



APPLIED TEST SYSTEMS
THE MARK OF RELIABILITY

INSTRUCTION MANUAL

Series 3310 & 3320

High Temperature Tube & Split Tube Furnaces



This manual contains important operating and safety information. Carefully read and understand the contents of this manual prior to the operation of this equipment.

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Information in this document is subject to change without notice and does not represent a commitment on the part of:

Applied Test Systems (ATS)
154 East Brook Lane
Butler, PA 16002
USA

Telephone: +1-724-283-1212

For assistance with set-up or operation, contact the ATS service department. Please have this manual and product serial number available when you call.

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Manual Contents

A. Introduction	1
A.1 Unpacking	1
A.2 Warranty Information.....	1
A.3 After Sale Support.....	1
B. Safety.....	2
B.1 Owners, Operators, and Maintenance	2
B.2 Environmental Conditions	4
C. System Overview.....	5
C.1 General Description	5
C.2 Technical Information.....	5
D. Installation	7
D.2 Installation.....	7
D.3 Control System Installation.....	8
E. Operation	10
E.1 Operation	10
E.2 Performance Tips.....	10
F. Maintenance	11
F.1 Maintenance.....	11
F.2 Furnace Bakeout	11
F.3 Replacement of Heating Elements	12
G. Safety Data Sheet	14
Appendix A: Warranty	15

A. Introduction

A.1 Unpacking

Retain all cartons and packing materials until the unit is operated and found to be in good condition. If damage has occurred during shipping, notify Applied Test Systems (ATS) and the carrier immediately. If it is necessary to file a damage claim, retain the packing materials for inspection by the carrier.

Carefully unpack the equipment and inspect it for damage during shipment. Retain all cartons and packing materials until the unit is operated and found to be in good condition. If damage has occurred during shipping, notify the carrier and ATS immediately. If it is necessary to file a damage claim, retain the packaging materials for inspection by the carrier.

A.2 Warranty Information

All new ATS systems are shipped with a warranty. Units have a warranty against defective parts and workmanship for one full year from the date of shipment. Please see APPENDIX A of this manual for complete details on the warranty.

A.3 After Sale Support

If there are any questions concerning the operation of the unit or software, contact the ATS Service Department at +1-724-283-1212.

Before calling, please obtain the software revision number from the View Screen and the serial number from the unit's data tag. A sample data tag is illustrated below, and can be completed with the unit's information for easy reference. Please be prepared to give a complete description of the problem to the ATS Service Department.

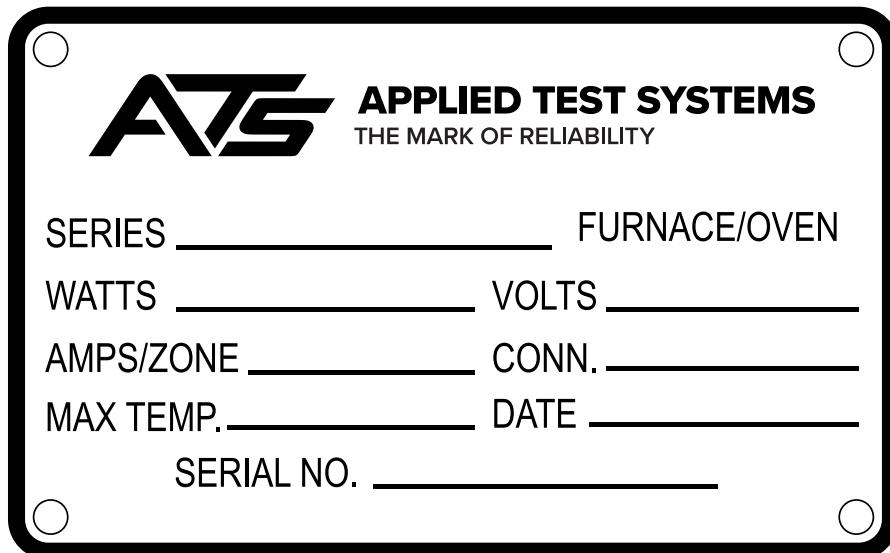


Figure A.1: ATS Sample Data Tag

B. Safety

B.1 Owners, Operators, and Maintenance

This manual uses note, caution, and warning symbols throughout to draw your attention to important operational and safety information.

Read and understand all instructions and safety precautions listed in this manual before installing or operating your unit. If you have any questions regarding operation of the unit or instructions in this manual, contact our Service Engineering Department at +1-724-283-1212.

In addition to the safety warnings listed here, warnings are posted throughout the manual. Read and follow these important instructions. Failure to observe these instructions can result in permanent damage to the unit, significant property damage, personal injury, or death.



Read and understand all instructions and safety precautions listed in this manual before installing or operating your unit. If you have any questions regarding operation of the unit or instructions in this manual, contact our Service Engineering Department.



Thoroughly understand the safety features and operation of the equipment. This manual will provide operators with safety concerns and general procedures. Be familiar with correct operating principles and use good judgment. Also refer to the appropriate manuals for system component safety instruction manuals.



Use caution when working with elements at elevated temperatures. Prevent burns by wearing protective clothing, and follow safety, operation, and maintenance procedures described in the appropriate instruction manuals.



Avoid radiating heat. Items with a large mass retain heat for a long time. First-degree burns may occur from heat radiation as well as from direct contact with a hot surface.



Follow all national and local electric code requirements. Furnaces and control systems must be grounded and wired according to national and local electrical code requirements.



Handle the furnace carefully. Avoid dropping and jarring the furnace.



Avoid damage to cables. Do not let the power cables touch the heated furnace shell.



Do not exceed maximum operating temperature. Operate the furnace and accessories within the appropriate temperature range. Refer to the appropriate manuals.



Dangerous high voltages present. Do not attempt to open the enclosure or gain access to areas where you are not instructed to do so. Refer servicing to qualified service personnel only.



Caution - Injury to the operator could occur if operational procedures are not followed. Follow all steps or procedures as instructed and refer to accompanying documents.



Ventilation – Slots and openings in the cabinet are provided for ventilation and to ensure reliable operation of the product. To protect the unit from overheating, those openings must not be blocked or covered. This product should not be placed in a built-in installation, such as a wall cut-out unless proper ventilation is provided. Hot temperatures will result.



Refer to manual. Before tuning the temperature controller, be sure to read and understand the tuning instructions in the controller manual. Follow all operating and other instructions carefully.



If it should become necessary to clean this equipment, disconnect the unit from its power source first. Do not use liquid cleaners, aerosols, abrasive pads, scouring powders or solvents, such as benzene or alcohol. Use a soft cloth lightly moistened with a mild detergent solution. Ensure the surface cleaned is fully dry before reconnecting power.



Do not attempt to operate the temperature control system in ambient temperatures higher than 120° F (49° C) without providing a cooling fan or air conditioning.



Do not use a temperature control system with a power output rating lower than the current rating of the furnace.



Use the same thermocouples as indicated on the setpoint controller. Other types will result in faulty control which may cause damage from overheated components.



When changing fuses in current limiting power controllers, use only the fuse type and size specified by the power controller manufacturer.



Use interconnecting cables of the proper gauge to match the ratings on the data labels for the furnace and controller.



Do not connect any measuring or controlling devices to the thermocouple other than the main temperature controller.



Use thermocouple extension wires and connectors that match the thermocouple type being used. Use of copper wires will cause errors in readings and result in faulty control.



Do not allow the bare thermocouple wires or any part of the thermocouple to come in contact with other metals. This could induce incorrect voltages and result in erroneous readings and faulty control.

B.2 Environmental Conditions

The furnace is meant for use in laboratory/factory settings in a dry, clean work environment. There should be a clean and sturdy work surface both at a reasonable working height and away from any water, gas, or electrical hazards. The work surface should be able to support more than the weight of the unit itself. The indoor area should be well ventilated and containing no open flames or materials that may constitute a fire hazard.

- Temperature of 15° C to 35° C
- Relative humidity not more than 75%
- Air pressure of 75 kPa to 106 kPa
- No hard-frost, dew, percolating water rain, solar irradiation, etc.
- Installation category II
- Pollution degree 2

C. System Overview

C.1 General Description

Series 3310 & 3320 High Temperature Tube & Split Tube Furnaces are available in a wide selection of diameters, lengths, and mounting types. Normally built to order for customer requirements, the 3320 Series provides an extremely versatile furnace capable of temperatures as high as 3272°F (1800°C)* when equipped with Molybdenum Disilicide elements. The heating elements are available in various sizes and may be replaced in the laboratory. The elements operate at a low voltage and high current requiring a transformer and current limiting in the control system. The furnace is constructed with a stainless steel shell, end flanges, and mesh terminal covers. Insulation is a low "K" factor vacuum cast ceramic fiber to provide minimum heat loss, high temperature capability, and rigid structure. The series is compatible with a variety of accessories to include: thermocouples, controls, recording systems, view ports, mounting brackets, and a variety of other products.

C.2 Technical Information

Molybdenum Disilicide elements have a life expectancy based on the following variables:

- OPERATING TEMPERATURE
- ELECTRICAL LOADING (WATTS PER IN² OF RADIATING SURFACE)
- ATMOSPHERE
- TYPE OF OPERATION (CONTINUOUS OR INTERMITTENT)
- OPERATING AND MAINTENANCE TECHNIQUES

Molybdenum Disilicide elements combine compact size with rapid heat – up and cool - down properties. Single elements may be replaced individually without the need of electrical matching. They are self cleaning and self healing. If surface cracks develop, simply heat the element above 2010°F (1100°C) in an oxidizing atmosphere and the element will heal over.

Molybdenum Disilicide heating elements normally operate between 1300°C and 1800°C (2372°F - 3272°F). Molybdenum Disilicide elements may be used below 1300°C (2372°F) particularly for furnace atmospheres harmful to silicon carbide heating elements (e.g., sulfur dioxide, water-steam, etc.). Molybdenum Disilicide should not be used between the temperature range of 400°C and 700°C (752°F - 1292°F), where a destructive low temperature oxidation may occur called pest.

Furnace atmospheres affect the life expectancy of Molybdenum Disilicide elements. Most favorable are oxidizing atmospheres such as air, CO₂, and water vapor, but they may also be successfully operated in neutral and carburizing atmospheres. Maximum recommended element temperatures in some common atmospheres are shown below.

Air	3270°F	1800°C
Nitrogen	3090°F	1700°C
Argon, Helium	3090°F	1700°C
Dry Hydrogen	2550°F	1400°C
Moist Hydrogen ¹	2730°F	1500°C
Exogas ²	3090°F	1700°C
Endogas ³	2640°F	1450°C
Ammonia ⁴	2640°F	1450°C

Molybdenum Disilicide Elements are not suitable for operation in a high vacuum at high temperatures.

For additional information about other furnace atmospheres and their effects on the Molybdenum Disilicide, call ATS Sales Engineering.

1. Dewpoint 15°C, 60°F.
2. 10% CO₂, 5%CO, 15%H₂, BALANCE N₂
3. 20% CO, 40%H₂, BALANCE N₂
4. Cracked and Partially Burnt (8% H₂)

D. Installation

D.2 Installation

Mount the furnace in the desired location.

Note: All 3310 & 3320 series furnaces must be mounted so that they heated portion of the elements hang vertically.

Adjust furnace position for proper alignment with load train, retort, etc.

Remove the terminal block cover to access the terminal block. Refer to connection diagrams and control system manuals to make the proper power connections. Refer to appropriate electrical codes.

Check fit of end caps to minimize heat loss at the ports.

Connect thermocouple to control system. Use thermocouple type as described in the furnace specification sheet.

NOTE: Thermocouple extension cables and connectors must be compatible with the thermocouple type being used.

CAUTION: Do not block cooling air flow to element terminal area on open top furnaces. Exercise caution when packing insulation in load train ports to prevent heat loss without blocking air flow to element connections.

CAUTION: Do not block, cover, or place insulation on top of the furnace that may restrict, block, or otherwise impede the cooling air to the heating element connections. This will result in damage to the element connectors. This practice constitutes misuse and voids warranty.

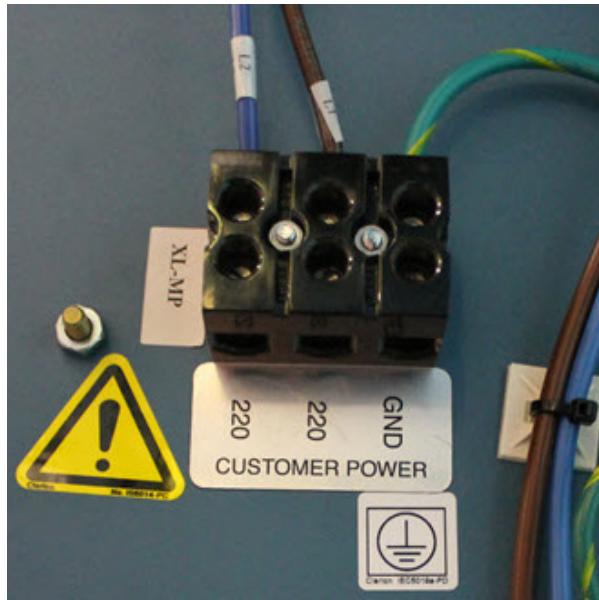
NOTE: To prevent possible damage to electrical components from high starting currents, it is recommended that a control system with a current limiting feature be used. On systems not supplied by ATS, start - up must be made with 1/3 normal system voltage.

CAUTION: Avoid contacting flammable materials with the heated furnace shell. For example, do not put the furnace directly on a wooden work bench. Trapped heat can cause a fire.

D.3 Control System Installation

If the unit comes with a control system, skip this step. If a control system is not supplied, remove the terminal block cover to access the terminal block. Refer to the electrical connection drawings to make the proper power connections.

CAUTION: Obey all national and local electrical code requirements. Furnaces and control systems must be grounded and wired according to national and local electrical codes.



If the control cabinet is not supplied with a power cord, supply the incoming power to the terminal block.

NOTE: ATS recommends one of the following cords. The gauge size should have the same amp rating or larger than the supplied circuit breaker.

Size (AWG)	Thermoset Types/ Thermoplastic Types*
14	15
12	20
10	25
8	35
6	45
4	60
2	80

*Thermoset Types: C, E, EO, PD, S, SJ, SJO, SJOW, SJOO, SJOOW, SO, SOW, SOO, SOOW, SP-1, SP-2, SP-3, SRD, SV, SVO, SVOO

Thermoplastic Types: ET, ETLB, ETP, ETT, SE, SEW, SEO, SEOW, SEOOW, SJE, SJEW, SJEO, SJEOOW, SJT, SJTW, SJTO, SJTOW, SJTOO, SJTOOW, SPE-1, SPE-2, SPE-3, SPT-1, SPT-1W, SPT-2, SPT-2W, SPT-3, ST, SRDE, SRDT, STO, STOW, STOO, STOOW, SVE, SVEO, SVT, SVTO, SVTOO

Ensure all connections are made between the control system and furnace.



Turn on the breaker and turn switch to ON to activate the controllers. Refer to the controller manufacturer instructions for operation instructions.



If the controller is equipped with an emergency stop button (E-stop button), be sure it is functioning properly by pushing the knob (this will stop the test in an emergency) and then pulling the knob and rotating it according to the arrows on the knob (this will re-engage the E-stop).



E. Operation

E.1 Operation

After completing furnace setup and connections, refer to the manufacturer's instructions or the ATS manual for the temperature controller operation.

NOTE: Refer to section F.2 for initial operation

CAUTION: Before setting the temperature controller to the desired temperature, be sure you have observed temperature change restrictions of other system components such as pull rods, extensometers, retort, and the specimen. Observe and comply with recommended heat-up and cool-down rates.

CAUTION: Make sure that nothing electrically conductive comes in contact with the elements which may short out the elements and cause element burnout. **CAUTION:** Do not exceed maximum operating temperature in any part of the furnace. Check the furnace specification sheet for the maximum temperature permitted for the insulation.

CAUTION: Molybdenum Disilicide elements which have been operating for a long time at high temperature and have cooled down, have internal stresses that may cause the glaze to splinter into small fragments. They may be cold for several days and emit a shower of fine glaze particles when touched or disturbed. Always wear eye protection, even when handling cooled down Molybdenum Disilicide elements.

E.2 Performance Tips

Some insulation shrinkage may occur and is normal. To eliminate heat loss at these points, seal cracks with an insulation of a similar temperature rating.

When using a retort, follow recommended procedures in retort manual. Exercise caution to prevent retort cooling water from coming in contact with the furnace components. Excessive water cooling can prevent the furnace from reaching the desired temperature.

Use smallest load train components that will accept loading to minimize heat transfer.

Pack load train ports around pull rods with blanket insulation to prevent heat loss. Assure blanket insulation is capable of the required temperatures. Be careful not to restrict load train motion.

Operate the furnace with the elements in the vertical, hanging position only.

F. Maintenance

F.1 Maintenance

On a frequent basis, the Series 3310 & 3320 Tube Furnaces should be inspected for problems that may cause abnormal operation. Some problems may include the following: bad connections, loose support clamps, missing or damaged insulation, and insulation blanket blocking the flow of air around the terminals.

About once a month, check the thermal insulation for any signs of damage, cracking, or poor fit.

NOTE: Surface cracks on the hot face are a normal occurrence

Any problems may cause poor furnace performance. Check with your ATS sales engineer if any insulation problems exist.

F.2 Furnace Bakeout

This bakeout only needs to be done once on new furnaces and after replacement of insulation on older furnaces. No bakeout is required when replacing heating elements. If the furnace is used with a retort, bake out retort with furnace. Vent retort during bake.

WARNING: BAKEOUT WILL PRODUCE ODORS AND SMOKE. IT SHOULD BE PERFORMED IN A WELL VENTILATED AREA.

1. The first time the furnace is fired, heat up to 1652°F(900°C). The heat - up rate can be rapid. Let the furnace soak at 1652°F (900°C.) for approximately two hours.

CAUTION: During the initial bake out of a high temperature furnace equipped with Molybdenum Disilicide elements, periodically observe the heating elements to assure that they are not bending toward the outside insulation to the point of touching. Slight bending is a normal condition. Excessive bending to the point of touching should be corrected. Shut down the furnace power, (observe cooling rates for furnace and accessories) disconnect, and rotate the bent element 180 degrees toward the center of the furnace. Reattach connections and hardware and resume bake out. Above 2192°F (1200°C) the element will straighten.

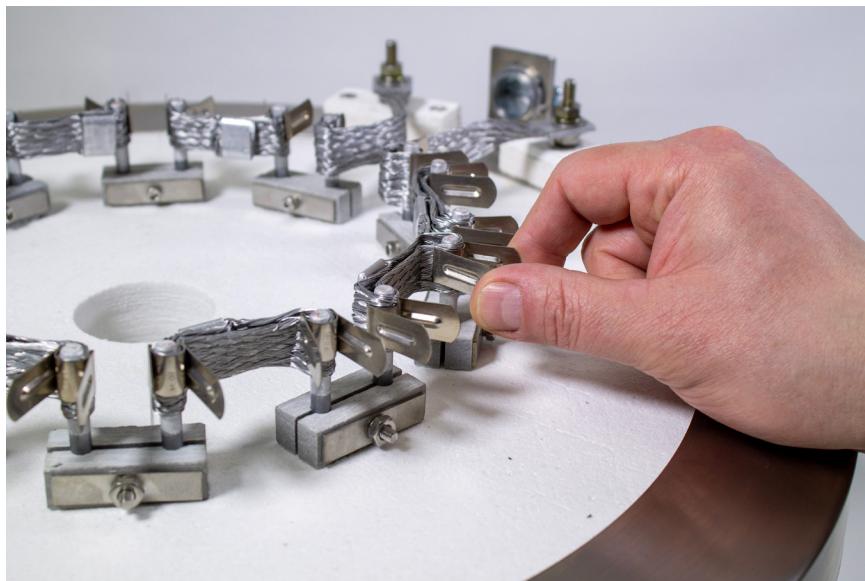
CAUTION: Molybdenum Disilicide elements are very brittle and easily broken. Handle with extreme care.

1. Increase the furnace temperature to 2192°F (1200°C.). The heat - up rate should not exceed 180°F (100°C) per hour. Let the furnace soak at 2192°F (1200°C.) for approximately 1 hour.
2. Increase the temperature to the expected operating temperature. At this time the temperature control system may be fine tuned for operation. Refer to manufacturer's literature.
3. At completion of bake out, gradually back off or ramp down the controller to allow 15 minutes for the furnace power output to drop to zero. Then shut off power and allow the furnace to slowly cool (overnight) to 200°F (93°C) or lower before opening.

NOTE: Re - tighten the support clamps on furnaces with Molybdenum Disilicide elements after the initial bake out. Inspect and re-tighten monthly for intermittent operation or when furnace is cooled after extended usage.

F.3 Replacement of Heating Elements

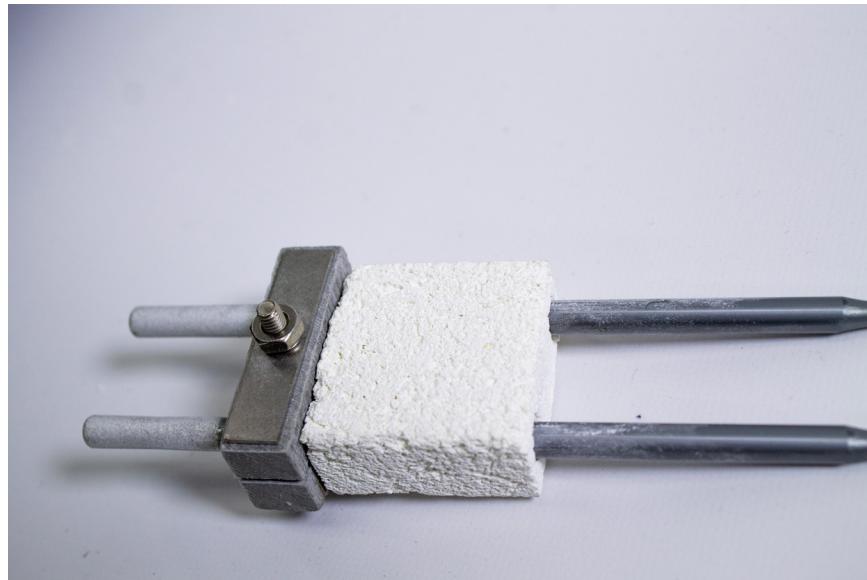
CAUTION: Heating elements are extremely fragile.



1. Disconnect power to the furnace.
2. If necessary, remove the furnace from its location and set upright on bench. DO NOT INVERT since the elements may slide out and possibly break.
3. Remove the heating element terminal cover to gain access to the heating elements.
4. Disconnect the cable to the elements being changed.



5. Remove the cable, inspect and replace if there are any indication of overheating / melting.
6. Carefully lift the heating element out of the furnace.



7. Remove any mounting hardware from the old element and attach them to the new replacement element. Replace and parts that are damaged or broken.
8. Carefully slide the new heating element into the furnace and connect electrical cables. Make sure there is a good contact between the aluminum braided cable and element end. If the spring clip is loose replace it with a new one.
9. Once all elements and cables are installed, double check there are no areas that are creating an electrical short. Re-install the terminal cover and relocate the furnace as required.
10. Normal operation can resume, no brake in is required.

NOTE: Do not drop heating elements, they are extremely fragile. Inspect and retighten monthly.

G. Safety Data Sheet

Available upon request.

Appendix A: Warranty

Your Applied Test Systems product has been manufactured and inspected by experienced craftsmen. Applied Test Systems warrants, for the original purchaser, each product to be free from defects in material and workmanship for a period of thirteen (13) months from date of shipment or twelve (12) months from date of installation - whichever comes first. This warranty does not apply to failures caused by normal usage, misuse, or repair or service by unauthorized personnel, nor does it cover limited life electrical components which deteriorate with age such as tubes, lamps, fuses, and heaters. Load cells are covered for manufactured defects only - incidents of over load or other customer misuse are not covered under warranty. The warranty does not extend to products not manufactured or assembled by Applied Test Systems.

This warranty is expressly limited to the repair, replacement, or adjustment of the product at Applied Test Systems' option. The product must be returned to the Applied Test Systems factory or an authorized repair center. Applied Test Systems shall not be liable for any labor, transportation, or installation costs that may arise in connection with the product or return.

To obtain warranty service:

1. Applied Test Systems must be promptly notified in writing of the defect.
2. Upon receipt of written authorization, said defective equipment is returned as directed, with transportation charges prepaid by the buyer and –
3. Applied Test Systems examination of such equipment discloses to its satisfaction that the defect exists and was not caused by negligence, misuse, improper installation, accident, or unauthorized repair or alteration.

This warranty is in lieu of all other warranties, expressed or implied, including the implied warranty of merchantability or fitness for particular purpose. In no event shall Applied Test Systems be liable for direct, indirect, special, incidental, collateral, or consequential damages.

The aforementioned provisions do not extend the original warranty period of any article that has been either repaired or replaced by Applied Test Systems.

Applied Test Systems reserves the right to change published specifications.



154 Eastbrook Lane, Butler, PA 16002 USA | www.atspa.com | +1-724-283-1212