



# Instruction Manual

## Model 270F

Flare Gas Probe



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## 1.0 Receiving and Storage

Carefully inspect the sample probe and any special accessories included with it immediately on arrival by removing them from the packing and checking for missing articles against the packing list.

Due to the weight of the unit, use of a lifting device with a sling is advised. If the unit is lifted by personnel, at least three persons should be used to lift it. Lift the unit by placing hands underneath the main enclosure itself (not the door), or by using the flange/flange bolts.

### **DO NOT LIFT THE UNIT BY ANY OF THE FOLLOWING:**

- HEATER CONTROLLER MOUNTED ON THE BOTTOM OF THE UNIT
- FLEXIBLE CONDUIT BETWEEN THE HEATER CONTROLLER AND THE ENCLOSURE ENTRY
- HEATER CONTROLLER SENSE WIRE (BLUE CABLE BETWEEN THE CONTROLLER AND THE ENCLOSURE) SAFETY VENT
- SAFETY PURGE PANEL

Check the items for any damage in transit and, if required, inform the shipping insurance company immediately of any damage found.

The sample entry boot and mounting flange gaskets are placed inside the enclosure for shipping. Items should not be removed until immediately before installation at the sampling point to ensure they do not get misplaced.

Storage location should be protected from the elements. Although all components provided are designed to resist corrosion, additional protection from heat (>140°F/ 60°C) and humidity is recommended.

**WARNING:** Exposure to some chemicals may degrade the sealing properties of the epoxy used to seal the filter heater and valve heater elements.

## 2.0 Definition of Symbols



CAUTION, RISK OF DANGER SYMBOL INDICATES INJURY MAY OCCUR IF MANUFACTURER'S INSTRUCTIONS ARE NOT ADHERED TO. PLEASE READ MANUAL CAREFULLY WHEN SYMBOL IS DISPLAYED



CAUTION, HOT SURFACE SYMBOL INDICATES EXPOSED SURFACE TEMPERATURE CAN CAUSE BURNS OR PERSONAL INJURY. CARE SHOULD BE TAKEN WHEN CONTACT IS REQUIRED.



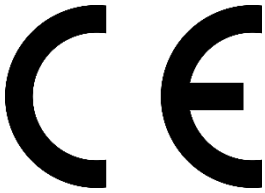
CAUTION, RISK OF ELECTRICAL SHOCK SYMBOL INDICATES ELECTRICAL SHOCK MAY OCCUR. CAUTION SHOULD BE TAKEN BEFORE DISCONNECTING OR CONTACTING ANY ELECTRICAL CONNECTIONS.



PROTECTIVE CONDUCTOR TERMINAL SYMBOL INDICATES THE TERMINAL LOCATION FOR THE PROTECTIVE CONDUCTOR. FAILURE TO CONNECT TO THE PROTECTIVE CONDUCTOR TERMINAL MAY RESULT IN A SHOCK HAZARD.

### 3.0 Declaration of Conformity

The product described in this manual complies with the following certifications:



CE – Certification

LVD – Low Voltage Directive (Directive 2006/95/EC)

Second Edition EN 61010-1:2001 - Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements.

SPV – Simple Pressure Vessels Directive (Directive 87/404/EEC)

EN 286-1:1998 – Simple unfired pressure vessels designed to contain air or nitrogen - Part 1: Pressure vessels for general purposes.

EMC – Electromagnetic Compatibility (Directive 2004/108/EC)

EN 61326-1:2006 – Electrical equipment for measurement, control and laboratory use.

## 4.0 Specifications

<b>OPERATING SPECIFICATIONS</b>	
Sample Flow Rate	0 to 20 l/m
Calibration Gas Requirement	Sample flow rate plus 10%
Operating Pressure Drop at 10 l/m	12" water column (0.03 bar)
Maximum Stack Temperature	700°F (370°C)
Oven Temperature	270°F (132°C)
Enclosure Dimensions	19" H x 17" W x 17" D (480mm H x 430mm H x 430mm D)
Weight	108 lbs (49 kg) (plus probe)
Input Voltage Requirement	115VAC 50/60 Hz / 230VAC 50/60 Hz
Input Power Requirement	575 watt maximum
<b>EXTERNAL FUSE REQUIRED OF 20 A OR LESS</b>	
Ambient Temperature, Operating	176°F (80°C) maximum
Blowback Tank Volume	.01 scf (2.8l)
Blowback Duration	1.5 sec to empty accumulator
Enclosure	SS, IP 65
Sample Line Connection	3" Heat shrink boot (standard) 4" Heat shrink boot (optional)
Heater Type	Rod heaters in aluminum block, controlled with thermal switch
Available Filter	2µm ceramic
Chamber Material	316SS, SilcoNert™ coated
Hazardous Area Classification	Class I, Div. 2, Groups B, C, D

## 5.0 Description and Principle of Operation

### 5.1 Application

The Universal Analyzers Model 270F Flare Gas Probe Assembly is designed to extract sample gases from a flare exhaust line, filter it, and deliver it to a heated sample line for delivery ultimately to a gas analyzer. It is designed to be installed on sample stacks containing non-hazardous gases. It has been designed specifically for sulfur (total or speciated) in flare gas applications. It is suitable to install in an unclassified or Class I, Division 2 location.

Filter changes can be made in less than one minute.

The Model 270F filter will mount by means of a pipe flange to a mating flange on the stack. The size of the flange can be specified by the user and can include 2", 3", 4" or 6". Other flange sizes may be available; contact the factory for more information. The probe tube used is specific to the Model 270F and is specified with the Model 270F.

For more accurate and faster response time, all sample wetted stainless steel parts have been SilcoNert™ coated. Sample flow rates of up to 20 l/m can be extracted and filtered through the Model 270F with a minimal amount of pressure drop.

### 5.2 General Description

The Model 270F is a Flare Gas Probe Assembly consisting of the filter body mounted in a NEMA 4X stainless steel enclosure. A blowback system is provided to allow the blowback to occur on command from a data logger, PLC or UAI timer card or external switch mounted in a safe area.

Two 63 watt heaters are mounted in an aluminum sleeve around the filter cavity. The heaters hold the temperature

of the filter near 270°F (132°C). A hermetically sealed bi-metallic thermal switch mounted to the filter body keeps the temperature from exceeding 280°F (138°C) by opening the circuit before that temperature. An optional independent temperature sensor can be provided as a means to measure and transmit or record the temperature of the filter. A second thermal switch, set at 225°F (107°C) is provided to be used as an alarm contact if the temperature drops below the switch temperature. An isolation valve is included in the sample path leading to the heated chamber. This valve is provided to protect maintenance personnel. It isolates the chamber from the process flare gas during filter changes. This valve is also heated with two 63 watt heaters, controlled to 270°F (132°C) and alarmed at 225°F (107°C) in the same manner as the heated filter. A second valve, heated and alarmed in the same manner, can be provided for further protection to personnel. A bleed port from between the first and second isolation valves will also be provided to allow releasing any trapped gases between these valves to avoid pressure build up due to valve leakage or temperature changes.

In colder climates, an additional heater can be supplied for the enclosure. This heater will maintain 194°F (90°C) inside the enclosure.

The Model 270F Flare Gas Probe is provided with a 2 µm ceramic filter. This filter is supplied as an economical general purpose filter. It also has the advantage of being relatively non-reactive to the sulfur content of the sample gas. Additional filtration materials and pore sizes are available.

Blowback air is used to clean the filter element. Compressed air supplied to the blowback assembly needs to be clean and dry (-40°F/°C recommended). Instrument quality air is preferred. The pressure should be as high as possible, up to 125 psig (8.6 barg). High pressure air fills the accumulator (a 7" (178mm) diameter stainless steel sphere) and provides a substantial blast when the high flow solenoid valve opens. This loosens the particles on the filter surface and forces them back through the sample probe into the sample point. The period between blowback cycles should be set to occur before the pressure drop across the filter begins to

increase beyond acceptable limits. By installing and monitoring a vacuum gauge ahead of the sample pump, a maintenance interval can be established. This can be as often as every 15 minutes but should be no less frequently than once per day. The period between blowback cycles can be based on calculations to estimate the amount of sample required to deposit from three to five grams of solids in the filter element.

Instrument air usage is minimal and smoothed by the fact that the air accumulator is charged relatively slowly through a 1/4" instrument airline. The recharge time could be extended with a restriction in the air line if it were desired to reduce the pressure pulses on the instrument air supply and to consume instrument air even more slowly.

The calibration gas may be injected into the chamber ahead of the filter. This is close to the sample source, as is required by many EPA officers. A back-pressure check valve (set at 3 psig (0.2 barg)) is provided in the cal gas injection path to ensure that calibration gas does not leak into the sample while the sample is being drawn through the filter. Alternately, a three-way valve may be supplied to switch between calibration gas or sample gas, providing for a closed loop calibration with no calibration gas lost to the flare line.

System seal between the enclosure and process is provided by a subflange mounted on the main flange. The probe tube and filter chambers are mounted on a separate subflange. The primary subflange mounts the isolation valves and filter chamber on one side, and the probe tube on the other. The remainder of the system seal between the enclosure and the process is maintained either by a triple O-Ring seal, or by a retractable probe tube support assembly.

For the triple O-Ring seal, the secondary subflange is mounted directly onto the flange. This secondary subflange seals the probe enclosure from process with a gasket between the subflange and the main flange, and with a triple O-Ring seal on the probe tube. The primary subflange may be removed from the flare probe assembly without disturbing the secondary subflange. This allows the filter chamber assembly and probe tube to be extracted from the process and isolated from the process by means of a process side root valve, without ever losing system seal.

Because the probe tube is sealed by the triple O-Ring seal in the secondary subflange, a specific style of probe tube

is required. The probe tube will need to be specifically sized, and must be coated with SilcoNert™ to maintain a faster response time in samples containing sulfur. The probe tube must have a probe stop to prevent it from being ejected from the secondary subflange and allowing process gas to escape.

The retractable probe tube support assembly has a secondary and a tertiary subflange. The tertiary subflange mounts

to the main flange and seals the enclosure from the process with a gasket. The secondary subflange has a probe tube support attached, and seals to both the probe tube and to the tertiary subflange by means of O-Rings. The probe tube attaches to the primary subflange, with its filter and isolation valves. The probe tube can be retracted into the probe

tube support, and the probe tube support can then be retracted through the tertiary subflange, all without losing system integrity.

The probe tube used with the retractable probe tube support is unique to this style of probe. The probe tube used with the triple O-Ring design cannot be used with a retractable probe tube support.



## 6.0 Installation

Due to the weight of the unit, use of a lifting device with a sling is advised. If the unit is lifted by personnel, at least three persons should be used to lift it. Lift the unit by placing hands underneath main enclosure itself (not the door), or by using the flange/flange bolts.

### DO NOT LIFT THE UNIT BY ANY OF THE FOLLOWING:

- HEATER CONTROLLER MOUNTED ON THE BOTTOM OF THE UNIT
- FLEXIBLE CONDUIT BETWEEN THE HEATER CONTROLLER AND THE ENCLOSURE ENTRY
- HEATER CONTROLLER SENSE WIRE (BLUE CABLE BETWEEN THE CONTROLLER AND THE ENCLOSURE) SAFETY VENT
- SAFETY PURGE PANEL

Because of the separate primary and secondary sub-flanges, the Model 270F Flare probe may be installed on an operating flare stack, provided that a process side isolation valve with at least 1.6" (4.1 cm) straight through internal clearance is installed on the sample nozzle. If a retractable probe tube support is to be used, internal clearance must be at least 2" (5.1 cm).

The Flare probe enclosure should be mounted to the stack sample nozzle using the studs on the flange. Ensure the probe is mounted so that the enclosure is vertical. Several items in the probe will not work properly without being oriented vertically, including the Safety Purge vent and the Liquid Stop.

Prior to installation, ensure the process is shut down and safe for personnel, or verify the process side isolation valve is closed, and remove the primary and secondary sub-flanges from the Flare probe by disconnecting the electrical and gas connections between the enclosure and the filter assembly, and removing the primary and secondary subflange retaining bolts. If the retractable probe tube option is used, the tertiary subflange may remain installed.

### 6.1 To Install a Triple O-Ring Model 270F

Insert the probe tube (stinger) through the secondary subflange, taking care to prevent damage to the O-Rings inside the subflange. Slide the probe tube into the subflange up to its probe stop. The probe tube should be screwed into the 3/8" NPT fitting on the inside of the primary subflange. To prevent galling, coat the threads with an anti-seize compound. Clean any anti-seize compound from the inner wall of the probe tube before attaching it to the subflange. The length of the probe should be selected to extend into the center third of the stack; or if the stack diameter is greater than 12' (3.7 m), at least 6' (1.8 m) into that stack.

Ensure the probe tube is correctly oriented and the subflange gasket is in place, then secure the secondary subflange to the main flange using the 4 shorter subflange retaining bolts.

Verify the filter sample isolation valve(s) are shut, and open the process side isolation valve. Slide the probe tube into the secondary subflange and mate the primary subflange to the secondary subflange. Secure the primary subflange to the secondary subflange using the longer 4 of the subflange retaining bolts. Ensure the spacer with cutout is in place when inserting the bolts.

Attach the electrical and gas connections between the enclosure and the filter assembly.

## 6.2 To Install a Retractable Probe Tube Support Model 270F

Insert the probe tube (stinger) through the probe tube support and secondary subflange, taking care to prevent damage to the O-Ring inside the end of the probe tube support. Slide the probe tube into the probe tube support up to its probe stop. The probe tube should be screwed into the 3/8" female NPT fitting on the primary subflange. To prevent galling, coat the threads with an anti-seize compound. Clean any anti-seize compound from the inner wall of the probe tube before attaching it to the subflange. Ensure the probe tube is correctly oriented with regard to probe tube tip and filter.

Insert the probe tube support into the tertiary subflange, taking care to avoid damage to the O-Ring in the subflange. Verify the filter isolation valve(s) are shut, and open the process side isolation valve.

Insert the probe tube support and probe tube into the nozzle. Mate the secondary subflange to the tertiary subflange, and secure using the subflange retaining bolts with the 1/2" spacer. Ensure the spacer is in place when installing the bolts, slide the probe tube through the probe tube support to make the primary subflange with the secondary subflange. Secure the primary subflange with the subflange retaining the bolts with the 1" spacer. Ensure the spacer is in place when installing the bolts. Attach the electrical and gas connections between the enclosure of the filter assembly.

## 6.3 To Install a Heated Sample Line

A heated sample line should be supported close to the Model 270. The Model 270F is not designed to support a heated sample line. The heated sample line should be fed through the heat shrink boot on the bottom of the enclosure. Connect the sample tube to the sample out fitting on the filter. The unheated portion of the sample line should be kept short and insulated to avoid condensation. Connect the calibration gas line to the marked 1/4" tube fitting. It is connected to the chamber via a check valve, or to a 3-way valve used to select between sample and calibration gas. If the compressed air line is part of the heated sample line, it can be connected to the 1/4" tube fitting marked for instrument air in. If an external air line is to be used for blowback, bring the air into the enclosure through a bulkhead fitting (supplied by others) to be installed in the wall of the enclosure, and connect the air to the same 1/4" tube fitting.

Provide power to the terminal block(s) within the stack filter enclosure in the Model 270F. 575 watts at 115VAC or 230VAC is required. If the external cutoff switch option is used, connect the power to the terminals in the switch.



**NOTE: The supply power circuit MUST include an overprotection device with a maximum rating of 20 A. A disconnect switch must be located in close proximity to the probe. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired per Clause 5.4.4(i) in Standard EN 61010-1.**



A thermal switch mounted in the aluminum heaters will control the temperature of the filter chamber and isolations valve(s) to 270°F (132°C). **An independent ground wire should be run to the grounding terminal on the terminal strip.**

If an independent measurement and display of the filter chamber temperature is desired, the Model 270F probe can be assembled with a temperature sensor inserted into a 1/8" diameter thermowell supplied on the heater tube assembly. The filter and enclosure temperatures can be monitored. Connect wires for this at terminal block 4. If type K thermocouples are selected, make sure to use the correct type of wire to connect between the probe and the instrument.

Control signals for blowback and calibration gas select should be run to terminal block 2. These may be 24VDC, 115VAC, or 230VAC, depending on options chosen. Each solenoid draws approximately 10 watts.



**NOTE: The control signal circuits MUST include a current limiting device with a maximum rating of 1 A.**

Terminal block 3 is used for low temperature monitoring. Connect a pair of signal wires to this block to monitor for low temperature alarm.

The final installation step is to ensure that the sample line is insulated completely. Close the cover of the enclosure and secure the latches. After securing the heated sample line, use a heat gun to shrink the entry boot onto the sample line. The goal is to keep the temperature of the gas sample at a temperature above the dew point of the gas all the way from the stack to the sample cooler/dehydrator.

## 7.0 Start Up

Apply power to the Model 270F Flare Gas Probe. Allow 15-30 minutes for the filter to come to temperature. This warm-up period is extremely important to avoid the condensation within the Model 270F filter which would cement the particulates to the filter surface. If an enclosure heater is used, it may take up to two hours to bring the enclosure to temperature.

Start the sample pump and determine that the proper amount of sample is being supplied to the instrumentation.

Perform a calibration cycle to ensure that the calibration lines are properly installed and sealed. If using flood calibration, a flow meter should be installed in the calibration gas supply line to ensure that there is at least 10 percent more calibration gas being supplied to the Model 270F than is being withdrawn as sample. This will ensure that the filter and probe are being properly flooded with calibration gas. The excess calibration gas will pass through the probe tube into the process.

Open the instrument air valve to charge the blowback accumulator. Exercise the blowback solenoid valve to insure it is properly wired. During and after a blowback cycle, the presence of a slight pressure pulse on the sample tubing in the analyzer shelter, and the momentary dilution of the sample with instrument air, is normal and signifies that a blowback cycle has occurred. If desired, and if installed, the Calibration Select valve can be cycled during blowback to block the pressure pulse down the sample line.

The optimum time between blowback cycles is to be determined by experience. Once a day is sufficient in relatively clean applications. The requirement could be as frequent as every fifteen minutes where the dust and soot levels are severe.

It is better to blowback too often than not often enough. A vacuum gauge in the sample line can be helpful to indicate if

the particulate loading of the filter has started to restrict the flow of sample. The blowback cycle should be initiated before unacceptable pressure drop occurs.

## 8.0 Operation

The Model 270F Flare Gas Probe normally operates with no required input. The filter will require regular maintenance as covered in the Maintenance section.

Should the need arise, there are valves in the unit that may be operated by hand. First are the filter isolation valve(s), isolating the process from the filter chamber. These ball valves are inside the enclosure, closer to the flange from the filter chamber. They are closed when the handle is crosswise to the filter chamber, and open when in line with the filter chamber.

Second is the optional vent valve. This valve is used to vent the space between the two filter isolation valves, and is only included if there are two filter isolation valves. This valve should never be opened during normal operations, and should only be opened if the primary filter isolation valve is closed.

The final manual valve is the drain valve. This valve is used if necessary to drain the Liquid Stop after it has sealed the system upon being flooded with liquid. It should never be opened during normal operations, and should only be opened if the filter isolation valve(s) is closed.

The vent valve and drain valve are tagged with identification labels. The filter isolation valve(s) are identified by their location.

**WARNING:** Exposure to some chemicals may degrade the sealing properties of the epoxy used to seal the filter heater and valve heater elements.

## 9.0 Shutdown

Before removing power from the unit, ensure filter chamber has been purged of any potentially hazardous components.

To purge the chamber, perform the following:

1. If equipped, perform a manual blowback operation.
2. Close the filter stack isolation valve(s).
3. Ensure no sample is being drawn through the filter chamber. If the sample is being drawn using a sample pump, turn off the power to the pump or disconnect the sample line.
4. If not already done, disconnect the sample line.
5. Use instrument air or other inert gas, flow ~10 l/m for 15-30 minutes through the filter chamber. Note: Inert gas can be routed through the chamber via the calibration gas line if flood calibration option is installed.
6. After purging is complete, follow the maintenance procedure to change the filter.
7. Cap the sample outlet tube connection and disconnect power from the unit. Note: If electrical wires are to be disconnected, follow applicable 'Lock Out/ Tag Out' requirements.

## 10.0 Maintenance

### 10.1 Changing the Filter



**CAUTION: THIS PROCEDURE CAN CAUSE SEVERE BURNS. USE PROPER PROTECTION.**

Changing the filter in the Model 270F Flare Gas Probe Assembly is extremely easy. Unsecure the door latches and open the door to the Heated Filter. Close the filter isolation valve(s) to isolate the filter chamber from process. Using gloves to protect the hand, grasp the cap on the end of the filter body opposite the probe and turn it counter clockwise. **The cap may be hot to the touch and may cause burns to the hand if not protected.** Removing the cap also removes the filter.

Inspect the O-Rings which are at each end of the filter to ensure they are still elastic and will seal the filter. Replace them if they are charred or deformed.

Replace the filter with a new one. Ensure it is in the center of the oven so that it is in contact with the O-Ring on the far end of the filter.

Screw the cap back on the filter body. Open the filter isolation valve(s). Close the door and secure the door latches. The filter replacement procedure is complete.

### 10.2 Removing the Probe Tube



**CAUTION: THIS PROCEDURE CAN CAUSE SEVERE BURNS. USE PROPER PROTECTION.**

Removing the probe tube (e.g. for maintenance or inspection) can be done while the process is still running. Shut down the probe in accordance with shut down instructions. Disconnect the electrical and gas connections to the filter chamber and isolation valve stack. Remove the subflange retaining bolts holding the primary subflange to the secondary subflange. Caution: Parts in the filter stack including the flange and probe tube may be hot. Use proper protection to avoid burns. Pull the filter stack assembly away from the secondary subflange, allowing the probe tube to slide through the secondary subflange or retractable probe tube support.

If using a retractable probe tube support, remove the bolts holding the secondary subflange to the tertiary subflange. Pull the filter stack and probe tube support away from the tertiary subflange, until the stop is reached. Do not pull the probe tube support out of the tertiary subflange.

When the filter stack assembly and probe tube (and probe tube support) are fully withdrawn, close the process side isolation valve. For the triple O-Ring seal, remove the secondary subflange from the main flange by removing the remaining subflange retaining bolts. For the retractable probe tube support, remove the filter and probe tube assembly. The probe tube may be removed from the filter stack assembly and primary subflange for maintenance. See the section on installation to reinsert the probe tube and filter assembly into the stack.

## 11.0 Troubleshooting

The following table should give an overview of possible errors and an instruction to check and to repair them (is not valid for the starting-up period of cooler).

<b>Error</b>	<b>Possible Reason</b>	<b>Check/Repair</b>
No sample gas flow	Filter element plugged	Check/ replace filter element
	Filter chamber exit port plugged	Remove filter element and inspect exit port. Exit port will be located at 180°
Low temperature alarm	Insufficient warm-up time	Ensure power has been applied to the unit for a minimum of 15 minutes
	Power disconnected	Ensure power is supplied to the unit. Check by measuring for AC voltage on TB1-1 & 4
	Control switch defective	Verify by measuring for a closed circuit between TB1-1 & 8 for the filter, between TB1-2 & 10 for the primary isolation valve, and between TB1-2 & 12 for the secondary isolation valve
High oxygen readings/low pollutant readings	Leak	Leaking past the filter element O-Rings. Remove filter element and inspect O-Rings. There are two O-Rings, one located at the base of the filter element and the other in the cap. Ensure both are pliable and seated in their respective grooves.  Leaking blowback solenoid valve. Block or disconnect the blowback supply to verify  Leaking/open bleed valve. Verify bleed valve between isolation valves is fully shut  Loose connection Verify all fittings are leak free
Low readings during calibration	Insufficient calibration gas flow	Ensure calibration flow is at least 110% of the sample gas flow



## 12.0 Drawings and Spare Parts

For the current revision of all Model 270F Probe drawings and spare parts, visit the Universal Analyzers website.

<https://www.universalanalyzers.com/>

Navigate to: Products -> Gas Sample Probes -> Model 270F

Links to all current drawings and spare parts for standard probe configurations are provided at the bottom of the page.

## 13.0 Terms and Conditions - Limited Warranty

THE FOLLOWING TERMS/CONDITIONS, TOGETHER WITH ANY OTHER TERMS/CONDITIONS SPECIFICALLY AGREED TO IN WRITING BY SELLER, SHALL APPLY TO ALL ORDERS ("Order(s)") FROM, AND SALES OF PRODUCTS ("Products") OR SERVICES ("Services") TO BUYER. ANY ACCEPTANCE OF ANY ORDER OF BUYER IS CONDITIONED UPON THESE TERMS/CONDITIONS. ANY ADDITIONAL OR DIFFERENT TERMS/CONDITIONS PROPOSED BY BUYER IN ANY DOCUMENT ARE OBJECTED TO AND SHALL NOT BE BINDING UPON SELLER. No salesperson is authorized to bind Seller to any promise or understanding not expressed herein.

### I. PRICES

All prices are subject to change without notice in the event of any changes in cost of materials or labor, specifications, quantities, delivery schedules, customs duties, other factors beyond Seller's control, or in the event of delays caused by instructions of the Buyer, or failure of the Buyer to give Seller adequate information. Further, prices payable by the Buyer shall be subject to immediate increase, should the Seller as a result of governmental action or regulation including, without limitation, those contemplated by an investigation under Section 232 of the Trade Expansion Act of 1962 (19 U.S.C. §1862), incur additional duties, tariffs or restrictions on products sold hereunder, or on the raw materials that are used in making such products. In no event shall prices include any amounts imposed on the Buyer in connection with Buyer's purchases from Seller, such as taxes, including but not limited to Value Added Tax (VAT) or excise taxes, duties, tariffs, or any other costs assessed against the Buyer by a governmental authority.

### II. DELIVERY

Delivery dates are approximate and are dependent on prompt receipt by Seller of all necessary information. Seller may deliver all or any part of Products/ Services as early as 30 days in advance of agreed schedule. The point of delivery shall be "Ex-works" Seller's premises, unless otherwise specified by Seller. Upon delivery, title to Products and all risk of loss or damage thereto shall pass to Buyer. Where Buyer notifies Seller that it cannot take timely delivery of the Products, Seller may place such Products in storage, at the risk of Buyer, and Buyer shall reimburse Seller for all expenses incurred in connection with such storage. Buyer shall dispose of the packing materials for Products at its own expense, and shall defend, indemnify and hold harmless Seller from any legal obligations in connection with such packing waste.

### III. PAYMENT

A. The term of payment shall be net 30 days from date of Seller's invoice, unless otherwise specified. Payments shall be made by Buyer without any deduction or set-off. Unless otherwise agreed, payment shall be made in U.S. dollars. Seller may charge late payment fees at the rate of 1.5% per month, or the highest rate permitted by law, whichever is less, accruing daily.

B. If the financial condition of Buyer is unsatisfactory to Seller, Seller may require full or partial payment in advance, or satisfactory security, in the form of a letter of credit or otherwise. In the event of bankruptcy or insolvency of Buyer, Seller may immediately cancel any Order then outstanding.

C. Buyer grants Seller a purchase money security interest in Products located in the United States, or Services, as well as any proceeds, for the purpose of securing the obligations of Buyer hereunder. Buyer authorizes Seller to execute on Buyer's behalf and file such financing statements as Seller deems appropriate to perfect and notify Buyer's creditors of Seller's security interest.

### IV. VARIATIONS IN QUANTITY; CHANGES.

Buyer shall accept delivery of quantities greater or smaller than the quantity specified in Order(s), provided that any such variation shall not exceed 5% of the quantity originally specified, or 2 units, whichever is greater. Seller shall not be required to give notice of any such variations other than in the applicable shipping notice and invoice. Seller reserves the option to make changes to Products or Services which do not affect form, fit, or function, and shall deliver Products to the latest configuration part number at the time of delivery.

### V. EXPORT CONTROLS; FCPA; ANTI-BOYCOTT

A. Buyer shall not make any disposition of the Products, by way of transshipment, re-export, diversion or otherwise, except as applicable U.S. export laws and regulations may expressly permit, and other than in and to the ultimate country of destination specified on Order(s) or declared as the country of ultimate destination on Seller's invoices or in the End Use Statement that Buyer supplies Seller. Seller shall not be named as shipper or exporter of record or U.S. principal party-in-interest (USPPI) unless specifically agreed to in writing by Seller in which case, Buyer shall provide Seller with a copy of the documents filed by Buyer for Export clearance purposes. At Seller's request, Buyer shall supply end-use and end-user information to determine export license applicability. Failure of Buyer to comply with this section shall constitute a material default allowing Seller to cancel related Order(s) without liability.

B. Buyer warrants that it shall not violate or cause the Seller to violate the U.S. Foreign Corrupt Practices Act of 1977 (FCPA), as amended, the United Kingdom Bribery Act (UKBA) of 2010, as amended, or their respective implementing regulations in connection with Buyer's sale or distribution of the Products and/or Services, and that Buyer does not know or have reason to believe that any consultant, agent, representative or other person retained by Buyer in connection with the sale and/or distribution of Products/Services has violated, nor caused Seller to violate the FCPA and/or the UKBA. Where Buyer learns of or has reason to know of any violation of FCPA and/or UKBA in connection with the sale or distribution of Products/Services, Buyer shall immediately advise Seller.

C. Buyer further warrants that Buyer shall not violate or cause Seller to violate the U.S. Antiboycott Provisions of the U.S. Export Administration Regulations issued pursuant to the U.S. Export Administration Act of 1979, as amended, in connection with Buyer's purchase of Products/Services and that Buyer shall not request or require Seller to make statements or Dec 2018 certifications against countries that are not subject to boycott by the U.S.

### VI. WARRANTIES

A. Seller warrants that Products manufactured by Seller, when delivered, shall be free from defects in material/workmanship.

Seller warrants that Services shall be performed in accordance with generally accepted industry practice. Seller's obligations under this warranty shall be limited exclusively to repairing or replacing, at Seller's option, any part of Products which, if properly installed, used and maintained, proved to have been defective in material or workmanship within 1 year from the date of shipment, or re-performing the Services. Seller warrants for a period of 1 year from the date of shipment that software or firmware, when used with Products, shall perform in accordance with Seller's published specifications. Seller makes no warranty, express or implied, that the operations of the software or firmware shall be uninterrupted or error-free, or that functions contained therein shall meet or satisfy the Buyer's intended use/requirements. Buyer shall notify Seller of any defect in the quality or condition of Products (including software/firmware) or Services within 7 days of the date of delivery or performance, unless the defect was not apparent on reasonable inspection, in which case, within 7 days after discovery of the defect. If Buyer does not provide such timely notification, it shall not be entitled to reject Products (including software/firmware) or Services, and Seller shall have no liability for such defect.

B. Seller's warranty obligations shall not apply to Products which (1) have been altered or repaired by someone other than Seller, or (2) have been subjected to misuse, neglect, or improper use or application, or (3) are normally consumed in operation, or (4) have a normal life inherently shorter than the warranty period stated therein.

C. No Products may be returned unless authorized in advance by Seller, and then only upon such conditions to which Seller may agree. Buyer must obtain a Return Material Authorization (RMA) number from Seller prior to any return shipment, and such RMA number must appear on the shipping label and packing slip. Buyer shall be responsible for returned Products until such time as Seller receives the same at its facility, and for all charges for packing, inspection, shipping, transportation or insurance associated with returned Products.

D. This section VI sets forth the exclusive remedies and obligations for claims based upon defects in or nonconformity of Products/Services, whether the claim is in contract, warranty, tort (including negligence of any degree or strict liability) or otherwise. THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, WHETHER ORAL, WRITTEN, EXPRESS, IMPLIED OR STATUTORY. NO IMPLIED OR STATUTORY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE SHALL APPLY.

#### VII. PATENTS/INDEMNITY

If Buyer receives a claim that Products, or part thereof manufactured by Seller infringes a patent, Buyer shall notify Seller promptly in writing and give Seller information, assistance and exclusive authority to evaluate, defend and settle such claim. Where Buyer has furnished specifications/designs for the manufacture of the allegedly- infringing Products, Buyer shall defend, indemnify and hold harmless Seller against third-party claims for infringement arising out of Seller's use of such specifications/designs.

#### VIII. LIMITATION OF LIABILITY

The total liability of Seller on any claim, whether in contract, tort (including negligence of any degree and strict liability) or otherwise arising out of, connected with, or resulting from the manufacture, sale, delivery, resale, repair, replacement or use of any Products/Services, shall not exceed the price allocable to the Products/Services or part thereof which gives rise to the claim. IN

NO EVENT, WHETHER AS A RESULT OF BREACH OF CONTRACT, WARRANTY, TORT, (INCLUDING NEGLIGENCE OF ANY DEGREE, STRICT LIABILITY OR PATENT INFRINGEMENT) OR OTHERWISE, SHALL SELLER, ITS AFFILIATES, SUBCONTRACTORS, OR SUPPLIERS BE LIABLE FOR ANY LOSS OF PROFIT OR REVENUES, LOSS OF USE OF THE PRODUCTS OR SERVICES, OR ANY ASSOCIATED EQUIPMENT, COST OF CAPITAL, COST OF SUBSTITUTE GOODS, FACILITIES, SERVICES OR REPLACEMENT POWER, DOWNTIME COSTS OR CLAIMS OF BUYER'S CUSTOMERS FOR DAMAGES OR FOR ANY SPECIAL, PROXIMATE, CONSEQUENTIAL, INCIDENTAL, INDIRECT OR EXEMPLARY DAMAGES. If Buyer transfers title to, or leases Products sold hereunder to, or otherwise permits or suffers use by, any third party, Buyer shall obtain from such third party a provision affording Seller and its subcontractors/suppliers the protection of the preceding sentence. Any action against Seller must be brought within 18 months after cause of action accrues.

#### IX. EXCUSABLE DELAYS

A. Seller shall not be liable for delays in delivery or failure to perform due directly or indirectly to causes beyond Seller's reasonable control including but not limited to: acts of God; war; terrorism; civil commotion; riots; embargoes; government regulations, orders, instructions or priorities; port congestion; acts of or failure to act on the part of Buyer or its agents/employees; fires; floods; sabotage; nuclear incidents; earthquakes; storms; epidemics; strikes; lockouts or other labor difficulties; shortages of or inability to timely obtain proper labor, materials, components, shipping space or transportation, fuel, supplies or power at current prices; or due to limitations imposed by the extent of availability of Seller's normal manufacturing facilities.

B. If a delay excused per the above extends for more than 90 days and the parties have not agreed upon a revised basis for continuing providing Products/Services at the end of the delay, including adjustment of the price, then either party (except where delay is caused by Buyer, in which event only Seller) upon thirty (30) days' notice may terminate the Order with respect to the unexecuted portion of the Products/Services, whereupon Buyer shall promptly pay Seller its reasonable termination charges upon submission of Seller's invoices thereof. Dec 2018

#### X. SOFTWARE/TECHNICAL/PROPRIETARY INFORMATION

A. Buyer shall not acquire any rights to any software which may be delivered with Products, except as granted in Seller's standard software license. Any software license granted in connection with Products shall be an interim license, which may be withdrawn, pending payment for Products in full.

B. The purchase of Products shall not include any right to supply of technical information such as drawings or specifications.

C. Proprietary information, including drawings, documents, technical data, reports, software, designs, inventions and other technical information supplied by Seller in connection herewith (hereinafter called "Data"), shall remain Seller's sole property and shall be held in confidence by Buyer. Data shall not be reproduced, used or disclosed to others by Buyer without Seller's prior written consent. Upon completion of Order, Buyer shall promptly return all Data to Seller together with all copies or reprints thereof then in Buyer's possession or control, and Buyer shall thereafter make no future use, either directly or indirectly, of any Data or any information derived therefrom without Seller's prior written consent. The foregoing shall in no way obligate Seller to provide or supply Data.

#### XI. DIES, TOOLS, PATTERNS

Seller's charges for dies, molds, patterns and the like represent the Buyer's proportionate cost thereof, it being expressly understood that they remain the property of Seller. Modifications made to dies, molds, patterns and the like in order to manufacture Products shall be at the discretion of Seller.

#### XII. GENERAL

A. The rights and obligations of the Buyer and Seller hereunder shall be governed in all respects by the law of the Commonwealth of Pennsylvania, U.S.A. The exclusive forum for adjudication of any disputes shall be the federal or state courts of the Commonwealth of Pennsylvania, and Buyer/Seller hereby consent to personal jurisdiction and venue in such courts in any proceeding. The United Nations Convention on the International Sale of Goods shall not apply.

B. These Terms and Conditions of Sale together with any other terms specifically agreed to in writing by Seller constitute the entire agreement between Buyer and Seller and supersede any prior or contemporaneous representations, agreements, proposals, warranties, or understandings, oral or written, express or implied. No waiver, modification, amendment, rescission or other change to these Terms and Conditions of Sale shall be binding unless specifically agreed to in writing by an authorized representative of Seller.

C. The invalidity, of any part hereof shall not affect the validity of the remainder. The failure of Seller to assert any right at any time hereunder shall not prevent Seller's subsequent assertion of the same or different rights.

D. Buyer may not assign this contract without the prior written approval of the Seller.

#### XIII. PROHIBITION FOR HAZARDOUS USE

Products sold hereunder are not intended for application in and shall not be used by Buyer in construction or application of a nuclear installation or in connection with use or handling of nuclear material or for any hazardous activity or critical application, where failure of a single component could cause substantial harm to persons or property, unless Products have been specifically approved for such activity or application. Seller disclaims all liability for loss or damage resulting from such unauthorized use and Buyer shall defend, hold harmless and indemnify Seller against any such liability, whether arising under breach of contract, warranty, tort (regardless of the degree of fault or negligence), strict liability or otherwise.

Where Seller approves the application of the Products in a nuclear facility, the Buyer shall, before such use or provision, arrange for insurance or governmental indemnity protecting the Seller against liability and hereby releases and agrees to indemnify the Seller and its suppliers for any nuclear damage, including loss of use, in any manner arising out of a nuclear incident, whether alleged to be due, in whole or in part to the negligence or otherwise of the Seller or its suppliers.

#### XIV. STATUTORY REQUIREMENTS

Seller reserves the right to make any changes in the general specifications of the Products which are required for the Products to conform to any statutory requirement.

#### XV. GOVERNMENT CONTRACTS

Only Federal Acquisition Regulation ("FAR") supplement clauses expressly accepted in writing by Seller shall be included or incorporated by reference herein. Seller shall not be bound by and makes no representation of compliance with any FAR or FAR

supplement clauses that Seller shall not have expressly accepted in writing.

#### XVI. INVOICE FRAUD PREVENTION

Given the increased risk of invoice fraud, Buyer should treat any notification to change details of Seller's bank account with suspicion. Seller will not inform or instruct Buyer to make remittance or money transfers to any other beneficiary, address or bank account via email. Always verify a request to update records or change bank account information BEFORE implementing a change or completing the payment. Verify any requested changes by speaking to a known Seller representative.