

GP 16-08-01	Instrument and Essential Services Power Supplies	November 2002
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Instrument and Essential Services Power Supplies

GP 16-08-01

Scope

[I] This Global Practice (GP) covers the design of systems and equipment for supplying power to essential instrumentation and other essential services. This Practice does not cover d-c power supplies internal to or integrated within instrument, control and protective systems but does cover the a-c feeds to these systems. See [GP 15-07-01](#).

[I] An asterisk (*) indicates that additional information is required. If a job is contracted, this additional information is furnished in the Job Specification.

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1. Additional Requirements

The following Practices and Standards shall be used with this Practice as specified by the Owner's Engineer.

[I] Purchase and use of equipment covered by this Practice shall conform to nationally recognized codes and standards which are approved by Owner's Engineer and which are acceptable within the country where the equipment will be used. This Section lists the minimum specifications and standards that shall be applied for equipment purchased to U.S. standards.

1.1. Global Practices–ExxonMobil Engineering Practices

GP 15-07-01	Electric Power Branch Circuit Design for Instrumentation
GP 16-12-01	Switchgear, Control Centers, and Bus Duct

1.2. IEEE–Institute of Electrical and Electronics Engineers

IEEE 315	Graphic Symbols for Electrical and Electronics Diagrams (Including Reference Designation Class Designation Letters) CSA Z99-75; Includes supplement to ANSI 732.2-75 and IEEE 315-75 (ANSI/IEEE)
IEEE 446	Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications IEEE Orange Book
IEEE C62.41	IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits (ANSI/IEEE)

1.3. NEMA–National Electrical Manufacturers Association

NEMA PE 1	Uninterruptible Power Systems
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1.4. UL–Underwriters Laboratories, Inc.

UL 1778	UL Standard for Safety Uninterruptible Power Supply Equipment
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- [I] Electromagnetic Interference (EMI) shall be minimized to ensure that computer systems and other sensitive electronic systems shall neither adversely affect nor be adversely affected by the UPS.
- [I] Control center power supply switchgear and essential services switchgear shall be per [GP 16-12-01](#), except as modified herein.
- [I] System Design Responsibility. For the instrument and other essential services power supply, the contractor shall assume overall responsibility for the system design including any Vendor engineered subsystems.

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2. Definitions

- 1) * [I] Essential instrumentation and controls when specified include the following:
 - a) Transmitters, controllers, recorders, indicators.
 - b) Computers, digital control systems, and related equipment unless otherwise specified.
 - c) Stream analyzers unless otherwise specified.
 - d) Startup, sequence, shutdown, and emergency trip systems.
 - e) Actuators.
 - f) Annunciators, monitors, alarms, telemetry.
 - g) Drives in purging, pressurizing, and air-conditioning systems necessary to instrumentation.
- 2) * [I] When specified, other essential services that may be fed from the instrument and essential services power supply, include (but are not limited to) the following:
 - a) Radio or other communications equipment needed during a power outage.
 - b) Control house (or room) emergency lighting.
 - c) Drives in purging, pressurizing, and air-conditioning systems necessary for maintaining a non-hazardous (unclassified) building area classification.
 - d) Boiler drum gauge glass lighting.
 - e) Motor operated valves in emergency service.
- 3) [I] Non-essential services are those loads which are not required during general power outages, and whose loss may also be tolerated during infrequent maintenance and repair of their power supply.
- 4) [I] Tolerable transfer and outage times are the longest supply interruption which will not have a significant effect on process or equipment operation.
- 5) * [I] Each unit or group of units considered critical and independent to plant operations will be specified by the Owner's Engineer. As a guide for large plants, a unit or group of units are defined as critical and independent if they can operate without the other(s) and they represent or are needed for 20 percent or more of plant throughput. The unit(s) can be process units, utilities, or other non-process units. Facilities not meeting the 20 percent rule may also be defined as critical and independent for commercial reasons.

3. Documentation

- 1) [O], [M] One-line diagrams shall cover all equipment up to and including distribution panels, and shall show the following:
 - a) All power connections
 - b) Metering
 - c) Identification of normal and standby equipment and circuits, and means of initiating switching to and from standby
 - d) Transformer connections (delta, wye)

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- e) System grounding
 - f) Bus ampere ratings
 - g) Breaker and fuse ratings
- 2) [O] Equipment ratings, provided with the one-line diagram, shall include:
- a) Batteries: Ampere-hour rating along with discharge rate and ambient temperature at which it applies, number of cells, recommended float voltage, maximum ambient temperature, and maximum equalize voltage.
 - b) Battery chargers and rectifiers: Maximum output current at rated voltage, maximum output voltage.
 - c) Inverters:
 - i) Output voltage, frequency, watts, and volt-amperes.
 - ii) Maximum steady state tolerance, at any load from zero to rated, for percent harmonics, voltage deviation and frequency deviation. Also, provide the range of load power factor, input (d-c) voltage, and ambient (room) temperature for which these tolerances hold.
 - iii) Minimum and maximum voltage, and time to recover rated voltage, upon sudden application or removal of rated load at rated power factor.
 - d) Stabilizers:
 - i) Output voltage, watts, and volt-amperes.
 - ii) Maximum steady state tolerance, at any load from zero to rated, for percent harmonics (a-c stabilizers) and voltage deviation. Also, provide the range of load power factor (a-c stabilizers), input voltage, input frequency (a-c stabilizers), and ambient (room) temperature for which these tolerances hold.
 - iii) Minimum voltage, and time to recover rated voltage, upon sudden application of rated load at rated power factor.
 - e) Transfer and Bypass Switches: Amperes, switching time.
 - f) Generators:
 - i) Voltage, number of phases, output power, and power factor.
 - ii) Maximum steady state tolerance, at any load from zero to rated load/phase, for percent harmonics and voltage deviation both for balanced load and for single-phase load only.
 - iii) Minimum and maximum voltage, and time to recover rated voltage, upon sudden application or removal of rated load.
 - iv) Rated voltage (saturated) subtransient, transient, and synchronous reactance; rated current (unsaturated) subtransient, transient, and synchronous reactance.
 - v) No load and full load current decrement curves for 3-phase, line-to-line, and line-to-ground short circuits. Curves shall be provided for operation with and without the effects of the voltage regulator.
- 3) [O] A load list covering each load shall include the following:
- a) Load classification per Section 4 Item 1.
 - b) Voltage, frequency, and total harmonic distortion tolerances, if critical.
 - c) kVA (rms) at full load, and inrush on energizing.
 - d) Range of power factor from no load to full load.
 - e) Crest factor (peak current/rms current) at full load and minimum load.

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- f) Peak current at full load and minimum load.
- g) RMS current at full load.
- 4) [O], [M] Operation and maintenance manuals shall be furnished by the vendor supplying each (a-c or d-c) system. Manuals shall be written specifically for the equipment being furnished and shall contain (but not be limited to) the following information:
 - a) Procedures for the installation, commissioning, operation and shutdown of the system.
 - b) Procedures for maintenance and trouble-shooting of the system utilizing shop test results as a basis.
 - c) Results of shop tests.
 - d) Complete Bill of Materials, Parts List and set of final "as-built" drawings.
 - e) Full description of each alarm including initiating conditions, effects on transfer status and further implications.
 - f) Full description of all conditions that will initiate or inhibit transfer.
- 5) [R], [O] A coordination study shall be prepared and shall demonstrate the selectivity of circuit protective devices throughout each system. The study shall consider all protective devices in the system, including those protecting individual loads and subfeeders downstream of the distribution panel in the stabilizing and distribution section. Where system components have a current limiting effect, the study shall include the bases other than time-current curves used to establish selectivity. The study shall identify any fault locations, and ranges of fault current, for which fault-clearing time exceeds the tolerable outage time of any affected instrumentation (as established by the load classification per Section 4 Item 1). The effect of battery internal resistance shall be considered in the study. The coordination study shall be furnished on two occasions:
 - a) Before final protective device characteristics are specified. This issue of the coordination study is preliminary and need only be complete and accurate enough to verify that proper ranges and types of protective devices have been selected.
 - b) When the coordination study is presented for final approval.
- 6) [R], [O] Each designated a-c and d-c power supply vendor shall furnish the following information for use by Contractor in preparing the coordination study:
 - a) Time vs. current characteristic curves of all protective devices in the equipment components furnished.
 - b) Data to assist Contractor in selecting protective devices for the battery which will be selective with other protective devices in the stabilization and distribution sections.
 - c) Data to assist Contractor in selecting protective devices for the branch circuit feeders in the power distribution section panels which will be selective with upstream devices in the distribution and stabilization sections.
 - d) Time-current characteristics of batteries (when supplied by designated vendor), battery chargers, inverters and voltage stabilizers under short circuit conditions.

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4. Load Classification

- 1) [R], [O] Classification of a-c essential instrumentation and other essential services loads shall be based on the tolerable time of transfer between normal and standby supplies, as follows:

Tolerable Transfer Time, Seconds	Class
0.005 (approximately $1/4-1/3$ cycles) or less	I
over 0.005 to 0.2 (10–12 cycles)	II
over 0.2–10 ⁽¹⁾	III
Transfer to Standby Not Required	Non-essential services

Note (1): Nominal transfer time approximately 10 seconds for diesel driven standby generator and may be 30 seconds or more if repeat start attempts are required.

- 2) * [R] Classification of d-c instrument power loads shall be by specification of tolerable outage time for each. Particular attention shall be given to devices in shutdown circuits.

5. Sources of Power

- 1) [R], [O] Sources of power for control center power supplies shall be selected in accordance with Figures 1(a), 1(b), and 1(c).
- 2) [R], [O] Control center power supply arrangements shall be provided per the following:
- Figure 1(d) for control centers without standby generation.
 - Control centers shall be provided with a standby power generator and essential services switchgear per Figure 1(e) if any of the following conditions exist:
 - Instrument power is required for the control instruments or shutdown systems of boilers. Examples of such loads are firewater, instrument air compression, or cooling water.
 - * Instrument power is required for the operation of process, manufacturing, or utility units or any essential services for which continuous operation during main power supply failure is specified.
- 3) [O] Sizing of standby generator shall be based on total non-diversified load of instruments and other loads connected to essential services switchgear Bus A and B of Figure 1(e).
- 4) [R] A withdrawable type ASCO transfer switch, or equivalent, shall be used to supply essential services switchgear unless it is not large enough to serve the expected load.
- 5) * [O], [C] Generator driver shall be a diesel engine unless otherwise specified.
- 6) * [R] The driver for the standby instrument power generator shall be arranged for automatic starting. Manually operated start and stop controls shall also be provided. Location of these controls will be specified.

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