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*Refrigeration, Air Conditioning, and Heating*

**Lab-Volt®**

## **GEOHERMAL TRAINING SYSTEM MODEL 46126**



**Geothermal Training System, Model 46126-A.**

### **GENERAL DESCRIPTION**

The Lab-Volt Geothermal Training System, Models 46126-0 and 46126-A, are designed to teach the fundamentals of heat transfer, refrigeration, and air conditioning applied to geothermal energy HVAC projects. The operation of the training systems faithfully reproduces that of a typical geothermal residential system.

The Geothermal Training System, Model 46126-0, consists of a geothermal heat pump, ground loop heat exchanger, pumping station, domestic hot water system, circulation pump, control panel, and the instrumentation required to measure the operating parameters of the

system. All components are mounted in a mobile workstation that is sized to fit through standard door openings. The Geothermal Training System, Model 46126-A, consists of a Model 46126-0 plus a second heat pump. The second heat pump is used to control the temperature in the ground loop heat exchanger to simulate various ground conditions. The second heat pump fits in the same mobile workstation as in the Model 46126-0.

Both systems include the security devices required to protect the users and the equipment.

# GEOTHERMAL TRAINING SYSTEM MODEL 46126

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### Geothermal Heat Pump

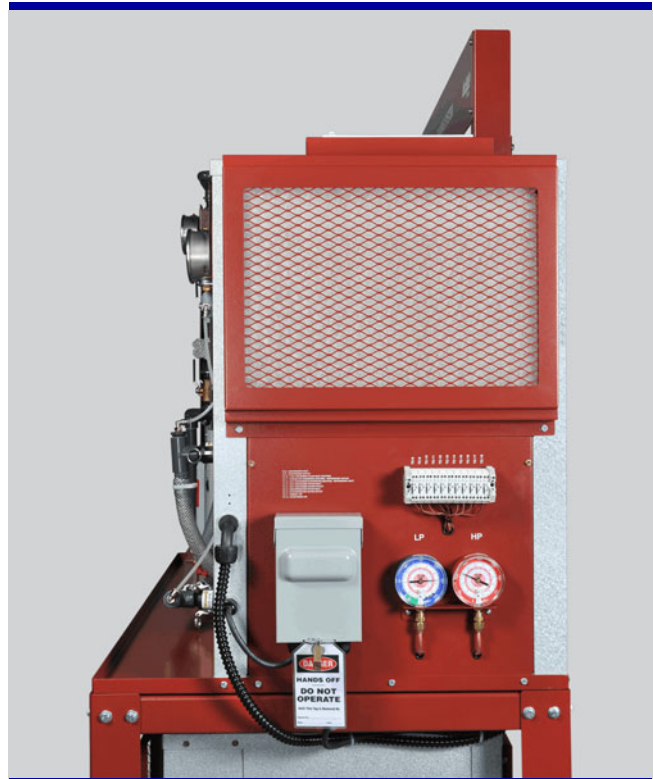
The geothermal heat pump is a standard product that is commonly installed in residential projects. However, many features have been added to allow flow, temperature, and pressure to be measured at each location of interest.



It is possible to safely look inside the heat pump cabinet through clear plastic panels while the system is running.

Clear plastic panels are added to the heat pump cabinet to show the electronic control board and the mechanical components such as the heat exchanger, compressor, thermostatic expansion valve and blower.

The system also features a standard pullout disconnect switch commonly used with HVAC equipment.



Pullout disconnect switch, thermocouple terminal blocks, and pressure gauges.

### Ground Loop Heat Exchanger

The ground loop heat exchanger mainly consists of two short loops and one long loop (copper coils) immersed in a water tank. Each loop includes a flow meter, flow control valves, and temperature test points at each end. Temperature values can be read via thermocouple terminal blocks. The inlet and outlet headers include transparent sections to observe the flow of fluid. A pressure meter with a three-way valve is also provided to measure the pressure at the inlet and outlet of the ground loop header.



Ground loop header.

The ability to change the configuration of the ground loop and to control the flow of water in each loop permits students to observe the impact of various ground loop conditions on the HVAC system performance. Furthermore, by using the second heat pump in Model 46126-A, it is possible to observe the impact of various ground conditions on the HVAC system performance.

### Domestic Hot Water System

The domestic hot water system consists of a hot water tank, a desuperheater heat exchanger and a pump. The domestic hot water system is provided with a flowmeter and thermocouples to measure the parameters required to calculate the amount of energy that is being transferred to the domestic hot water tank. The desuperheater heat exchanger and pump section is also equipped with a clear plastic panel for safe observation.



Partial view of the domestic hot water system.

### Control Panels

The operation of the geothermal heat pump and circulation pump is controlled via the Geothermal Heat Pump control panel. This control panel features a main power switch, thermostat, indicator lights, and fault switches. Electrical faults can be inserted for troubleshooting purposes using switches hidden behind a cover.



Geothermal Heat Pump control panel and Simulated Ground Heat Pump control panel.

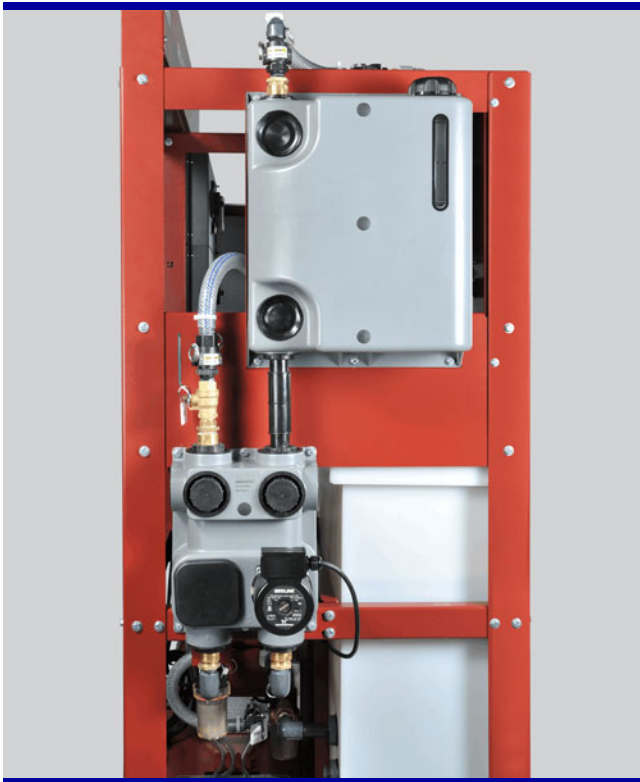
The second heat pump, in the Model 46126-A, is controlled via the Simulated Ground Heat Pump control panel. This control panel contains a main power switch, temperature controller, and indicator lights.



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## Pumping Station

The pumping station mainly consists of a priming tank and a circulation pump. The priming tank supplies the circulation pump with water at the start up, and prevents cavitation. The priming tank also allows variations in water level to compensate for pressure changes in the loop and can be bypassed to create a pressurized loop configuration. This configuration also features an expansion tank typical for such loop. The pumping station also contains the connections to fill and flush the loops. A strainer is inserted in the network to remove impurities.



Priming tank and circulation pump.

## Troubleshooting

The Geothermal Heat Pump training system allows the users to develop troubleshooting abilities. The instructor can insert up to six faults in the electrical circuit using switches. To allow the users to diagnose the faults, connections to the control board are provided. The instructor may also insert many mechanical faults to affect the operation of the system, such as choking a flow control valve, obstructing an air opening, etc.



Connections to the control board are provided for troubleshooting purposes.

## Courseware

The courseware supplied with the training systems consists of a student manual and an instructor guide. The student manual consists of a series of job sheets. Each job sheet includes an information sheet where the theory involved is presented, and a manipulation section where the students have to carry out a series of tasks. The student manual is fully illustrated and color printed. Refer to the *Table of Contents of the Student Manual* section of this datasheet to see the list of the topics that are covered.

The instructor guide provides the results of measurements carried out under similar operating conditions and the answers to all questions.

## Prerequisite

Although it is preferable to have a basic knowledge in refrigeration, this is not essential. All the theory required to attain the learning objectives of each job sheet is included in the information sheets.

## TABLE OF CONTENTS OF THE STUDENT MANUAL

### Geothermal Heat Pump Systems (88271-20)

#### Job Sheet 1: Geothermal Energy

Introduction to geothermal energy, Familiarization with the training system.

#### Job Sheet 2: The Ground Loop

Geothermal potential, Ground loop configurations, Piping materials, Fittings and joints, Ground loop installation, Grouting and backfill materials, Ground loop heat carriers.

#### Job Sheet 3: Heat Pump Connections and Interior Piping

Pipe length and pressure drop, Bernoulli equation, Reynolds number, Ground loop headers, Ground loop pumping station, Pressurized and non pressurized systems, The flush cart, Filling and flushing the geothermal system.

#### Job Sheet 4: The Refrigeration Cycle

Pressures and temperatures, Subcooling, saturation and superheating, Sensible and latent heat, The refrigeration cycle, Refrigerants, Pressure enthalpy diagram, Compressors.

#### Job Sheet 5: Psychrometrics

Atmospheric air, Specific and relative humidity of air, Dry and wet bulb temperature, Dew point, The psychrometric chart, Simple heating and cooling process, Heating with humidification, Cooling, dehumidifying and reheating, Adiabatic mix of air streams, Air conditioning application example.

#### Job Sheet 6: Geothermal Heat Pumps

Air-to-air heat pump, Air-to-water heat pump, Water-to-water heat pump, Geothermal heat pumps, The 4-way reversing valve, The thermostatic expansion valve, Heat pump COP, EER and SEER.

#### Job Sheet 7: Heat Exchangers

Types of heat exchangers, Heat exchanger analysis, The evaporator and the condenser coils, The desuperheater, Thermal efficiency.

#### Job Sheet 8: Heat Pump Control and Safety Devices

Electricity Basic principles, Measuring voltage, resistance, and current, Contactors and control relays Circuits and diagrams, The power circuit, The control circuit, Pressure switches, Freeze sensor, Heat pump electronic control, Malfunction error codes.

#### Job Sheet 9: System Characterization

Unit check-out sheet.

#### Job Sheet 10: Maintenance and Troubleshooting

Maintenance, Troubleshooting skills, Troubleshooting.

#### Job Sheet 11: Geothermal Software Design Tools

Description and general features of a geothermal design software package.

## SPECIFICATIONS

| Model 46126-0 – Geothermal Training System |  |   |
|--|--|---|
| Geothermal Heat Pump                       | Capacity                                 | 4.4 kW·h (15 000 BTU·h)                                   |
|  | Refrigerant                              | R-410A [nominal charge of 1.0 kg (36 oz)]                 |
|  | Water-to-Refrigerant Heat Exchanger Type | Tube-in-tube coil (coaxial)                               |
| Ground Loop Heat Exchanger                 | Loops                                    | 2 shorts, 1 long  |
|  | Water Tank Capacity                      | 140 L (37 gal)  |
|  | Expansion Tank                           | 2.8 L (0.75 gal)  |
|  | Water Additives                          | Rust inhibitor solution and antibacterial solution        |
| Pumping Station                            | Priming Tank                             | Insulated with level sight glass and two three-way valves |
|  | Pump Type                                | Centrifugal   |
| Domestic Hot Water System                  | Tank Capacity                            | 7.5 L (2 gal)   |
|  | Circulation Pump Type                    | Centrifugal   |
|  | Desuperheater Heat Exchanger Type        | Tube-in-tube coil (coaxial)                               |

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| Model 46126-0 – Geothermal Training System (cont'd)     |  |   |
|---|--|---|
| Control Panel   | Heat Pump Thermostat<br>Indicator Lights<br>Fault Insertion<br>Other component   | Cooling/heating, non-programmable<br>Loop pump, reversing valve, compressor, desuperheater, heat pump fault, circulation pump<br>Six faults that can be inserted using slide switches<br>Main power switch  |
| Safety Devices  |  | High pressure control, frost sensor, relief valve, fuse, breaker, pullout disconnect switch, tag and padlock  |
| Instrumentation   | High Pressure Gauge<br>Low Pressure Gauge<br>Flowmeters<br>Thermocouples<br>Pressure Gauge<br>Anemometer<br>AC/DC Clamp-on Meter | 0 kPa to 5500 kPa (0 psi to 800 psi), refrigerant monitoring<br>-200 kPa to 0 kPa / 0 kPa to 3450 kPa (-30 psi to 0 psi / 0 psi to 500 psi), refrigerant monitoring<br>315 cm <sup>3</sup> /s (5 gal/min), quantity 4<br>Type K, quantity 18 located at pertinent points and accessible through terminal blocks<br>0 kPa to 690 kPa (0 psi to 100 psi), heat exchanger monitoring, quantity 2<br>Waterproof pocket size with air velocity, temperature, relative humidity, dew point, and wind chill<br>Dual type K thermocouple inputs, true rms measurements for ac voltage and current measurements, built-in non-contact voltage detector, resistance, capacitance, and frequency measurements. |
| Power requirement                                       | Voltage - Phase - Frequency<br>Circuit Required  | 208/230 V - 1 - 60 Hz<br>One 15.0 A circuit   |
| Physical Characteristics                                | Dimensions (H x W x D)<br>Net Weight   | 1905 x 2273 x 740 mm (75.0 x 89.5 x 29.1 in)<br>219 kg (615 lb) (empty tanks)   |
| Model 46126-A – Geothermal Training System <sup>1</sup> |  |   |
| Geothermal Heat Pump                                    | Capacity<br>Refrigerant<br>Water-to-Refrigerant Heat Exchanger Type  | 5.3 kW·h (18 000 BTU·h)<br>R-410A [nominal charge of 1.0 kg (35 oz)]<br>Tube-in-tube coil (coaxial)   |
| Control Panel   | Indicator Lights<br>Other components   | Reversing valve, heat pump fault<br>Main power switch, temperature controller   |
| Power requirement                                       | Voltage - Phase - Frequency<br>Circuits Required   | 208/230 V - 1 - 60 Hz<br>Two 15.0 A circuits  |
| Physical Characteristics                                | Dimensions (H x W x D)<br>Net Weight   | 1905 x 2273 x 740 mm (75.0 x 89.5 x 29.1 in)<br>TBE kg (TBE lb) (empty tanks)   |

## ORDERING NUMBERS

| 208/230 V – 60 Hz |                  |         | 220 V – 50 Hz |        |         | 240 V – 50 Hz |
|-------------------|------------------|---------|---------------|--------|---------|---------------|
| ENGLISH           | FRENCH           | SPANISH | ENGLISH       | FRENCH | SPANISH | ENGLISH       |
| 46126-00          | N/A <sup>2</sup> | N/A     | 46126-05      | N/A    | N/A     | 46126-05      |
| 46126-A0          | N/A              | N/A     | 46126-A5      | N/A    | N/A     | 46126-A5      |
| 88271-20          | N/A              | N/A     | 88271-20      | N/A    | N/A     | 88271-20      |
| 88271-30          | N/A              | N/A     | 88271-30      | N/A    | N/A     | 88271-30      |

Table 1. Equipment Ordering Numbers

<sup>1</sup> All components in Model 46126-0 repeat for Model 46126-A

<sup>2</sup> N/A = Not available



Reflecting Lab-Volt's commitment to high quality standards in product, design, development, production, installation, and service, our manufacturing and distribution facility has received the ISO 9001 certification.

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