**Price Linear Natural Convection Terminal**

**Division 23 – Heating, Ventilating, and Air Conditioning**

**Section 23 37 13 – Diffusers, Registers, and Grilles**

The following specification is for a defined application. Price would be pleased to assist in developing a specification for your specific need.

**PART 1 – GENERAL**

* 1. **Summary**
1. This section includes the following:
2. Linear Natural Convection Terminal

**1.02 Related Documents**

1. Section 01 30 00 – Administrative Requirements
2. Section 01 40 00 – Quality Requirements
3. Section 01 60 00 – Product Requirements
4. Section 01 74 19 – Construction/Demolition Waste Management and Disposal
5. Section 01 78 00 – Closeout Submittals
6. Section 01 79 00 – Demonstration and Training
7. Section 23 30 00 – HVAC Air Distribution
8. Section 23 32 00 – Air Plenums and Chases
	1. **Reference Standards**
9. All referenced standards and recommended practices in this section pertain to the most recent publication thereof, including all addenda and errata.
10. ASHRAE Standard 55 – Thermal Environmental Conditions for Human Occupancy
11. ASHRAE Standard 62.1 – Standards for Ventilation and Indoor Air Quality
12. ASHRAE Standard 70 – Method of Testing the Performance of Air Outlets and Air Inlets
13. ASTM Standard D610 – Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
14. ASTM Standard D714 – Standard Test Method for Evaluating Degree of Blistering of Paints
15. ASTM Standard D1308 – Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
16. ASTM Standard D1654 – Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
17. ASTM Standard D4752 – Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub
18. ASTM Standard E84 – Standard Test Method for Surface Burning Characteristics of Building Materials
19. NFPA Standard 70A, Article 100 – National Electrical Code

**1.04 Administrative Requirements**

A. Pre-installation Meeting: Conduct a pre-installation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and efficient manner.

**1.05 Submittals**

1. See Section 01 30 00 – Administrative Requirements for submittal procedures.
2. Product Data:
	1. Provide data indicating configuration, general assembly, materials used in fabrication, rated capacities, and furnished specialties and accessories.
	2. Include drawings indicating size, profiles and dimensional requirements of the linear floor grilles that are based on the specific system indicated.
	3. Include catalog performance ratings that indicate airflow volume, initial pressure drops, sound performance, and throw, as tested in accordance with ASHRAE 70.
3. Shop Drawings: For each type of product indicated, include the following:

1. Equipment assemblies and indicated dimensions.

2. Required clearances.

3. Method of field assembly.

4. Revit models.

1. Coordination Drawings:
	1. Include floor plans, and other details, drawn to scale, on which the following items are shown and coordinated based on input from installers:
	2. Floor or underfloor-mounted items including:
		* 1. Floor structure (floor tiles, concrete, etc.)
			2. Floor finishing (carpet, tile, etc.)
			3. Access panels
			4. Electrical components
			5. Plumbing
			6. Networking components
			7. Terminal Units and other HVAC components
2. Operation and Maintenance Data: Include manufacturer’s descriptive literature, operating instructions, maintenance schedules and repair data, and parts lists.

**1.06 Quality Assurance**

1. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum ten years of documented experience.
2. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
3. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100 by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

**1.07 Warranty**

1. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
2. Provide 18-month manufacturer warranty from date of shipment for grilles and registers.

**PART 2 – PRODUCTS**

**2.01 General**

1. Basis of Design: Price Industries, Inc.
2. Power and Control Module with Zone Controller [Price PCM]
3. Linear Natural Convection Terminal [Price Model LNT]
4. General Product Information:
5. Furnish and install Price model LFGH linear floor grilles of the sizes and capacities indicated on the drawings or outlet schedule.
6. Unit sizes shall be selected in accordance with ASHRAE guidelines and manufacturer’s literature.
7. Manufacturers shall demonstrate that they have successfully supplied and installed underfloor HVAC products, as well as the computer modeling thereof for a minimum of 10 years.
8. Manufacturers must be pre-qualified to bid based on the completion of a minimum of [xx] jobs in similar climates.
9. Manufacturers shall provide a list of completed jobs and references.
10. Underfloor Air System Controls:
	1. Air Grilles and diffusers specified for underfloor service shall incorporate the following requirements:
	2. Damper construction shall include an integral flow-modulation damper and motor (air valve) that is specifically designed for low static pressure air distribution.
	3. Air dampers shall not include fast acting actuators that require high life cycle ratings.
	4. Airflow and throw heights shall decrease in response to lower space demands with flow-modulation of constant temperature plenum air. The flow-modulation technique shall be implemented to maximize stratification, leading to energy savings and increased thermal comfort.
	5. Modulation by timed duty cycle of fully open and closed periods shall not be acceptable. This type of modulation can greatly reduce stratification, removing potential energy savings. Timed duty cycle modulation also increases the possibility of creating stagnant zones and starving buoyancy driven flow. Any use of this type of modulation shall be modified in order to demonstrate stratification to the project team prior to being considered acceptable.
	6. Plenum Rated Cables: Color-coded plug-and-play plenum rated cables with [RJ12] or [RJ45] connectors shall be used between devices.
	7. Terminal block type plugs shall not be acceptable.
	8. Plug-and-play cables shall carry both the power and control signal to each device and connect to a single port on the device control board.
	9. Cable types shall be limited to no more than one type and connector per device to reduce complexity in wiring and future modifications.
	10. Cables shall be stranded wire to increase flexibility in the wires, to improve ease of installation, and reduce opportunity for damage during installation.
	11. Cables shall have eight wires with redundant wires to provide a more robust system and protection against damage, and to allow the current for multiple devices to be controlled through a single cable. Solid wires shall not be acceptable.
	12. The Power and Control Module shall include a direct digital controller (DDC) and transformer to supply both power and control signals to air devices.

**2.02 Power and Control Module with Zone Controller**

1. Description:
2. Furnish and install Price Model PCM with Price thermostat, with the voltage, wiring, and configurations indicated on the plans and controller’s schedule. All components shall be factory wired, calibrated and pre-tested to ensure a fully functional unit.
3. The digital control package shall include a Price thermostat mounted in the occupied zone and a dedicated, microprocessor-based zone controller that shall modulate up to a maximum thirty ModuFlex devices, 12 of which can be heaters based on the room temperature through a series of plug-and-play connectors. The thermostat shall be (**select one**):
	1. Remote type
	2. Room Sensor type
	3. Dial type
	4. LCD type
	5. Motion Sensor with LCD type
4. The digital controller shall have two dedicated RJ45 ports to control up to twelve ModuFlex linear floor heaters with a maximum of six units per chain.
5. The digital controller shall have five RJ12 ports to control up to thirty ModuFlex cooling only devices with a maximum of six units per chain.
6. The PCM zone controller shall be provided with an integral 96VA transformer, and the controller shall have LED display lights to indicate availability of control power, overload of each output, and the direction of damper movement.
7. The PCM zone controller shall be configurable in the field with either the LCD thermostat, service port or the BACnet BAS network. The LCD thermostat will allow setup and balancing of the zone controller without need to access the plenum space. It will include a zone temperature sensor, set point adjust, and character LCD display, and a service port for computer access to the zone controller. The LCD and keypad functions shall include the following:
	* + - 1. Customer Mode:

Space Temperature/Set-point display

Set point adjustment

* + - * 1. Service and Commissioning Mode (password protected):

Control sequence diagnostics

Control of VAV damper position over entire stroke (Manual Force to min/max flow, or min/max position/ Automatic Mode)

VAV Sensor calibration

* + - * 1. Configuration Mode (password protected):

Network configuration

Display option configuration

1. The programmable native BACnet controller shall be used in either a stand-alone operation or a peer-to-peer Building Automation networked architecture.
2. The controller shall have an RS-485 network port to allow for plug-in connection onto a BACnet MS/TP LAN. The RJ12 Service Port shall allow for the connection of a personal computer, which shall allow for the full display of all VAV control parameters and Inputs/Outputs.
3. All components shall be factory wired, calibrated and pretested to ensure a fully functional unit. The PCM shall be ETL listed to UL 1995 and CSA C22.2.
4. The PCM with DDC Interface control package shall include a modulation controller capable of accepting an input signal from BAS network, integration by Controls Contractor. The PCM shall be a dedicated, microprocessor-based controller mounted in the underfloor plenum, and shall have the following technical specifications:
	* + - 1. Inputs: 1 analog input – 8 bit
				2. Outputs: 2 binary triac outputs (24 VAC)
				3. Transformer: 96 VA
				4. Ambient Ratings: 32 to 131 degrees Fahrenheit (0 to 55 degrees Celsius), 10 to 90 percent relative humidity (non-condensing)
				5. Technology: 8-bit microprocessor
				6. Connections: 5 RJ12 connectors, and 5 RJ45 connectors
				7. Wiring: Class II
				8. Size (including housing): 3.8 x 15.5 x 8.5 inches (97 x 394 x 216 millimeters)
				9. Weight: 10.18 pounds (4618 grams)
5. Enclosure: All control components shall be mounted inside a protective metal enclosure.

**2.03 Linear Natural Convection Terminal**

1. Description:
	1. Furnish and install Price model LNT (L x W) with the sizes, configurations and capacities indicated on the plans and air outlet schedule.
2. Performance:
3. The manufacturer of the linear natural convection terminal shall provide performance data for air volume, initial pressure drop, and heating element performance.
4. Performance data published should be collected from testing completed for in floor applications that represent the intended application. Bare heating element data not tested within the convective trough should not be considered.
5. Air shall be delivered to the space without the use of nozzles.
6. All data must be tested in accordance with the most recent publication of ASHRAE 70.
7. Construction:
	1. The plenum shall be constructed of minimum 20-gauge steel.
	2. The plenum shall have a finished height of 10-3/8 inches and shall be suitable for installation above conduit in a twelve-inch raised floor.
	3. The LNT shall be ETL certified.
	4. The LNT shall be supplied complete with two modular jacks for system connections and modular plug-in control cable.
	5. The CFLEX cable shall be 15, 25 or 35 feet in length and shall be plenum rated.
	6. Each cable shall have two (2) modular male plugs to interface with type RJ45 jacks for plug-and-play system connections.
	7. The cable shall be constructed of eight 8 individually insulated wires wrapped in an insulated jacket.
	8. Each wire shall be constructed of stranded copper fibers; solid core copper is not acceptable.
	9. The plenum shall be [floor tile] or [pedestal] supported.
	10. Removable end caps for continuous grille integration
	11. Equipped with front and side knockouts.
8. Heater:
9. The unit shall be supplied with a [high-capacity fin pack] or [hydronic heater] **or** [electric coil] (**select one**):
10. Ultra Heat – High-Capacity Fin Pack
	* + 1. The LNT shall be equipped with an Ultra Heat multi-pass coil consisting of copper tubes and aluminum fins that are designed to minimize pressure drop through the coil for Underfloor applications and maximize heat output.
			2. Ultra Heat multi-pass coil has been tested at 500psig high pressure water and is rated for a max working pressure of 250 psig at 300 degrees F.
11. Standard Capacity Hydronic Heater
	* + 1. The LNT shall be constructed with integral hydronic copper tube with aluminum fin element.
			2. The hydronic heater shall be supplied with 1.125 inch outside diameter, 1 inch nominal sweat connection.
			3. The hydronic heater has been tested at 700psig high pressure water and is rated for a max working pressure of 200psig at 300 degrees F.
12. Electric heater:
	* + 1. Shall be supplied with an electric finned strip heater constructed of stainless steel sheath material and nickel-plated fins. Heaters are of UL construction, and shall be equipped with over temperature protection through an automatic temperature reset switch that allows sensing throughout a continuous unit length. The thermal cutoff switch should be designed for sensitivity that allows a response to individual hot spots along the unit length. Disconnect switch is included.
			2. The electric heater element shall be mounted in the sheet metal plenum below the grille.
			3. The electric heater shall be supplied with a [120-volt, single phase, 60 Hertz] **or** [277-volt, single phase, 60 Hertz], complete with a transformer.
			4. Single stage heat
			5. The electric heater capacity shall be:
				1. 1000 Watts [48-inch-long units]
				2. 1500 Watts [72-inch-long units]
				3. 2000 Watts [96-inch-long units]
13. Finish:
14. The plenum shall be finished in pre-painted black powder coat.
15. Mounting/Fastening:
16. Floor tile supported units shall be supplied with a 1/2-inch flange on all sides.
17. Pedestal supported units shall be supplied with support brackets attached to the units.
18. Support pedestals shall be positioned without the use of tools.
19. Pedestal and pedestal heads shall be provided by others.
20. Options:
	1. Air Valve:
21. A VAV Damper shall be supplied complete with a 24-volt AC floating point actuator.
22. The damper actuator and circuit board housing shall be room side accessible for ease of maintenance.
23. The Air valve shall be sized for a 100, 200, 300, 400, 600 or 800 cfm maximum air volume.
24. The Air valve shall be constructed inset from the outside of the unit so when the damper is fully open it will not interfere with the floor pedestals.
25. Air valve shall be gasketed to close off airflow when closed to minimize energy consumption. Dampers without gasket or some type of seal should not be used.
26. Fiber-Free acoustic insulation:
27. Insulation shall comply with UL 181 erosion, mold growth and humidity requirements in accordance with ASHRAE 62.1 and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
28. The insulation shall be secured with adhesive.
29. Insulation thickness shall be 1/2 inch thick, three-pound density, R-value of 2.0.
	1. High-Voltage Modular Cables
	2. The High Voltage Modular Starter cable (HVS) shall be supplied with one stripped end for wiring to the building junction box and one end with a high voltage plug for connection to the linear natural convection terminal with an electric coil.
	3. The High Voltage Modular Extender cable (HVS) shall be supplied with one receptacle end and one end with a high voltage plug to allow for daisy chaining of high voltage power.
	4. Cables shall be [20ft] or [40ft] or [60ft] in length.

**2.04 Linear Natural Convection Terminal – Cooling Only**

1. Description:
2. Furnish and install Price model LNT (L x W) with the sizes, configurations and capacities indicated on the plans and air outlet schedule.
3. Performance:
4. The manufacturer of the linear natural convection terminal shall provide performance data for air volume, and initial pressure drop.
5. Air shall be delivered to the space without the use of nozzles.
6. All data must be tested in accordance with the most recent publication of ASHRAE 70.
7. Construction:
8. The plenum shall be constructed of minimum 20-gauge steel.
9. The plenum shall have a finished height of 10-3/8 inches and shall be suitable for installation above conduit in a twelve-inch raised floor.
10. The LNT shall be ETL certified.
11. The LNT shall be supplied complete with two modular jacks for system connections and modular plug-in control cable.
12. The CFLEX cable shall be 15, 25 or 35 feet in length and shall be plenum rated.
13. Each cable shall have two (2) modular male plugs to interface with type RJ12 jacks for plug-and-play system connections.
14. The cable shall be constructed of eight (8) individually insulated wires wrapped in an insulated jacket.
15. Each wire shall be constructed of stranded copper fibers; solid core copper is not acceptable.
16. The plenum shall be [floor tile] or [pedestal] supported.
17. A variable air volume damper shall be supplied complete with a 24VAC floating point actuator.
18. The damper actuator and circuit board housing shall be room side accessible for ease of maintenance.
19. The air valve shall be sized for a 100] or [200, 300, 400, 600 or 800 cfm maximum air volume.
20. The air valve shall be constructed inset from the outside of the unit so when the damper is fully open it will not interfere with the floor pedestals.
21. The air valve shall be gasketed to close off airflow when closed to minimize energy consumption. Dampers without gaskets or some type of seal should not be used.
22. Removable end caps for continuous grille integration
23. Equipped with front and side knockouts.
24. Finish:
25. The plenum shall be finished in pre-painted black powder coat.
26. Mounting/Fastening:
27. Floor tile supported units shall be supplied with a ½-inch flange on all sides.
28. Pedestal supported units shall be supplied with support brackets attached to the units.
29. Support pedestals shall be positioned without the use of tools.
30. Pedestal and pedestal heads shall be provided by others.
31. Options:
32. Fiber-Free acoustic insulation:
33. Insulation shall comply with UL 181 erosion, mold growth and humidity requirements in accordance with ASHRAE 62.1 and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
34. The insulation shall be secured with adhesive.
35. Insulation thickness shall be 1/2 inch thick, three-pound density, R-value of 2.0.

**PART 3 – EXECUTION**

**3.01 Examination**

A. Verify that conditions are suitable for installation.

B. Verify that field measurements are as shown on the drawings.

## 3.02       Manufacturer’s Field Services

* + 1. The manufacturer shall provide the services of an underfloor air systems specialist. This engineer shall make at a minimum the following trips to the site with construction and design personnel.
			1. The first trip to the job shall occur right before the raised access floor is being installed. The Price engineer will inspect and ensure proper installation of Price products. While on site, the Price engineer will also inspect the area near the Price products for any obvious concerns with construction within the underfloor plenum regarding the air tightness of the plenum. Any deficiencies found shall be brought to the general contractor's attention on site that day. Site observation report shall be made and emailed to the Engineer of Record for approval. If approved they shall forward the report to the construction team as appropriate. The Price engineer will address any issues regarding the equipment supplied by Price to help ensure a successful completion of the project. Price will not be held liable for issues outside of the operation of the product supplied by Price.
			2. The second trip to the job shall occur during the building commissioning process. The Price engineer shall verify proper operation and installation of the Price supplied equipment and assist to solve problems that may prevent project completion due to said equipment. Any deficiencies found shall be brought to the general contractor's attention on site that day. Site observation report shall be made and emailed to the Engineer of Record for approval. If approved they shall forward the report to the construction team as appropriate. The Price engineer will address any issues regarding the goods supplied by Price to help ensure a successful completion of the project. Price will not be held liable for issues outside of the operation of the product supplied by Price.

**3.03 Installation**

1. Install linear floor grilles level and plumb.
2. Complete installation and startup check according to manufacturer’s instructions and perform the following.

1. Verify that inlet duct connections are as recommended by manufacture to achieve proper performance.

2. Verify that any identification tags are visible.

3. Verify locations of thermostats, humidistats, and other exposed control sensors with drawings and room details before installation.

1. Maintain sufficient clearance for normal services, maintenance, or in accordance with construction drawings.
2. See drawings for the size(s) and locations of linear floor grilles.
3. Connect to ductwork in accordance with Section 23 31 00.

**3.04 Adjusting**

1. Balance outlets according to manufacturer’s recommendations.
2. Verify that field measurements are as shown on the drawings.

**3.05 Field Quality Control**

1. See Section 01 40 00 – Quality Requirements for additional requirements.

**3.06 Cleaning**

1. See Section 01 74 19 – Construction Waste Management and Disposal for additional requirements.

**3.07 Closeout Activities**

1. See Section 01 78 00 – Closeout Submittals for closeout documentation requirements.
2. See Section 01 79 00 – Demonstration and Training for additional requirements.