**SECTION 23 73 24**

**FACTORY FABRICATED CUSTOM LABORATORY EXHAUST ENERGY RECOVERY UNITS**

**BASED ON DFD MASTER SPECIFICATION DATED 04/12/2022**

***This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add materials, delete items or modify what is currently written. The Division of Facilities Development expects changes and comments from you.***

**P A R T 1 - G E N E R A L**

**SCOPE**

This section includes specifications for factory fabricated custom exhaust energy recovery units. Included are the following topics:

PART 1 - GENERAL

Scope

Related Work

Reference

Reference Standards

Quality Assurance

Submittals

Operation and Maintenance Data

Design Criteria

Delivery, Storage and Handling

Warranty

PART 2 - PRODUCTS

Manufacturers

Casing

[Service Corridor]

Doors

Electrical and Lights

Fans

Coils

Piped Service

Filters

Dampers

Diffusers

Bypass Dampers

***Edit scope index and delete energy recovery unit components that are not applicable to this project. Where required, add components to the specification that are not listed.***

PART 3 - EXECUTION

Installation

Leakage Test

Construction Verification

Functional Performance Testing

Agency Training

**RELATED WORK**

Section 01 91 01 or 01 91 02 – Commissioning Process

Section 00 08 00 – Commissioning of HVAC

Section 23 05 13 - Common Motor Requirements for HVAC Equipment

Section 23 05 15 – Piping Specialties

Section 23 05 23 – General Duty Valves for HVAC

Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment

Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment

Section 23 09 14 - Pneumatic and Electric Instrumentation and Control Devices for HVAC

Section 23 21 13 – Hydronic Piping

Section 23 31 00 – HVAC Ducts and Casings

Section 23 33 00 - Air Duct Accessories

Section 23 41 00 - Particulate Air Filtration

Section 23 34 00 – HVAC Fans

Section 23 73 12 - Air Handling Unit Coils

Division 26 – Electrical

**REFERENCE**

Applicable provisions of Division 1 govern work under this section.

**REFERENCE STANDARDS**

ARI 430 Standard for Central Station Air Handling Units.

NFPA 90A Standard for Installation of Air Conditioning and Ventilation Systems.

NFPA 90B Installation of Warm Air Heating and Air Conditioning Systems.

ASTM A167 Stainless & Heat-Resisting Chromium-Nickel Steel Plate, Sheet, & Strip

ASTM A500-03a Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.

ASTM A568 Standard Specification for Steel Sheet, Carbon, and High Strength Low-Alloy, Hot-Rolled and Cold – Rolled.

ASTM A653 Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.

ASTM A90 Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.

ASTM B209 Aluminum and Aluminum Alloy Sheet and Plate.

ASTM B429A Standard Specification for Aluminum Alloy Extruded Structural Pipe and Tubing.

ASTM E-84 Surface Burning Characteristics of Building Materials.

NEMA National Electrical Manufacturers Association

NFPA 70 National Electrical Code

SMACNA HVAC Duct Construction Standards, 3rd Edition – 2005

SMACNA HVAC Air Duct Leakage Test Manual

UL 1995 Heating and Cooling Equipment

UL 723 Surface Burning Characteristics of Building Materials.

**QUALITY ASSURANCE**

Refer to division 1, General Conditions, Equals and Substitutions.

The manufacturer shall have been designing and producing air handling units for a minimum of ten years.

The units shall be factory assembled and tested per this specification.

All shipping splits must be joined at the factory to confirm proper alignment of all components before disassembly for shipping.

All of the energy recovery unit components, adhesives, sealants, insulations, vapor retarders, and films shall have a flame spread index of not over 25 and a smoke developed index of not over 50 per ASTM-E84; NFPA-255 and UL-723.

**SUBMITTALS**

Refer to division 1, General Conditions, Submittals

Submit shop drawings including the following information:

Dimensioned computer generated drawings showing unit plan, elevation views, all internal components, wall and floor penetrations, structural frame design, and unit weights at lifting lugs. Drawings shall be submitted at a minimum scale of 1/4”=1’-0”.

Panel joint(s) and panel details showing thermal breaks.

Base connection details.

Shipping split connections details.

Indicate fan class, fan performance and motor electrical characteristics. Provide fan curves with specified operating point clearly plotted.

Provide final reviewed submittal information to Division 26 contractor for coordination of motor protection and disconnects.

Indicate metal gauges, material finishes, assembly, construction details, and field connection details including the following:

Construction details and material finishes.

Verification that a Structural Engineer has reviewed roofs for snow loads, wind loads, and rain.

All required service and operation clearances.

Field connection details.

Filter, coil, and damper performance data.

Piping connection diagrams and field fabrication details.

Unit specific power and control circuit wiring diagrams.

Interconnection wiring diagrams.

Catalog data and illustrations edited for each unit’s application.

Provide maximum casing radiated sound power levels.

Sound absorption coefficient of panel system obtained using ASTM method of Test for Sound Absorption of Acoustical materials in Reverberation Rooms (ASTM Designation C423-66).

Provide static pressure calculation including individual internal component pressure losses.

# OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

***Delete the following if there are no additional requirements.***

In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

1. ***[A/E and commissioning provider to define detailed operation and maintenance data requirements for equipment specifications added to this section.]***

**DESIGN CRITERIA**

Furnish factory fabricated energy recovery unit(s) complete meeting the configuration shown on drawings and/or as scheduled.

Units to conform to NFPA 70, 90A, and 90B.

The unit(s) shall bear the ETL label and/or ISO-9000 certified

The unit(s) shall contain only UL listed components.

Any revisions made by the Contractor to the inlet and outlet ductwork conditions from that shown on the drawings shall not increase system effect and/or static pressure and shall not decrease mixing efficiencies.

**DELIVERY, STORAGE, AND HANDLING**

Provide protective coverings for all openings during shipping. Loose shipped items must be contained within factory provided protective coverings, with factory installed shipping skids and lifting lugs.

Store the unit in a clean dry place and protect from weather and construction traffic.

**WARRANTY**

Provide a manufacturer’s parts and labor warranty against factory defects in material and workmanship for the entire unit for a period of 1 year after startup.

**P A R T 2 - P R O D U C T S**

**MANUFACTURERS**

Air Flow Equipment, Buffalo, Nortek, Haakon, Ingenia, Trane Custom, York Custom, Marcraft, or approved equal.

**CASING**

Casing joints and seams shall be thermally broken. This includes floors, walls, roofs and all door frames. Only screws will be permitted as a thermal bridge through the panels. Caulk will not be accepted as a thermal break. Thermal break shall prevent condensate from forming on the exterior surface of the energy recovery unit casing at an exterior temperature of 91°DB and 74°WB and an interior air handling temperature of 50°F DB.

Internal liner shall be suitable for pressure washing or steam cleaning. Seal all seams with lap joints and install to permit all water to drain into the water tight base rather than into the wall panel system itself.

WALL/ROOF CONSTRUCTION

Construct walls and roof from 4”thick double wall panel assemblies. Panels shall be insulated with a minimum 3.0 lb/ft3 density rigid fiberglass insulation or 2.5 lb/ft3 density polyisocyanurate insulation or 3 lb/ft3 urethane foam type insulation. Panel assemblies shall have a heat transfer factor not greater than 0.06 btu/hr-ft3 - °F. The outer shell shall be constructed of solid, minimum 16 gauge, G60 galvanized steel with an etch bond primer and factory finish. The inner liner shall be constructed of solid, minimum 20 gauge, Type 304 or 316 stainless steel with No. 2B finish.

***Verify appropriate outer shell finish with the Architect and the manufacturer and edit this specification as necessary.***

Sound Transmission Loss of the panel assembly in accordance with ASTM E90 shall equal or exceed the following:

Octave Band Center Frequency (Hz)

125 250 500 1000 2000 4000

Transmission Loss (dB) 21 28 34 44 51 53

Structural reinforcement shall be designed so no member exceeds a deflection of 1/200 of span based on equipment loading and differential static of 10” W.C.

Construct the internal horizontal and vertical cross members of formed type 304 or 316 stainless steel using standard shapes and sizes.

Internal supports shall not interfere with mechanical equipment operation or maintenance.

EXTERIOR ROOFING CONSTRUCTION

Exterior standing seam panel shall be constructed from 16 gauge, G60 galvanized steel with an etch bond primer and factory finish to match the energy recovery unit color. The standing seam panels shall be sloped in one or two directions to drain water. Roof color shall match the color of the outer shell of the unit. Minimum slope shall be ¼” per foot.

Install rib caps at each shipping split and continuously caulk both sides prior to installation.

Where roof panels slope in two directions, install rib cap and roof peak cap at the peak.

***Verify appropriate outer shell finish with the Architect and the manufacturer for exterior locations.***

Provide a walking surface on the roof of the energy recovery unit to permit access to the exterior exhaust fans. Include a galvanized steel handrail with kneerail and toeboard. Provide a ladder, attached to the energy recovery unit, from 12” above the building roof to the roof of the energy recovery unit. [Include a galvanized steel safety cage around the ladder from 7’-0” above the roof or ground to the top of the handrail on the fan deck.] The walking surface, handrail and ladder assembly must comply with OSHA guidelines.

The walking surface, handrail and ladder assembly shall be finished to match the standing seam panel roof and not interfere with drainage the drainage of the roof.

**OSHA requires a safety cage on ladders 20’ or more tall. Remove the safety cage requirement if the energy recovery unit is not 20’tall.**

**DFD expects that the walking surface and railings are to be detailed on the drawings.**

FLOOR AND BASE CONSTRUCTION

Construct floors from 4”thick double wall assemblies. Floors shall be insulated with a minimum 3.0 lb/ft3 density rigid fiberglass insulation or 2.5 lb/ft3 density polyisocyanurate insulation or 3 lb/ft3 urethane foam type insulation. Floor assemblies shall have a heat transfer factor not greater than 0.06 btu/hr-ft3 °F. The outer shell shall be constructed of solid, minimum 22 gauge, G90 galvanized steel with a mill galvanized finish. The floor plates shall be constructed of solid, minimum Type 304 or 316 stainless steel, 10 gauge floor.

Each section shall have a turned up lip around the section perimeter with welded corners and continuously welded seams and joints. Each section shall be capable of retaining a minimum of 1 ½” of water without leakage. Locate drain connections at lowest point of each pan type floor section. Extend drain connection through the perimeter base channel and weld water tight. Provide removable cap on each drain.

The floor plates shall be welded to the unit base.

Perimeter floor frame members and intermediate members shall be welded cold formed carbon steel using standard shapes and sizes.

Install lifting lugs to perimeter steel along the longest length of unit or unit section. Lifting lugs shall be removable after placement of equipment.

The unit base shall be primed and finished with rust inhibiting epoxy paint.

Floor sections shall be constructed to prevent oil canning.

INTERNAL PARTITION WALL CONSTRUCTION

The internal partition walls shall be constructed of solid, minimum 16 gauge, Type 304 or 316 stainless steel with No. 2B finish.

Panels shall form a water and airtight seal with adjacent panels. Fasteners used to attach the panel shall not penetrate into the air tunnel.

Panel deflection shall not exceed 1/200 of span based on maximum operating differential pressure across the panel.

LEAKAGE RATE

Leakage rate shall not exceed 1% of the total system air quantity when subjected to - 10” static pressure.

***Each project must be evaluated and the static pressure requirements increased as necessary to meet individual project requirements.***

CASING PENETRATIONS

Install sealing collars to the interior and exterior of each penetration to prevent air leakage where electrical conduits penetrate energy recovery unit casing. Silicone sealants and duct sealants are not acceptable to seal pipe and conduit penetrations of the energy recovery unit casing.

Duct sealant and/or gaskets as indicated in specification section 23 31 00 may be utilized to seal duct connections to the energy recovery unit casing. Silicone sealants are not acceptable.

**SERVICE CORRIDOR**

***Service corridors may not be necessary or desired for every project. Consult with DFD prior to designing the energy recovery unit.***

***If service corridors are utilized all disconnects, controls, electrical equipment, VFD’s, piping headers, piping accessories, and valves are to be located within the service corridor. DFD expects the AE to coordinate installation locations and show locations of all equipment to be located in the service corridors on the drawings.***

Provided and installed by the energy recovery unit manufacturer the entire length of the unit as shown on the drawings.

WALL/ROOF CONSTRUCTION

Same as listed above except inner liner shall be constructed of solid, minimum 20 gauge, G90 galvanized steel.

FLOOR AND BASE CONSTRUCTION

Same as listed above except floor plates shall be constructed of solid, minimum 12 gauge steel checker plate or 3/16” aluminum checker plate. Steel floor plates shall be finished with rust resistive epoxy paint.

INTERNAL PARTITION WALL CONSTRUCTION

Construct from 4”thick double wall panel assemblies. Panels shall be insulated with a minimum 3.0 lb/ft3 density rigid fiberglass insulation or 2.5 lb/ft3 density polyisocyanurate insulation or 3 lb/ft3 urethane foam type insulation. Panel assemblies shall have a heat transfer factor not greater than 0.06 btu/hr-ft3 - °F. The outer shell, exposed to the service corridor, shall be constructed of solid, minimum 20 gauge, G90 galvanized steel with a mill galvanized finish. The inner liner, exposed to the airstream, shall be constructed of solid, minimum 20 gauge, Type 304 or 316 stainless steel with No. 2B finish.

Provide pipe and electrical chases complete with 18 gauge G90 galvanized steel cover through the base. Install a 1 ½” perimeter collar to the periphery of all chases to maintain a 1 ½” water level without leakage.]

**DOORS**

Doors shall be 4”double wall, constructed, and insulated with the same materials used in the surrounding unit walls. Extruded aluminum doors are acceptable provided that they are 4” double wall, and insulated with the same materials used in the surrounding unit walls.

Door frames shall be continuously welded and formed of the same materials as the surrounding wall. Doors shall be sealed against the door frames with neoprene bulb type gaskets installed around the entire periphery of the door.

Each door shall be furnished with corrosion resistant metal hinges or continuous piano hinge and shall have at least two stainless steel, lockable, high compression type cam latches operable from either side of the unit.

Doors shall open in direction against pressure of the section.

Each door shall contain a double pane, tempered, reinforced or safety glass window.

All doors except for fan sections shall be a minimum of 24” wide and 72” high, unless noted otherwise on the drawings. All doors located in fan sections shall be a minimum of 30” wide and 72” high, unless noted otherwise on the drawings.

**ELECTRICAL AND LIGHTS**

***Electrical and lighting will be installed by the Division 26 contractor. Coordinate all electrical and lighting requirements with the Electrical Engineer during the design phase. Refer to the following minimum requirements for electrical and lighting design.***

***Provide a marine grade gasketed light fixture in all fan sections and a light switch for each fan section located on the exterior wall of each fan section. Sections wider than 6 feet shall have multiple marine grade light fixtures with maximum spacing of 6 feet.***

***Provide a marine grade gasketed light fixture for each accessible section on units above 10,000 CFM and a light switch located on the exterior wall on both sides of each fan section and filter section. No more than three light switches per side of AHU. All light switches shall be capable of switching all lights within the air handling units. Do not wire the lights separately per switch. Sections wider than 6 feet shall have multiple marine grade light fixtures with maximum spacing of 6 feet.***

***Provide a GFI receptacle on either side of the exterior of the air handling unit where the air handling unit is less than 10’-0” in length. Provide two GFI receptacles spaced at least 5’-0” apart on either side of the exterior of the air handling unit where the air handling unit exceeds 10’-0” in length.***

***Provide separate junction box or packaged control motor protection panel for each engineered supply and return/relief/exhaust fan system at exterior wall of air handling unit.***

***Provide local disconnect in each fan section containing a motor.***

***All lights and receptacles shall be wired to a single junction box located on the exterior of the air handling unit to serve as a single point connection. Each set of lights and receptacles must remain on if the air handling unit fan’s disconnects are switched off.***

Electrical receptacles, switches and unit lighting shall be provided by the Division 26 contractor. Wiring and conduit for receptacles, motors, and unit lighting shall be field installed by the Division 26 contractor. Coordinate openings in the casing with the Division 26 contractor. Sealing of openings shall be the responsibility of the Division 26 contractor.

**FANS**

Coordinate all fan inlet opening sizes and structural support requirements with the fan manufacturer and mechanical contractor prior to constructing the energy recovery unit.

The energy recovery unit shall be constructed to support the weight of the exhaust fans along with snow loads, wind loads and rain loads.

**COILS**

Provided and installed by the energy recovery unit manufacturer in accordance with specification section 23 73 12 except use type 304 or 316 stainless steel casing, end supports, top channel, and bottom channel to produce a rigid frame with allowance for expansion and contraction of the finned tube section.

Unit manufacturer shall design and provide 304 stainless steel structure to support all coils. The coil frames shall be arranged to permit coil removal through the face of the structure without affecting the other coils in the coil bank or cutting and removal of housing panels.

Entire coil frame, headers and U-bends shall be enclosed within the unit casing. Manufacturer shall extend coil piping connections, air vent and drain connections to exterior of casing if applicable.

Support coils along entire length within casing and pitch coil for proper drainage.

Fabricate cooling coil drain pans from 18 gauge stainless steel. Install a drain pan under each cooling coil. Extend drain pans the entire width of each coil, including piping and header if in the air stream, and from the upstream face of each coil to a distance ½ of the vertical coil height downstream from the downstream face. Pitch drain pans in two directions towards the outlet, with a 1/8” slope. Pipe drain pans individually down to the drain pan below using a minimum 1” type 304 stainless steel piping. The bottom drain pan shall be piped to below the floor of the unit using a minimum of 1 ½” type 304 stainless steel piping.

The bottom drain pan may be substituted with a recessed pan, integral with the unit floor. It shall be constructed as specified above and incorporate required drain trap height. The floor insulation thickness at the integral drain pan shall be as indicated in the Floor and Base Construction portion of this specification.

Insulate the underside of the drain pans, except those integral with the floor, with a minimum of 1” flexible polyolefin sheet insulation.

***Coordinate drain locations and provide access within the unit to enable the Mechanical Contractor to properly pipe the condensate from under the unit to the floor below.***

Blank off space between coil frames and energy recovery unit casing airtight.

Mount coils at appropriate height above floor to insure proper condensate trap depth and condensate drainage.

**PIPED SERVICE**

Interior piping and equipment installation shall be complete. Piping shall be installed and tested per appropriate specification sections. Unit manufacturer shall be responsible for any leaks which occur in unit during system testing which occurs before system startup.

Unit manufacturer shall extend piping for each coil through panel casing [and into the service corridor]. Terminate piping with flanges for pipe 2 ½” and larger or threaded connection for pipe 2” and smaller and caps.

***Service corridors may not be necessary or desired for every project. Consult with DFD prior to designing the laboratory exhaust energy recovery unit.***

***If service corridors are utilized all disconnects, controls, electrical equipment, VFD’s, piping headers, piping accessories, and valves are to be located within the service corridor. DFD expects the AE to coordinate installation locations and show locations of all equipment to be located in the service corridors on the drawings.***

**FILTERS**

Filters provided and installed by the energy recovery unit manufacturer in accordance with specification section 23 41 00.

Construct frames of type 304 or 316 stainless steel with provisions for assembly in a bank.

Filters shall be accessible from the front of the filter rack. Frames for MERV 11 filters, MERV 14 filters, HEPA filters, and activated carbon filters to have provisions for installation of MERV 7 prefilters upstream of high efficiency media. Secure prefilters by means of spring clips or a spring loaded mechanism. Spring clips or latches shall be on the upstream side of the prefilter. Provide leak-proof gaskets between prefilter media and holding frame. Prefilters shall be removable without removal of final filters.

Provide static pressure tips that are arranged to prevent damage to the filter elements during replacement. Provide minimum 2” gap between final and prefilters for static pressure probes.

**DAMPERS**

Reference drawings for damper arrangement [top and rear] or [rear and bottom].

Provided and installed by the energy recovery unit manufacturer in accordance with specification section 23 09 14 - Dampers used for laboratory fume exhaust systems.

**DIFFUSERS**

Manufacturer shall provide perforated diffuser plate at fan discharge to ensure uniform airflow downstream of diffuser plate.

**BYPASS DAMPERS**

Provided and installed by the energy recovery unit manufacturer in accordance with specification section 23 09 14 - Dampers used for laboratory fume exhaust systems.

**P A R T 3 - E X E C U T I O N**

**INSTALLATION**

Install all energy recovery units and accessories as indicated on drawings and/or as scheduled and according to manufacturer's installation instructions.

Install energy recovery unit to provide for adequate service access. Coordinate with other trades to assure energy recovery unit does not infringe upon access or service clearances of other equipment.

Lubricate fan bearings. Verify fan isolators have proper deflection.

Upon completion of installation of energy recovery units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning components, then retest to demonstrate compliance.

Furnish one spare set of fan drive belts and one additional set of filters.

**LEAKAGE TEST**

Field test all factory fabricated custom laboratory exhaust energy recovery units.

Seal all openings and dampers at the energy recovery unit to the pressure class listed below before performing the test. A minimal amount of ductwork may be connected to the energy recovery unit in order to seal off large openings. The ductwork must meet or exceed -10” static pressure.

Test draw through energy recovery units at -10” static pressure. The contractor and/or the unit manufacturer may brace the access doors in positive sections of the energy recovery unit to meet the testing requirements.

***Verify each energy recovery unit on a case by case basis and edit the Leakage Test requirements accordingly.***

If excessive air leakage is found locate leaks, repair in the area of the leak, seal, and retest.

Leakage rate shall not exceed more that 1% of the total system air quantity when subjected to -10” static pressure.

Submit a signed report to the Division's Construction Representative, indicating test apparatus used, results of the leakage test, and any remedial work required to bring energy recovery units into compliance with specified leakage rates.

**CONSTRUCTION VERIFICATION**

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 23 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

**FUNCTIONAL PERFORMANCE TESTING**

Contractor is responsible for utilizing the functional performance test forms supplied under specification Section 23 08 00 in accordance with the procedures defined for functional performance testing in Section 01 91 01 or 01 91 02.

# AGENCY TRAINING

All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 or 01 91 02.

END OF SECTION

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|  |  |  |  | **FACTORY FABRICATED CUSTOM EXHAUST LABORATORY ENERGY RECOVERY UNIT LEAKAGE TEST REPORT** | | | | | |  |  |  | |  |
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| **State of Wisconsin** | |  |  | |  |  |  |  | **DFD Project Number:\_\_\_\_\_\_\_\_\_** | | | | |  |
| **Department of Administration** | | |  | |  |  |  |  |  |  |  |  | |  |
| **Division of Facilities Development** | | | | |  |  |  |  | **Date Submitted:\_\_\_\_\_\_\_\_\_\_\_\_\_** | | | | |  |
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| **System** |  | **AHU No:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | | | | |  | **Test Pressure: - 10” S.P.** | | | | |  | |
| **Data** |  | **AHU Design CFM:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | | | | | | **Leakage at 1% of total design CFM (CFM):\_\_**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  **Test Leakage at -10” S.P. (CFM):\_\_**\_\_\_\_\_ | | | | |  | |
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| **Test** |  |  |  | |  |  |  |  |  |  |  |  |  | |
| **Equipment** |  | **Manufacturer:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | | | | | | **Model No:\_\_\_\_\_\_\_\_\_\_\_** | | | **Serial No:\_\_\_\_\_\_\_\_\_\_\_\_\_** | | | |
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