UL 3141

Outline of Investigation for Power Control Systems

Issue Number: 2

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Summary of Topics

This second issue of the Outline of Investigation for Power Control Systems, UL 3141 dated October 9, 2024, covers Power Control Systems (PCS) used in Distributed Energy Resource (DER) systems which include one or more power sources in addition to the primary power source, typically the utility grid.

Several clarifications and terminology updates were made to UL 3141. Additionally, 3 new PCS functions related to PIL/PEL functionality were included as well. See below for a numbered list of the clarifications and new functions added to UL 3141 under issue number 2:

1) The term "Supplementary PCS" was removed. All PCS are required to be installed with a passive protective device.

2) The option to evaluate a PCS for branch circuit functionality in accordance with UL 489 was eliminated from the scope. This was done to align with current NEC (NFPA 70) electric code aspects. Note: PCS circuit controllers may be separately evaluated to UL 489 to provide branch circuit rated overcurrent protection however a PCS is not able to provide this type of overcurrent protection.

3) A new term "Single Source PCS" was added covering load management applications. All PCS are to be installed with a passive protective device. Further, the PCS functionality for PCS-LC was removed as this term was redundant relative to the new name of "Single Source PCS" for this application. The outline was revised to implement these new names throughout the document.

4) The scope of the document was revised to indicate 3 primary PCS types in clauses 1.3 – 1.5. This includes "Single Source PCS", a new term of "multisource PCS", and a new PCS type covering PCS with a PIL/PEL functionality. These types are to be used with the PCS functions covered in section 8.1.1. Definitions were also updated to cover new terms.

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5) The remote and onsite communication requirements were clarified with respect to PCS control functions and settings being required to be onsite versus communications related to other PCS features not related to PCS control settings such as data monitoring, reporting, and status information having the option to be located remotely. PIL and PEL PCS functions were exempted from this onsite requirement as it pertains to PCS control settings. See 3.6 and 6.4.2 for details.

6) The safety analysis for PCS within the functional safety section of UL 3141 was updated to include additional items to be considered during the safety analysis. These items were covered in the list of items to be considered in the first issue of UL 3141 however the revised list identifies these items directly adding more detail.

7) The step change in load test was revised to include a 110 % test load step. This was added to demonstrate that the PCS is able to prevent an overload condition via adjustment of PCS controlled sources, loads, or both if uncontrolled loads are present at a level that could potentially overload the busbars / controlled conductors.

8) Section 8.6 was retitled "PCS Functional Tests for Power Export Limiting (PEL) and Power Import Limiting (PIL)" versus the original title of "Optional PCS Functional Tests". This was done to provide clarity that section 8.6 was always optional within the body of the requirements. Further, the content of section 8.6 always applied only for PIL/PEL functions and had no relation to overload functions covered in other sections.

9) The ESS operating modes and ESS export limiting and ESS import limiting functions were moved to their own new section 8.8 and as such removed from the general PCS PEL/PIL functional test section 8.6. This was done to address the fact that these tests are outside the general PCS PIL/PEL functions and are their own unique functions related to ESS operation within a PCS.

10) The abnormal test section 8.7 was renamed to reflect that the fault conditions addressed in this section related to a loss of control abnormal test of the PCS.

Further, Table 4 of this section was revised to acknowledge that a delayed PCS reaction is allowed when a single fault condition has been implemented if the delay length does not exceed the requirements in clauses 8.2.3 or 8.2.4 as applicable for the PCS function under consideration. While a delay was allowed under issue number 1 of UL 3141, it was not clearly identified or discussed.

Table 4 was also revised to add additional clarity regarding the exceptions present as well as associating them with the relevant abnormal test conditions stated within Table 4.

11) Three new PCS functions all related to PIL/PEL functionality were added to issue number 2 of UL 3141 that were not covered under the scope of issue number 1 of UL 3141. These 3 new functions are:

A) Power Import Limiting (PIL) at the Point of Common Coupling (PCC) under new section 8.6.3. This new function address when a PCS is evaluated for PIL at an external reference point of applicability such as the PCC which limits power flow(s) from the Area EPS to the local EPS using a combination of PCS controllable loads and PCS controllable sources.

B) A new ESS operating mode function addressing when a PCS is used for Net Energy Metering (NEM) Integrity Mode. Under this new ESS operating mode of new section 8.8.5, a

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PCS is evaluated for a specific mode known as NEM Integrity Mode. PCS capable of NEM Integrity Mode can applies to systems with renewable resources (e.g. PV and ESS). PCS capable of this mode may include stationary storage, bidirectional EVSEs and EVs, etc. PCS with NEM Integrity Mode include power export limiting (PEL) based on dynamic limits tied to 15-minute energy production of an existing legacy generation system (commonly referred to as Near Real Time).

C) PCS scheduling was added to a new optional, normative Annex A. Annex A address PIL/PEL functions implemented in combination with a schedule to allow PIL/PEL functions to adjust their PCS control settings as a function of the date and time.

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1 Scope

1.1 These requirements cover Power Control Systems (PCS) used in Distributed Energy Resource (DER) systems which include one or more power sources in addition to the primary power source, typically the utility grid. The PCS electronically limits or controls current or power to stay within defined limits and may consist of a single device or multiple devices operating together as a system. The current or power measurement reference point(s) may be located internally to equipment or externally within the system. All elements of the PCS are intended to be installed in accordance with the National Electric Code (NEC). Section 705.13 in the 2020 edition or section 750.30 in the 2023 edition.

1.2 PCS may be evaluated and rated for one or more of the primary types of PCS addressed in 1.3 – 1.5 as well as provide one of more of the PCS functions per clause 8.1.1 of this outline. See 10.1 for details regarding rating requirement specifics.

1.3 A PCS may be evaluated as a single source PCS. Single source PCS provide an overload functionality when used with a passive protective device [e.g. Overcurrent Protective Device (OCPD)] used for the protection of service, feeder, or branch circuits. A single source PCS limits power drawn from a single source of supply (e.g. the area EPS) via load management.

NOTE 1: Uncontrolled sources complying with the requirements of NEC 705.12 may be present in a single source PCS however these sources are not controlled by the PCS. A single source PCS often provides overload control for power imported from the area EPS through load management.

NOTE 2: In the previous issue 1 of UL 3141, the term PCS-LC was used for PCS in which load control only applications were implemented with a single controlled source. With the inclusion of the single source PCS term and definition, the term PCS-LC was removed to avoid a redundant term falling within the definition of a single source PCS.

NOTE 3: A single source PCS is located in a circuit(s) where branch circuit rated OCPD's located external to the PCS provide additional protection from overloads.

1.4 A PCS may be evaluated as a multisource PCS. Multisource PCS contain critical overload functionality addressing system overload conditions of systems supplied by more than one source and have control over more than one source. Multisource PCS may contain separate passive protective devices included in their design however these passive protective devices are unable to fully address overload conditions of the multisource system in the event the PCS fails.

NOTE: Multisource PCS may include passive protective devices (typically overcurrent protective devices (OCPDs) used for the protection of service, feeder, or branch circuits however the PCS controlled conductors are able to experience overload conditions that the passive protective devices are not able to fully address at the system level. The PCS functionality addresses these system overload conditions of the PCS controlled conductors per NEC 705.13.

1.5 A PCS may be evaluated for power import limiting (PIL) and/or power export limiting (PEL) functionality where the PCS control and monitoring point is at an external reference point of applicability, such as the point of common coupling with the area EPS. The PCS may limit current and/or power flow from generation sources to the Area EPS (exporting) or limit current and power flow from the Area EPS to loads / the local EPS (importing). PEL and PIL functions do not address overload mitigation per 8.1.1, items B-E (overload conditions as defined in the NEC).

NOTE: PIL / PEL functions only address utility facing functionality (area EPS side of the PCC) and do not address NEC overload conditions (local EPS side of the PCC). PCS may be evaluated only for PIL/PEL functionality, NEC overload functionality, or a combination of both functionalities. The ratings of the PCS reflect which functionalities are included in the scope of the evaluation of the PCS.

1.6 In addition to the required autonomous operation, the PCS may respond to external commands or schedules provided by authorized third parties . The format for scheduling of export or import to or from utilities is defined in this Outline, but specific communication protocols, or other methods, used for transmitting commands or schedules are outside the scope of this Outline. See Annex A for further details.

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1.7 The requirements in this Outline are intended to evaluate PCS that electronically control power or current flow within local EPS power distribution equipment, or import or exported to the area EPS, via use of external measurement and control devices. Such systems may be made up of generation devices (inverters, engine generators, etc.), energy storage systems, loads, load control applications ((charging power/load management, etc.), circuit controllers, or other equipment used to manage the current or power flow at the point of reference. The power control function may utilize communication-based approaches and may include onsite monitoring devices and or controllers remote from the point of control.

1.8 The PCS may include multiple external reference points used to control power or current on multiple conductors or bus bars. For example, an external point of reference may be at the Point of Common Coupling (PCC) to control power flows to or from the utility grid as well as providing overload protection of the busbars in the main service panel. External reference points may also be located to control currents within a piece of equipment or on other circuits on the premises wiring.

1.9 Products and systems covered by this Outline are intended to be installed in accordance with the National Electrical Code, NFPA 70.

2 Glossary

2.1 For the purpose of this Outline, the following definitions apply. Relevant acronyms are listed in Table 1.

Table 1
Acronyms

ASCII	American Standard Code for Information Interchange
ASIL	Automotive Safety Integrity Level
BOS	Balance of System
BBOC	Busbar Overload Control
CA	California
COC	Conductor Overload Control
CSV	Comma-Separated Values
DER	Distributed Energy Resource
EPRI	Electric Power Research Institute
EV	Electric Vehicle
FMEA	Failure Mode and Effect Analysis
ISE	Interconnection Service Equipment
LGP	Limited Generation Profile
LOPA	Layer of Protection Analysis
NRTL	Nationally Recognized Testing Laboratory
OCPD	Overcurrent Protective Device
PCC	Point of Common Coupling
PCS	Power Control System
PEL	Power Export Limiting
PIL	Power Import Limiting
PL	Performance Level
POC	Point of Connection

Table 1 Continued on Next Page

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Table 1 Continued

RMS	Root Mean Square
RPA	Reference Point of Applicability
SIL	Safety Integrity Level
SRD	Source Requirement Document
SSOC	Single Source Overload Control
UTF	Unicode Transformation Format
VIG	Variation in Generation
VIL	Variation in Load

2.2 ACTIVE PROTECTIVE DEVICE - Device provided to prevent hazardous conditions that require electrical energy in order to implement control logic to operate and that are identified in the safety analysis as being required to prevent hazardous conditions.

NOTE: Examples of active protective device include PCS circuit controllers, loads, and/or sources controlled using communication with the PCS control function(s) used to comply with PCS requirements.

2.3 AREA ELECTRIC POWER SYSTEM (area EPS) – An EPS that supplies local EPS's. The most common example for an area EPS is an electric utility.

2.4 BRANCH CIRCUIT – The portion of the building wiring system beyond the final Overcurrent Protective Device (OCPD) in the power-distribution panel that protects the ac output of the field-wiring terminals in a permanently connected unit.

2.5 ELECTRIC POWER SYSTEM (EPS) – Equipment or facilities that deliver electric power to a load. An EPS may be a local EPS or an area EPS.

2.6 ENERGY STORAGE SYSTEM (ESS) – Equipment that receives energy and then provides a means to store that energy in some form for later use in order to supply electrical energy when needed.

2.7 EQUIPMENT UNDER TEST (EUT) – An individual piece of equipment that is evaluated to perform a function for testing purposes.

2.8 INVERTER – An electronic device that changes dc power to ac power.

2.9 FUNCTIONAL SAFETY – Part of the overall safety of a system which depends on the correct execution of specific functions performed by active protective controls. The method of evaluation is through risk reduction related to hazards of the system context, executed by control systems, electrical circuits, components, and/or software.

2.10 LOCAL ELECTRIC POWER SYSTEM (local EPS) – An EPS contained entirely within a single premises or group of premises. The most common example for a local EPS is the building wiring.

2.11 NEAR REAL-TIME – Response time of the PCS in 30 seconds or less.

2.12 MULTISOURCE PCS – A PCS providing overload control of multiple sources to mitigate overload conditions of controlled conductors in a system supplied by more than one power source. Multisource PCS may also include load management in addition to control of multiple sources. Multisource PCS controlled conductors may experience overload conditions that separate passive protective devices are not able to fully address at the system level. The multisource PCS functionality addresses these system overload conditions of the PCS controlled conductors.

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2.13 OVERLOAD – As defined in the NEC.

2.14 PASSIVE PROTECTIVE DEVICE – Device provided and appropriately sized to prevent hazardous conditions that do not require electrical energy in order to operate and that are identified in the safety analysis as being required to prevent hazardous conditions.

NOTE: Examples of a passive protective would be fuses, thermal snap switches and circuit breakers.

2.15 PCS CIRCUIT CONTROLLER - A device, within a PCS, which modulates or interrupts current flow on a conductor connected to a source and/or load.

NOTE: Examples of PCS circuit controllers include a relay under PCS control, a PCS controlled OCPD that complies with UL 489 or other controllable devices,which are wired in series with a source or load.

2.16 PCS CONTROL FUNCTION – The function, located within any device, that performs the control logic.

2.17 PCS CONTROL SETTING – The defined setting for a current limit or power limit in which the PCS function shall take action to implement the PCS function. For a PCS with an adjustable control setting, the range shall be defined over the minimum to maximum of the allowed range. PCS control settings are continuous limits.

2.18 PCS CONTROLLED CONDUCTOR – A conductor or busbar in which the steady state current is regulated by a PCS.

2.19 PCS CONTROLLED BIDIRECTIONAL SOURCE – A source that also operates as a load where the output and input is capable of being increased or decreased using communication with the PCS control function(s) or whose output and input circuit are controlled by a PCS circuit controller.

2.20 PCS CONTROLLED LOAD – A load that is capable of being increased or decreased using communication with the PCS control function(s) or whose input circuit is controlled by a PCS circuit controller.

2.21 PCS CONTROLLED SOURCE – A source where the output is capable of being increased or decreased using communication with the PCS control function(s) or whose output circuit is controlled by a PCS circuit controller.

2.22 POINT OF COMMON COUPLING (PCC) – The connection point between the area EPS and the local EPS.

2.23 POINT OF CONNECTION (POC) – The connection point between the DER unit and the local EPS.

2.24 POWER CONTROL SYSTEM (PCS) – A system consisting of one or more devices that actively limits and/or controls AC or DC currents or power on conductors or busbars to settable limits or levels using electronic control logic.

2.25 PRIMARY POWER SOURCE – For the purpose of testing within this Outline, the term primary power source is the grid or a grid simulator, e.g., a programable AC power source.

2.26 RESPONSE TIME – The duration between a control signal input step change (reference value or system parameter) until the controlled output changes by 90 % of its final change, before any overshoot.

NOTE: Response time as used by this Outline is functionally similar as open loop response time as defined or commonly used in documents, such as IEEE 1547-2018, supplement SA and SB of UL 1741, or referenced in tariff rules.

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2.27 SINGLE SOURCE PCS – A PCS providing overload protective function(s) via power limitation of a single source of supply (e.g. area EPS) via load management. A branch circuit rated overcurrent protection device (e.g. passive protective device) is required in the design and installation of the Single Source PCS.

NOTE 1: Single Source PCS are installed so that a failure of the PCS will not result in an overload condition and/or fire risk. In a single source PCS, all PCS controlled conductors are installed with appropriately sized passive protective devices (e.g., branch circuit rated fuse, circuit breaker, etc.). The passive protective device provides overload prevention via the branch circuit rated overcurrent protection for the single source of the system. During single fault conditions, the system may experience nuisance tripping, but overload conditions are mitigated via the presence of the passive protective device.

NOTE 2: A single source PCS is located in a circuit(s) where OCPD's provide additional protection from overloads.

NOTE 3: Uncontrolled sources complying with the requirements of NEC 705.12 may be present in a single source PCS however these sources are not controlled by the PCS. A single source PCS often provides overload control for power imported from the area EPS through load management.

2.28 SIMULTANEOUSLY – For the purpose of testing within this Outline, the term simultaneously indicates that multiple switching events will all occur with no intentional delay. Test circuits shall be designed to minimize temporal switching event differences.

2.29 STAND-ALONE INVERTER – An inverter intended to supply a load, has no utility connection, and does not provide power back to the electric utility.

2.30 STEADY STATE – The condition where both the average and the 1-cycle RMS variations around the average magnitude of the observed parameter are limited to ±7.5 % of the per unit value of the observed parameter.

2.31 TIME TO STEADY STATE – The earliest time at which variations of the RMS value of the observed parameter around the steady state average value are limited to ±7.5 % of the per unit value of the observed parameter.

3 Components

3.1 A component of a product or system covered by this Outline, including equipment evaluated by this Outline, shall comply with the requirements as specified in this Outline.

3.2 Except as indicated in 3.1, a component of a product covered by this Outline shall comply with the requirements for that component. See Section 5 for a list of standards covering components commonly used in the products covered by this Outline.

3.3 Component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this Outline, or

b) Is superseded by a requirement in this Outline.

3.4 A component shall be used in accordance with its rating established for the intended conditions of use.

3.5 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

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3.6 The controller hosting the PCS control function(s) and PCS control settings used for overload control of PCS controlled conductors of the local EPS shall be located on-site of the PCS installation only. Local Communication networks are permitted for systems with multiple devices.

Exception: PCS control function(s) are permitted to include communication interfaces to off-site controllers or control functions for data monitoring, configuration purposes.

3.7 PCS control function(s) are permitted to include communication interfaces to off-site devices for features not related to PCS control settings such as data monitoring, reporting, and status information.

3.8 For PIL and PEL control functions only, PCS control settings may be adjusted remotely by permission of the area EPS operator. PIL and PEL functions shall not create an overload condition on any PCS controlled conductors of the local EPS during any normal or abnormal operation of the PCS.

4 Undated References

4.1 Any undated reference appearing in the requirements of this Outline shall be interpreted as referring to the latest edition of that standard.

5 Referenced Publications

5.1 The following standards are referenced in this Outline, and portions of these referenced standards may be essential for compliance.

International Electrotechnical Commission (IEC) Standards

IEC 60812, *Failure Modes and Effects Analysis (FMEA And FMECA)*
IEC 60730, *Automatic electrical controls*
IEC 61025, *Fault Tree Analysis (FTA)*
IEC 61508, *Functional safety of electrical/electronic/programmable electronic safety-related systems*

International Standards Organization (ISO) Standards

ISO 13849, *Safety of machinery – Safety-related parts of control systems*
ISO 26262, *Road vehicles – Functional safety*
ISO 3864-2, *Graphical Symbols – Safety Colors and Safety Signs – Part 2: Design Principles for Product Safety Labels*

National Fire Protection Association (NFPA) Codes and Standards

NFPA 70, *National Electrical Code*

National Electrical Manufacturers Association (NEMA) Standards

NEMA Z535, *Safety Colors*

UL Standards

UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*
UL 489, *Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures*
UL 67, *Panelboards*
UL 916, *Energy Management Equipment*

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UL 1998, *Software in Programmable Components*
UL 2202, DC Charging Equipment for Electric Vehicles
UL 2594, *Electric Vehicle Supply Equipment*
UL 991, *Tests for Safety-Related Controls Employing Solid-State Devices*
UL 62109, *Power Converters for Use in Photovoltaic Power Systems*
UL 2808, *Energy Monitoring Equipment*
UL 5500, *Remote Software Updates*
UL 60730-1, *Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements*,
UL 61010, *Electrical Equipment for Measurement, Control, and Laboratory Use*
UL 9741, *Electric Vehicle Power Export Equipment (EVPE)*

US Department of Defense (DOD) Standards

MIL-STD-1629A, *Procedures for Performing a Failure Mode, Effects, and Criticality Analysis*

CONSTRUCTION

6 General

6.1 All monitoring equipment and components of a PCS shall be rated for the voltage and current of operation and intended for installation in accordance with the PCS manufacturer's installation instructions for the end application. The maximum current and voltage ratings of the PCS shall be included in the manufacturer's installation instructions.

6.2 PCS voltage monitoring circuits shall be provided with overcurrent protection located within the monitored enclosure and sized for the monitoring conductors.

6.3 Where field installed sensors are placement and or polarity sensitive, and can be located or relocated during installation the correct placement direction of the sensor shall be clearly marked on the sensor. Polarity indication of sensor wiring shall be via color coding, wire labeling, through use of polarity keyed connectors or other means that minimizes the potential for miswiring.

6.4 For PCS capable of including an overload prevention function (e.g. overload prevention of controlled conductors, feeders or busbars, etc.) with additional import/export control function(s), the overload control function(s) shall not be superseded by the import/export control function(s). Changes to import/export limits shall not disable or supersede the overload prevention control functions so that the overload control function is maintained.

6.4.1 The priority of PCS overload control function(s) relative to power import/export control function(s) shall be subjected to a PCS safety analysis to ensure functional safety of the priority function. See 7.1.1, item d for details.

6.4.2 PCS shall utilize on-site controllers for overload control. PCS control settings shall be configured on-site. Local communication networks are permitted for systems with multiple devices.

6.4.3 Connection to offsite controllers, (i.e. web-based control), shall not be used for overload control (as defined per the NEC). Any connection to offsite controllers shall be disabled or disconnected during functional and abnormal testing. Upon loss of onsite communications, the PCS shall enter a controlled state (fail safe) as defined in Functional Safety, Section 7.

NOTE: See clauses 3.6 – 3.8 of this outline for further details regarding PCS control function(s) and communication requirements.

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6.7 Where the PCS is only compatible with specific equipment, the manufacturer shall identify the compatible equipment by model number. The list of compatible products shall be included in the manufacturer's instructions.

6.8 Where specific devices are required for proper functionality of the PCS those devices, (e.g. external current sensors) shall be specified in the manufacturer's instructions. Other examples of devices required for proper functionality include power converters or inverters, PCS controllers, and controllable AC or DC loads. When specified by the manufacturer, the PCS may optionally be evaluated with a larger number of devices.

6.9 Where loads or sources operate as an active protective device to comply with PCS functionality requirements, those loads or sources shall be evaluated as part of the PCS, otherwise those loads or sources shall be considered as uncontrolled loads or uncontrolled sources. The ability to connect uncontrolled loads or sources to a PCS shall be considered when conducting the evaluation of the PCS.

NOTE: Uncontrolled loads are used when performing the normal operating tests. If the PCS controls sources as part of the function being evaluated, then the impact of other uncontrolled sources that may be added to the local EPS would need to be considered in the testing unless the instructions warm against adding other sources.

6.10 PCS current monitoring equipment shall comply with one of the following options (a)-(d):

a) PCS current monitoring equipment intended to be installed in another manufacturer's panelboard(s) or switchboard(s) shall be rated for the application and comply with UL 2808;

b) Complete PCS current monitoring equipment intended to be used with specific panelboards or other equipment and located externally shall meet the requirements in UL 61010-1;

c) PCS current monitoring function(s) installed in end products other than (a) and (b) above shall meet the applicable end product standard for the equipment in which the PCS current monitoring function(s) are located; or

d) Current transformers and similar current sensing devices when used as a component within PCS devices not covered in (a)-(c) above shall comply with Components, Section 3.

6.11 PCS voltage monitoring circuits shall be provided with overcurrent protection located within the monitored enclosure and sized for the monitoring conductors. The voltage monitoring circuit shall comply with the control circuit requirements of Control Circuits, Section 31, of UL 1741.

6.12 All monitoring circuits shall comply with the control circuit requirements of Control Circuits, Section 31, of UL 1741. Monitoring circuits shall be treated as Class 1 circuits and shall be installed in accordance with NEC Chapter 3 wiring methods.

NOTE: Requirements for segregation of circuits in field wiring applications is covered in NEC Article 725.

6.13 A description of all supported PCS modes of operation shall be included in the documentation supplied by the manufacturer in accordance with requirements in section 8.1.1 and section 10.1.

6.14 Single Source PCS which may be used with DER source(s) not controlled by the PCS provided the DER sources are sized in accordance with 705.12 of NFPA 70 and be marked per section 9.6.

6.15 PCS shall be evaluated for general construction and risk of electric shock and fire safety using one of the following methods:

a) If the PCS is integrated into another end-product type, the construction requirements and general safety testing from the relevant end-product UL standard shall be applied per the design of

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the PCS and integration of the PCS into the end-product. Allowed end product UL standards are as follows: UL 67, UL 2808, UL 1741, UL 489, UL 62109, UL 916, UL 1008, UL 61010, UL 2594, UL 2202, and UL 9741.

For any construction or testing aspects of the PCS design not addressed via the application of the end-product standard, item (b) shall also be applied.

Functional safety requirements are not considered general construction or safety testing. The functional safety requirements from this Outline apply in addition to this requirement.

b) If the PCS is an independent product not directly integrated into another end-product type, the PCS shall be evaluated and tested in accordance with UL 1741, as applicable for the PCS design under consideration.

6.16 Adjustment of PCS control settings:

a) Shall be located within the PCS user interface;

b) Shall not utilize communication networks for the adjustable PCS control settings; and

Exception: Adjustable settings for overload control functions shall be permitted using local, nonnetworked, communication networks for systems with multiple devices.

Informational Note: PCS control function(s) can include communication interfaces to off-site devices for features not related to PCS control settings such as data monitoring, reporting, and status information

c) Access to the adjustable PCS control settings shall be limited by a minimum of one of the following:

1) Located behind locked doors accessible to only qualified personnel;

2) Software that has password protected access to the adjusting means accessible to qualified personnel only; or

3) Hardware (e.g. dip switches, etc.) shall be located behind locked doors or areas requiring a tool for access.

6.17 PCS control settings for overload functions defined in 8.1.1, items (b)-(e) shall be considered continuous limits.

NOTE: The use of the phrase continuous limits is intended to align with the definition of continuous duty in NFPA 70.

7 Functional Safety

7.1 PCS Safety Analysis

7.1.1 A safety analysis consisting of a hazard identification, risk analysis, and risk evaluation shall be conducted on all power control systems (PCS). This safety analysis shall include at a minimum active protective devices and related components of the PCS. This safety analysis shall determine which parts of the PCS are safety related through an existing methodology such as outlined in 7.1.2. This approach should determine the hazard scenarios and define mitigation mechanisms. This safety analysis shall identify safety circuits or software utilized as active protective device(s)s that address each hazardous condition and consider the performance of each safety circuit or software of active protective device(s).

The following conditions in (a) – (g) shall be considered at a minimum unless sufficient justification (e.g., additional safety analysis) is provided by the manufacturer that these conditions are considered not

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