



500 Series Thermoelectric Gas Coolers

Instruction Manual



TABLE OF CONTENTS

1.0	Receiving and Storage	3
2.0	Definition of Symbols.....	4
3.0	Product Identification	5
4.0	Specifications	6
5.0	Description and Principle of Operation	8
6.0	Installation	11
7.0	Start-Up.....	12
8.0	Shutdown	13
9.0	Maintenance.....	14
10.0	Troubleshooting.....	15
11.0	Drawings and Spare Parts.....	17
12.0	Standard Terms & Conditions of Sale and Warranty	18

1.0 Receiving and Storage

The Universal Analyzers Series 500 Thermoelectric Gas Coolers are completely pre-assembled. 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

For the current version of all Series 500 product configurations, visit the Universal Analyzers website.

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

Navigate to: Products -> Gas Sample Coolers -> 500 Series Cooler

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

4.0 Specifications

OPERATING SPECIFICATIONS	
Sample Flow Rate	
Model 520	0 to 2 1/2 l/m total (at STP)
Model 530	0 to 5 l/m total (at STP)
Model 540	0 to 4 l/m total (at STP)
Model 560	0 to 5 l/m total (at STP)
Model 570	0 to 4 l/m total (at STP)
Model 574	0 to 4 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	180°F (82°C)*
Maximum Inlet Water Concentration	50%*
Minimum Ambient Temperature	34°F (1°C)
Maximum Ambient Temperature	105°F (41°C)*
Maximum Cooling Power	
Model 520	63 BTUs per hour (60 kJ/hr)
Model 530	63 BTUs per hour (60 kJ/hr)
Model 540	126 BTUs per hour (120 kJ/hr)
Model 560	126 BTUs per hour (120 kJ/hr)
Model 570	126 BTUs per hour (120 kJ/hr)
Model 574	126 BTUs per hour (120 kJ/hr)
Outlet Sample Dew Point	41°F (5°C)
Gas Sample Inlet Fitting	3/8" tubing fitting
Gas Sample Outlet Fitting	1/4" tubing fitting
Bottom Water Drain Fitting	3/8" tubing fitting
Maximum Input Power	
Model 520	250 watts
Model 530	250 watts
Model 540	475 watts
Model 560	475 watts
Model 570	475 watts
Model 574	925 watts
Voltage	
All models	90-132/180-264VAC, 50/60 Hz
Electrical Classification	General Purpose, NEMA 1
Dimensions **	
Model 520	11" H x 9" W x 9" D
Model 530	11" H x 11" W x 9" D
Model 540	11" H x 11" W x 10" D
Model 560	11" H x 9" W x 9" D
Model 570	11" H x 11" W x 10" D
Model 574	11" H x 11" W x 11" D

Weight	
Model 520	19 lbs (8.5 kg)
Model 530	21 lbs (9.5 kg)
Model 540	21 lbs (9.5 kg)
Model 560	21 lbs (9.5 kg)
Model 570	25 lbs (11.5 kg)
Model 574	25 lbs (11.5 kg)
Soluble Gas Removal Rates	NO 0% loss NO ₂ <10% loss SO ₂ < 2% loss CO 0% loss CO ₂ < 2% loss
Storage Requirements	Cool and dry location, -20°F < x < 120°F < 95° relative humidity, non-condensing

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

** DIMENSIONS DO NOT INCLUDE FITTINGS OR MOUNTING HARDWARE

5.0 Description and Principle of Operation

APPLICATION

In order to accurately analyze combustion gases, moisture must be removed from the sample without removing gas components of interest. The Universal Analyzers Thermoelectric Gas Cooler provides an ideal repeatable, and stable way to decrease the dew point of combustion gasses. This prevents water condensation in sample prefilters, sample pumps, and gas analyzers. Where water vapor is an interferent, a stable and repeatable dew point becomes a part of the gas analyzer's performance specification. The 500 Series Cooler provides this constant, resulting in an accurate analysis of the gas components of interest.

The gas sample is first pulled through a sample probe, which usually contains a heated filter, and then through a heated sample line, which keeps the sample above its dew point. The 500 Series Cooler then condenses water out of the sample, which lowers the dew point to 5°C (41°F).

The 500 Series Thermoelectric Gas Coolers are for general purpose, light duty applications. Several models are available to meet various application conditions. Use the cooler selection chart below to best fit a model to the expected flow rates, water vapor concentrations, and ambient temperature conditions. If none of the models listed meet the needs of the application, contact your Universal Analyzers local sales representative for more options.

GAS COOLER SELECTION CHART

Conditions		Model						
Ambient	Water	520	530	540*	560	570	574*	574*
77°F (25°C)	12%	2.5 l/m	4.0 l/m	2.5 l/m	5.0 l/m	4.0 l/m	5.0 l/m	2.5 l/m
	15%	2.0 l/m	4.0 l/m	2.0 l/m	4.0 l/m	4.0 l/m	4.0 l/m	2.0 l/m
	30%	1.0 l/m	4.0 l/m	1.0 l/m	2.0 l/m	4.0 l/m	2.0 l/m	1.0 l/m
	50%	0.6 l/m	4.0 l/m	0.6 l/m	1.0 l/m	4.0 l/m	1.0 l/m	0.6 l/m
90°F (32°C)	12%	2.0 l/m	3.0 l/m	2.0 l/m	4.0 l/m	3.0 l/m	4.0 l/m	2.0 l/m
	15%	1.8 l/m	3.0 l/m	1.8 l/m	3.5 l/m	3.0 l/m	3.5 l/m	1.8 l/m
	30%	0.9 l/m	3.0 l/m	0.9 l/m	1.8 l/m	3.0 l/m	1.8 l/m	0.9 l/m
	50%	0.5 l/m	3.0 l/m	0.5 l/m	0.9 l/m	3.0 l/m	0.9 l/m	0.5 l/m
105°F (41°C)	12%	1.5 l/m	2.0 l/m	1.5 l/m	3.0 l/m	2.0 l/m	3.0 l/m	1.5 l/m
	15%	1.2 l/m	2.0 l/m	1.2 l/m	2.5 l/m	2.0 l/m	2.5 l/m	1.2 l/m
	30%	0.6 l/m	2.0 l/m	0.6 l/m	1.3 l/m	2.0 l/m	1.3 l/m	0.6 l/m
	50%	0.3 l/m	2.0 l/m	0.3 l/m	0.7 l/m	2.0 l/m	0.7 l/m	0.3 l/m
# of Gas Streams		1	1	2	1	2	2	4

*THE DATA PROVIDED IS FOR EACH STREAM

Various combustion processes can produce high levels of corrosive elements. An array of materials is available for the 500 Series Coolers, where gases come into contact with heat exchangers. 316SS is the most common option and meets the needs of most general-purpose applications. Coatings of Silconert™ 2000, or Teflon® may be added to the stainless-steel heat exchanger to enhance chemical resistance. Heat exchangers may also be made of other materials for corrosion resistance, such as Glass/Kynar®, Kynar®/Kynar®, and Hastelloy® C276. Contact your local sales representative for information on which material is best suited for your application.

New Jersey Thermocouple Types K and J are available for external monitoring of heat exchanger temperatures.

DESCRIPTION

The Universal Analyzers 500 Series Thermoelectric Gas Coolers condition gas sample streams to remove water vapor. The gas sample is cooled thermoelectrically to a controlled temperature, and water vapor is condensed and removed.

The key to success is being able to condense the water from a wet gas sample with a minimal loss of the water-soluble gas fraction. The separation occurs in a classical impinger, which has a highly polished cylindrical surface, cooled to the desired dew point temperature. The gas sample is brought to the bottom of the cylinder through an insulated tube and allowed to rise through a narrow annular area at a relatively high Reynolds number to insure 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 cylindrical, condensation surface of the heat exchangers is maintained through intimate contact with aluminum heat transfer blocks. The blocks are cooled with thermoelectric elements, controlled to a temperature of 5°C. The temperature sensor is a type "K" thermocouple. The temperature controller is proportional with a band of 1°C.

The fan cooled heat sink is constructed from anodized, pure aluminum fins which transfer heat to the surrounding air. The pure aluminum material is a far better conductor of heat than the aluminum alloys which are normally used for extruded heat sinks. The result is an assembly with superior heat exhausting capabilities under high ambient temperature conditions.

The 500 Series Coolers have a digital display for front panel indication of the operating temperature of each of the heat transfer blocks (switch selectable) in degrees Centigrade. Two internal jumpers at the top of the control circuit board within the enclosure can be moved to change the indicated temperature to read out in degrees Fahrenheit.

Three LED lamps to indicate the status of the cooler. The "COOL" lamp is a green LED which indicates when the operating temperature has fallen below the factory set temperature of 10°C. An "Over-temperature relay" is energized and closed to the cool position when the "COOL" lamp is on. The relay board within the enclosure has dual terminal strip relay contacts for alarm/shutdown purposes. The external gas sample pump may be interlocked with this relay to power off when temperatures become too high (fail safe).

The "DRY" lamp is a green LED which indicates when there is no water in contact with the water carry-over sensor (provided separately or as a system option). If no moisture sensor is used, the lamp may be turned off by installing a jumper on the moisture sensor input terminals on the relay board. Without a moisture sensor installed, the "DRY" lamp is always lit and does not indicate a condition. The moisture sensor relay, which is energized in the "DRY" condition, provides contacts to an annunciator panel and/or to turn off the sample pump in the "wet" condition.

The "TC" lamp is a red LED which indicates when there is a problem (open connection) in the temperature control thermocouple. The "Over-temperature" relay will also transfer to the high temperature condition if the red "TC" lamp comes on.

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. Condensate sensor (CCS/CCSF) sold separately for 500/1000 series coolers.

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 one 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.

LED INDICATOR CHART

LED	Color	Status	Condition	Relay Status
COOL	Green	On	Operating properly, temperature below 10°C	Over Temperature: Energized, towards COLD
		Off	Temperature too high or unit is OFF	Over Temperature: De-Energized, towards HOT
DRY	Green	On	CCS sensor connected, and sample is dry	Condensate Sensor: Energized, towards DRY
		Off	Moisture detected, or jumper installed	Condensate Sensor: De-Energized, towards WET
TC	Red	On	Temperature control TC has BAD quality	Over temperature: De-Energized, towards HOT
		Off	Temperature control TC has OK quality	Does not affect relays

A gas sample pump may be provided as part of the sampling system. If the pump is placed ahead of the sample cooler, it should be provided with a heated head to avoid the condensation of water vapor. If the sample pump is placed after the sample cooler, drawing the sample through the cooler, the sample has been dried, and a standard, non-heated pump may be used.

A means to control the flow of the sample through the system should be available and visible to the operator. This may be accomplished with pressure regulators and gauges, flowmeters, and/or flow control needle valves.

Condensate removal from the heat exchanger(s) within the Sample Cooler can be accomplished through one of the following methods:

1. A continuously running peristaltic tubing pump.
2. Installing the heat exchanger as a bypass condenser, pulling excess sample through with an eductor.
3. Using float drain traps similar to a steam trap. This requires the sample within the cooler to be at a positive pressure.
4. Use of drain pots on level control with a removal pump.

6.0 Installation

The 500 Series Thermoelectric Gas Coolers are best suited for Indoor, air-conditioned environments. Each unit dissipates heat, and the surrounding area must be well ventilated to provide adequate cooling. The cooler should be located away from other heat sources. If located inside a small enclosure, outside air should be ducted directly onto the heat sink, and thermostatically controlled fans and vents should be utilized. Never mount the unit in direct sunlight to avoid solar heat loading.

Route heated sample line directly to the 3/8" inlet tubing fittings located on the top of the cooler heat exchangers. Keep the sample heated all the way up to the inlet fitting. Sample outlet tubing fittings are reduced to 1/4" Tube. Some 500 series chillers are available in a dual stream configuration – in this case each channel will have a 3/8" Tube inlet and a 1/4" Tube outlet.

At the bottom of each heat exchanger, a 3/8" tubing fitting is provided for the condensate drain. The condensate fitting may be removed to expose a female 3/8" NPT connection. Equipment must be installed to remove the condensate such as a peristaltic pump, liquid drainer, or aspirated drainer. If an aspirator drain is utilized, the outlet tubing should have a small bore and be no longer than two feet to minimize back pressure. The drain must be run to an appropriate condensate disposal location.

A sample pump is normally required to pull the gas sample through the cooler. A Condensate Carry-Over Sensor (CCSF) is recommended for each sample path. It is typical to install the sample pump between the chiller and the moisture sensor to protect the pump head for condensation.

Each cooler consumes about 2 amps (at 115VAC) per every active heat exchanger. Use minimum wire size of 18 AWG, stranded, tinned copper with a minimum rating of 300 Volts. Dual relays are provided for both the WET/ DRY and HOT/ COLD conditions. One set of relays are MOV protected and designed to interrupt power to the sample pump upon alarm.

The temperature of the heat exchangers may be viewed on the display on the front of the unit. A toggle switch on the left side of the display allows the user to view the settings for the relay set-point and cooler temperature. Jumpers inside the unit on the control panel allow setting the display for degrees Celsius or degrees Fahrenheit.

Sample pumps, CCSF sensors, drains, flow meters, regulators, and other optional equipment are available from Universal Analyzers. These may be purchased separately or installed on a complete 500 Series Sample Conditioning System. Contact the factory for details.

All installations shall be in accord with the local/plant regulations, manufacturer's instructions, and the National Electric Code (ANSI/NFPA 70).

7.0 Start-Up

Apply power to the Universal Analyzers 500 Series Thermoelectric Gas Cooler. The indicated temperature will start to drop immediately. It should be below the over-temperature set point in approximately four minutes and the "COOL" green LED lamp should light. When the temperature reaches the control point (set at 5°C), the rate at which the temperature drops will be reduced. It will stabilize between 4° and 5°C.

Start the sample gas flow. Water should be observed to be removed from the bottom of the heat exchanger when steady state conditions are established.

If condensate sensors are installed, the (DRY) light should remain on as dry gas is transported to the analyzer(s). Turn on the analyzer(s) and calibrate as required.

8.0 Shutdown

Stop sample gas flow to the Universal Analyzers 500 Series Thermoelectric Gas Cooler by turning off the sample pump. Allow the drain pump to run for several minutes to remove any remaining condensate from the heat exchangers. After all condensate has been drained, turn off power to the cooler.

9.0 Maintenance

Before performing any maintenance on the 500 Series Thermoelectric Gas Cooler, ensure that all plant safety procedures are followed. The 500 Series Cooler is designed for maintenance free operation, but if any is required, ensure power has been removed before maintenance 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
Diaphragm sample pump	Replace diaphragm every 6 months
Clean heat exchanger	Annually
Inspect heat sink fins	Monthly

10.0 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).

Error	Possible reason	Check/Repair
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
Condensate carry over Presence of water	Inadequate drain apparatus Excessive flow rate High ambient temperature Defective Cooler	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
High oxygen readings / low pollutant readings	Leak	Loose connection Verify all fittings are leak free Defective peristaltic pump tubing Replace tubing Broken or leaking heat exchanger Remove heat exchanger and replace if broken or repair (replace O-Ring) if leaking

<p>'Cool' light is not illuminated</p>	<p>Ambient temperature too high</p> <p>Flow rate / water content too high</p> <p>Failed Peltier element</p>	<p>Reduce the ambient temperature (Increase ventilation or relocate cooler)</p> <p>Lower the flow rate through the cooler and observe the results</p> <p>If condition corrects itself, consult the factory for further troubleshooting</p> <p>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.</p>
<p>Power only on drain pump</p>	<p>Blown fuse (F1)</p> <p>Defective transformer (T1)</p>	<p>Replace fuse</p> <p>Replace power supply board</p>

11.0 Drawings and Spare Parts

For the current revision of all 500 Series Cooler drawings, visit the Universal Analyzers website.

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

Navigate to: Products -> Gas Sample Coolers -> 500 Series Cooler

Links to all current drawings and spare parts for standard 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 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.

and makes no representation of compliance with any FAR or FAR supplement clauses that Seller shall not have expressly accepted in writing.

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