Application Note:
L3 HVR-60 Fire Safety System Overview

This application note outlines the following for the Sol-Ark L3 HVR Battery Cabinet:

- Fire Detection and Suppression
- Ventilation and Explosion Control

1. Overview



Sol-Ark's L3 series HVR-60 outdoor battery cabinet is an IP55-rated, high-voltage (HV), UL 1973-listed, and Lithium-ion-based battery stack and enclosure for use with the Sol-Ark 30K-3P-208V and 60K-3P-480V hybrid inverters.

The battery modules contain 100 Ah prismatic LFP cells with built-in pressure relief valves. These HV battery and inverter pairings have UL 9540 compliance certification, and the battery has a unit-level UL 9540A testing report.

As a self-contained battery stack, the L3 HVR provides a conditioned space, security, hazard detection, emergency ventilation, visual/audio alerts, and aerosol fire suppression.

This application note addresses common AHJ concerns about the operation and capability of the HVR's integrated fire safety system when installed outdoors. The HVR's safety system is fully installed during manufacturing and is ready for operation. No testing and minimal maintenance are required unless the unit has been damaged, activated, or more than 10 years old.

There is no full-system testing procedure. A full test would release the aerosol and disable the system until the canister is replaced and the unit is cleaned. This document explains the system components and operation steps.

2. Fire Safety Requirements

AHJs, including fire departments, have adopted strict safety requirements for energy storage systems, particularly those using Lithium-based batteries. Plan reviewers and inspectors will require proper equipment certification and system planning (including installation, operation, and servicing) to receive a permit.

For fire safety, the AHJ refers to the National Electrical Code (NEC), UL certifications, the state fire code (and local amendments), state building codes, and possibly NFPA 68, 69, 72, 855, and 2010. Installers and designers need to be familiar with fire safety requirements and how selected equipment and systems meet these requirements.

2.1 Related Documents

This application note outlines the operation, maintenance, and testing of the L3 HVR cabinet's integrated safety system, and is sourced from the following documentation:

- *L3 HVR Installation Manual*
- Aerosol Fire Suppression System Overview ("Aerosol Overview") application note
- "*Appendix A. HVR Suppression Strategy*" on page 9 includes a single-line diagram of components and sequence-of-operations list. This document and the resources above should provide the necessary information for permit submissions.
- *Jiandun Condensed Aerosol Fire Extinguishing System Model: JAD300-U01 Design, Installation, Operation and Maintenance Manual* ("JAD300-U01 Manual")

3. HVR Electrical Energy Storage System Safety

The L3 HVR battery cabinet contains the fire safety system (detection, ventilation and pressure relief, suppression, and annunciation) for the battery portion of the Sol-Ark BESS.

3.1 L3 HVR Fire Prevention and Suppression Components

The L3 HVR's integrated fire safety system includes:

- One heat detector, one smoke detector, and one CO detector
- One BCU, 12 battery modules, and cabinet emergency ventilation
- Alarm Indicators: audible and visual
- Aerosol Fire Suppression: cabinet and module level

All detection, alarm, ventilation, and aerosol devices require 24 V_{DC} power, which comes from a DC Power Supply (see "Appendix B. Auxiliary Power" on page 10).

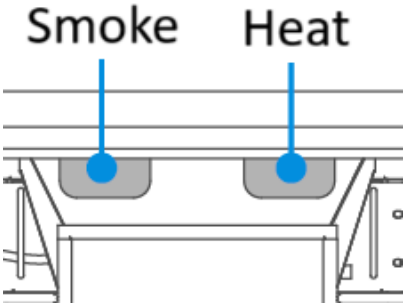
This power supply is fed from the 208 V_{AC} or 240 V_{AC} Auxiliary Power as explained in section 2.8 of the *L3 HVR Installation Manual.* Providing this AC power is a normal part of the installation process as it also powers the HVAC unit.

See "Appendix B. Auxiliary Power" for power distribution details.

3.1.1 Testing Smoke and Heat Detectors

The cabinet ceiling has System Sensor Series 800 smoke and heat detectors, with the manufacturer's detector bases:





Model	Detector Type	Detection Method	UL Standard	UL File Number
882	Smoke	Photoelectronic	UL 267	S911
885	Heat	65 °C (149 °F)	UL 521	S2101

Testing Model 882

Before testing, notify the proper authorities that the system is undergoing maintenance and will temporarily be out of service. Disable the system to prevent unwanted alarms. Detectors must be tested after installation and following periodic maintenance.

The detector can be tested in the following ways:

- **Calibrated Sensitivity Test (Gemini 501):** The GEMINI model 501 aerosol generator can be used for smoke entry testing. Set the generator to represent 4%/ft. to 5%/ft. obscuration as described in the GEMINI 501 manual. Using the bowl-shaped applicator, apply aerosol until the panel alarms.
- **Smoke Entry Test:** Hold a smoldering punk stick or cotton wick at the side of the detector shown above, and gently blow smoke through the detector until it alarms.

A detector that fails any of these tests should be cleaned and retested. If the sensor fails after cleaning, it must be replaced. When testing is complete, restore the system to normal operation and notify the proper authorities that the system is back in operation.

Testing Model 885

Before testing, notify the proper authorities that the system is undergoing maintenance and will temporarily be out of service. Disable the system to prevent unwanted alarms. Detectors must be tested after installation and following periodic maintenance. The detector can be tested in the following way:

WARNING: Do not use an open flame or a burning cigarette for testing heat sensitivity. Items like these may cause thermal failure!

Direct Heat Method (Hair dryer of 1000-1500 watts)

1. From the side of the detector, direct the heat toward the detector. Hold the heat source about 6 inches (15 cm) away to prevent damage to the cover during testing.
2. The LED on the detector latch should be on when the temperature at the detector reaches the alarm set point 65 °C (149 °F). Otherwise, check the power to the detector and the wiring in the detector base.
3. Reset the detector using the control panel.

Note: When triggered, each device will power an LED alarm signal; if both are in alarm state, they will activate the aerosol release process.

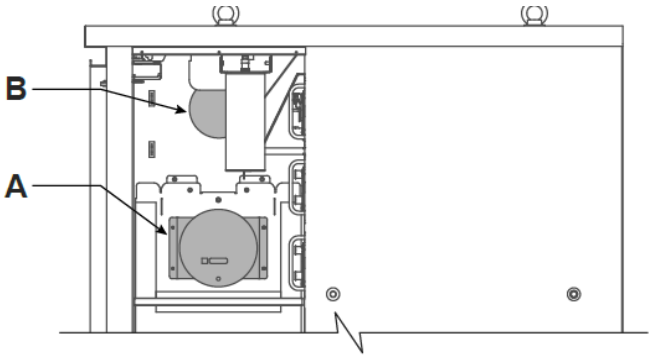
3.1.2 Carbon Monoxide (CO) Gas Detection and Ventilation

Carbon monoxide and carbon dioxide are two commonly released gases during a LiFePO4 battery fire. When the CO detector "**A**" (below) senses CO gas, the fan-assisted exhaust vent "**B**" will open to exhaust flammable gases outside the cabinet's upper left side, while an equivalent intake vent opens on the lower right side. The CO detector is listed with UL and the California State Fire Marshal. When activated, the detector sounds an 85 dBA alarm.

Air Intake Vent

A Gamewell US model CO1224TR Detector (UL 2075 compliant)

B Exhaust Vent and Fan



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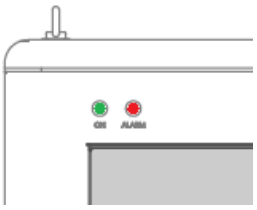
LISTING
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SERVICE
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The HVAC system is shut down (by shunt-tripping the QF3 breaker).

Buildup of trapped flammable gases would cause an explosion hazard; the exhaust and intake ports will also open under pressure as they are also designed as explosion-proof valves.

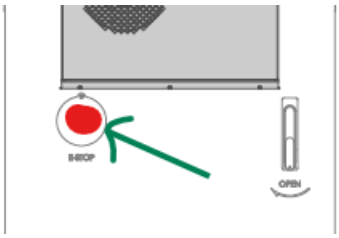
3.1.3 Visual Alarm Indicators

Status indicators include a green light as shown on the upper left of the front door, which indicates the system is ON and operating normally. If smoke or smoke and heat is detected, the red alarm indicator will light.



3.1.4 Emergency Stop Button

The front door of the HVR cabinet has a red E-stop/EPO button illustrated at the right for rapidly stopping DC battery power and non-essential AC power (the HVAC system). Activating this E-stop will result in the HVAC breaker (QF3) tripping. Be sure to reset the breaker when resetting the E-stop button.



3.1.5 Aerosol Fire Suppression

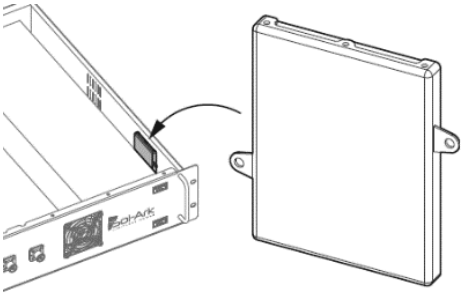
There are two levels of aerosol fire suppression: **battery module level** and **cabinet level**.

Note: Both aerosol devices were NOT triggered during the UL 9540A thermal runaway testing of the HVR. The test passed without either aerosol device being activated

The aerosol is mostly ultra-fine potassium salt particles that are considered non-toxic in normal concentrations.

Battery Module Aerosol

Each battery module has a 12-gram supply of aerosol fire suppressant (QRR0.012G/S/SA). The aerosol pack releases when encountering excessive heat (175 °C, +/-5°). Because the suppression system is located inside the battery next to the cells, it can suppress fires where they are most likely to occur.



The fire control was exhibited in the module-level fire test, which showed extinguishment 10 seconds after flaming:

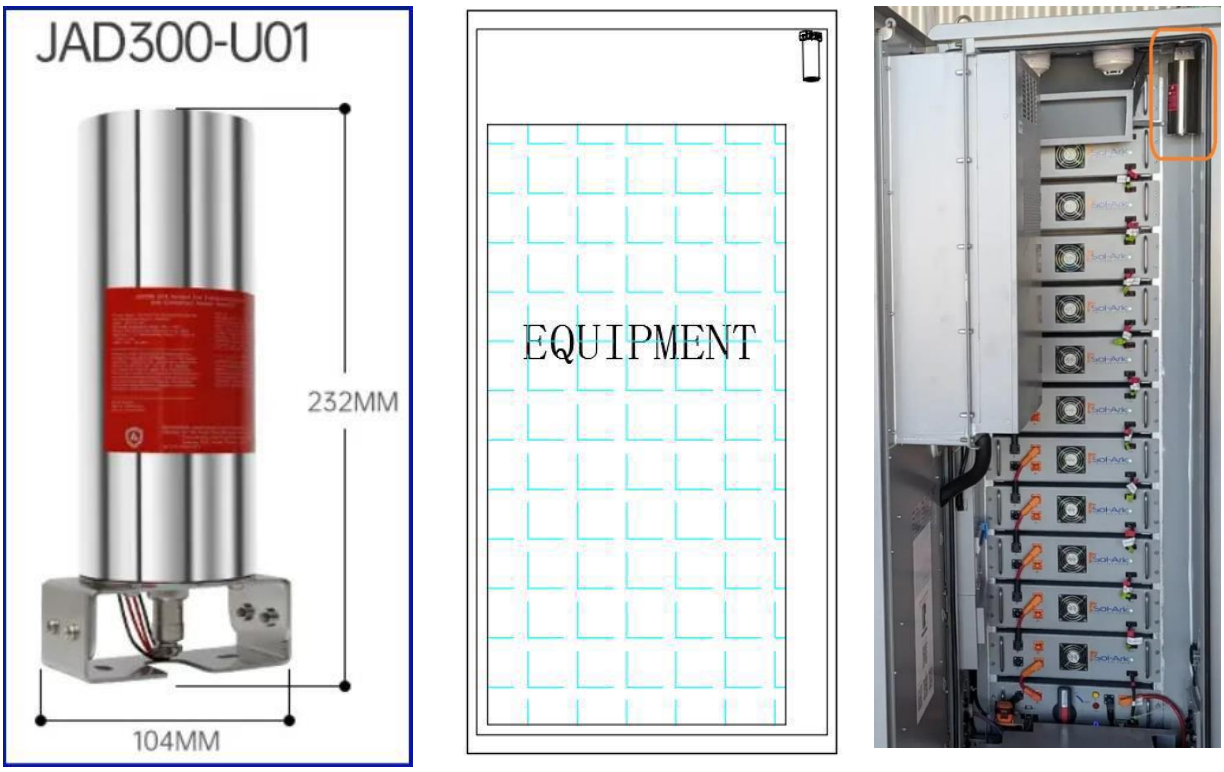






Cabinet Level Aerosol

The cabinet aerosol device model JAD300-U01 is a 300-gram canister compliant with UL 2775 (per NFPA 2010). It is factory-installed in the upper right of the unit, matching the illustrated placement provided by the aerosol canister manufacturer (Hubei Jiandun Fire Technology Co., Ltd):



JAD300-U01(UR) [A] Aerosol canister: [B] instructed placement [C] and actual placement

The amount of aerosol (approximately 300 g) for this approximately 1.2 cubic meter of space is more than twice what's required for Classes A-C fire types (per UL 2775). The aerosol is deployed for 10 to 15 seconds when *both* smoke and heat detectors are activated.

Unlike traditional extinguishers, the contents are not under pressure, which reduces inspection/maintenance of the system. Section 3.2 of the *L3 HVR Installation Manual* outlines the fire suppression and deflagration protection in the L3 HVR. For more detail, see the Aerosol Overview document and "Appendix A. HVR Suppression Strategy" on page 9.

For information about the generic operation of these components, see the JAD300-U01 Manual and the aerosol canister webpage by the manufacturer.

4. Post-Activation Recovery

4.1 Cleanup After Cabinet Aerosol Discharge

Cleaning should be completed within 24 hours after discharging. Contact Sol-Ark immediately.

Corrosiveness

Tests show that the aerosol fire extinguishing system is non-corrosive and harmless to various materials, including structural metals, plastics, electrical components, films, and tapes. If the system is not cleaned in time after discharging, some metal alloys may develop slight surface discoloration. The discoloration will not continue to spread or affect operation.

Conductivity

Residue left after discharge can absorb moisture. If it is not cleaned, the residue may form clumps and cause surface discoloration on unprotected metal. If clumps form on a PCB, the moisture and metal particles in the residue may cause a short circuit.

Cleanliness

The fire extinguishing agent can remain suspended for a long time and be easily discharged by fan or air treatment. A small amount of aerosol deposited on the floor or other horizontal surfaces can be cleaned by vacuuming, brushing, or washing. Small amounts of residue or agglomerated mass that have not been removed during the ventilation process must be thoroughly cleaned with contact cleaner spray.

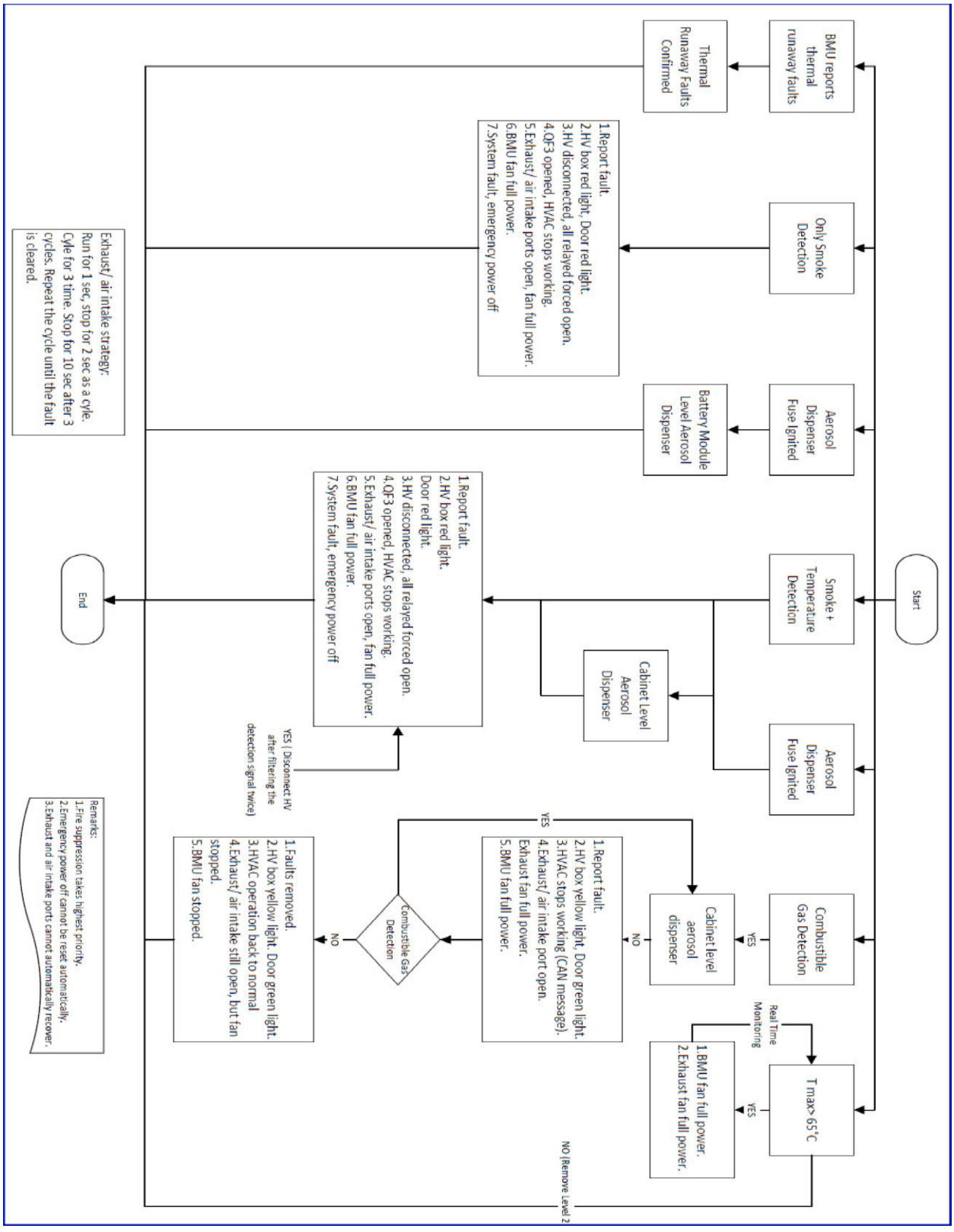
Use trained service personnel. Isolate all AC and DC energy sources and verify the absence of voltage before cleaning.

4.2 Replacement

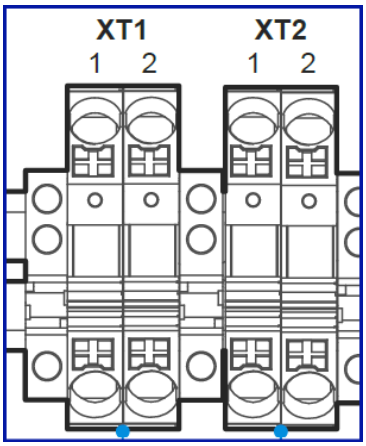
Contact Sol-Ark for replacement parts and installation qualifications. Follow the aerosol canister manual and Sol-Ark's instructions for installation, being careful to:

1. Shut off the Auxiliary AC power
2. Use only 304 stainless steel bolts

Appendix A. HVR Suppression Strategy



Appendix B. Auxiliary Power

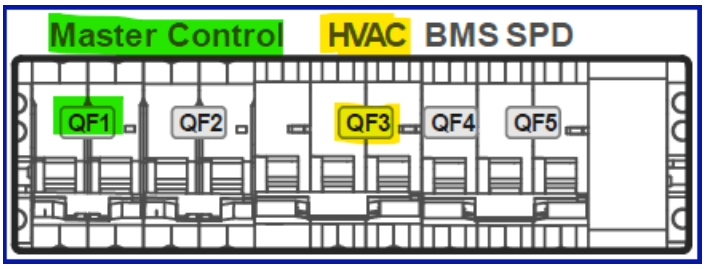


The HVR cabinet needs 208 to 240 V single-phase, 2-wire power to operate its numerous components. Most of the power is for the HVAC system (1.0-1.8 kW). This Auxiliary Power comes from an external source, most commonly L1/L2 (30K-3P) or L1/N (60K-3P Aux. Transformer) conductors derived from the inverter's **LOAD** terminal power supply. Those conductors are connected to the two auxiliary XT terminals inside the cabinet shown to the right.

A set of QF breakers control the distribution of this AC power:

1. **QF1** – **16 A** two-pole: **Main:** disconnect for other breakers
2. **QF2** – **4 A** two-pole: **Aux Devices via 24VDC Power Supply**
3. **QF3** – **16 A** two-pole: **HVAC**
4. **QF4** – **16 A** one-pole: **BMS**
5. **QF5** – **32 A** two -pole: **SPD2 (always leave ON)**

The QF2 breakers feed the integrated fire safety system (detectors and loads). Upon smoke and/or heat detection, the HVAC system's QF3 breaker will be tripped. During normal operation, all breakers must be turned ON.



DC Power

The QF2 breaker feeds a UL-60950-1 power supply that provides 24 V_{DC} power to the low-power components like detectors, lighting, and communications. This is shown in "Appendix C. Fire Suppression Safety Circuits" on page 11. It is also what powers the processing unit that controls the logic of the safety circuits (see "Appendix A. HVR Suppression Strategy" on page 9).

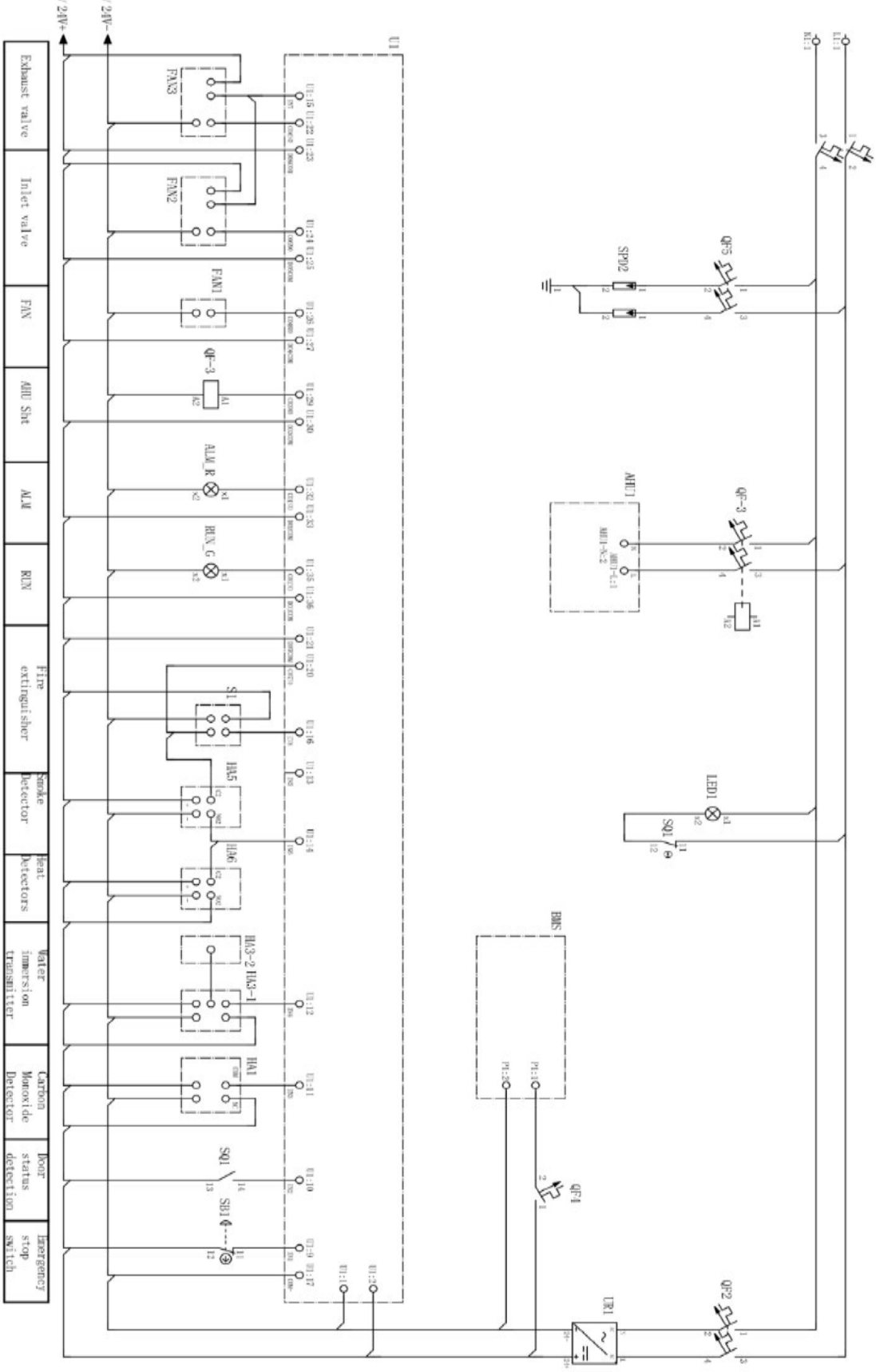
Appendix C. Fire Suppression Safety Circuits

The 24 V_{DC} power supply feeds the following devices and circuits. This is based on the processor logic and sensor statuses listed in “Appendix A. HVR Suppression Strategy” on page 9.

- Emergency Stop Switch
- Door Status Detector (determines if cabinet door is open or closed)
- Carbon Monoxide Detector
- Water Immersion Detector (located in base of cabinet)
- Smoke Detector (ceiling-mounted)
- Heat Detector (ceiling-mounted)
- Aerosol Fire Extinguisher (ceiling-mounted)
- Green LED for normal ON operation (exterior front)
- Red LED for Alarm indication (exterior front)
- HVAC Breaker Trip device (QF3)
- Air Inlet Port Door release (bottom right)
- Air Outlet Port Door release and Fan No. 3 start (upper left)

A diagram of these circuits is attached to the inside of the HVR door and shown on the next page.

Electrical Schematic Diagram



Document Revision History

Rev.	Date	Author	Description of Changes
1	04/10/2024	Michael Miller, Liam O'Brien	Document created
2	08/10/2026	Trevor Owens	Updates to testing instructions