considered in design of substation facilities and equipment:
  - Windstorms
  - Floods
  - Lightning
  - Elevation
  - Ambient Temperature Extremes
  - Icing/Snow& Rain Accumulation
  - Contamination/Pollution
  - Salt Spray (roads/ocean)
  - Earthquakes

Environmental Factors (2/2)

- Wind/Ice/Seismic References: ASCE-7 & NESC
- Flood Plain: Structure ground line above 100 yr flood
- Load Combinations:
  - Wind Load/No Ice (ASCE-7 Wind Map/NESC Extreme Wind)
  - Ice Load/No Wind (13mm/19mm/25mm/38mm)
  - Ice Load + Wind Load (40 mph/64 km/h)

Insulation Levels/Coordination (1/4)

- Connection Entity BIL levels must be coordinated with TFO BIL levels
- Substations in high airborne pollution areas will require higher BIL insulation or extra creep insulation.
- Transmission additions in general should be modeled and Transient Study done to evaluate transient over-voltages that may affect insulation level, arrester choice and equipment capability requirements.

Insulation Levels/Coordination (2/4)

- Altitude corrections factors must be applied to BIL above 1000m(3300ft)

- Insulation minimum creep distance requirements (mm/kV) provided in IEEE C37.100.1

- IEEE 1313.1(now C62.82.1) & 1313.2 should be followed when selecting arrester ratings and insulation levels.

Insulation Levels/Coordination (3/4)

Equip	13.8 (15.5)	25 (25.8)	34.5 (38)	69 (72.5)	138 (145)	161 (169)	230 (242)
Xfmr-B	110	150	200	350	650	750	900 950
Xfmr-W	110	150	200	350	550	650	750 850
Bus	110	150	200	350	550	650	900
CB	110	150	200	350	650	750	900
CT/VT	110	150	200	350	650	750	900
Cap	110	150	200	350	550 650	650 750	900

Insulation Levels/Coordination (4/4)

Equip	240 (252)	345 (362)	500 (525)/(550)
Xfmr-B	950 1050	1300/1050	1550/1175 1800/1300
Xfmr-W	850 900 950	1050 1175	1425 1550
Bus	900 1050	1050/950 1300/1050	1550/1175 1800/1300
CB	1050	1300/1050	1550/1175 1800/1300
CT/VT	1050	1300/1050	1550/1175 1800/1300
Cap	900 1050	1300/1050	1550/1175 1800/1300

Minimum Electrical Clearances(1/2)

- Flexible/Strain Bus must be designed such that any possible conductor movement will not create less than minimum required clearances to other phases and grounded planes with all environmental conditions factored in.

- Each TFO has different design clearances based on design methodologies but their starting point is based on IEEE 1427 or IEC60071 minimum phase-to-ground clearances for BIL/SIL insulation levels, NESC, and IEEE C37.32 switch clearance requirements.

Minimum Electrical Clearances(2/2)

- Sufficient space shall be provided to maintain OSHA minimum approach distances

Surge Protection & Lightning Shielding(1/6)

- Transmission facilities shall be shielded from direct lightning strikes in accordance with IEEE 998.
- Substation non self-restoring insulation shall be protected against incoming surges
- Arrester ratings need to be evaluated on a case-by-case basis considering the electrical and mechanical characteristics required for lightning & switching surges and transient over-voltages.
- Arrester selection shall conform to IEEE C62.22

Surge Protection & Lightning Shielding(3/6)

- The following substation components should be directly protected by arresters:
  - U/G Cables
  - AIS/GIS Switchgear

- Verify arrester zone protection is sufficient for CTs, VTs, CVTs, CBs , and Cap Banks without arresters.

- Lightning protection shall be designed for zero failure rate i.e. voltage stress is 3 standard deviations less than the CFOV.

Surge Protection & Lightning Shielding(4/6)

- Rolling Sphere and Cone-of-Protection methods of IEEE 998 and NFPA 780

- All substation arresters shall be Station Class Metal Oxide type with polymer housing.

- Following minimum arrester design evaluations are required:
  - MCOV
  - Rated Duty Cycle Voltage
  - Energy Discharge Capability
  - TOV Capability
  - Environmental Factors & Electrical Clearance Requirements

Surge Protection & Lightning Shielding(5/6)

- Arrester discharge capability must be sufficient to survive a capacitor bank discharge from at least one maximum energy restrike of the switching device.

- Arrester service life shall be comparable to the life of equipment it is applied to.

- Transformer bus conductor should connect to arrester <u>before</u> connecting to the transformer bushing.

- Cap Banks shall have arrester protection on each phase.

Surge Protection & Lightning Shielding(6/6)

- All u/g cable line entrances shall have arrester protection
- U/G Cable arresters shall consider maximum voltages resulting from system restoration switching.
- Arresters shall be installed on each ungrounded phase of a tertiary winding when it is used to provide service voltage.
- Arresters shall be located on line side of CBs to protect the gap in open CBs

System Grounding (1/2)

- Transmission system must be “effectively grounded” from all sources.
- X0/X1 </= 3.0 and R0/X1 </= 1.0.
- If one or more of the relationships are not true effective grounding must be checked by referring to curves in “*Westinghouse Transmission Distribution Reference Book*”. Ratios below 80% curves will provide effective grounding for 80% arresters.

System Grounding (2/2)

- The following shall be considered to maintain system as effectively grounded for generation connection:
  - HV-Wye/LV-Delta
  - HV-Wye/Delta Tertiary/LV-Wye
  - HV-Delta with grounding transformer installed

Substation Grounding & Safety Issues (1/4)

- Minimum grounding and safety requirements must meet:
  - IEEE 80-Design
  - IEEE 81-Field Testing
  - NESC
  - Local Electrical Codes/Regulations

- Primary objectives of a grounding system are:
  - Public Safety
  - Operating and Maintenance Personnel Safety

- TFO must provide system X/R values, short circuit values, and fault clearing times

Substation Grounding & Safety Issues (2/4)

- Substation must have a ground grid that is solidly connected to all metallic structures, and non-energized metallic part of all equipment, switches, and insulators.

- If ground grids of two or more substations are to be interconnected, the interconnecting grounding conductors must be sized appropriately for fault currents.

- For wood-pole structures all switch bases, insulator bases, fuse bases, OHGW, and equipment non-current carrying metal parts must be grounded.

Substation Grounding & Safety Issues (3/4)

- The ground grid conductor must be sized to carry the ultimate fault level for the substation
- Substation ground grid connectors must meet the IEEE 837 test requirements.
- Grounding design shall be done using industry recognized grounding design software such as those from SES and EPRI.
- For high substation GPR fiber-optic cables shall be considered for telecommunication/control circuits.

Substation Grounding & Safety Issues (4/4)

- Grounding grid design in high crime areas shall use materials and techniques to deter copper theft

- Ground grid safety shall be verified by field testing after installation.

Substation Illumination

- Service lighting (2 fc minmum) shall be provided at all equipment locations
- Security lighting (0.5 fc minimum) shall be provided for all pedestrian and vehicle travel areas of substation
- Substation lighting shall meet NESC requirements

AC Station Service(1/2)

- ACSS preferred secondary voltage is 240/120 V
- Primary and backup ACSS shall be provided from two unique busses or sources with automatic or manual transfer switch.
- Independent sources:
  - SS transformer on independent MV busses
  - HV-SSVT
  - Transformer tertiary supply
  - Distribution line to padmount transformer(not as primary)
  - Diesel/Natural Gas/Propane Generator(not as primary).

AC Station Service(2/2)

- ACSS components must be capable of operating continuously and properly without malfunction or overheating in the voltage range and load current requirements of the substation.

- ACSS must be installed:
  - To meet electrical codes of the local area.
  - In accordance with Manufacturer instructions
  - To meet Utility industry standards

- ACSS shall be monitored and alarmed for abnormal conditions.

DC Station Service Supply(1/3)

- Standard battery voltage shall be 125V nominal.
- Battery sizing shall be done as per IEEE 485 to carry all the required DC loads during an AC power failure
- Minimum 20 year rated batteries shall be installed.
- Lead Calcium batteries are preferred.

DC Station Service Supply(2/3)

- Substations rated 230kV and above shall have dual battery banks and dual battery chargers installed.
- Battery charger shall be able to provide full rated DC output current with battery disconnected.
- Battery Capabilities amongst Utilities:
  - 8 hours
  - 12 hours
  - 16 hours (stations with no restoration plan)
- Battery full recharge time amongst Utilities:
  - 12 hours

DC Station Service Supply(3/3)

- DCSS shall be monitored and alarmed for abnormal conditions.

- Acid spill containment shall be provided for batteries

Structures/Structural Design Loads(1/2)

- Line dead-end structures shall be designed to meet TFO line tension requirements.

- Rigid bus structures shall be designed to meet IEEE 605 calculations for short circuit, ice, and wind.

- Four loading cases shall be evaluated:
  - NESC Heavy (OL Factor 2.5 wind;1.65 wire tension;1.5 vertical)
  - Extreme Ice (OL Factor = 1.1)
  - Extreme Wind (OL Factor=1.25)
  - Short Circuit and High Wind (OL Factor=1)

Structures/Structural Design Loads(2/2)

- Weather related loads shall use 100 yr return period
- Structures and Foundations shall be designed to requirements of ASCE publications
- Deflections shall be limited such that equipment function, switch operation, and electrical clearances are not affected.
- A site-specific geotechnical study shall be used as the basis of structural foundation design parameters.

Equipment -General(1/2)

- Substation equipment shall be designed for ultimate fault duty
- Equipment shall be suitable for -40C to 50C ambient temperature range
- Special equipment design rating requirements due to altitude, atmospheric conditions, seismic, weather loads shall be addressed.
- GIS equipment shall have gas pressure alarming / tripping/ lockout schemes.

Equipment -General(2/2)

- Equipment Emergency Ratings:
  - LTE: 3hours/4 hours (Lifetime max: 300 hours)
  - STE: 15 minutes/20 minutes (Lifetime max: 12 hours)
- Loads exceeding equipment nameplates are acceptable only when allowed by:
  - Manufacturer Design Documentation
  - Standard Industry Practice
- Equipment ratings shall be sized for load and system expansion for a 15-20 year time frame
- Consult with NFPA 850 and Insurance Agent for oil filled equipment spacings in substations.

Equipment – Capacitor Banks(1/7)

- Cap Bank neutral grounding:
  - 69kV and below: ungrounded wye
  - 138kV and above: single point grounded; single or double-wye
- A can failure shall not cause more than 110% of rated voltage on other cans
- Cap bank and components shall be designed, installed, and maintained as per:
  - IEEE 18
  - IEEE 1036
  - IEEE C37.99

Equipment – Capacitor Banks(2/7)

- Cap bank switching devices shall have either pre-insertion resistors or synchronized closing scheme to reduce switching transients.
- Cap bank switching device shall have capability to make & break capacitive current a sufficient number of times so that it does nor require maintenance more than once a year.
- For 500kV, gas insulated cap bank CBs with transient current limiting reactors and pre-insertion resistors are required.

Equipment – Capacitor Banks(3/7)

- Cap bank switching devices shall not be reclosed before trapped charge has decayed (5 minutes minimum)

- The current rating of cap bank switching device shall include effects of:
  - Overvoltage: 1.1 pu
  - Capacitor Tolerance: 1.15 pu
  - Harmonic Content: 1.1 pu

- Back-to-back switching of cap banks can create high transient current flow between banks. This should be controlled by series reactors, pre-insertion resistors, or controlled closing

Equipment – Capacitor Banks(4/7)

- High energy MOV arresters should be considered for protection against lightning surges and switching transients on capacitor banks.

- Cap bank inrush and discharge currents must not exceed ratings of switching devices.

- CTs used in protection schemes for cap banks must have a voltage class that is suitable. High magnitude transient/harmonic currents can saturate and/or thermally overload the CT and cause relay mis-operation.

Equipment – Capacitor Banks(5/7)

- Switching of cap banks can initiate high frequency, high magnitude transients in nearby control and power cables. Cable shielding, surge protection, or optical isolation should be considered.

- Cap bank switching devices that have long arcing time and multiple restrike characteristics can initiate transients with harmonic content and may cause resonance with inductive components resulting in high magnitude transient voltages.

- Flammability of capacitor fluid should be considered when locating banks in the substation.

Equipment – Capacitor Banks(6/7)

- Capacitor switching device must have a continuous voltage rating a minimum of 10% above rated capacitor voltage.

- IEEE 18: Capacitor limitations that must not be exceeded:
  - 135% of nameplate kVAR
  - 110% of V_{rms}
  - Crest voltage : 2.83 x Vrms (incl. harmonics/no transients)
  - 180% I_{rms} (fundamental + harmonics)

Equipment – Capacitor Banks(7/7)

- Bank De-Energization: Capacitor switching devices must be capable of sufficient dielectric recovery to prevent a sustained current arc restrike.

- Shunt capacitors must not be inadvertantly de-energized by operation of an up-line CB. This could cause restrike and subsequent cap bank failure.

Equipment- Circuit Breaker & CB Duty(1/4)

- Circuit Breaker must be able to:
  - Continuously carry normal full rated current
  - Carry emergency rating load currents
  - Withstand and interrupt ultimate fault currents
  - Carry maximum current of interconnected facility
  - Interrupt any kind of fault with due care given to TRV and RV
  - Withstand insulation voltage stresses
- Circuit Breaker must be able to perform all required switching duties without creating transient over voltages:
  - Line/Cable dropping (capacitive currents)
  - Load current switching
  - Out-of-phase opening

Equipment- Circuit Breaker & CB Duty(2/4)

Nominal Voltage Class	Rated Interrupting Time (Cycles)
500 kV	2
320 kV	2
230 kV	3
138kV	3/5
69kV and lower	5/8
Additional Breaker Fail Time	8 or less

Equipment- Circuit Breaker & CB Duty(3/4)

- CBs shall be designed and applied according to IEEE C37 series of standards
- CBs shall be tested in accordance with C37.09
- SF6 CBs shall have leakage rates of 0.5% or less/year
- CBs shall have a service life comparable to other equipment in the substation

Equipment- Circuit Breaker & CB Duty(4/4)

- CBs must be able to perform an O-C-O sequence after 8 hours of power loss.

- CB shall have interrupting rating based on maximum close-in fault at point of application:
  - Gas CB or Circuit Switcher: 110% minimum
  - Oil CB: 120%

Equipment – Power Transformers(1/3)

- Transformers connecting to a transmission system must have a ground source of current on the HV side.
- Loading on autotransformers shall be limited to 100% of maximum MVA rating (normal/emergency)
- Transformer winding configurations and phase relationships shall be consistent with transmission system.
- Tap changer(s) with adequate range shall be supplied on the transformer to allow operation over the range of system operating voltages on HV and LV sides.

Equipment – Power Transformers(2/3)

- Transformer cooling shall be supplied from two separate ACSS sources with a transfer switch.
- Transformers shall be designed, tested, and applied to comply with IEEE C57 series of standards.
- DETC HV tap changers shall have five full capacity taps.
- At a minimum a transformer summary alarm shall be provided to the control building.

Equipment – Power Transformers(3/3)

- Transformer firewalls shall be provided when required by NFPA or local fire code requirements.

Equipment – PTs/CVTs

- PTs/CVTs shall be designed with adequate electrical, mechanical, and safety characteristics for the specific electrical system they are applied on.
- PTs/CVTs shall be designed and applied as per IEEE C57.13
- Accuracy Classes:
  - Relaying: CL 1.2 WXYZ
  - Metering: CL 0.3 WXYZ.ZZ

Equipment – CTs

- CTs shall be designed and applied as per IEEE C57.13
- CTs shall be designed with adequate electrical, mechanical, and safety characteristics for the specific electrical system they are applied on.
- CTs used for relaying shall be C800 with a thermal rating factor of 2.0 or greater

Equipment – Switches (2/2)

- Switches shall be applied so they are not the limiting component in the normal and emergency current ratings of a circuit or bus.

Equipment - GIS

- GIS equipment shall meet all aspects of IEEE C37.122

Equipment - Other

- Application of faulting switches to trigger remote tripping is not an acceptable practice

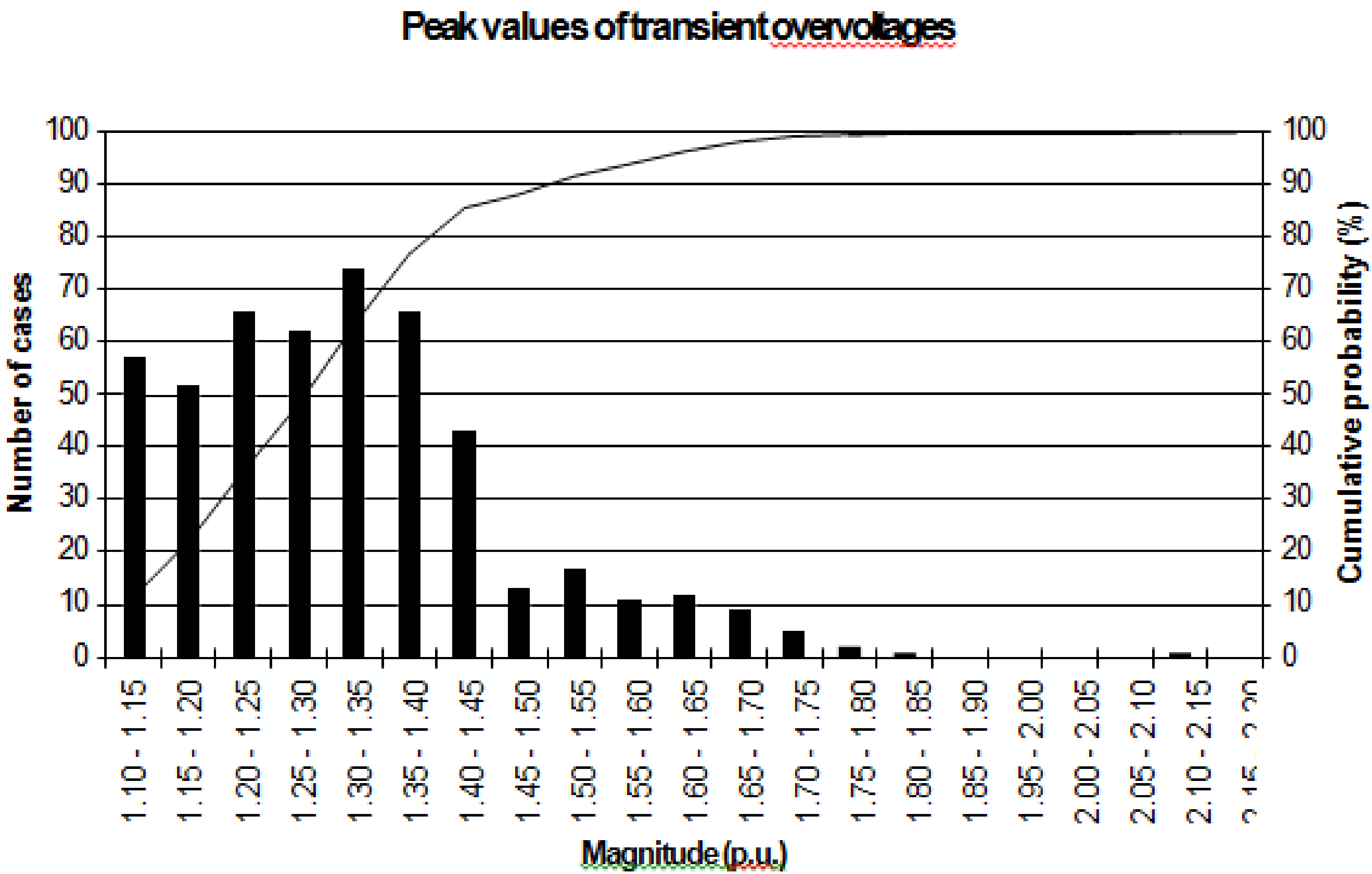
Physical & Cyber Security

- The potential vulnerability of the substation facility to sabotage or terrorist threat should be factored into the design and operating procedures

Temporary/Transient Overvoltages(1/2)

- Maximum TOV: </= 1.8 pu
- Maximum Peak Transient OV: </=2.0 pu of system operating peak voltage
- Chart on next slide was generated from measured transient overvoltages at 21 stations (1933-1995) on Quebec Hydro system (phase-to-neutral voltages)
- Maximum TOV: </= 1.8 pu. They result from:
  - Islanding
  - Faults
  - Loss of Loads
  - Dropping Long Lines

Temporary/Transient Overvoltages(2/2)



Definitions(1/2)

- Good Utility Practice: Any of the practices, methods, and acts engaged in or approved by a significant portion of the electric utility industry during the relevant time period, or any of the practices, methods and acts that, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety, and expedition. Good utility practice is not intended to be limited to the optimum practice, method, or act, to the exclusion of all others, but rather is intended to include acceptable practices, methods, and acts generally accepted in the region.

Definitions(2/2)

- Transmission –operating at voltages xx kV and above.

- Following are what various Utilities call Transmission voltages:
  - 44 kV and above
  - 60 kV and above
  - 100kV and above
  - 115 kv and above

Reliability and Availability Criteria

- A Connection shall not cause power disturbances on the TFO system that exceed any of the annual limits listed below:
  - Creation of more than 0.0067 *Sustained Outages* per 1 MW of load (*SAIFI* of 0.0067 per MW load).
  - Creation of more than 0.0333 *Momentary Interruptions* or *Equivalent Faults* per 1 MW of load (*MAIFI* of 0.0333 per MW load).
  - Creation of more than 400 *Customer Equivalent Incapacitating Disturbances* (CEID) per 1 MW of load.

Minimum Power Factors

- Loads: 97% (95% at system peak)
- Generator: 95% (leading/lagging)

Bus Configurations/Bus Design(1/8)

- Acceptable bus configurations for new switching stations shall be either ring bus or breaker-and-a half
- Overhead line crossings near the substation should be avoided
- Bus arrangement must allow access to all equipment without dismantling any portion of the substation.

Bus Configurations/Bus Design(2/8)

- The key factors that must be considered when evaluating a switching or transformer station configuration include:
  - *Security* and quality of supply
  - Extendibility: The design should allow for forecast need for future extensions if practical
  - Maintainability: The design must take into account the practicalities of maintaining the substation and associated circuits. It should allow for elements to be taken out of service for maintenance without negatively impacting *security* and quality of supply

Bus Configurations/Bus Design(3/8)

- Operational Flexibility: The physical layout of individual circuits and groups of circuits must permit the required operation of the *IESO-controlled grid*
- Protection Arrangements: The design must allow for adequate protection of each system element
- Short Circuit Limitations: In order to limit short circuit currents to acceptable levels, bus arrangements with sectioning *facilities* may be required to allow the system to be split or re-connected through a fault current limiting reactor

Bus Configurations/Bus Design(4/8)

- Bus outages associated with maintenance or repair of equipment shall only involve the circuit to which equipment belongs to.
- Preferred arrangement for 230kV is breaker and ½.
- Substations served by more than two lines must be built either as a ring bus or breaker and ½.
- Substation buswork shall be designed in accordance with IEEE 605.

Bus Configurations/Bus Design(5/8)

- Minimum amperage rating for bus conductors:
  - 138kV: 1200A
  - 240kV: 2000A
  - 345kV: 3000A
  - 500kV: 4000A

- Bare conductor ampacity ratings shall be based on IEEE 738 calculations.

- Ring bus shall not be greater than 5 breakers; adding a 6^{th} breaker will require conversion to breaker and ½ design. (Xcel Energy)

Bus Configurations/Bus Design(6/8)

Voltage	Expected Maximum Number of Terminals	Preferred Arrangement
100-200	1-2	Simple Bus
	3-5	Ring Bus
	6 or more	Breaker + ½ Breaker + 1/3
201-765	1-4	Ring Bus Breaker +1/2
	More than 4	Breaker +1/2

Bus Configurations/Bus Design(7/8)

Arrangement	ISU Paper	IEEE 605	ISO-NE	Reliability Indices (min/yr)
Single Bus	1.00	1.00	1.00	3.53/4.42
Sectionalized Bus	1.22	1.20	1.22	3.26/3.50
Main&Transfer Bus	1.43	1.40	1.76	
Ring Bus	1.14	1.25	1.56	1.42/2.17
Breaker + ½ Bus	1.58	1.45	1.58	0.56/0.63
Breaker +1/3 Bus				
Double Bkr-Double Bus	2.14	1.90	2.14	0.70/0.72

Bus Configurations/Bus Design(8/8)

- Substations designated for mobile transformer backup shall have provisions ready for installation;
  - Terminals and/or bus connection point
  - Disconnect switch

- Several design aspects must be considered for mobile transformers:
  - Size & Maneuvering of the mobile transformer
  - Installation location and Provisions for connection
  - Electrical clearances
  - Grounding and Safety
  - Auxiliary System requirements

Control Building(1/7)

- A central control building shall be provided
- Sufficient space for the future installation of protective relaying and control equipment to accommodate the ultimate, planned development of the substation shall also be provided.
- The control house shall have a separate battery room(s), one for Battery No. 1 and one for Battery No. 2.

Control Building(2/7)

- The control house shall be constructed either with a “pedestal” type (floating) floor to facilitate cabling and equipment installation and relocation or with trenches.

- Advantages of the installation of a floating floor:
  - Cable installation working space
  - Cable replacement/changes easily facilitated
  - Cabling for added piece of equipment easily achieved
  - Cables are beside each other not on top of each other
  - Avoids flooding possibilities

Control Building(3/7)

- Building weather loads shall be based on a 100 year mean return period.
- Wall and roof insulation shall be designed for the applicable Climate Zone
- Design loads and load combinations shall be based on the requirements of applicable *Building Codes*.
- Should be located as centrally as practical to minimize circuit length to electrical equipment

Control Building(4/7)

- Two individual, physically separated, cable entrances shall be provided into the control house
- Established roadway access to the building does not require going under an energized main bus.
- Control building must be constructed for life of the substation and require minimum maintenance.
- Control Building is not to be part of the Substation fence

Control Building(5/7)

- All materials and equipment used in the control building shall be non-combustible to the extent possible.

- Consideration should be given to either sizing the building to accommodate the needs of the ultimate station development or to allow for the expansion for such accommodation.

- Building design loads shall include all live loads, snow loads, icing loads, wind loads, and dead loads.

Control Building(6/7)

- Two exits with panic bar and door holder mechanism are required.

- The building shall be equipped with sufficient heating, cooling, and ventilation equipment to provide acceptable ambient temperatures within the building so as not to impact the operation and life expectancy of the control equipment within.

- Adequate ventilation shall be provided to prevent the accumulation of hydrogen gasses resulting from battery operation. Forced ventilation shall be used when required.

Control Building(7/7)

- Use National Electrical Safety Code for minimum illumination levels.
- Emergency lighting shall be provided
- Exterior lighting at doorways shall be provided to effect safe access to the building
- Security monitoring of exit doors shall be provided
- A desk and filing cabinet shall be provided for operational support purposes