



# Installation Guidelines for Medium Voltage Arc Plenums and Chimney Systems

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## Overview

The purpose of this document is to provide additional supporting technical information and reference information that is related to our Allen Bradley Bulletin 1500/1900 ArcShield Medium Voltage Motor Controllers (MV MCC) arc-resistant controller products and the installing and configuring the arc plenum, ducts, and chimney pieces associated with.

For additional installation details, always refer to the user manual for the specific model of equipment. See [Additional Resources on page 33](#).

You and/or your installation contractors must read and understand all instructions before attempting installation, operation, or maintenance of this equipment. Observation of the National Electrical Code (NEC), Canadian Electrical Codes (CEC), OSHA, and all other local procedures and standards for installation and operation is required. You are responsible for conforming to all applicable code requirements with respect to proper equipment grounding. Use adequate fall protection when working above ground level. Always wear the appropriate Personal Protective Equipment (PPE) when working in and around electrical equipment.

This document does not cover all possible contingencies and variations available for these systems. Individual local installations require specific review and may require the inclusion of custom components that are provided by Rockwell Automation.

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**IMPORTANT** For information on installation site preparation, see General Handling Procedures for Medium Voltage Products, publication [MV-QS050](#).

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**ATTENTION:** Use suitable personal protective equipment (PPE) per local codes or regulations. Failure to do so may result in severe burns, injury, or death.

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**ATTENTION:** Lock out incoming power to avoid shock hazards. Verify with a hot stick or appropriate voltage measuring device that all circuits are voltage free. Failure to do so may result in severe burns, injury, or death.

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Disconnect all sources of power, both low voltage and medium voltage, before working on the equipment per all Occupational Safety and Health Act (OSHA) and lockout procedures. Verify that the voltage has been removed from all sources. This should also include performance of visual inspections while the door is open, making any adjustments inside or outside the enclosure, performing required and suggested maintenance, or installing any replacement parts.

## ArcShield Motor Controllers

All Rockwell Automation arc-resistant, medium voltage products (ArcShield™) are tested to the applicable standards used for arc-resistance verification. IEEE std. C37.20.7: "IEEE Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults" is the most commonly used standard for products in North America. For other parts of the world, IEC 62271 Part 200: "AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV" can be used. Both standards provide a similar definition of arc protection.

An integrated arc gas plenum or chimney exhaust system is required to help ensure that the by-products of an arc fault, in an arc-resistant motor control center or arc-resistant adjustable speed drive system, are channeled away from the equipment and personnel.

The arc gas ducting method is critical in maintaining the arc-resistant capabilities and in the protection of personnel from the arc blast itself and the other associated by-products from an arc fault event.

If the arc gases are released directly into the area around the arc-resistant controls, the need for personnel to evacuate the electrical control room space is of utmost importance. If the gases are exhausted into a controlled and contained or external location, this need is eliminated. However, personnel should evacuate the local electrical control room immediately and not return until told to do so by an authority. The exhaust or exit point(s) for either the plenum discharge point or the chimney exhausts should be classified as a hazardous location.

The available arc-resistant ratings are 50 kA and 40 kA. There are two ratings available for different equipment configurations of ArcShield arc-resistant medium voltage motor controllers. The arc-resistant rating should not be confused with the main bus short circuit rating. These are different ratings.

The size/rating of the power bus can be 1200, 2000, or 3000 A (the same as the non-arc resistant controls), with a short circuit rating of 50kA as defined by the UL347 standard for medium voltage controllers.

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<b>IMPORTANT</b>	The arc-resistant rating of the structure is only valid when all covers, hardware, and medium voltage doors are properly secured in place over the entire extent or length of any arc-resistant equipment lineup. When working inside any open medium voltage compartment, even though the compartment is electrically isolated, personnel will not be protected against an arc fault and must wear appropriate arc flash PPE.
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## ArcShield Arc-resistant Ratings

There are specific minimum configuration sizes to achieve a given arc-resistant rating.

For a 50 kA arc-resistant rating, a minimum combined structure width of 1829 mm (for example, two 36 in. structures) wide structures are required to achieve this rating. The main power bus must be bare tin or silver plated copper (for the insulated bus option, the maximum arc resistant rating is presently 40 kA).

For 40 kA arc-resistant ratings, there is a minimum cabinet width of 660 mm (one 26 in.) wide cabinet. The main power bus can be insulated tin or silver plated copper.

All arc-resistant enclosures are 915 mm (36 in.) deep. However, when the arc gas plenums are used, an additional 10 in. (22 mm) of forward overhead depth extends away the front of the structure, starting at an elevation of approximately 2590 mm (102 in.). The alternative arc gas system are individual chimney systems that are attached to the top of each controller structure.

Each has specific installation and physical site installation considerations. See [Installation Guidelines for Plenum Extensions on page 11](#) or [Installation Guidelines for Bulletin 1500/1900 Chimney Sections on page 13](#).

## ArcShield Medium Voltage Structures

Only structures that have been tested, or combinations of tested structures that have had full design reviews completed, can be used in a certified arc-resistant application. Shown below are the present structures that are defined as arc resistant. Various units can also be applied as complementary control elements within an ArcShield PowerFlex® 7000 drive system. Combinations of these structures can be applied for custom controller applications. An engineering review is required to validate custom arc-resistant configurations.

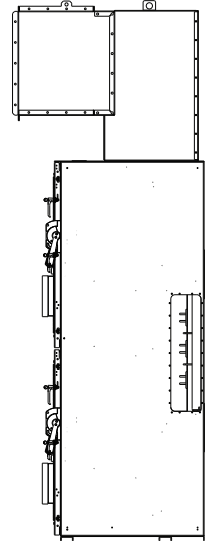
### Arc-resistant Structures



## Installation Safety

Only qualified electrical personnel with training and experience on medium or high-voltage equipment should be permitted to work on arc-resistant control products, their proper installation requirements and proper access techniques for maintenance. Always review the products installation and operating instructions. A thorough understanding of these instructions and guidelines is required before attempting any of installation, operation, or maintenance on the equipment. A task/risk review meeting should be held in preparation for the installation work.

During an arc fault, the plenum is subjected to a brief high-pressure shock wave. The discharge, extension, and elbow assemblies may experience dynamic loading. It is important to account for dynamic loading when selecting supporting means and materials.



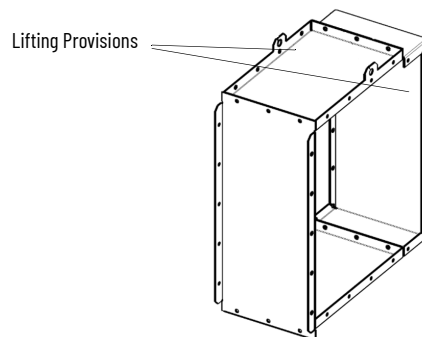
## Lifting ArcShield Structures

Arc-resistant products and their associated components are made of heavy gauge materials. Always use lifting devices to place structures and arc plenum or chimney components in place. See [ArcShield Structure Specifications on page 6](#) and [Plenum Components Specifications on page 7](#) for typical weight and equipment dimensions. Adequate space above the ArcShield enclosures is required to lift the plenum system parts to their position on to the top of their associated structures or as they are combined to complete the systems exhaust.

A recommended minimum of 1270 mm (50 in.) above the top of the ArcShield MV MCC structures, which has a base height of 2317 mm (91 in.), is required to facilitate the lifting and attachment of the top mounted plenums. The ceiling height directly above the location of the ArcShield equipment must be approximately 3581 mm (140 in.) from floor level. If possible, this area is to remain free of any obstruction including conduit, lighting, smoke alarms, cable trays, and HVAC ductwork.

The preferred method of lifting and maneuvering the ArcShield controllers sections and their associated plenum components into their final position is using an overhead lifting means (crane or other). Alternative methods are outlined in each installation section of the user manual of the controller. If an overhead lifting device is not available, extra precautions and safeguards must be used to help ensure that the equipment is not mechanically stressed in any one direction during maneuvering. Shipping section can also be moved into place by using suitable pipe rollers. Plenum system components need an overhead lifting device.

## Hanging and Lifting Locations of the Overhead Plenum



Lifting individual plenum and discharge pieces that must be bolted to the top of each shipping section may require an assisted lifting means (see [Dimensions, Weights, and Door Swing Requirements on page 6](#)). See publication [MV-QS050](#) for additional lifting and handling instructions and details.



**WARNING:** All lifting angles and/or lifting clips, which are used for each arc-resistant structure, must be removed to install either arc gas plenum system. Do not discard the mounting bolts and hardware, which is used for the lifting angles or clips on the main arc-resistant structures. Return all bolts to the holes from where they were removed. Failure to return these bolts to their original holes nullify the arc-resistant capabilities of the controller.

## Plenum Discharge, Extension, and Elbow Support (Vertical and Lateral)

Plenum system pieces are made of heavy steel so that the pressure wave associated with the arc gases do not cause deformation and help prevent the leaking of these gases. Whenever the plenum system is extended beyond the basic controller structures, these plenum components must be rigidly retained for both lateral and downward forces. The standard plenum discharge, extension, and elbow component include hanging eyelets on the top side of each component (see [Hanging and Lifting Locations of the Overhead Plenum on page 5](#)). These hanging locations facilitate the hanging of these plenum components from the building's roof or other structural building component cable of the lateral and weight bearing considerations. Uni-strut style systems are commonly used to provide this overhead support.

When the corner plenum components are added to the plenum system, they must be braced both from overhead but some lateral support is required. There are high dynamic forces from the pressure wave and arc fault by-products as they travel through the plenum away from the arc location. Most of this force will be in the direction opposite to the plenum extension exit points. The amount of bracing depends on how the plenum is supported at its exit and the distance from the end of the cabinets to the exit vent. The Installer of the plenum system is responsible for confirming that the plenum extension has sufficient support to resist the effect of vibrations and other seismic effects in zones where they may be prevalent.

## ArcShield Structure Specifications

### Dimensions, Weights, and Door Swing Requirements

ArcShield Arc-resistant Controller/ Enclosure Description	Dimensions (W x H x D) (mm [in.])	Weight (kg [lb])	Power Cell Door Swing (mm [in.])
1-High, 400 A FVNR -1512A (bottom exit)	661 x 3264 x 915 <sup>(1)(2)</sup> (26 x 128.5 x 36)	600(1320)	597 (23.5)
1-High, 400 A FVNR -1512A (top exit)	915 x 3264 x 915 <sup>(1)(2)</sup> (36 x 128.5 x 36)	650(1433)	857 (33.75)
1-High, 600 A FVNR -1512A-C	915 x 3264 x 915 <sup>(1)(2)</sup> (36 x 128.5 x 36)	773(1700)	857 (33.75)
1-High, 800 A FVNR -1512A-D	1575 x 3264 x 915 <sup>(1)(2)</sup> (62 x 128.5 x 36)	1400(3080)	857 (33.75)
2-High, 400 A FVNR -1512B	915 x 3264 x 915 <sup>(1)(2)</sup> (36 x 128.5 x 36)	1050(2310)	857 (33.75)
1-High 200 & 400 A RVSS -1562F-A/B <sup>(3)</sup>	915 x 3264 x 915 <sup>(1)(2)</sup> (36 x 128.5 x 36)	886(1950)	857 (33.75)
1-High 600 A RVSS -1562F-C <sup>(3)</sup>	2743 x 3264 x 915 <sup>(1)(2)</sup> (108 x 128.5 x 36)	2322(5120)	857 (33.75)
Incoming Line Unit -1591	457 x 3264 x 915 <sup>(1)(2)</sup> (18 x 128.5 x 36)	464(1020)	394 (15.5)
	915 x 3264 x 915 <sup>(1)(2)</sup> (36 x 128.5 x 36)	663(1459)	857 (33.75)
1-High, 400 A, VFD Input - 1512AD	661 x 3264 x 915 <sup>(1)(2)</sup> (26 x 128.5 x 36)	627 (1382)	597 (23.5)
1-High, 600 A VFD Input - 1512AD	915 x 3264 x 915 <sup>(1)(2)</sup> (36 x 128.5 x 36)	773(1704)	857 (33.75)
PowerFlex 7000 Drive System with ArcShield Technology <sup>(4)</sup>	See order documentation. 3300 x 3265 x 1000...4100 x 3265 x 1000 <sup>(5)</sup> (130 x 128.5 x 39.4...161.5 x 128.5 x 39.4) <sup>(5)</sup>	See order documentation. 3975...7500 kg (8763...16537 lb)	Varies by cabinet

(1) Height dimension includes top mounted plenum (which adds 953 mm [37.5 in.]). Plenum is removed for shipping and must be installed by customer once the equipment is in place.

(2) Depth dimensions exclude plenum that extends 254 mm (10 in.) to the front of the structure. This extension begins at approximately 2603 mm [102.5 in.] from floor level.

(3) Available only up to 5 kV. See publication [1560E-SR022](#) for additional details. Contact factory for 7.2 kV applications.

(4) Requires the additional of a minimum of 1-1512AD arc-resistant controller.

(5) Height dimension includes top-mounted plenum (953 mm [37.5 in.]) which is removed for shipping, and must be installed by customer once the equipment is in place.

## Plenum Components Specifications

### Dimensions, Weights, and Door Swing Requirements

Description	Dimensions (W x H x D) (mm [in.])	Weight (kg [lb])	Lateral Support Needed?	Notes
Plenum (18 in. wide enclosures)	See structure info.	45 (99)	No	Height included with ArcShield controller Attached to top of ArcShield enclosure
Plenum (26 in. wide enclosures)		65 (144)		
Plenum (36 in. wide enclosure)		88 (194)		
Plenum Discharge and Extensions	Weight indicated by length ⊗ x 673 x 673 (⊗ x 26.5 x 26.5)	Weight by length 28 kg/m (19 lb./ft)	Yes	Width varies by use
Two Piece Plenum Elbow (90°)	848 x 848 x 762 (33.4 X 33.4 X 30.0)	65 (144)		Two pieces (45°) ea.
Plenum Environmental Sealed Discharge Point (Explovent)	193 x 876 x 876 (7.6 x 29.7 x 34.5)	16 (35)		Varies based on plenum configuration and wall dimensions-
Standard Exterior Exit Hood 18 in. Length	457 x 673 x 673 (18 x 26.5 x 26.5)	11 (24)		Includes internal vermin screen
Standard Exterior Exit Hood 36 in. Length	914 x 673 x 673 (36 x 26.5 x 26.5)	20.5 (45)		Includes internal vermin screen
Plenum Cover Plate-Solid	673 x 673 (26.5 x 26.5)	2.3 (5)	No	—
Plenum Cover Plate-Screen	673 x 673 (26.5 x 26.5)	1.4k (3)		—
Chimney (Self-supporting)	1000 (39.4)	14 (30)		Adds to the standard ArcShield structure height of 2317 mm [91.2 in.]
Peak Pressure	See structure info.	45 (99)		—
Plenum (for 26 in. wide enclosures)		65 (144)		—
Plenum (for 36 in. wide enclosures)		88 (194)		—

## Field Modifications to ArcShield Enclosures and Plenum Components

Any modifications to the equipment, outside of the general installation and assembly instructions that are provided in the referenced controller installation documentation, compromises the compliance to the testing and certification provided in alignment with IEEE C37.20.7 or IEC 62271-200. Before permitting or making any modification, you must contact the factory with any related questions.

Modification to any low voltage compartment doors or the addition of low voltage control components in the low voltage section of the low voltage compartment is permitted as they are not critical to retaining the arc-resistant rating of the structure.



**WARNING:** Any field modifications to any major structural portion of the arc-resistant enclosure including the plenum, chimney or discharge systems, will compromise the equipment's ability to retain an arc flash/blast and thus nullify the enclosure and plenum system arc-resistant properties.

## Description and Applications

The ArcShield line of arc-resistant products use plenums and chimneys as two possible arc exhaust methods. Both the plenum and chimney systems have been tested to help ensure adequate protection is achieved if these systems are installed according to our guidance and specifications. These systems can be installed in most building designs, including power distribution centers or electrical house (E-house) type constructions.



**WARNING:** Before energizing any equipment, confirm that the equipment is secured on a true and level surface, confirm all hardware is in place and torqued per specified values, confirm all medium voltage doors are closed and fully latched closed, confirm no tools, grounding straps or other objects are left inside the enclosure, confirm all devices, covers, cable access covers, medium voltage doors, panels, etc., are completely secured.

ArcShield units typically include a pressure relief vent on the roof of the structure (some incoming units may not have a pressure relief vent if top cable entry is required). Under arc flash conditions, the pressure relief vent opens allowing hazardous flames and gases to exit the enclosure via the plenum or chimney system. This pressure relief/exhaust vent, which is attached with screws on top of the equipment, may not be tampered with, and it can not to be used as a step nor can any weight be applied to it. In preparation for mounting a plenum or chimney, the cabinet lifting means (slips of lifting angles) must be removed. The bolts retaining the lifting means must be replaced in the holes from where they came. Failure to do this will remove the cabinets ability to properly control any arc gases. After the lifting angles or clips are removed, you must remove all but the four corner retaining fasteners holding the relief vent to the top of the medium voltage enclosure (1/4-20 threaded self-tapping). The corner mounting screws are intended to remain in place and should not be removed.

The plenums and chimneys are designed to fit over the fastener heads at the four corners of the pressure relief vent.

### Recommended Torque Values

Fastener Size/Type	Metric	Imperial
1/4 in.-20 thread	7.5 N•m	6 lb•ft
5/16 in.-18 thread	14 N•m	11 lb•ft

## Connecting Arc Plenums to Third-party Products

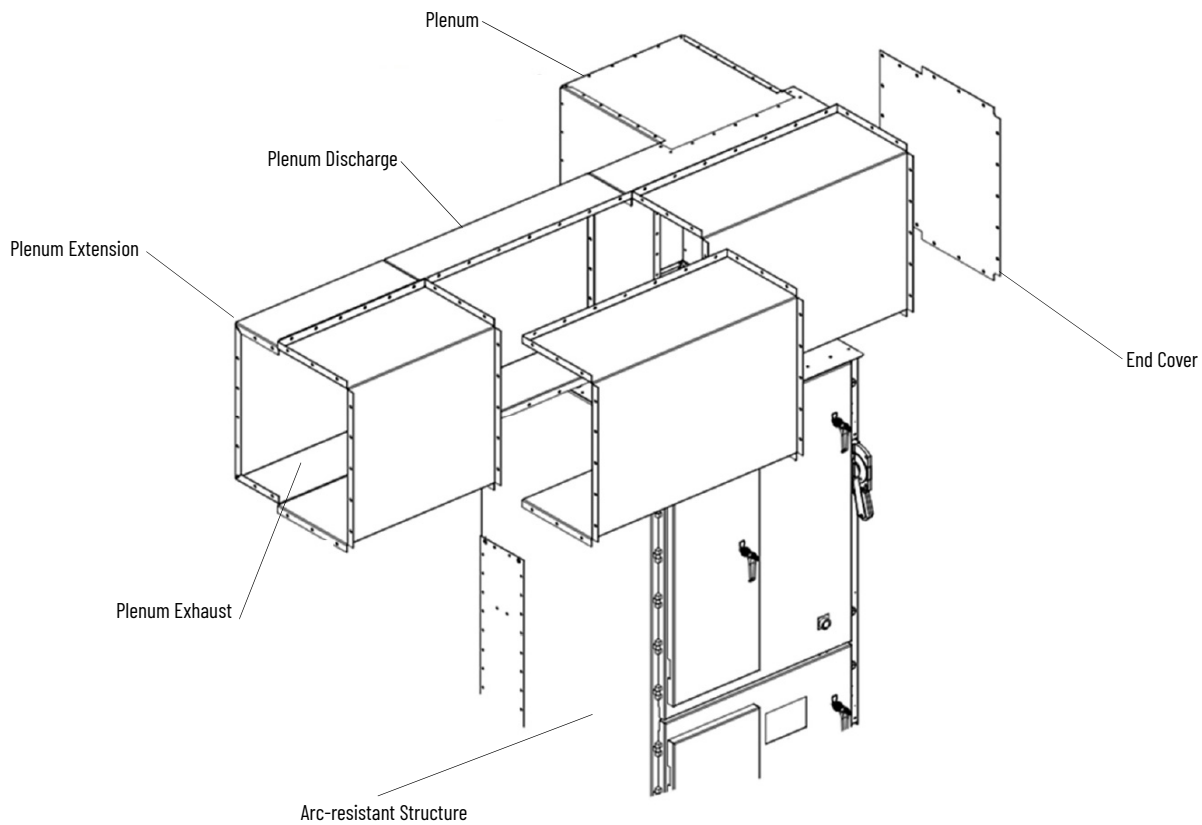
If the plenum system is to be directly interfaced to an alternative vendors plenum or if it is to be interfaced to an alternative ducting system. Follow the guidelines that are outlined in publications [1500-AT002](#) and [1500-AT003](#).



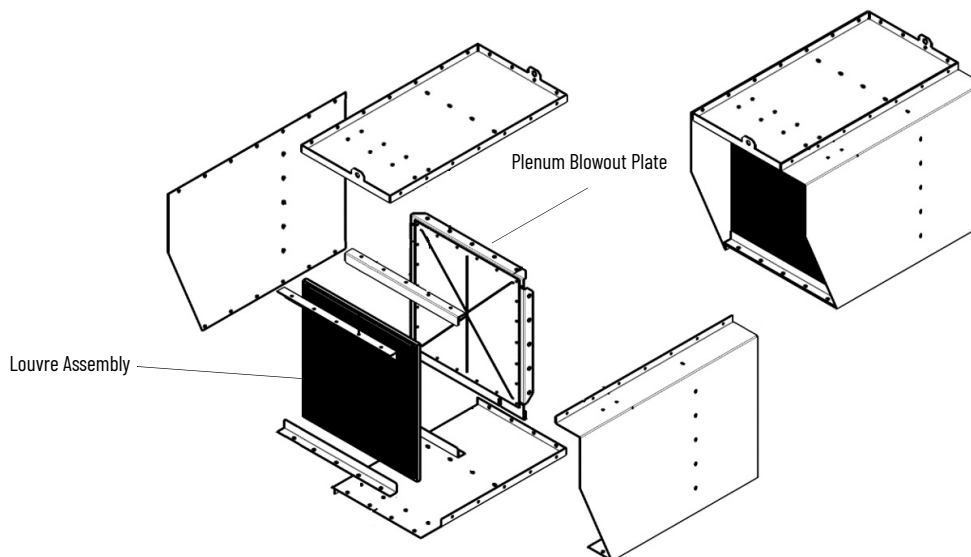
## Arc Plenum Components

For further information on component definition, see the [Glossary on page 27](#).

### Arc Plenum Components



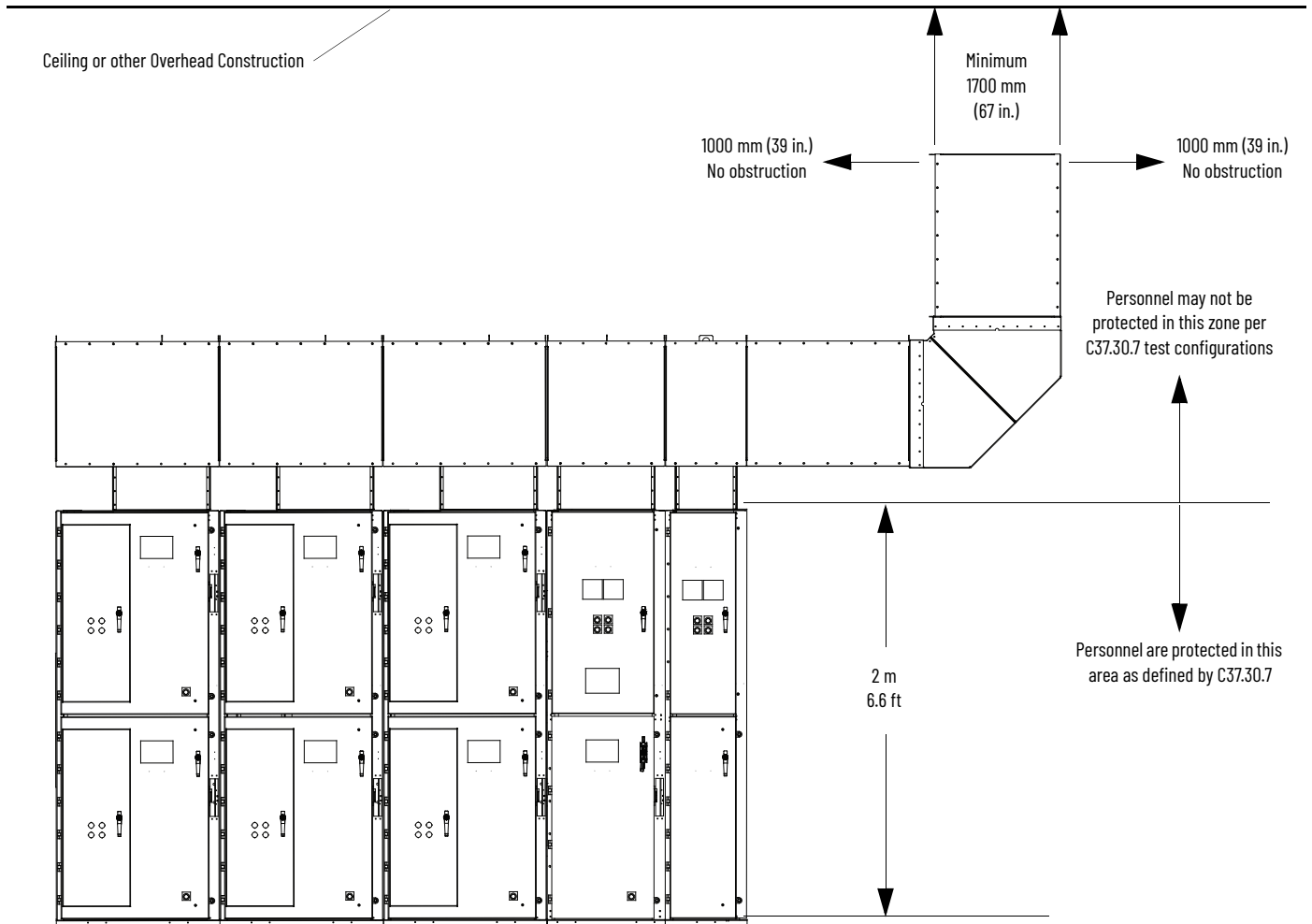
### 36 in. Uninsulated Environmentally Sealed Exit Extension



## Clear Space Restrictions

Plenum components are shipped separately and must be mounted on top of the equipment. Extensions must be added and supported by competent installers. The aluminum pressure relief plate must always remain fixed to the top plate. Rockwell Automation can provide pre-engineered lengths of plenum extensions that can be connected to the equipment by the installer. The plenum can direct the pressure relief to either the right or the left of the equipment.

### Clear Space Requirement on Arc-resistant Starters



## Installation Guidelines for Plenum Extensions



**ATTENTION:** Plan the location where the plenum exits. Confirm that there is no access to personnel while equipment is energized. The area must be free of flammable material and marked as a hazard zone. Equipment in the area of the plenum exit will be damaged or destroyed.

The plenum is provided in a standard length of 914 mm (36 in.). Multiple lengths can be joined to form the required plenum length using 1/4 in.-20 thread forming screws (12 lb•ft [16 N•m]). A flange is available for installing hangers for supporting the weight of the plenum. Silicone is applied generously along the inside of sheet metal joints. The plenum system must be at least 1.6 m (60 in.) in linear length from the closest exhaust port, on top of any arc-resistant structure containing an exhaust port/plate.

Mechanical support of plenum extension:

- The plenum extension has holes for mechanical support.
- Weight per unit length of Rockwell Automation supplied plenum is 28 kg/m (19 lb/ft).
- Installer is responsible for confirming that the plenum extension has sufficient support to resist the effect of vibrations and seismic effects.

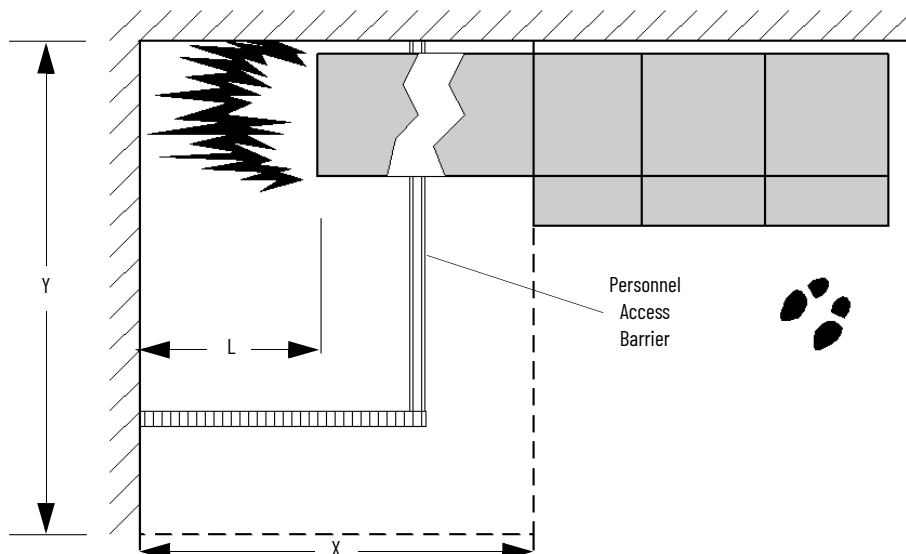
The following options for locating the plenum exit are presented:

- Plenum that is ducted to an area outside the control room where arc gases are permitted to escape, with plenum extensions (see [Plenum Exit Left with Extensions to Internal Area \(Top View\)](#) and [Plenum Exit Left with Extensions to Internal Area \(Front View\)](#)).
- Plenum duct to outside of control room (see [Plenum Exit Left with Extensions to External Area \(Top View\)](#) and [Plenum Exit Left with Extensions to External Area \(Top View\)](#)).

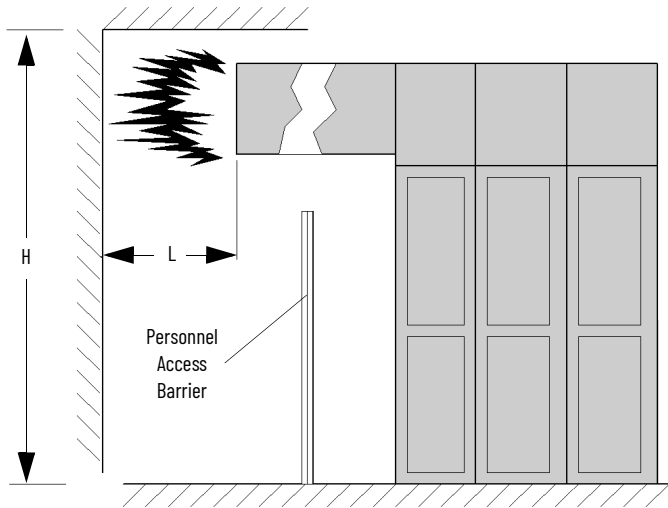
*Minimum Volume of Space Required for Extension to Internal and External Areas*

- Minimum H = 3500 mm (138 in.)
- Minimum L = 1200 mm (47 in.)
- Minimum Volume of space required for safe pressure relief:  $X \times Y \times H = 11 \text{ m}^3 (390 \text{ ft}^3)$

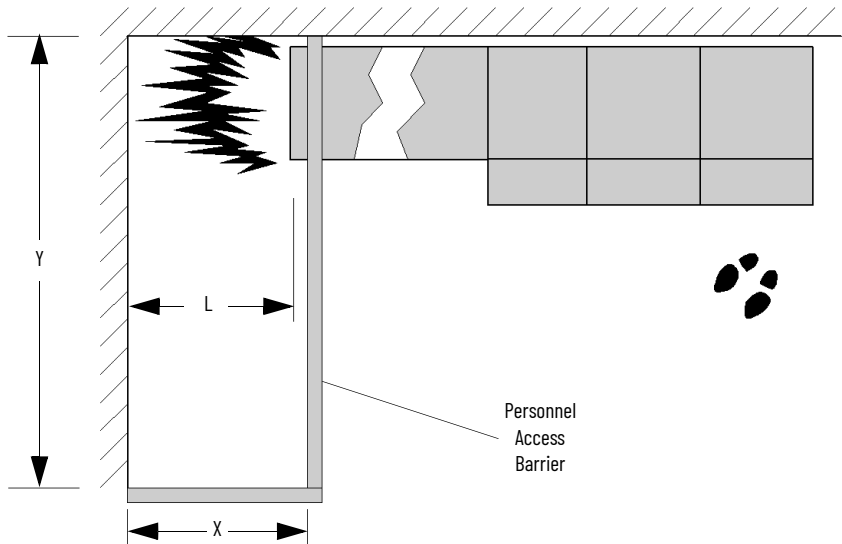
### Plenum Exit Left with Extensions to Internal Area (Top View)



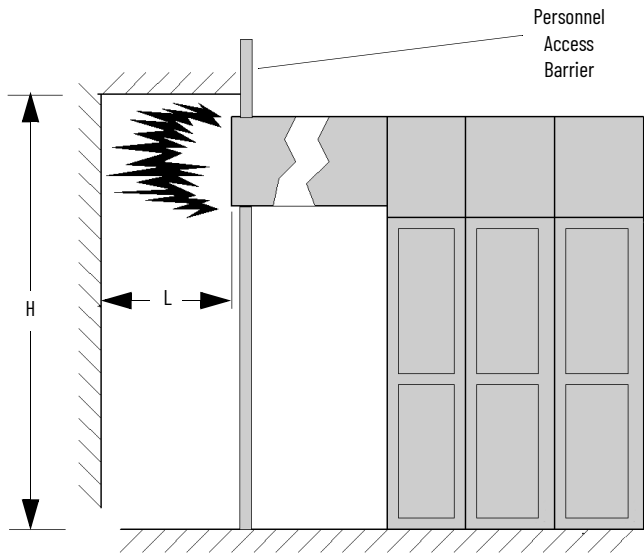
Plenum Exit Left with Extensions to Internal Area (Front View)



Plenum Exit Left with Extensions to External Area (Top View)



Plenum Exit Left with Extensions to External Area (Top View)



## Installation Guidelines for Bulletin 1500/1900 Chimney Sections

The chimney system for arc gas management was developed for those customers who have adequate ceiling height and clear space above their arc-resistant equipment. When equipped with an arc chimney, each individual section includes an individual chimney, (except for those 18 in. cabinets where pressure relief plate is not included). There is not a common arc by-product release point; each individual chimney can be a release point.

There are specific guidelines for the use of the chimney method.

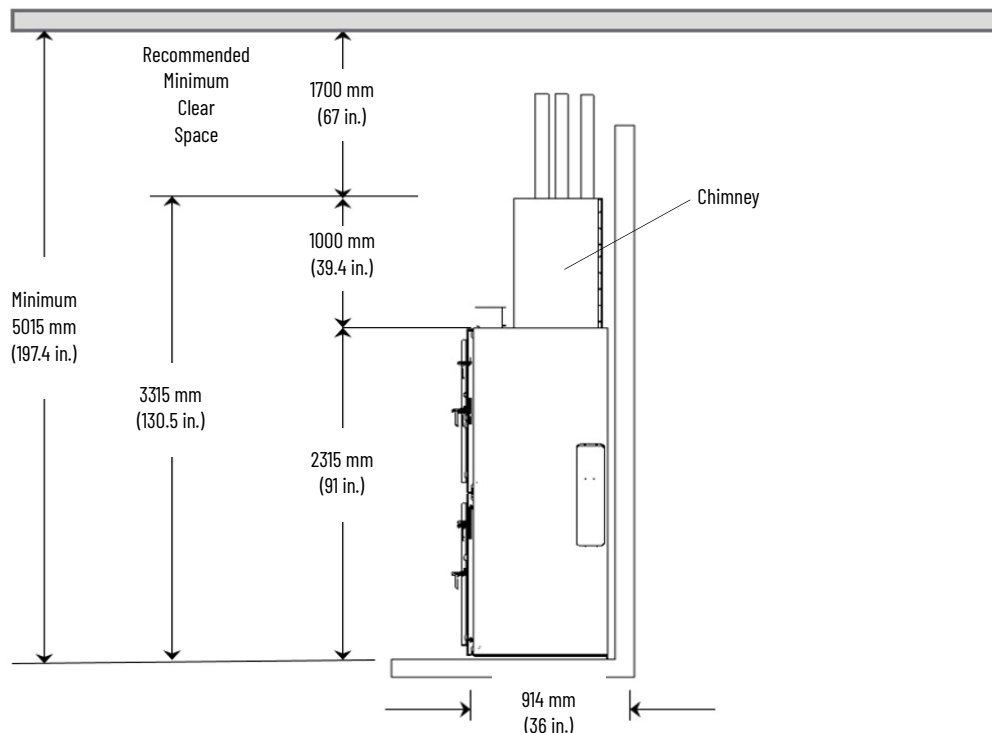
There must be 1.7 m (67 in.) of clear space directly above the chimney. This distance has been defined by the test configuration that is used for verification to the C37.20.7 testing guide.

Clear space is defined as nothing being directly above the chimney's horizontal cross-sectional area. If cables, cable-ways, cable ducts, or other obstructions are in this area, the arc plasma could be redirected back down on an individual standing in the perimeter of the equipment or the intense heat from the arc by-products could ignite any materials directly above the restricted height area. The temperature of the by-products at the point of release can be as high as 7000 °C (12,632 °F).

Any obstruction in this area would nullify the type 2B accessibility level of protection.

Redirection of this chimney exhaust has not been tested, and as such, bends or redirective devices should not be considered for the chimney.

### Arc-resistant Cabinet With Chimney (Side View)



## Plenum and Chimney Arrangement for PowerFlex 7000 Drives

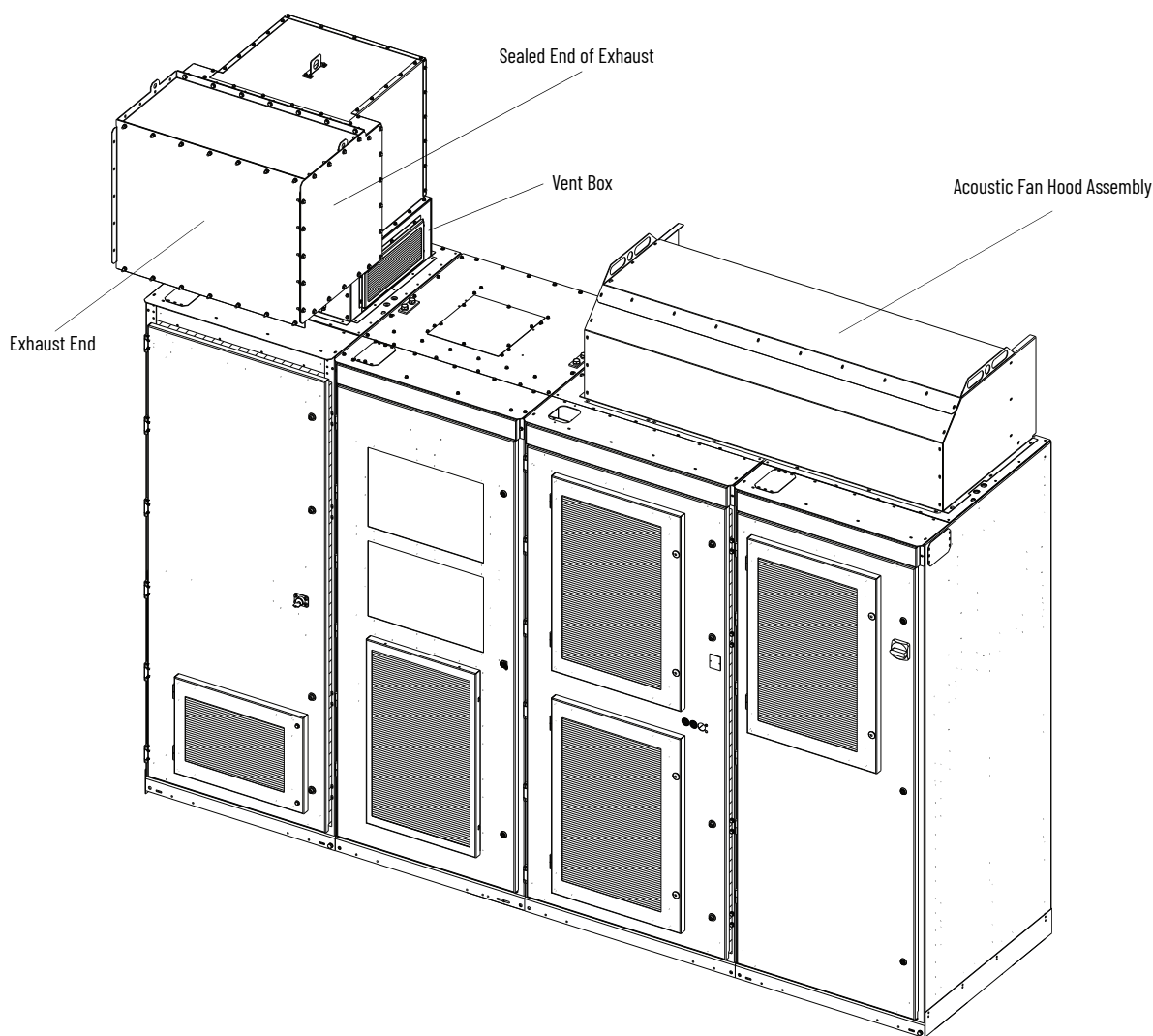
ArcShield units have a robust arc-resistant enclosure design that has been tested per IEEE C37.20.7. The arc-resistant (ArcShield) enclosure is an option that cannot be retrofitted in the field. The arc-resistant drive was tested to withstand the effects of an arc flash at 50 kA for 0.5 seconds with current limiting fuses. ArcShield units provide an enhanced Type 2B Accessibility level.

ArcShield units typically include a pressure relief vent on the roof of the structure (some incoming units are without a pressure relief vent if top cable entry is required). Under arc flash conditions, the pressure relief vent opens to allow hazardous flames and gases to exit the enclosure via plenum or chimney system. The low voltage panel area is sealed to help prevent flames and gases from entering. Regardless, suitable personal protective equipment (PPE) must be used whenever working on live circuits.

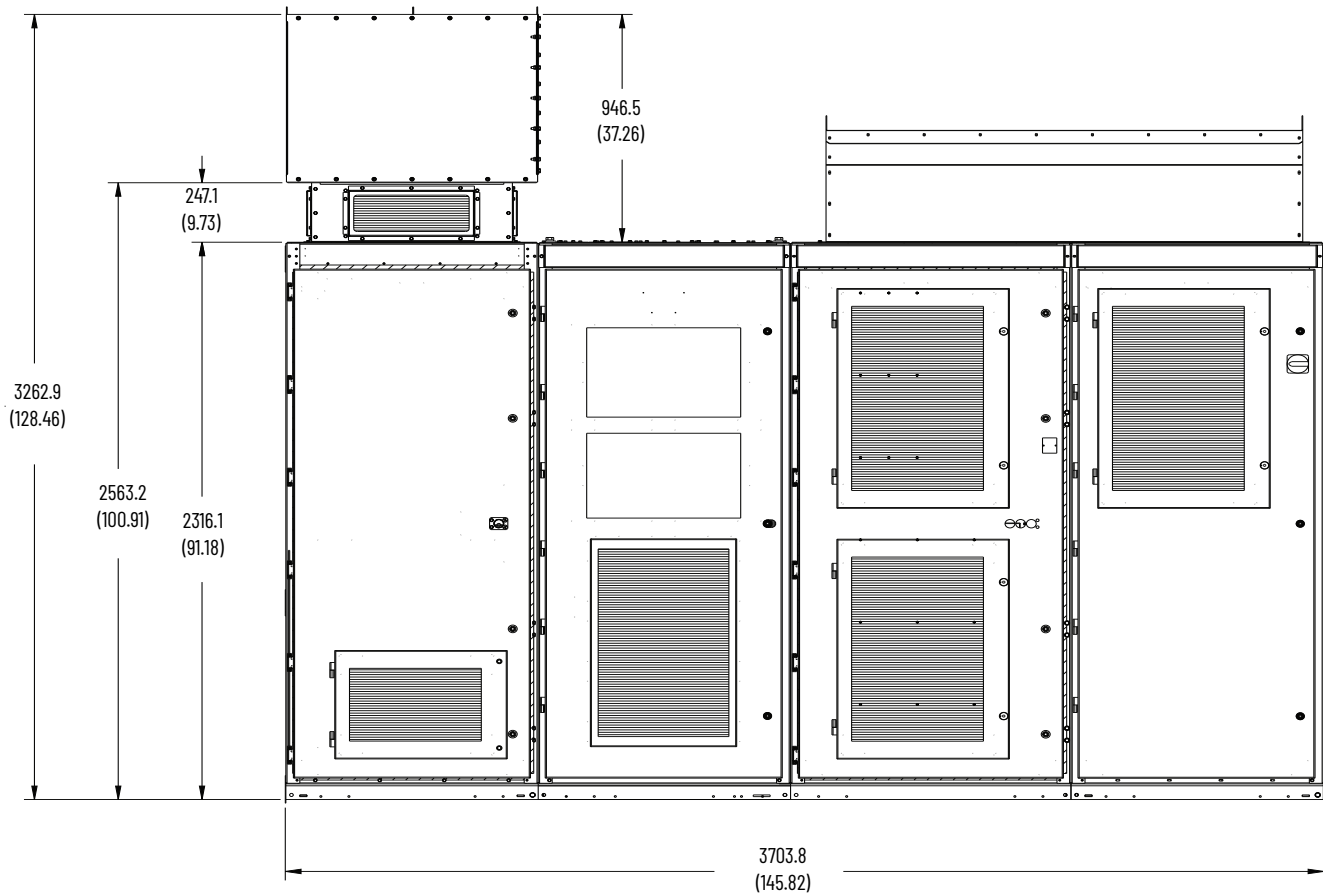
Right-handed plenums are not offered as the standard height of plenum interferes with exit of cooling air from the main exhaust fan. Plenums to the right may also interfere with the passage of top entry power cables of the drive.

Combinations of elbows and extensions may be added at the end of the plenum. Where a plenum passes through an exterior wall, a special assembly is needed that has exterior grade paint, stainless steel hardware and protection from ingress of precipitation and vermin.

### ArcShield Lineup (Left hand Exhaust)



## Arc Shield Lineup Dimensions



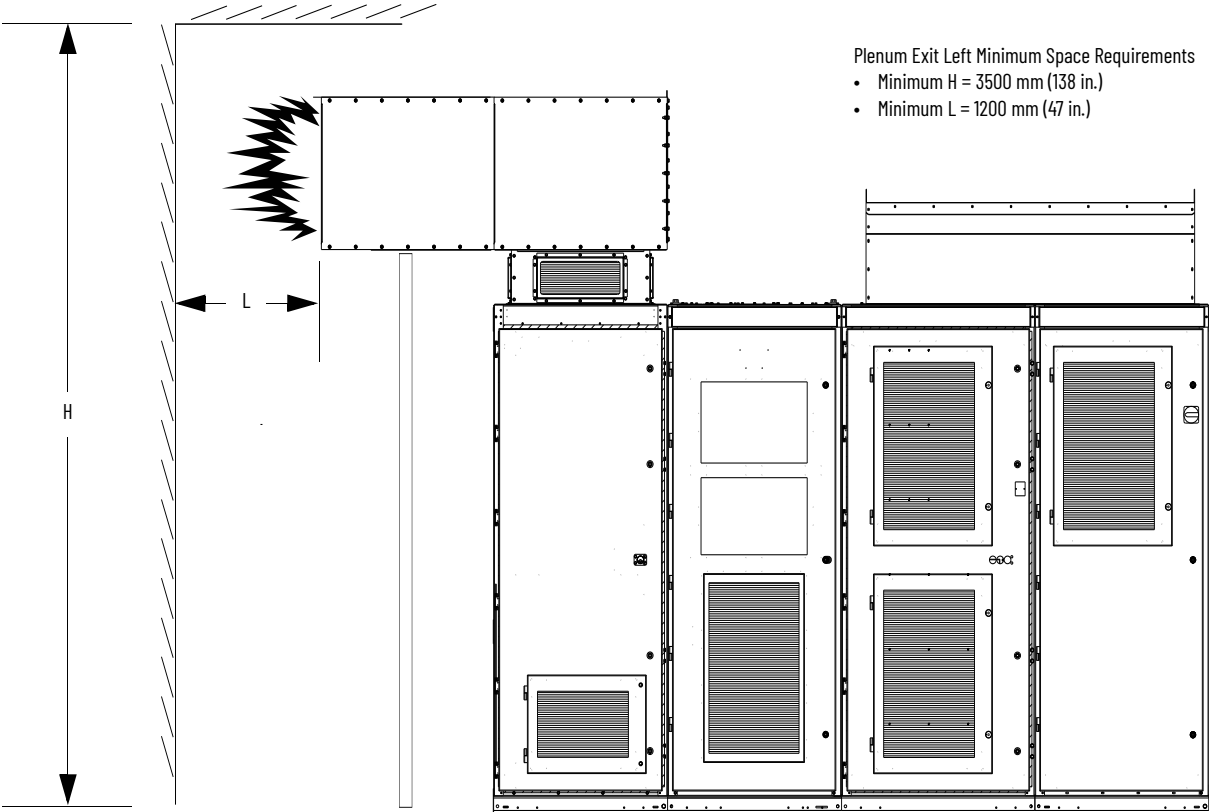
All dimensions are in mm (in.).

The only cabinet of the drive that requires an arc chimney or plenum is the line reactor cabinet. Arc testing has been performed in all cabinets of the drive. Where appropriate, ventilation opens have features to limit the escape of arc products.

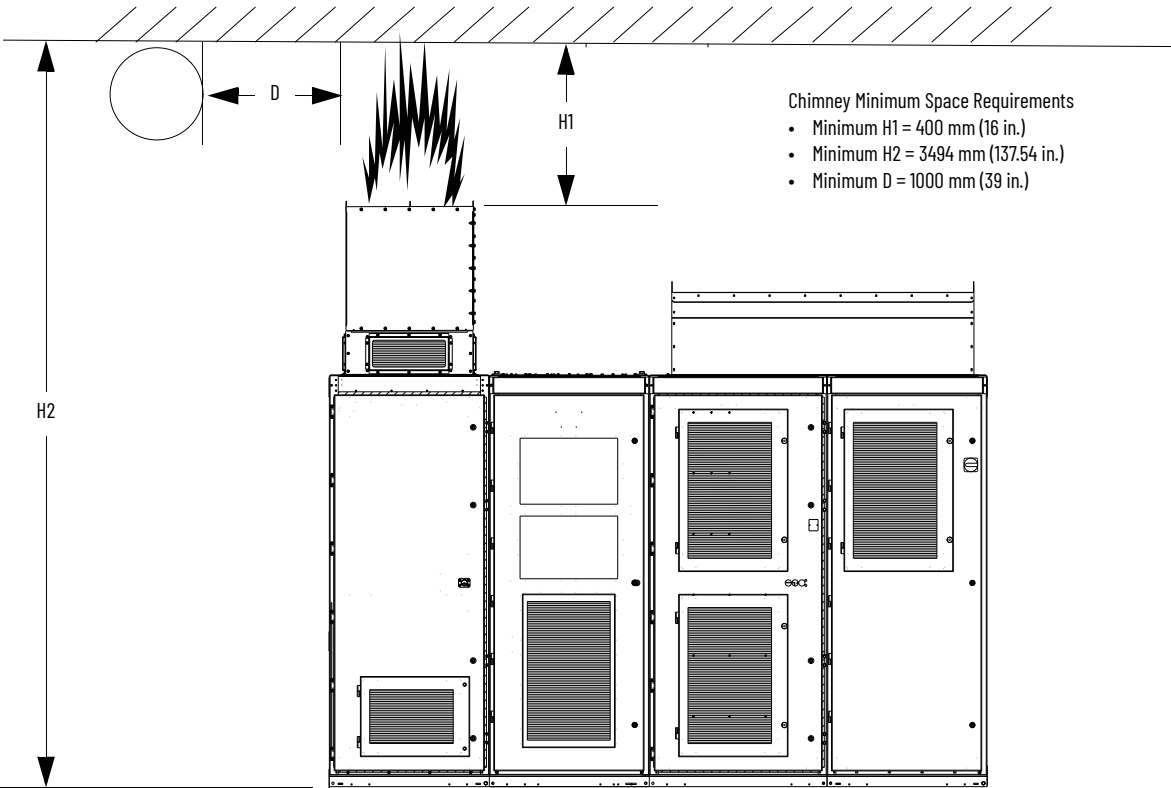
For PowerFlex 7000 standalone drive, the standard options for directing arc products from the line reactor cabinet include:

- Chimney that directs the arc products up, inside the room in which the drive is installed.
- Plenum directing arc products to the left
- Special options for the plenum can be provided such as rearward and frontward plenums

Plenum Exit Left with Extension to Internal Controlled Access Area (Front View)



Chimney Exhaust Space Requirements





## Ceiling and Wall Requirements

Any painted surfaces that face direct contact with the arc products can ignite. Flame suppression is recommended. The exit point can also be outside the building. Make sure that ice, snow, or vermin nest cannot block the exit area. Access barriers are recommended to restrict access by personnel while the equipment is energized. A chain link fence is a suitable barrier material.

## Basic Requirements

The minimum clearance required from the top of the chimney to the ceiling is 1.7 m (5.6 ft) for Bulletin 1500/1900 motor control centers. For the PowerFlex 7000 arc resistant drives, the minimum distance is 0.4 m (16 in.).

For horizontal plenum discharge points, the minimum clearance from the end of the plenum discharge is 1.2 m (3.9 ft).

If the minimum clearance is used, the ceiling or wall material must be non-flammable i.e. concrete, concrete block, metal or flame resistant drywall (Type X, Type C, Fire Board, X Board) or similar fire-resistant materials. These materials must also be braced rigidly to absorb or redirect the high temperature pressure wave in the neighborhood of the 10 psi.

If the ceiling height or horizontal distance to an adjacent fixture (wall or other) is less than the minimum required, each situation must be reviewed individually.

If the height of a ceiling is >3 m (9.8 ft) above the top of the Bulletin 1500/1900 MCC chimney, (4 m [13.1 ft] above the top of the cabinet) the rigidity and flame resistance of the materials that are used can significantly be reduced as the temperature and pressure wave will be much lower at that height. For horizontal obstructions, each situation is different and must be reviewed in detail as this will be a hazardous location.

A major issue to consider is dust. Many secondary fires are created due to the ignition of dust and residual materials in areas around or above equipment. The blast wave from the chimney could dislodge materials that have settled on beams, girders or adjacent cabinets. Once dislodged and combined with the hot arc gas, a secondary fire ball is created.

The walls of the plenum exit area must be capable of withstanding the pressure generated.

Equipment that consists of more than four vertical sections that are bolted together may require additional plenum exits. Rockwell Automation provides guidance on requirements for additional plenum exits when required.

## Moisture and Condensation Factors

Extreme temperature differences in the immediate environment may cause condensation on the inside or outside of the ductwork. For these cases, it is recommended that the duct assemblies be wrapped with insulating material to reduce condensation effects.

- Plenum Exit Points
- Internal
- External
- Plenum weather resistant.

All exterior sections of plenum (those with ANSI 49 outdoor finish) are weather resistant. The exhaust assembly includes a weep hole to drain any ingress of water from the atmosphere. The louvered end of the exhaust is closed under normal conditions. The louvered end opens due to the differential pressure caused by an arc event. A protective screen is also installed on the outside of the exhaust assembly to prevent incursion of objects or rodents into the plenum. In cold-weather installations, positive pressure from the cooling of the switchgear through the plenum, along with space heaters that are located in the exhaust assembly, block the ingress of cold air from outside, and the formation of ice on the exhaust assembly that could affect its functionality.

What clearance is required at the plenum exhaust?

All personnel, equipment, and other obstructions must remain clear of an 2.4 m (8 ft) diameter area extending 4.5 m (15 ft) from the plenum exhaust point. The area below this exhaust cone must remain restricted to personnel access.

Can the plenum be installed in a Class I Division 2 or Class II Division 2 environment?

A Class I Division 2 environment is one where flammable gases and/or vapors are possible, but not likely to exist under normal conditions. A Class II Division 2 environment is one in which combustible dusts are possible, but are not likely to exist under normal conditions. For installations in a Class I Division 2 or Class II Division 2 environments, a full engineering review is required.

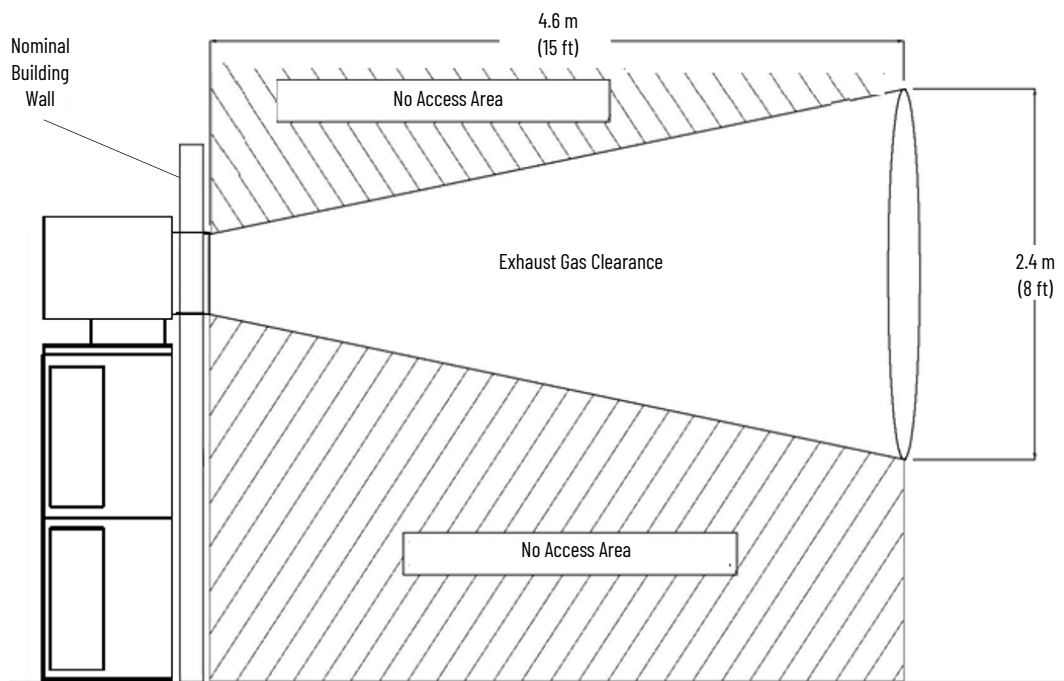
## Exterior Plenum Termination Considerations

Equipment designed to mitigate internal arcing faults does so by providing a mechanical barrier between the operator and the fault and by exhausting the arc fault by-products from the equipment to a location that is controlled and safe. This exhaust is typically from the top. To successfully pass the requirements of the testing guides, the mechanical integrity of the equipment is a must and generally remains unaffected by the site installation.

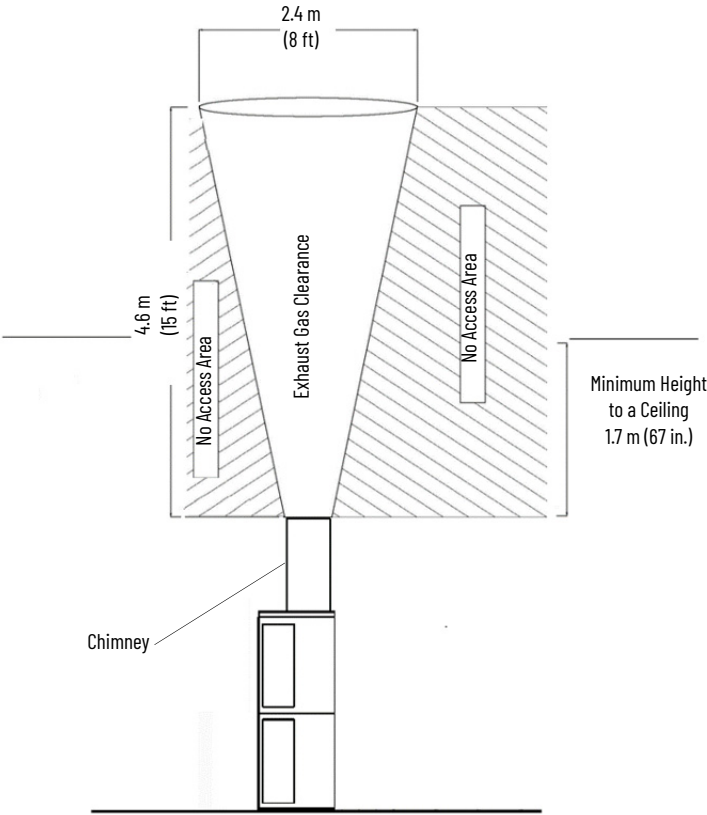
The exhaust function is greatly influenced by installation. If arc gases exhaust from the top, there must be clear space above the arc-resistant equipment. This means a clear space that is devoid of cables, conduits, cable trays, piping, or other obstructions. Hot arc plasma released from the top of the structure needs adequate space to exhaust and cool before reaching a location where contact with an operator or any other flammable item could occur.

The area where personnel should be restricted depends on the plenum exit method that is employed and its location. The figures below outline several common configurations of exit points. These values are assumed to be worst case and may be reduced after a full engineering review of the system details and site configurations.

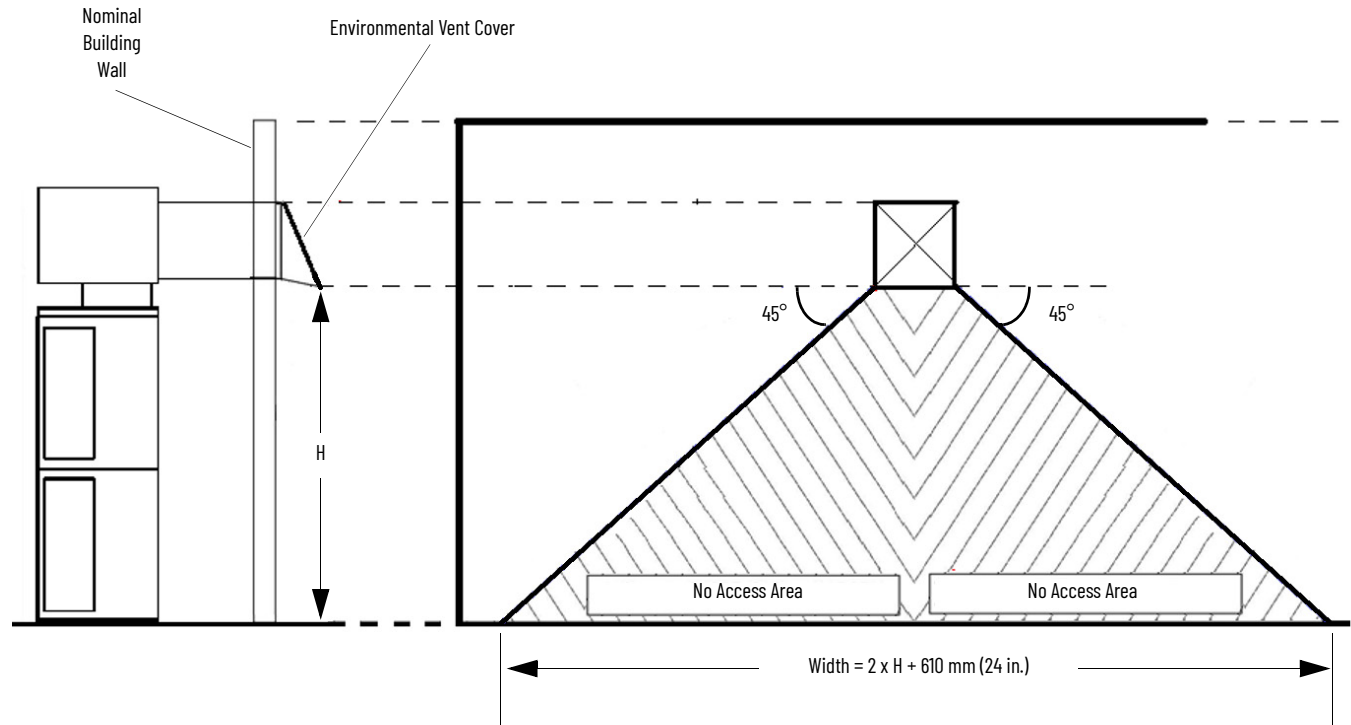
### Exterior Exit, No Directional Hood or Environmental Seal



### Chimney Exit, Internal Use



### Exterior exit, With Directional Hood or Environmental Seal



Maximum height (H) to consider is 4.6 m (15 ft). Heights greater than 4.6 m (15 ft) do not need to be considered.

## Field Modification Services

Rockwell Automation is highly committed to provide excellent customer services to their clients. A dedicated team of field modification services can help you with customized solutions for plenum installation. This is important if you haven't decided on your equipment placement within your facility at the time of order. This situation leads to have critical changes on field for plenum installation.

For such cases, you have an option for to order plenums separately after deciding on your equipment installation requirement .

## Top Cable Space

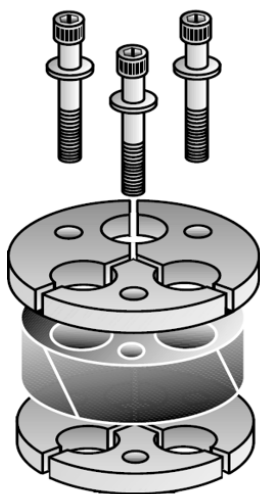
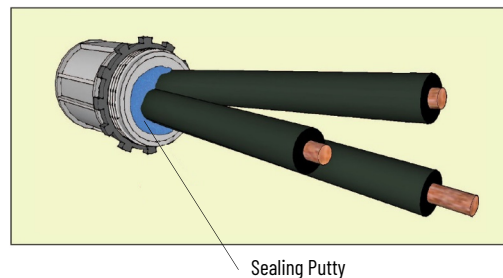
If the equipment is designed to exhaust from the top, then power cable entry space may be limited. It is preferred that cable entry be made from the bottom. However, this may not be always possible. Some equipment configurations must be constructed with extra deep cable sections to allow both cable and exhaust openings. Some configurations may require additional width.

Additionally, the cable trays must not compromise the area above the equipment in such a way that exhausting gases could be reflected or redirected into the qualified aisle ways as defined by the Accessibility Type Rating.

Further, when routing the cable trays outside the perimeter of the equipment, lighting becomes an issue. Care must be taken to adequately illuminate the area so these trays do not create "dark spots" on the equipment that could lead to misreading meters or relay settings.

Where control and power cable entry is made into compartments that are exposed to the arc by-products, these points must be sealed to confirm that the pressure wave does not propagate into unintentional locations through rigid or flexible conduits. The pressure impact is a function of the conduit fill rate, length, and number of bends. Knowledgeable engineering judgment should be used regarding this.

There are different sealing systems available to help the prevention of arc gas propagation and pressure waves through conduits. One of the simplest systems is the use of 'sealing putty' to fill in the gaps around the cables and the conduit. The sealing putty should be pushed tightly around the cables and into gaps at the end of the conduit. The putty should be placed at each end of the conduit to insure full protection. The putty is not adversely affected by the high temperature since the putty is exposed to the hot gases for a very short period and is primarily used only to block the pressure wave.



There are also intumescent/elastomeric sealing systems that expand under high temperatures to provide a tight seal around cables or an opening. These systems typically do not perform well under the rapid temperature rise that is associated with an arc blast. These types of sealants are not recommended for this type of application.

Alternatively there are conduit/cable sealing systems available that provide an air-tight seal. These systems use compression style sealing rings to seal tightly around each individual power conductor.

CFC-free polyurethane expanding foams, designed for use with cables and conduits, can also be used to seal the end of the conduits. These typically come as a two part system. The two parts are mixed and, after a specific time, can expand up to approximately eight times in volume.

The installation considerations for power cables also apply to a bus duct entry system. An appropriate system is required to limit egress of arc gases into a bus duct system.

## Room Layouts

Several decisions must be made concerning the room before the equipment can be specified. These considerations need to be addressed for any installation of power equipment, not just arc-resistant equipment, as these conditions affect the safety of the operator in all cases. It is critical to address these concerns for arc-resistant equipment, so that the expected increase in operator safety is not compromised by the conditions of the installation.

Review the room/installation site for the following factors:

- Will the fault gases be vented into the room or out of the building?
- If the gas is to be vented into the room:
  - Can the room physically withstand the expected overpressure?
  - What collateral damage can be expected?
  - Is adequate protection provided to the operator for potential exposure to gases and smoke?
  - Is there a designated place to vent the fault gases within the room?
- If the fault gases are vented external to the room:
  - Is the vent area protected from personnel?
  - Is the atmosphere in the vicinity of the exhaust point volatile?
  - Is there equipment nearby that may be compromised?
  - Are there any items in the vicinity of the exhaust point that are flammable?

Once these questions are answered, the basic effects to the site are identified and the general arrangement of the equipment may be established.

The next step is to determine where the equipment will be placed in the room.

## Installation Considerations

Installation of arc-resistant control equipment within an indoor room or outdoor enclosure requires special review of the room geometry in relationship to the equipment's placement. This is true when the fault gases are vented into the room through a plenum system and exhaust duct. The room or building that houses arc-resistant equipment to which the gases will be exhausted into must be designed to withstand overpressures of up to 15...20 pounds per square inch (PSI), on a transient basis.

The plenum size, weight, and exit point must be considered in the room layout. The plenum size is critical to proper pressure relief of the equipment. Restrictions in the venting area, numerous turns in the exhaust duct, and extreme lengths of exhaust duct can all contribute to reducing the effectiveness of the pressure relief. The exhaust duct arrangements can also create structural issues for the building due to its weight.

The plenum discharge location must be carefully considered since this point must be identified with an arc flash boundary and marked accordingly. Additionally, the plenum and duct concentrate the fault by-products into a specific opening and the resultant outflow of gases can produce significant risk of injury from the thermo-acoustic wave. Room geometry can increase the effect as the wave reflects and crosses itself, often multiplying the forces. When the plenum discharge is to the outside, suitable access restrictions to the exit point area may be necessary.

If the location does not support an exterior exhaust of the arc gases, an interior containment system may be necessary. The containment room or building must be designed to withstand the overpressures associated with the rapid release of the arc gases.

In the case of installations where no plenum is used, special care must be made regarding the ceiling materials that are used and proximity of other flammable items at or near the exhaust points. This should be reviewed even if the manufacturer's recommended space is provided. Special warning signs need to be affixed to the building warning of the need to keep the area above the control equipment clear of all items.

Finally, the determination of Accessibility Type is made, based on the accessibility of surfaces of the equipment. Where all surfaces are potentially accessible, Type 2 equipment should be specified. If Type 2 equipment is not available at the required fault ratings, then the unprotected areas surrounding the equipment must be quarantined where possible and the areas clearly marked for flash hazard.

## Commissioning Checks Before Energization

Installation practices for this type of equipment are important. Incomplete equipment installation practices could result in mitigating the overall protection capabilities of the arc-resistant equipment installation.

Special care must be taken to confirm that the following conditions are met to help ensure integrity or compliance:

- The equipment must be installed per the supplier's installation instructions and recommendations
- All internal and external cover/access plates must be completely installed and sealed per the manufacturer's instructions
- All mounting hardware for these plates must be reinstalled and specified torque properly applied to the retaining hardware
- All removable cover plates may have a sealing strip or other sealant material that is attached to them (when present) - it must not be damaged
- Sealing of seams and gaps during installation, such as plenums joints or between adjacent cabinets, requires special attention. The sealant materials that are used should be only those supplied or recommended by the arc-resistant controls manufacturer
- Verify all plenum and exhaust ducts are tightened and sealed appropriately
- Verify all conduits entering the arc-resistant cabinets are sealed appropriately
- Confirm the appropriate warning labels been affixed per NFPA 70E [7]

### *Bus/Cabinet Connections*

You must install all 0the bolts retaining two adjacent cabinets together. The seal around the bus opening must be adequately held together. There are 26 bolts that should go around this opening along with another 6 bolts holding the front and top of the cabinets.

### *Connection to someone Third-party Switchgear*

When connecting to an adjacent piece of equipment, it is important for the customer/user to help ensure that ALL of the holes (26) surrounding the main power bus opening are used to physically connect to the adjacent equipment. Bolts and nuts should be used to retain the two adjacent cabinets together. The seal around the bus opening must be adequately held together. Place a 1/8 in. bead of silicone around the opening on one of the cabinets. There are 26 bolts that should go around this opening along with another 6 bolts holding the front and top of the cabinets.

### *Low Voltage Control and communications wiring considerations*

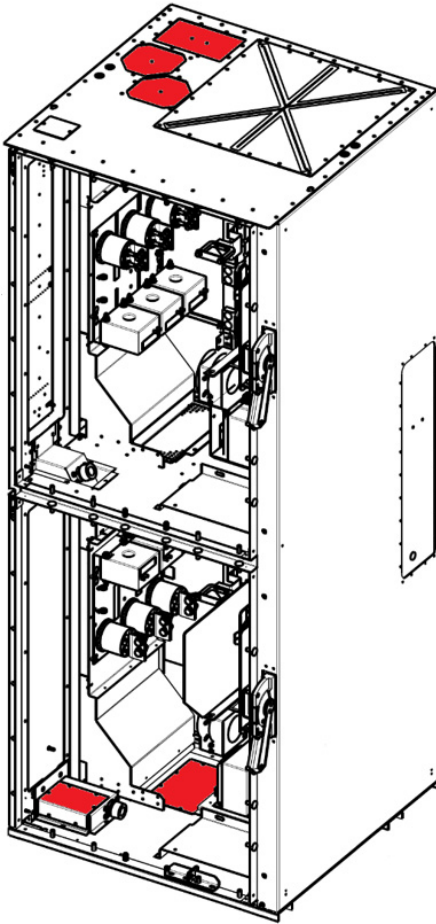
The low voltage wireway is sealed off from any arc blast. Thus as long as the low voltage control or communications cables are routed in the proper location no degradation of the arc-resistant capabilities of the cabinet should occur. Failure to route the cables properly will result in possible arc-resistant capabilities being compromised.

### *Floor and roof cut-outs*

Refer product-specific user manuals for detailed information on Floor/Roof cut-outs for arc-resistant Products.

See [Location of Removable Gland Plates on ArcShield MVMCC Structures on page 23](#) for typical location of gland plates. These must be in place before the equipment is energized.

## Location of Removable Gland Plates on ArcShield MVMCC Structures



### *Medium Voltage Drives*

One of the design features of the arc-resistant version of the PowerFlex 7000 is a barrier assembly behind the swing out LV tub of the Input section.

The standard PowerFlex 7000 (without arc-resistant) has a key interlock that helps prevent the LV tub being swung out unless upstream power sources have been locked out. This is necessary because behind the swing out compartment direct access to medium voltage components is available.

To access medium voltage elements in the input section of an arc-resistant PowerFlex 7000, the LV tub must be swung open and barriers need to be removed using tools.

## ArcShield Installation Checklist

See User's Manual for structure placement and connection details.

### Hardware Torque Information

1/4 in.-20 hardware, Grade 2	6 ft/lb (8 N·m) maximum
5/16 in.-18 hardware, Grade 2	11 ft/lb (15 N·m) maximum

### Main Structure Anchoring

Step	✓
The floor surface, where the ArcShield equipment is to be installed, must be level to the specifications provided in the user manuals.	
All anchors bolts must be securely installed in place, see the user manuals for details.	
Confirm that all holes are filled with either a bolt, silicone, or are covered.	
All anchor bolts must be a minimum size of 1/2 in. in diameter.	
See the joining sections below for additional structural security.	

### Joining Sections Together and Hardware Requirements

Step	✓
Generously apply supplied silicon <sup>(1)</sup> between adjacent surfaces at the bus opening and the perimeter of the structures in accordance with the user manual instructions.	
Apply a minimum 1/8 in. (3 mm) bead of silicone caulk been added around the perimeter of each section?	
Have all 1/4 in.-20 self-tapping screws been installed around the bus openings on the adjacent controller structures containing main power bus and there are no open holes?	
Have all 1/4 in.-20 self-tapping screws, which are used at the corners between adjacent cabinets, been installed through the clearance holes into the adjacent structure?	
Is the gap between adjacent sections less than or equal to 1/16 in. (1.5 mm)	

(1) Silicone supplied by Rockwell Automation, for use in sealing the enclosures and plenums, is part number W-662 and is a clear RTV 108 type silicone.

### Gland Plates and Hubs

Step	✓
All gland plates have been reinstalled, with the gasket material still intact, and all mounting hardware has been reinstalled for each gland plate removed? (To maintain an arc-resistant enclosure, all internal and external covers and access plates must be installed and sealed completely).	
Have hubs been tightened and are sealed on to any gland plates?	
Have sealing bushings or has sealing compound be used inside each hub installed? (Only approved CFC free polyurethane expanding foams or sealing putty should be used.)	
Have the low voltage control wiring bushings or hubs also been sealed?	

### Plenums and Extension Components

Step	✓
Have plenums have been installed on top of each enclosure in accordance with Rockwell Automation user manual instructions?	
All Plenums have been secured and sealed to the starter top plate using the 1/4 in.-20 hardware (or all chimneys are secured and sealed to the starter top plate using the 1/4 in.-20 hardware)?	
All required 5/16 in.-18 hardware, used to connect plenums and extension pieces, have been installed and torqued to specification?	
All plenums and plenum extensions have gasket material on at least one mating surface at all joints	
No gasket material has been damages and gasket material is at all joints?	
Silicone sealing has been used to seal any small gaps and voids anywhere in the plenum system?	
Plenum extensions, which extended beyond the base controller structures, have been adequately supported from above and for lateral movement?	
The plenum exhaust is directed to a suitable safe area and this area is cordoned off from access by all personnel?	
The distance of the plenum to the exhaust point is adequate?	
Is the exhaust point clear of material or obstructions?	



## Plenums and Extension Components

Step	✓
If the arc gas exhaust point is to the outdoors, has there been consideration for insuring that the exhaust point will not be blocked by ice or snow and any possibility of vermin infiltration have been addresses?	
The number of turns to the exhaust point has been considered and approved to be within the back pressure maximums for the plenum? (The maximum back pressure over plenum is 0.12 in. H <sub>2</sub> O)	
If there is a common plenum interface between ArcShield products and another third-party's equipment, have the guidelines outlined in publications <a href="#">1500-AT002</a> and <a href="#">1500-AT003</a> been followed and has the installation been approved by Rockwell Automation and the third-party?	

## Arc Exhaust Point Safety

Step	✓
Has a designated area or space been assigned for the arc gases to vent into?	
If it is a confined space, does the volume meet or exceed the requirements that are outlined in this document?	
Have all clearances and clear space requirements been met?	
Is access near the exhaust exit area controlled and restricted?	
Is the controlled and restricted space suitably marked? (Chain link fence, etc.)	

## Safe Area

Step	✓
Is the exhaust exit location chained, fenced off or inaccessible and is it appropriately labeled as a hazardous location?	
Is the minimum safe area at least 390 ft <sup>3</sup> (11 m <sup>3</sup> )?	

**Notes:**

The following terms and abbreviations are used throughout this manual. For definitions of terms not listed here, refer to the Allen-Bradley Industrial Automation Glossary, publication [AG-71](#).

**Arc Exhaust Chamber** See [Plenum on page 29](#).

**Arc-resistant Equipment** Electrical equipment designed to withstand the effects of an internal arcing fault and that directs the internally released energy away from the employee. Arc-resistant equipment provides protection from internal arcing faults only when the equipment doors are closed and the equipment is installed and operating normally.

**Arc-resistant Type/Accessibility Rating** ANSI/IEEE standard C37.20.7 defines arc resistance in two basic categories or ratings:

- ANSI type 1 (accessibility rating)
  - Arc resistance from the front of equipment only
- ANSI type 2 (accessibility rating)
  - Arc resistance provided from the front, sides and rear of the equipment

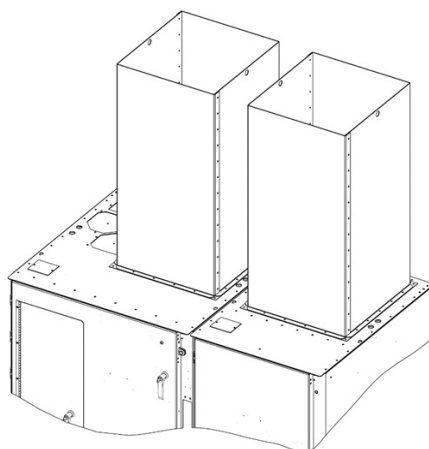
A suffix can be added to either of these two types (accessibility ratings) to further define the type of protection provided:

- A: Basic design
- B: Arc resistance is maintained even while opening designated low voltage controls compartments
- C: Arc resistance is maintained even when opening designated adjacent compartments and adjacent structures
- D: Special designation that supplements the Type 1 designation, but identifies additional arc resistance in certain structures

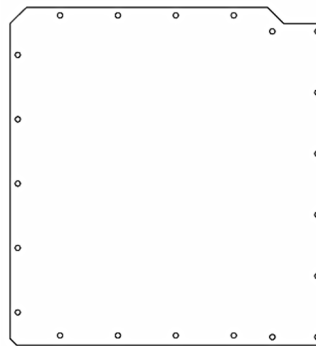
The Bulletin 1500/1900 arc-resistant products have an arc rating (accessibility rating) of Type 2B regardless of the arc-resistant rating.

**ArcShield** A trademark for low voltage and medium voltage arc-resistant control products that are manufactured by Rockwell Automation and branded as Allen-Bradley CENTERLINE.

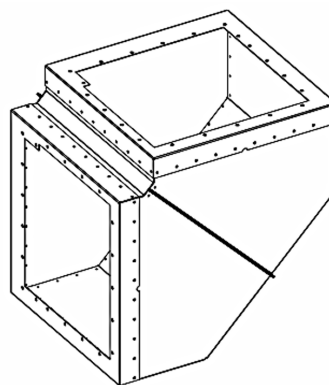
**Chimney** A simple, four sided, self-supporting, duct assembly that is designed to direct the arc energies straight up above the associated enclosure. A minimum of 1700 mm (67 in.) of clear-open space is required above the 1000 mm (67 in.) duct.



**End Cover Plate** Seals one end of the plenum system so that arc gas is directed to an alternative end or location within the plenum system.

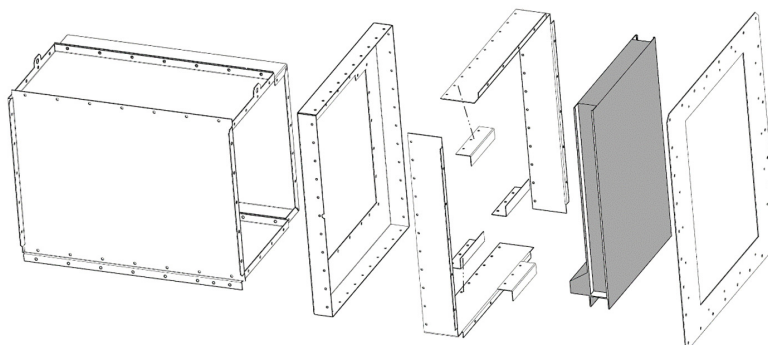


**Elbow** This component connects to either the Plenum Extension or to additional plenum exhaust components. It is composed of two 45° pieces creating a 90° corner. The 45° portions can be used on their own to provide other angular turns of the plenums so that it can reach the needed location.



**Exhaust Port/Plate** See [Pressure Relief Plate on page 31](#).

**Explovent** is an environmental sealing system that is used at the exit point of the plenum system at the points where the plenum exits to an exterior location or location with another ambient temperature. It is factory mutual approved for explosive applications. It is a hinged, insulated, aluminum, wall explosion vent mounted in a frame. The explosion vent is the weakest part of the plenum exhaust structure. As the vent experiences the pressure rise of the arc gases in the plenum, it quickly opens allowing the rapidly expanding heated gases to be released to the outside of a building or other location. Explovent is a trademarked product from Construction Specialties, Inc.



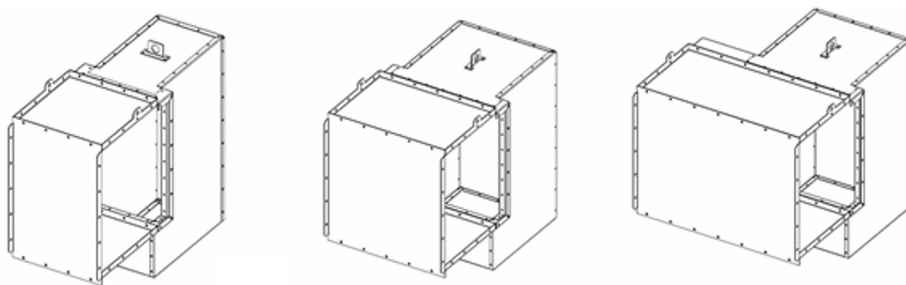
**Gas Duct** See [Plenum System on page 30](#).

**Gland Plate** These are removable plates that are used on the top and bottom of the structure to permit the inclusion of both medium voltage load or line cables and low voltage control cable hubs. These plates can be removed, drilled, or punched to permit the use of a cable or conduit hub and returned to their permanent locations.

NOTE: These must plates must be replaced after their removal. Failure to replace these plates put personnel at risk of arc blast exposures as these are required to maintain the arc-resistant integrity of the enclosure. See [Location of Removable Gland Plates on ArcShield MVMCC Structures on page 23](#).

**Main-Bus Short Circuit Rating** This is the current rating that is associated with the maximum allowed short time circuit current that is defined by UL347. These current levels have changed over various editions of UL 347. The current edition (6th) requires that the power bus be able to support 50,000A for 500 ms. This requirement also includes the associated ground bus. [In the past this test had been 60,000A for 50 ms]. This is not the same rating as the arc-resistant rating!

**Plenum** An arc gas duct system component mounted on top of each arc-resistant structure. It is used to direct arc energies upwards and then laterally. The plenum component sits directly on top of the arc-resistant structure and its weight is support by that structure. The plenums of side-by-side enclosure must be connected directly together forming a near air-tight seal.

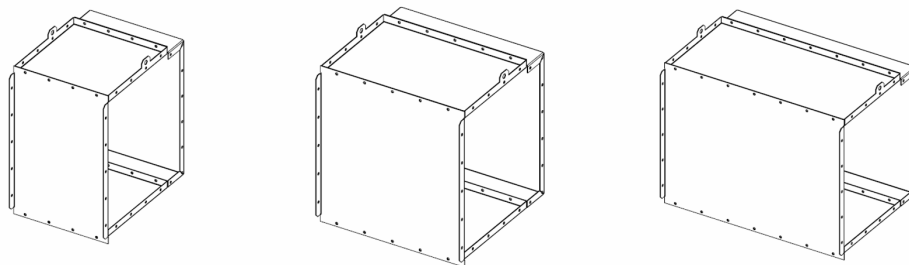


**Plenum Exhaust** This component connects to the Plenum Extension on one end then to additional plenum exhaust components, thereafter. Plenum exhaust components are used to create adequate length to safely channel the arc energies away from the controller or controller line up to the Exhaust Point.

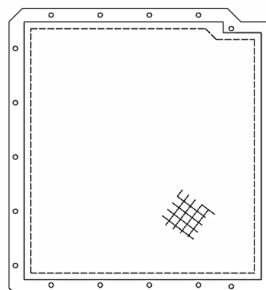
**Plenum Exhaust Point** The exit/exhaust location at the endpoint of the plenum where the arc gases escape. At this point can be various other plenum components such as a plenum screen, plenum exhaust hood, Explovent. This location should be deemed as hazardous as arc gas and arc by-products are exiting at this point. Appropriate proceeds and location markings much be in place.

**Plenum Exhaust Hood** A curve down hood used at the end of the plenum, at the plenum exhaust point. It is shaped to help prevent rain infiltration. It is NOT an environment seal.

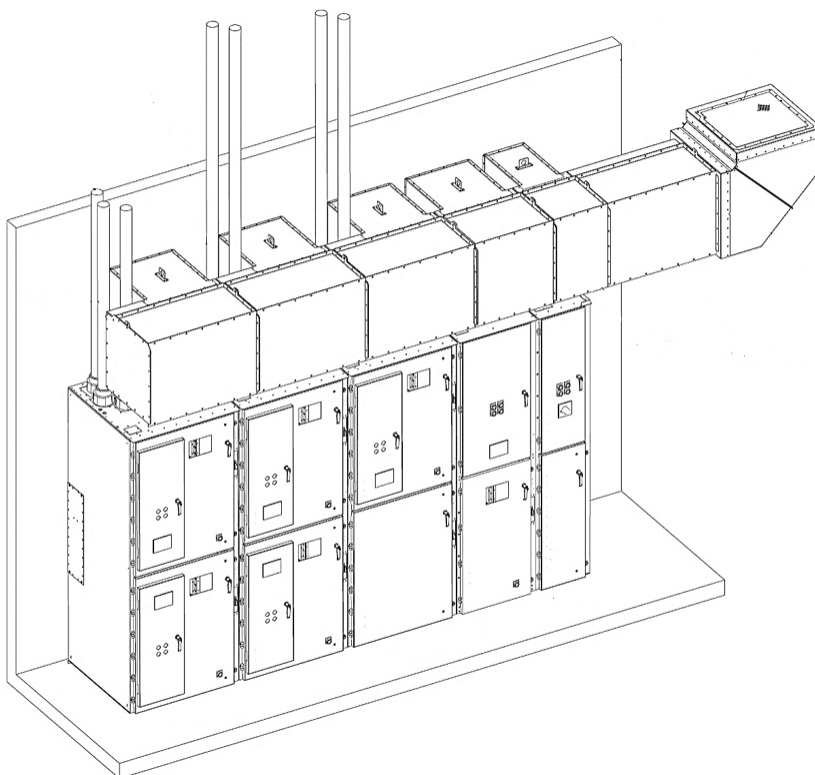
**Plenum Extension** This is the first piece plenum duct extension component that attaches directly to the end controller-structure plenums. A minimum of one 1000 mm (39.4 in.) piece is required to be connect on the last plenum, of the end controller-structure, for every arc gas plenum release system. At least one plenum extension piece is required to provide a completed plenum system.



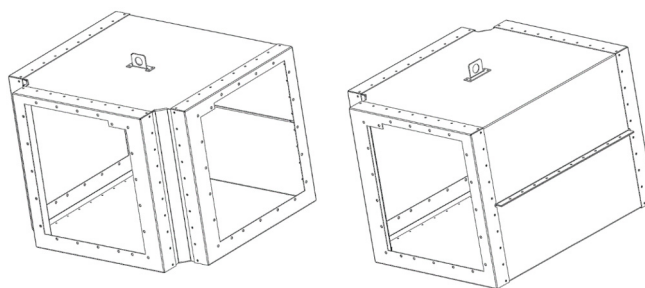
**Plenum Screen Cover Plate** A screen that can be added to the end of the plenum, at the exhaust point, to limit egress by vermin, etc.



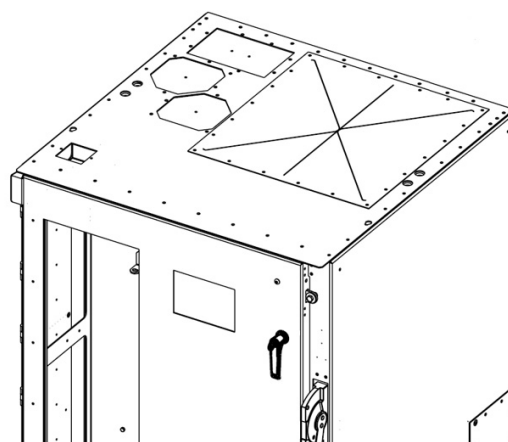
**Plenum System** A group of plenums, extensions, elbows, or exit components that create an interconnected ducting system to channel dangerous arc energies to a safe location.



**Plenum Tee** A special plenum component used as an interconnection plenum on back to back MV MCC configurations.



**Pressure Relief Plate** A specially designed plate, typically including a laser cut pattern on its surface, to control the internal pressure rise within an arc-resistant enclosure. The open under specific pressure and allow arc gas and arc by-products to enter the plenum system. When they are not open, they provide a dust-tight seal on the top of the enclosure.



**Notes:**



## Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
EtherNet/IP Network Devices User Manual, <a href="#">ENET-UM006</a>	Describes how to configure and use EtherNet/IP devices to communicate on the EtherNet/IP network.
Ethernet Reference Manual, <a href="#">ENET-RM002</a>	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.
System Security Design Guidelines Reference Manual, <a href="#">SECURE-RM001</a>	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication <a href="#">IC-TD002</a>	Provides a quick reference tool for Allen-Bradley industrial automation controls and assemblies.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-state Control, publication <a href="#">SGI-1.1</a>	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication <a href="#">1770-4.1</a>	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, <a href="http://rok.auto/certifications">rok.auto/certifications</a> .	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at [rok.auto/literature](http://rok.auto/literature).

# Rockwell Automation Support

Use these resources to access support information.

<b>Technical Support Center</b>	Find help with how-to videos, FAQs, chat, user forums, and product notification updates.	<a href="http://rok.auto/support">rok.auto/support</a>
<b>Knowledgebase</b>	Access Knowledgebase articles.	<a href="http://rok.auto/knowledgebase">rok.auto/knowledgebase</a>
<b>Local Technical Support Phone Numbers</b>	Locate the telephone number for your country.	<a href="http://rok.auto/phonesupport">rok.auto/phonesupport</a>
<b>Literature Library</b>	Find installation instructions, manuals, brochures, and technical data publications.	<a href="http://rok.auto/literature">rok.auto/literature</a>
<b>Product Compatibility and Download Center (PCDC)</b>	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	<a href="http://rok.auto/pcdc">rok.auto/pcdc</a>

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Rockwell Automation maintains current product environmental compliance information on its website at [rok.auto/pec](http://rok.auto/pec).

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