



Model Series 3000

Thermoelectric Gas Cooler

Instruction Manual



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1.0 Receiving and Storage

The Universal Analyzers 3000 series dual channel or single channel dual stage gas sample cooler is a completely pre-assembled unit. No assembly is necessary when received on-site.

Carefully inspect the product 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.

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

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.

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 Product Identification & Configuration

For the current version of all Model 3000 product configurations, visit the Universal Analyzers website.

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

Navigate to: Products -> Gas Sample Coolers -> Model 3000 Thermoelectric Gas Cooler.

A link to the current configuration is provided at the bottom of the page.

4.0 Specifications

OPERATING SPECIFICATIONS	
Sample Flow Rate	
Model 3040	0 to 6 l/m total (at STP)
Model 3050	0 to 8 l/m total (at STP)
Model 3080	Single sample mode: 0 to 10 l/m total (at STP) Dual sample mode: 0 to 12 l/m total (at STP)
Maximum Inlet Temperature	
Stainless Steel Heat Exchanger	700°F (351°C)
Kynar/Glass Heat Exchanger	280°F (138°C)
Maximum Inlet Gas Dew Point	
Model 3040	180°F (82°C)
Model 3050	194°F (90°C)
Model 3080	Single sample mode: 194°F (90°C) Dual sample mode: 180°F (82°C)
Maximum Inlet Water Concentration	
Model 3040	50%
Model 3050	70%
Model 3080	Single stream mode: 70% Dual sample mode: 50%
Minimum Ambient Temperature	
32°F (0°C)	
Maximum Ambient Temperature	
105°F (41°C)*	
Maximum Cooling Power	
Model 3040	126 BTUs per hour (120 kJ/hr.)
Model 3050	126 BTUs per hour (120 kJ/hr.)
Model 3080	252 BTUs per hour (240 kJ/hr.)
Outlet Sample Dew Point	
39°F (4°C) adjustable	
Gas Sample Inlet Fitting	
3/8" tubing fitting	
Gas Sample Outlet Fitting	
1/4" tubing fitting	
Bottom Water Drain Fitting	
3/8" tubing fitting	
Dimensions (Without Accessories)	
Model 3040	18" H x 7.5" W x 11" D
Model 3050	18" H x 7.5" W x 11" D
Model 3080	18" H x 7.5" W x 11" D
Weight	
33 lbs (15kg)	
Soluble Gas Removal Rates	
NO 0% loss NO ₂ <10% loss SO ₂ < 2% loss CO 0% loss CO ₂ < 2% loss	

*AT REDUCED FLOW RATE ABOVE 77°F. (25°C.) AMBIENT.

COOLER CAPACITY DATA												
	Ambient 77°F/25°C Water Vapor				Ambient 90°F/32°C Water Vapor				Ambient 105°F/41°C Water Vapor			
	12%	15%	30%	50%	12%	15%	30%	50%	12%	15%	30%	50%
3040	5 l/m	4 l/m	2.8 l/m	1.4 l/m	5 l/m	4 l/m	2 l/m	1 l/m	2.8 l/m	2.4 l/m	1.2 l/m	0.6 l/m
3050	8 l/m	8 l/m	7 l/m	6 l/m	6 l/m	6 l/m	5.5 l/m	4.5 l/m	3 l/m	3 l/m	2.5 l/m	2 l/m
3080	10 l/m	8 l/m	4 l/m	2 l/m	8 l/m	7 l/m	3.5 l/m	1.8 l/m	4.6 l/m	4 l/m	2.2 l/m	1.1 l/m

(Flow Rate, Water Vapor % and the Ambient Temperature are the three main factors to consider when sizing a gas cooler.)

5.0 Description and Principle of Operation

5.1 Application

The Universal Analyzers 3000 Series Gas Sample Coolers are designed to be installed in a sample system where the gas sample contains moisture to be removed. They have an option to be installed in hazardous locations or unclassified locations.

The 3000 Series Coolers are designed as standalone equipment that does not require integration onto a panel. They are also designed for minimal maintenance.

The 3000 Series Coolers have mounting holes for 1/4" hardware and may be installed into a protected shelter or enclosures that are designed to remove the exhaust heat.

Ambient Temperature, Required Flow Rate, and Moisture Content will determine the specific model required for a specific application.

The use of a Heated Filter and Heated Sample Line are highly recommended to be installed between the sample extraction location and the input to the 3000 Series Gas Sample Cooler. They are recommended to keep the temperature of the sample above the boiling point of water or above the dew point of any chemical reactions that would skew the desired analytical results.

5.2 Description

The 3000 Series Gas Sample Coolers are Thermoelectric Coolers consisting of Peltier Thermoelectric Elements, control electronics, a heat sink, peristaltic pump motor, and blower fan assembled in a NEMA Type 1 Enclosure designed for mounting of optional equipment. The optional equipment consists of drain options, water carry over sensor, sample pump, flow meters, as well as different materials for the impingers (water removal columns) depending on the application.

The 3000 Series Coolers operate by condensing the water from a wet gas sample to a dew point of 4°C with a minimal loss of water-soluble gas due to the design of the impingers. The impinger is composed of an insulated tube enclosed in a highly polished cylinder that is then cooled. The hot wet sample is brought to the bottom of the cylinder through the insulated tube and is then allowed to rise through a narrow annular area at a relatively high Reynolds number to ensure the entire sample is influenced by the cold surface. The condensate falls down the cold polished surface in the form of a sheet (as opposed to droplets or the bubbling of the gas sample through the condensate) which minimizes the surface area in contact with the gas sample.

The temperature of the impinger is maintained through contact with a heat transfer block. Depending on the model the heat transfer block will either be ambient temperature or be actively cooled to 4°C through the use of Thermoelectric (Peltier) elements. A model 3040 has a single transfer block with two thermoelectric elements, a model 3050 has an ambient temperature transfer block and an active transfer block with two thermoelectric elements, and a model 3080 has two active transfer blocks for a total of four Thermoelectric Elements. The temperature is measured using an AD592 semiconductor temperature sensing device. This temperature is controlled to 4°C with a variance of one degree.

The Thermoelectric Elements create a temperature differential between the two sides of element when power is applied. This creates a cool side that cools the impinger and a hot side where the heat is discharged through a heat sink with a centrifugal drum blower forcing air through the heat sink.

The 3000 Series Sample Coolers have a digital display on the front panel indicating the operating temperature (in degrees C) of the heat exchangers. In addition, there are two green LED lights to indicate the status of the cooler. The 'COOL' light will shine yellow when the operating temperature is between 0°C and 10°C (32°F and 50°F) and otherwise be unlit. The "DRY" light will shine if there is no condensate sensor installed or if the installed condensate sensor sees water carry over past the impingers.

There are two alarm relays in the 3000 Series Sample Coolers. There is a relay with wetted contacts that will have the system voltage present and a relay with dry contacts for customers to provide their own signals. They are both triggered by either the moisture alarm or the temperature alarm.

Universal Analyzers Sample Chillers are designed to interface with a condensate carry over sensor. The standard sensor is provided with a filter (which is referred to as a “CCSF”) or it can be ordered without a filter (“CCS”). This sensor is put in place as an early warning device to ensure that a clean, dry sample is presented to the analyzer(s), thereby minimizing future maintenance and/or costly repairs.

The sensor is designed to operate with any current model Universal Analyzers sample chiller. If the sensor needs to be used as a standalone device, then a 100A Moisture Detection Module must be used in conjunction with the moisture sensor.

The technology behind the CCSF is a capacitive proximity sensor – this is advantageous because the condensate does not need to be conductive to trigger an alarm. The sensor has an M12 connector on the bottom and uses the same 1-meter cable (Universal Analyzers Part No. 3907-1017) to interface between the CCS/CCSF and all chillers and the 100A Moisture Detection Module. In addition, there is an LED indicator on the sensor itself that illuminates upon detection of condensation or particulate.

There is a potentiometer near the LED to adjust the sensitivity of the sensor. The CCS and CCSF are pre-set at the factory, and it is not necessary to calibrate in the field. However, we know every application is unique, and there may be a need or desire to adjust the sensitivity of the sensor to meet your specific application needs – be it more or less sensitive. The sensor has an arrow with +/- marked near the trim pot. To increase sensitivity, adjust the trim pot clockwise, conversely, turn the trim pot counterclockwise to reduce the sensitivity. Contact the factory if additional assistance is required.

The standard drain, a peristaltic pump, is a positive displacement pump that allows for use in either a pressure or vacuum sample. It provides for easy leak detection but does require periodic maintenance in replacement of the tubing. A secondary drain option is the use of a float drain trap. This can only be used if the heat exchangers are at a slight positive pressure in relation to atmosphere. Condensate collects in the trap until the float rises and allows for the condensate to drain. An eductor (aspirator) is another standard option for condensate removal. This option requires an instrument air source to create a vortex with the drain and draw the condensate out of the eductor.

A Sample Pump is offered as an option that is recommended for most applications to draw the sample from the point of extraction. Universal Analyzers uses a diaphragm pump for this purpose that is designed for reliability and minimal maintenance. The pump will draw the amount of sample required for the analyzer plus any bypass flow that may be desired to increase response time. When chosen as an option the pump has a sample pressure controller that is set at 10 PSI. When the ATEX option and the sample pump option is chosen an internal 140°C over-temperature switch in the pump is wired to shut power off to the pump to prevent damage. Operation will resume once the temperature has lowered to a safe level.

The final option in the sample stream offered is a flow meter with a flow control needle valve. This is offered in a variety of common desired flow ranges.

6.0 Installation



TO COMPLY WITH HAZARDOUS AREA STANDARDS, UNIT MUST BE INSTALLED IN A MINIMUM IP54 ENCLOSURE AND PROTECTED FROM DUST/ WATER INGRESS. ADEQUATE VENTILATION MUST BE PROVIDED FOR DISSIPATION OF A MINIMUM OF 1200 BTU/hr (1265 kJ/hr)

Universal Analyzers 3000 Series Sample Coolers should be installed away from heat sources in a well ventilated area of an instrument rack or enclosure. The Cooler performance is proportional to ambient temperature, too high a temperature will degrade performance. Contact the factory for recommendations. Air purging an enclosure generally requires more flow than is available to remove the heat which will be generated internally by the sample chiller. There are air conditioners and vortex cabinet coolers designed to provide the necessary cooling for enclosing thermoelectric chillers.

The 3000 series sample cooler has mounting taps on the top and bottom to allow it to be wall mounted or mounted to rails in an instrument rack. Accessories mounted on the side can be supported by the mounting flange on the cooler.

Sample tubing should be brought to the front heat exchanger. A 3/8" tubing fitting is provided at the top of the first heat exchanger as the sample inlet. The dry sample outlet from the cooler is the 1/4" Kynar tubing fitting coming out of the top of the exit heat exchanger at an angle. Unless integrated options are ordered.

The flow path option is a flow meter with adjustable needle valve. The customer connection is a 1/4" Kynar tubing fitting on the exit (top) of the flow meter.

A drain line from the peristaltic pump, eductor, or drain pot must be run to sewer, a container, or to the ground outside the instrument enclosure to avoid collecting water (condensate) on the floor.

If an eductor is utilized to remove the condensate, the outlet tube length should be no longer than two feet in order to keep too much back pressure from the outlet of the eductor. The outlet tube can be placed in a larger pipe to channel the condensate to a drain.

The electrical power, about 3 amps at 115VAC or 1.5 amps at 230VAC 50/60 Hz should be supplied. Installation shall be in accord with the manufacturer's instructions and the National Electrical Code (ANSI/NFPA 70). Tampering and replacement with non-factory components may adversely affect the safe use of the system. For the 115VAC case, a power cord is supplied. It can be replaced with conduit wiring easily.



NOTE: THE SUPPLY POWER CIRCUIT MUST INCLUDE AN OVERPROTECTION DEVICE WITH A MAXIMUM RATING OF 20A. A DISCONNECT SWITCH MUST BE LOCATED IN CLOSE PROXIMITY TO THE COOLER. 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.

7.0 Start-Up



NOTE: IT IS IMPORTANT THAT THE HEATED PROBE AND HEATED SAMPLE LINE SHOULD BE AT OPERATING TEMPERATURE BEFORE STARTING THE CHILLER AND SAMPLE PUMP

Apply power to the Universal Analyzers 3000 Series Sample Cooler. The indicated temperature will start to drop immediately. It should be below the over-temperature alarm point in approximately four minutes and the "COOL" green LED lamp should light. When the temperature reaches the control set point, the rate at which the temperature drops will be reduced. The temperature will stabilize within 1°C of the control set point.

If the optional sample pump is ordered, it will activate once the temperature has reached <10°C. If the optional flow meter is ordered, adjust the flow control valve to the desired flow rate. Water should be observed to be removed from the bottom of each heat exchanger when steady state conditions are established. The green "DRY" LED light will be active.

If an eductor is utilized to remove the condensate, a strong flow of air should be felt to be flowing from the eductor outlet tube. The outlet tube length should be no longer than two feet. The outlet tube can be placed in a larger pipe to channel the condensate to a drain.

Turn on the analyzer(s) and initiate the calibration cycle.

8.0 Shutdown

Disconnect the heated sample line. Allow the cooler to run for several minutes to remove any remaining possibly hazardous condensate from the impingers. Turn off power to the cooler.

9.0 Maintenance

Before performing any maintenance on the cooler, ensure that all plant safety procedures are followed. As with any electrical device, ensure power is removed before performing any procedures.

The cooler is designed for maintenance free operation but if any is required, ensure power has been removed before maintenance or repair is performed.

For the best performance of the cooler, the following maintenance schedule is recommended:

Maintenance Activity Frequency Peristaltic Pump Replace Tubing every 3 months Clean Heat Exchanger Annually Inspect Heat Sink Fins Monthly

9.1 Replacement of Peristaltic Tubing (If Equipped)

1. Please refer to manufacturer's website for instructions: <http://bit.ly/1zfmrzt>
2. YouTube: <http://bit.ly/1MPLUJO>

9.2 Replacement of Sample Pump Diaphragm

Please refer to manufacturers' website for instructions: <http://www.airdimensions.com>

9.3 Installing or Replacing Heat Exchangers

Removing the Heat Exchanger

1. Remove the inlet and outlet tubes by loosening the compression fittings. Always use a backup wrench on the fitting body to ensure no damage to the heat exchanger occurs.
2. Remove the drain fitting using the same procedure as the inlet/outlet. Remove the drain fittings from the exchanger. Use a backup wrench on the lower heat exchanger hex to prevent damage to the exchanger.

Replacing the Heat Exchanger

1. Dry and clean the heat exchanger opening in the heat transfer block using a dry, lint-free cloth (If reusing the heat exchanger, clean the outside as well.) Dried heat transfer paste can be removed by using a very fine abrasive pad wrapped around a drill bit.
2. Apply a thin layer of heat transfer paste onto the outer diameter of the heat exchanger.
3. Gently push the heat exchanger into the heat transfer block until the head is fully seated against the insulation on top.
4. Reinstall the drain fitting. Ensure pipe tape is used on the pipe threads before installation. Use a backup wrench on the heat exchanger lower hex to prevent damage to the exchanger.
5. Reconnected the drain, inlet and outlet tubes.

10.0 Troubleshooting

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

Error	Possible reason	Check/Repair
Condensate sensor alarm/ Dry light not illuminated	Overloading of the refrigeration capacity of the cooler due to too much water vapor or too great a sample flow rate. An air leak in the condensate removal tubing. Failure of the sample cooler. The cooler is not cold enough. Inadequate drain apparatus or a fault in the condensate removal equipment. The heat exchanger has become full of condensate. Excessive flow rate. High ambient temperature. Defective cooler.	Reduce flow rate Verify moisture content of sample and compare to operating specifications on page 6. Verify drain tubing is unobstructed and equipment is functioning satisfactory. Reduce the flow rate. Reduce the ambient temperature (Increase ventilation or relocate cooler). Verify air flow across the heat sink. Hold hand in front of heat sink fins and ensure air movement.
No sample gas flow	Heat exchanger plugged. Alarm shutoff. No power on cooler.	Check for an obstruction. Remove heat exchanger from unit and disassemble. Verify cool & dry indicators are illuminated. Ensure cooler has power supplied
High oxygen readings/ low pollutant readings	Leak. Defective peristaltic pump tubing Broken or leaking heat exchanger	Loose connection. Verify all fittings are leak free. Replace tubing. Remove heat exchanger and replace if broken or repair (replace O-Ring) if leaking.
'COOL' light is not illuminated	Ambient temperature too high flow rate/ water content too high. Failed peltier element.	Reduce the ambient temperature (Increase ventilation or relocate cooler). Lower the flow rate through the cooler and observe the results. If condition corrects itself, consult the factory for further troubleshooting. Measure resistance between the red & black peltier leads. A failed peltier element will read high resistance or 'Open'. Consult wiring diagram for wire location details.
Power only on drain pump	Blown fuse (F1). Defective transformer (T1)	Replace fuse. Replace power supply board.

11.0 Drawings and Spare Parts

For the current revision of all Model 3000 drawings and spare parts, visit the Universal Analyzers website.

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

Navigate to: Products -> Gas Sample Coolers -> Model 3000 Thermoelectric Gas Cooler.

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

12.0 Standard Terms & Conditions of Sale and 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 "Exworks" 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 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 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.

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.