SECTION 25 5911

equipment shutdown Circuits for BAS systems

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LANL MASTER SPECIFICATION

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| Rev. 1 Summary of Changes:  Minor corrections and editorial changes to section.  Added *2.3.D to clarify that one side of demarcation terminals shall be used for field connections.*  Appended 2.4.C to address high traffic areas.  Modified 2.4.E to clarify how smoke duct detectors, that are not connected to a fire alarm panel, should be connected to shutdown circuits.  Appended 2.4.E to require exception is filed and approved when temporary jumpers are installed in fire shutdown circuits.  Modified 2.7.B to clarify that software should be used for the required function.  Added 2.7.D to require clear indication of shutdown circuits on graphic displays.  Modified 3.1.B to clarify wiring diagram requirements.  Modified 3.1.G to clarify jog circuit requirements.  Added 3.2.E to require formal test procedures for ML-3 shutdown circuits.  Added 3.2.F to require proof of calibration or field testing on pressure sensing switches to validate trip settings. |

Word file at <https://engstandards.lanl.gov>

**This template material is to be included in the Project Specification when the project includes a BAS that also requires one or more shutdown circuits and design is delegated to a BAS firm, either as this section or by incorporation of the material herein into 25 5000, *Integrated Automated Facility Controls*.**

This template must be edited for each project. In doing so, Specifier must add job-specific requirements. Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.  Once the choice is made or text supplied, remove the brackets.  This section must also be edited to delete requirements for processes, items, or designs that are not included in the project -- and specifier’s notes such as these.

To seek a variance from requirements in this Section that are applicable, contact the Engineering Standards Manual Chapter 8[POC](http://engstandards.lanl.gov/POCs.shtml#ic). Please contact POC with suggestions for improvement as well.  
  
When assembling a specification package, include applicable sections from all Divisions, especially Division 1, General requirements.  
  
Section developed for ML-4 projects.  For ML-1, 2, and 3 applications, additional requirements and independent reviews should be added if increased confidence in procurement or execution is desired; see ESM Chapter 1 Section Z10 Att F Specifications and Quality sections.

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1. GENERAL
   1. Section Includes
      1. Equipment shutdown configuration.
      2. Equipment shutdown component identification.
      3. Special timed overrides of shutdowns.
      4. building automation system (BAS) interface and alarming requirements.
      5. Testing requirements.
   2. LANL-PERFORMED WORK
      1. None
   3. SUBMITTALS
      1. None. The components and installation details used to meet the requirements of this Section shall be submitted as part of BAS Section 25 5000, *Integrated Automated Facility Controls* requirements. No separate submittal is required for this section.
   4. REGULATORY REQUIREMENTS
      1. Conform to requirements of the National Electrical Code (NEC), NFPA 70E, and OSHA.
   5. Coordination
      1. Verify component and equipment designations with LANL through the Subcontract Technical Representative (STR) if they are not specifically designated on design documents or clearly stated in this specification. Do not arbitrarily assign designations.
   6. Applicability
      1. All Building Automation Systems (BAS) that require hardwire shutdown of equipment such as, but not limited to:
         1. Fire Alarm Shutdown
         2. Freeze Stat Shutdown
         3. High/Low Duct Pressure Shutdown
         4. Manual Operator Emergency Shutdown
         5. [other project defined shutdowns]
   7. SCOPE LIMITATIONS
      1. This Section shall not be applied to ML-1, 2, or 3 safety shutdown systems without express written permission from the LANL ESM Chapter 8 POC.
2. PRODUCTS
   1. PRODUCT OPTIONS AND SUBSTITUTIONS
      1. Alternate products may be accepted; follow Section 01 2500, *Substitution Procedures*.
   2. Shutdown relays
      1. Relays used in shutdown circuits shall be of the traditional “ice cube” relay type with the following characteristics:
         1. 24 Volt AC or DC coil
         2. Coil voltage indication (LED indicator)
         3. Mechanical contact position-indication flag
         4. Provided with DIN rail wiring mounting base
         5. Form C contacts, number of poles as required
         6. Provide dedicated marking location on face of relay
         7. Contacts rated at minimum of 10 Amps
         8. Typical example of approved device is Magnecraft 782XBXM4L-24A with 70-782D8-1 mounting socket.
      2. Relays and their mounting sockets shall be permanently marked with the following identifiers based on use [designer: add other shutdown relays below based on Project requirements; use acronym Rxx (replace “xx” with appropriate acronym for relay usage)]:

|  |  |  |
| --- | --- | --- |
| **Relay** | **Label** | **Use** |
| Master shutdown | RSD | combines all shutdown signals and provides the shutdown output to the system |
| Fire alarm shutdown | RFA | controlled by fire alarm input signal |
| Freeze protection shutdown | RFZ | controlled by freeze stat input signal |
| High pressure shutdown | RHP | controlled by high duct pressure input signal |
| Low pressure shutdown | RLP | controlled by low duct pressure input signal |
| Manual shutdown | RMS | controlled by operator manual shutdown input signal |

* 1. DEMARCATION TERMINALS
     1. Terminals used for connections to field-located signaling devices shall have the following characteristics:
        1. Screw cage clamp connections (spring clamps not allowed)
        2. DIN rail mounted
        3. 600V AC/DC rated
        4. 35 Amp rating
        5. Accept wire gauges from 22 AWG to 10 AWG
        6. Include end caps, spacers, and retainers as required
        7. Typical example of approved device is Allen-Bradley 1492-J4-RE (for a red terminal).
     2. Label terminals used for connections to field-located signaling devices as follows [Designer: Add any other project-specific shutdown needs in table below]:

|  |  |  |
| --- | --- | --- |
| **Signal** | **Terminal Color** | **Label Text** |
| fire alarm signal | red | fa |
| freeze protection | blue | fz |
| high pressure | white | hp |
| Low pressure | white | lp |
| Manual shutdown | gray | ms |

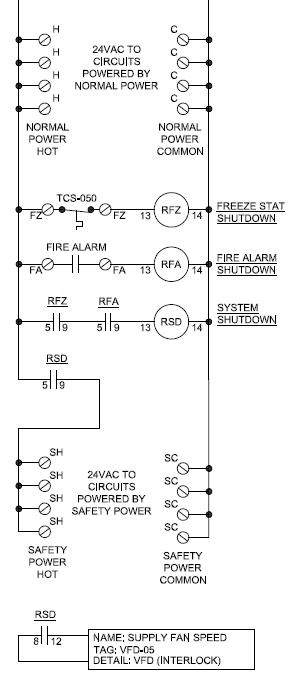
NOTE: If more than one signal is present for a given shutdown signal, terminals shall be appended with a unique number starting at 1. For example, fire alarm input 1 terminals would be “FA1” with fire alarm input 2 terminals being marked “FA2”.

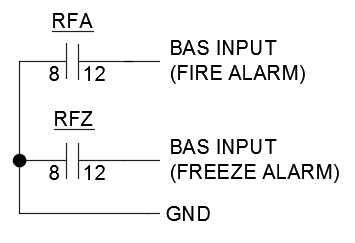
* + 1. Terminals used for connections to field-located signaling devices shall be marked with the same terminal label and be of the same color independent of whether they are tied to a power supply common or hot leg. For example: For a fire alarm connection, both terminals shall be red in color and marked “FA” even if one terminal is tied to the 24V AC power source.
    2. Field connection to the demarcation terminals shall be located on the same side of the terminal strip and be directly adjacent to each other. No other wires shall be connected to the side of terminals where the field connections are made (i.e., field connection points shall be dedicated for field connections only)
  1. failsafe input devices
     1. Contacts used to signal running or stopped shall be configured such that the alarm (shutdown) condition will be activated when the circuit has been compromised.

*Example: If the expected condition is running, such that a stopped condition will trigger an alarm, the equipment should use a Form-A (normally closed) contact for indication. In the event a conductor in the signal circuit is broken, the alarm will be triggered as well. If the expected condition is for the equipment to be stopped, a form-B (normally open) contact should be used. In this case, an alarm condition will be triggered if the unit is running or if a wire is cut.*

* + 1. Freeze protection and high- and low-pressure cutouts shall require manual reset at the device that must be reset by an operator before returning the system to normal operations (exception: timed override freeze protection described in Article 2.6 TIME DELAY RESTART OVERRIDES below)
    2. Manual operator shutdown switches shall be of the e-stop type with push-to-activate mushroom actuation button with a pull-to-reset or twist-to reset-feature. When located in high traffic locations, a flip-up cover or a recessed button guard shall be used to prevent inadvertent actuation.
    3. When an addressable fire alarm system is installed in the building, the fire alarm shall provide addressable remote relays with contacts that open on alarm. These fire alarm relays shall be located within 3 ft of the BAS control cabinet containing the shutdown relays. In this configuration, the duct smoke detectors shall report to the fire alarm panel which in turn shall be programmed to open the remote addressable fire alarm relays.
    4. When an addressable fire alarm system is not installed in the building, the duct smoke detectors relay outputs for a given HVAC unit shall be wired in series and tied to the red fire alarm shutdown demarcation terminals. The smoke detectors shall open their alarm contact on detection of smoke. If the building is updated to an addressable fire alarm system in the future then paragraph 2.4.D requirements shall be implemented.
    5. When a shutdown signal is not available at the time of the BAS installation, a jumper may be placed across the shutdown terminals provided the jumper is clearly marked “TEMPORARY JUMPER – REMOVE WHEN SHUTDOWN CIRCUIT IS CONNECTED”.   
         
       *NOTE: The project shall ensure an exception is filled and approved with the Fire Protection Office when temporary jumpers are installed.*
  1. FAILSAFE END DEVICES
     1. When end devices are required to respond to shutdown signals they shall be designed to “failsafe” in the following ways:
        1. Dampers and Valve actuators – Actuators shall be provided with spring return, capacitive discharge or battery driven positioning that automatically position the controlled device to the correct position upon loss of power. Power to these devices shall be removed upon the presence of a shutdown signal.
        2. Relays – Relays used in shutdown circuits shall be installed such that under normal operating conditions (not in shutdown mode) the coil of the relay shall be energized.
        3. Inputs to Other Systems – Whenever possible the use of signals that are held closed in normal operations and open in shutdown mode shall be utilized.
        4. [Add other end device as needed]
  2. TIME DELAY RESTART OVERRIDES
     1. On HVAC equipment delivering 100% or high volumes of outside air where restart during cold weather may not be possible due to heating operation being disabled until after the supply fans have started, a time delay override shall be used for the freeze protection shutdown.
     2. The time delay override shall have the following requirements:
        1. A red LED 22mm or larger indicator to indicate when the freeze protection system is tripped.
        2. A latching relay or a relay with a hold in circuit that holds the system in shutdown until manually reset by an operator using an adjacent pushbutton.
        3. A time delay relay that allows the system to operate normally for [15 minutes][other specified delay] independent of the freeze detection device status to allow the unit to attempt to restart and resume normal operations.
        4. The freeze protection sensing device (freeze-stat) shall be of the auto reset type when used in this configuration.
        5. The trip indicator and the reset button shall be located in the general location of the freeze detection device and be clearly labeled as to indication and function.
        6. The time delay override circuits shall be wired to the blue freeze protection demarcation terminals.
        7. [See LANL Standard Detail ST-XXXX for additional details. (being developed)]
  3. BAS ALARMING AND CONTROL SIGNALS
     1. All shutdown inputs to the BAS system shall report independently to the BAS through a set of dry contacts. The BAS shall be programmed to generate an alarm specific to the cause of the shutdown.
     2. The BAS outputs shall produce identical outputs, via software, to match what the hardwired shutdown circuits are producing (e.g., close the outside air damper or stop the supply fan) when a shutdown signal is received.
     3. In no case shall correct operation of the BAS controller be required to complete the required hardware equipment shutdown functions.
     4. BAS graphics for the affected equipment shall indicate the status of all shutdown inputs with red text that is only visible when the shutdown is active.

1. EXECUTION
2. INSTALLATION - General
3. Group shutdown relays and terminals together inside the respective BAS control cabinet. If more than one set of shutdown circuits are located in a single BAS panel, then they shall be grouped together based on the equipment they serve (e.g., HVA-1 shutdown circuits shall be grouped separate from HVA-2 shutdown circuits).
4. Provide shutdown circuit wiring and panel layout as part of the detailed engineering drawing set or as part of the shop drawings; show in a schematic format (ladder diagram) rather than a wiring diagram format. Terminal numbers for contact and coil connections shall be clearly shown on the drawings and/or shop drawings. Use NEMA (Not IEC) terminal numbers on drawings when dual labeled devices are used.
5. A typical safety circuit shall be wired as shown below (example only):





1. Safety shutdown relays located in BAS cabinets shall not switch any voltage greater than 50V AC or DC with respect to ground.
2. Shutdown circuits shall not be allowed to be bypassed by Hand-Off-Auto (HOA) or other manual operator devices.
3. When shutdown of variable frequency drives (VFDs) is required, the safety signal shall be tied to a dedicated operation interlock input on the VFD that cannot be bypassed at the operator terminal of the VFD. Other required interlocks for the drive may be wired in series with the shutdown signal if needed.
4. Momentary jog or momentary test buttons used for verification for lockout/tagout procedures shall operate the motor directly, with no circuit interrupting components in the control scheme except the motor overloads. No equipment shutdown contacts, interlocks or permissives are allowed.
5. [Operator manual shutdown switches shall be clearly labeled as to their use, and be located so that either inadvertent actuation is unlikely or be protected from inadvertent actuation by some other means such as a guard or shroud.]
   1. TESTING
      1. All equipment shutdown circuits shall be tested during system commissioning and shall be witnessed by a LANL representative for correct operations.
      2. If HOAs (Hand-Off-Auto) are present on equipment being shut down, then they shall be tested for correct shutdown operations in both the HAND and AUTO positions.
      3. If momentary jog/test switches used for LOTO (Lock Out, Tag Out) checking are present, then they shall be tested to assure shutdown circuits do not disable their operation.
      4. Additional testing may be required to verify correct fire alarm interlock operations as required by the fire alarm system specifications.
      5. [When shutdown circuits are of the ML-3 level, a formal test procedure shall be written and approved by LANL prior to performing final testing.]
      6. Pressure sensing switches that do not include an indicator of setpoint, shall be calibrated to the specified pressures provided on the design drawings. Proof of calibration or field testing that validates correct settings must be provided to the commissioning agent and included in the final test results.  
           
         Exception: Devices that directly indicate setpoints (i.e. Photohelix gauges or digitally programmed sensors) must only provide confirmation that they have been set to the correct settings.

END OF SECTION

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Do not delete the following reference information.

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THE FOLLOWING STATEMENT IS FOR LANL USE ONLY

This project Specification section is based on LANL Master Specification Section 25 5911, Rev. 1, dated May 1, 2024.