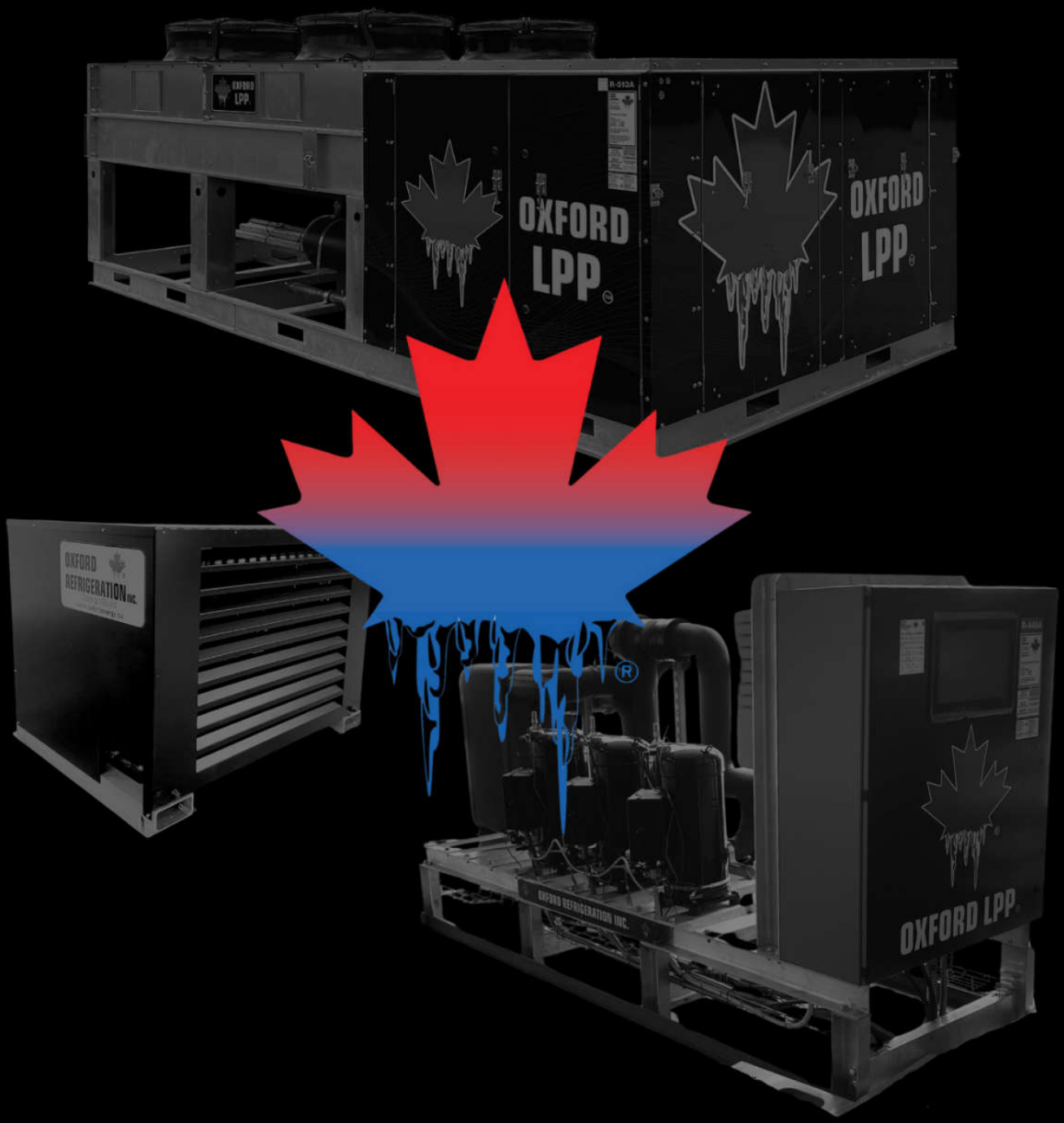
OXFORD LPP™ MANUAL



OXFORD REFRIGERATION - OXFORD ENERGY SOLUTIONS INC.

Made in Canada

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Low Pressure Platform (LPP) System Manual

PLATFORM OVERVIEW

The Oxford Energy Solutions' Low-Pressure Platform (LPP) represents a significant advancement in commercial and industrial refrigeration technology. This integrated system combines innovative engineering with sophisticated controls to deliver superior performance while simplifying operations.

System Overview

The LPP utilizes single and two-stage compression technology optimized for next-generation A1 HFO refrigerants. By eliminating traditional low-temperature components, the system achieves greater efficiency through a streamlined design. The integrated Sensori™ control system provides comprehensive system management and monitoring capabilities.

Key Features

- ✓ Advanced compression technology
- ✓ Compatible with next-generation A1 HFO refrigerants
- ✓ Integrated BAS control system
- ✓ ***Optional*** Cloud-based architecture for advanced Artificial Intelligence, further data collection, user-assigned responsibilities
- ✓ Simplified component architecture
- ✓ Pre-charged and factory-tested
- ✓ Comprehensive Digitalization
- ✓ Future-proof design and custom pages
- ✓ Remote Connection through GateManager Secure Connect

Applications

The LPP system is engineered for diverse commercial and industrial refrigeration applications, offering scalable solutions that maintain consistent performance across varying operational demands.

Future-Ready Design

The system's adaptable architecture supports seamless transitions to emerging refrigerant technologies through simple control panel adjustments. This forward-thinking design protects the initial investment while supporting long-term sustainability goals.

About This Manual

This manual provides guidance for:

- System installation
- Operational procedures
- System Features

Each section contains detailed information to ensure safe, efficient, and reliable system operation throughout its lifecycle.

This manual should be used in combination with Sensori™ Control Manuals for the system. Also Refer to "Sensori Control Through Secure Connect" for HMI overlay and Remote Connectivity.

ADVANCED SYSTEM FEATURES

These features combine to create a comprehensive, efficient, and future-ready refrigeration system that prioritizes performance, sustainability, and user control.

Low-Pressure System Advantages

The low-pressure design offers several key benefits:

- ✓ *Reduced potential for refrigerant leaks due to lower system pressures*
- ✓ *Superior energy efficiency*
- ✓ *Enhanced system reliability through reduced component stress*
- ✓ *Improved safety with lower risk of catastrophic failures*
- ✓ *Significant cost savings on installation and maintenance*
- ✓ *Extended equipment life through reduced wear and tear*
- ✓ *Streamlined piping process with fewer components*

Secure System Management

- ✓ *Easy and secure remote access capabilities*
- ✓ *Sensori Control Platform completely digitized system*
- ✓ *Comprehensive email and alarm management*
- ✓ *Complete system diagnostics with operating envelope monitoring*
- ✓ *User-friendly set-up without IT personnel requirements*
- ✓ *GateManager integration for enhanced cybersecurity*
- ✓ *Real-time monitoring and adjustment capabilities*

Sustainability and Future-Readiness

The system is designed for:

- ✓ *Seamless incorporation of upcoming refrigerants*
- ✓ *Minimal refrigerant charge requirements*
- ✓ *Easy adaptation to evolving environmental regulations*
- ✓ *Enhanced long-term investment protection*
- ✓ *Reduced environmental impact through efficient operation*
- ✓ *Simple control panel adjustments for refrigerant updates*

SAFETY

Refrigeration systems involve pressure components and electrical systems that pose significant hazards during installation, commissioning, and service.

WORKPLACE PRECAUTIONS: Adhere to National Health and Safety Standards when working with the system. Ensure that all required protective measures are in place and followed to prevent accidents.

QUALIFIED PERSONNEL ONLY: This system must only be installed, commissioned, or serviced by a certified technician trained to handle refrigeration systems safely and competently.

SERVICING GUIDELINES: All service procedures must comply with national safety regulations - specific to refrigeration systems to ensure safe handling and operational integrity. Always follow the recommended procedures and adhere to all warning labels, tags, and stickers affixed to the system. If warning labels are missing or not visible, contact Oxford Energy Solutions Inc. immediately for replacements to maintain safety compliance.

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FACTORY PRESSURIZATION PRECAUTIONS: Units are factory pressurized with dry air/ nitrogen at 40 psig. Exercise caution when opening or servicing the system to avoid unexpected pressure release or exposure to compressed gases.

FACTORY CHARGE/REFRIGERANT PRECAUTIONS: For equipment that has been ordered pre-charged, please consult the name tag of unit for type and quantity of refrigerant in system. The system will have been pressure tested, evacuated, filters installed, and then pre-charged with refrigerant if applicable.

EQUIPMENT HANDLING

Incorrect handling of units may result in damage to the equipment and pose a risk of injury to Personnel. Adhere to established standards and required certifications for equipment and material handling. Weight/sizing of individual units can be found in accompanying schematics for model type.

FORKLIFT: When lifting, position the heaviest side *(compressor side)* of the unit toward the lift truck. Ensure that the forks extend the full length of the unit and make firm contact with a structural part or frame to provide proper support. Avoid placing the forks directly against panels or coils.

CRANE: Identify the center of gravity prior to lifting. Spaces are provided to insert lifting bars or hooks. Ensure lifting bars/hooks are secured. Spreader bars should be used during lifting to safeguard the unit.

INSTALLATION REQUIREMENTS

OUTDOOR CONDENSING UNIT – PACKAGED SYSTEM

Packaged units are self-containing systems that house all essential components within a single enclosure. Installed outside on the ground or on the roof, they compensate for limited indoor space or keeping mechanical equipment out of the way. The compact design simplifies installation by centralizing all components in one location. Units are built to withstand outdoor conditions, with weather-resistant features for reliable operation across various climates. Controls are located indoors and easily accessible through HMI.

ROOFTOP INSTALLATION

Roof-mounted units are bolted to a steel frame, wood sleepers, and other specified means of support to ensure secure positioning. The ideal installation location is above the supporting walls and above areas where sound levels are not a concern, (i.e. storage areas, hallways, secondary spaces). Please consult a certified engineer for load details and structural requirements on a building.

- Verify roof load capacity.
- For optimal unit operation, ensure frame levelness within ¼ inch per 10 feet.
- Ensure adequate airflow clearance.
- Maintain minimum clearances:
    - Service access: 36 inches
    - Air intake: 48 inches
    - Between units: 96 inches
    - Overhead clearance: 160 inches for proper air discharge
- Position away from polluted air or corrosive vapors and prevent interference by considering the air intake and discharge of surrounding units.
- Position units near the power supply and evaporators for efficient operation.
- Orient vertical condenser coils toward prevailing winds to maintain proper condensing pressure.
- Please be sure to order proper type/coating required for equipment that is an environment of sea spray/coastal to help avoid excessive salt corrosion.

REMOTE/SPLIT CONDENSING UNIT

In a remote system, the condenser is separated from the indoor compressor rack/station. It can be installed outside, adjacent to the facility, or on the roof, where it releases heat directly into the

environment. Condensers come standard with a sub-cooled loop, base-mounted receiver under the condenser, and optional split valves on the condenser if necessary for the application.

Outdoor Ground-level Condenser Installation

- A minimum 6-inch concrete pad must be provided as a base for the unit to protect the unit from groundwater and debris.
- Ensure proper airflow clearance with adequate distance from exhaust vents or other contamination sources.
- Securely bolt the unit to the base for stability.
- Provide proper vibration isolation for all piping.
- Piping and devices must be secured against unauthorized access. For ground units in public areas, install 8-foot security fencing with a lockable entry point accessible only to authorized maintenance personnel.
- Warning signage on all access points

Indoor Rack Installation

- Clearance around skid for maintenance: ensure a minimum clearance of 4 feet on all sides for maintenance purposes. Vertical clearance requirements vary depending on the model; please refer to the system's cut sheet for specific details.

REFRIGERATION PIPING

General Requirements

All refrigerant system components must be installed in accordance with applicable local and national codes using proper engineering practices by a technician with Brazing certification.

Materials:

- Take precautions during field piping to prevent the entry of contaminants/moisture into the system. Use high-quality ACR-type refrigeration tubing that is capped, nitrogen-purged, and free of internal dirt, moisture, or other contaminants. Do not use unsealed tubing.
- All fittings must be wrought copper and certified for use.
- Long-radius elbows are strongly recommended, as well as long-radius bent fittings with mechanical benders for soft and rigid piping.

Installation Practices:

- Use high-temperature brazing alloys meeting AWS specifications.
- Purge lines with nitrogen during brazing to prevent oxidation and carbon deposits.
- Clean all joints before and after brazing. Minimize the use of brazing/soldering flux to avoid internal contamination of joints.

Support Systems:

- Support all piping adequately. Install hangers at a maximum 10-foot intervals, as per code based on size of pipe. Maintain proper slope on vapour lines for oil return.
    - Support piping connected to vibrating components to allow unrestricted movement of the vibrating parts.
    - Provide additional support at direction changes
    - Note that piping should support itself, and equipment should never be used to support piping.
- A final and thorough inspection of all piping should be completed once equipment operation has commenced.

Line Requirements

Proper design and installation of refrigeration system plumbing are critical for efficient operation and maintenance. Ensure all lines are installed and serviced in compliance with applicable regional codes and regulations.

Line Sizing and Design

- Size all lines to maintain proper refrigerant velocity and minimize pressure drops, limiting temperature changes to approximately 2°F.
- For systems with variable capacity, use double risers to maintain appropriate velocity under different load conditions.

Slope and Oil Management

- Slope horizontal lines 1/4 inch per 10 feet in the direction of flow to ensure proper oil and refrigerant movement.
- Install oil traps at the base of vertical rises and every 20 feet of vertical piping to support oil return.
- Size traps appropriately for system capacity and refrigerant velocity.

Multiple Component Connections

- When connecting multiple evaporators to common lines, ensure suction lines enter from the top and use inverted traps to prevent oil and refrigerant migration.
- For liquid lines serving multiple evaporators, take connections from the bottom of the main liquid line to ensure a consistent supply of sub-cooled liquid.

Insulation

- Insulate all lines to prevent heat gain, sweating, or freezing, particularly in exposed or heated areas.
- Use at least 3/4 inch closed-cell foam insulation for medium-temperature suction lines and 1 inch for low-temperature suction lines.
- Apply a minimum of 1/2 inch insulation on liquid lines to maintain sub-cooled liquid quality.

Routing and Protection

- Avoid exposing lines to direct sunlight or heat sources, and ensure all piping is properly supported to prevent kinks or sharp bends that may restrict flow.
- Use proper brazing techniques and support methods to reduce stress and vibration on piping and connections.

Velocity Requirements

- **Liquid Line**
  < 1°F to 2°F, < 300 fpm

- **Suction Line**
  < 2°F, > 750 fpm (horizontal), > 1500 fpm (suction riser), < 4000 fpm

Evacuation/Leak Detection

Leak testing and evacuation must be performed in compliance with local and national regulations.

- Ensure all pressure testing completed before evacuation of system
- Evacuate system below 500 microns.
- Ensure all valves are open.

UNIT WIRING 

- Refer to wiring schematics for specific information on model.
- All system wiring must follow applicable local and national codes.
- Units have been pre-wired. Inspect that no wires have come loose during transit. The control panel shows clearly marked connection ends on terminal blocks.

REFRIGERANT INFORMATION 

This refrigeration platform provides a versatile solution that is compatible with current and future refrigerants across all refrigeration applications.

- Current Refrigerant Type:
  - Uses next-generation Hydrofluoroolefins (HFOs)
  - Safety Classification: A1 (non-toxic, non-flammable)
  - Low-pressure operation characteristics
  - Fully recyclable
- Supports seamless transition to upcoming refrigerant alternatives without requiring component modifications
- Reduced refrigerant costs through minimal charge requirements
- Compact receiver design with enhanced condenser sizing
- Meets California and European charge limitation requirements

- Optimized charge size. Designed around 50lb max charge/system if required
- **IMPORTANT**: Always follow proper refrigerant handling procedures:
    - Use approved recovery equipment, Prevent atmospheric venting
    - Comply with local regulations for refrigerant management

REFRIGERATION OILS

Condensing units are designed for next-generation HFO refrigerants and refrigerant blends and require Polyolester (POE) oil. Compressor Oil Level is maintained and monitored by electronic Oil Level Control. Please ensure Oil Separator is at adequate levels and add oil accordingly.

- Exercise caution when handling POE oils
- Always use appropriate personal protective equipment (i.e., gloves, eye protection)
- Consult MSDS (Material Safety Data Sheets) for detailed safety guidelines before handling POE lubricants.

Proper oil management is critical for system reliability.

Oil Level Monitoring

- Maintain level between 1/2 and a full sight glass
- Check levels during stable operation
- Monitor oil return from system
- Record oil addition amounts and dates

SYSTEM OPERATION OVERVIEW

The Low-Pressure Platform (LPP) operates through the Sensori™ control system, a network of programmable logic controllers (PLCs) that manage all system functions. This digital automation platform **eliminates the need for mechanical controls and manual adjustments**.

- Fully automated electronic control system
- No mechanical pressure controls or valve adjustments required
- Near-hermetic design minimizes potential leak points
- Simplified maintenance requirements
- Automated performance optimization

The streamlined architecture removes traditional components including:

- Flanged valves
- Bolted connections
- Suction stops
- Three-way valves
- Mechanical pressure controls

***NOTE*: For detailed control system programming and operation, please refer to the separate Sensori™ Control Manuals.**
****Beyond factory default settings, call Oxford Energy Solutions for further explanation and to ensure proper set-up.**

Condenser

Condenser Management Control uses floating head pressure control based on outdoor ambient to improve system efficiency as outdoor ambient changes.

Condenser fans run on a VFD algorithm using a measurable 0-10VDC output for fan speed control and adjustments made by PID method.

Refer to Condenser Management Setpoints in Sensori™ OLPP Control manual for condenser setpoints and operation.

Subcooled Loop

- High Efficiency – Reduces overall energy/BTU consumption compared to traditional rack systems.
- Enhanced Capacity – An extra-pass subcooled loop in the condenser increases subcooling by 10–40°F, boosting system capacity by 16–20% with no additional input costs.
- Automated Monitoring – Alerts notify if subcooling is out of range.
- Optimized Freezer Performance – LT compressors run at low compression ratios and amperage, maintaining setpoints efficiently.
- Free Subcooling – Achieves 20–30°F subcooling, improving evaporator performance and liquid quality, with liquid lines often below 32°F in winter.
- Suction-to-Liquid Heat Exchange – Lowers case superheat setpoints, further increasing subcooling and system capacity.

Electronic Expansion Valves

Oxford LPP Sensori Platform uses electronic valve settings to "fine tune" system operation to get PEAK performance and operation efficiency. Electronic valves provide a very wide range of system capacity, thus Sensori VEV management gives a full range of advanced setpoints for fine-tuning.

- **Max Valve Open**, to prevent system from overshooting refrigerant charge in evaporator and temperature of coil, causing unnecessary increased compressor capacity
- **Superheat Setpoint Shift**, to get maximum capacity from evaporator, based on outdoor ambient, and proper compressor cooling to extend compressor lifetime.
- **Continuous Modulation**, to maintain a near-perfect case temperature within a small deadband and ensure case temperature does not overshoot or undershoot, causing product inconsistencies.
- **Max Variation**, to avoid too quick valve step movement, causing unnecessary increased compressor capacity and inconsistent case temperatures

Refer to VEV Setpoints in Sensori™ OLPP Control manual for further valve operation.

The above setpoints should always be set properly to ensure system performance is at its peak since outdoor ambient/liquid quality is always changing.

The system supports high-capacity operations using industry-leading hermetic, stainless steel, bipolar valves: **Emerson Electronic Valves, Danfoss Colibri EXVs**

- Performance Benefits
  - Reduces operating head pressure
  - Optimizes refrigeration cycles
  - Minimizes required refrigerant charge
  - Ensures reliable oil return through high mass flow design
- Advanced Control
  - Provides precise refrigerant flow regulation
  - Delivers rapid response to system changes
  - Maintains tight temperature and pressure control
  - Synchronizes evaporator and condenser operation
  - Seamlessly interface with control system for monitoring and adjustment.

NOTE: Electronic Valves should NEVER be powered when evacuating a system.

Compressor

Oxford LPP Sensori Platform provides every compressor with a Compressor Safety device (PLC) to ensure individual safety and performance are controlled through compressor management. Each compressor will have a digitalized sensor configuration for fine-tuning safety ranges and extending the lifetime of compressors. Compressor navigation and tracking are straightforward, with historical trending for all data, including, compressor operating hours and cycles.

Refer to the Sensori™ Compressor Safety and Compressor Management in the Sensori™ OLPP Manual for detailed features and settings.

- Copeland Scroll Compressors for low power consumption
- Two-stage coupled compression approach
- Control system ensures compressors maintain setpoints

Low Compression Ratio

- Compressors operate with a low compression ratio, starting compression work at just 5 PSIG differential across the scroll.
- Low compression ratios increase compression efficiency, reduce energy use and losses.
- Less discharge superheat allows for cooler running compressors.
- Protects Components – Reduces damage to internal oils and motor windings.
- Reduced noise output.

Variable Frequency Drives

- Variable Frequency Drives (VFDs) control electric motors' speed, ensuring precise refrigeration alignment with varying load requirements.

- VFD on Primary MT and LT Compressors (*and secondary compressor, based on the size of system*). These drives provide:
    - *Continuous monitoring of cooling requirements*
    - *Dynamic speed adjustment based on system demand*
    - *Smooth and stable operation by preventing frequent on/off cycling*
    - *Reduced wear and tear on compressors*
    - *Integration with centralized control systems*
    - *Real-time sensor feedback for optimal performance*

Floating Head Control

The system dynamically modifies the condensing pressure setpoint to maintain optimal heat rejection while preventing refrigerant overcooling and undercooling. This adaptive control enables stable operation across varying ambient conditions.

- Improved System Stability
    - Maintains consistent system pressures
    - Enables precise valve operation
    - Enhances compressor staging control through optimized PID control
- Increased Efficiency
    - Reduces compressor/condenser fan cycling frequency
    - Automatically adjusts system parameters for optimal performance in all weather conditions
- Cold Weather Performance
    - Maintains proper system pressures during low ambient conditions
    - Prevents common cold weather operational issues
    - Ensures reliable year-round operation

PID Control for Compressor Management

The Sensori Platform manages compressors in a way that helps prolong their proper operation and balance machine lifetime. It provides features for compressor breakdown management and to optimize operation. Compressor Sequence control helps ensure equal compressor usage and optimize power consumption.

- Proportional-Integral-Derivative (PID) control regulates temperatures, pressures, flow, and speed for precise compressor staging
- Manages multiple compressors' cycling to match cooling demand while ensuring operation within intended ranges

Evaporator/Case Control

Fan Control

- Integrated control for all evaporator fan systems, including:
    - Single-speed
    - Two-speed ECM
    - 0-10VDC modulation ECM, adjusting based on room temperature, evaporator temperature, or room humidity

Anti-Sweat Heat Control

- Anti-sweat heaters are controlled based on temperature setpoint for freezer doors to protect product integrity when in defrost/system being off.

Heater Control

- Heat program controls a separate room heater for dehumidification or space heating, using a temperature setpoint independent of case cooling.

Defrost

Defrost can be adjusted remotely to monitor valve performance in real-time. The system employs electric defrost instead of hot gas defrost, providing:

- *Reduced system stress from pipe expansion/contraction*
- *Minimized valve complexity and leak potential*
- *Improved system control and flexibility*
- *Better energy efficiency*
- *Enhanced system longevity*
- *Simplified maintenance requirements*

Defrost Initiation

- The BAS interface accommodates multiple defrost settings and varied schedules, allowing simple/automatic set-up via the HMI. *Refer to Sensori Control Manuals for functionality.*
- Available settings:
  - Defrost on time
  - Defrost on run-time to save on energy from unnecessary defrost activation
  - Defrost on temperature
  - Mixed Defrost to save on energy when room temperature high enough to defrost
- Duration: 5-60 minutes depending on frost load
- Manual override and "Stop Defrost" capability for special conditions

Defrost Sequence

- Electronic Valve Closes fully, stopping the refrigerant flow
- Fans stop (Electric Defrost)
- Electric defrost heaters energize
- Temperature sensor monitors defrost progress
- Termination on temperature or time

Defrost Termination

- Heaters de-energize at termination temperature
- Drip time delay
- Compressor restarts
- Fan delay until coil temperature normalizes

Energy Meter

The built-in energy meter monitors system energy consumption, identifying trends to reduce waste, enhance operation, and lower costs through data-driven adjustments.

NOTE: Ensure proper voltage settings and CT (Current transformers) are installed correctly (arrows on CTs pointing in current flow direction)

- Comprehensive Tracking – Monitors total power consumption, frequency, voltage and current averages
- Historical Data – Uses accumulators to track and log energy usage over time
- Works within the control system for automated tracking and reporting

BAS

The Sensori control system continuously monitors the entire refrigeration system envelope and automatically adjusts its operation to maintain the desired conditions while maximizing efficiency.

- Several key parameters:
  - Suction pressure and temperature
  - Discharge pressure and temperature
  - Liquid line pressure, temperature, and subcooling
  - Condenser Management
  - Room temperature and humidity Control (Case Management)
  - Variable compressor, and compressor staging (Compressor Management)
  - Low-Temperature Booster Compression
  - Oil level and pressure
  - Room Heat Control
  - Anti Sweat Heat Control

- Secure Remote Access into system using Oxford/Schneider IPC/GateManager coupled with Oxford's Sensori control system
- System logging, graphing
- Email and alarm management is built in
- Connection to the internet/ set-up is automatic
- No I/T personnel required
- Optional Aviva Cloud-based services for further Artificial Intelligence and Control

See Sensori™ manuals for all features and functionality

START-UP

A main system on/off switch (service switch) is provided to enable the main management, and the case is enabled in the Oxford LPP electrical cabinet. Confirm the Start-Up Checklist before turning this switch on.

NOTE: Electronic Valves should NEVER be powered when evacuating a system.

START-UP CHECK LIST

PREPARE THE SYSTEM	RECOMMENDATIONS
-IMPORTANT: Before starting system, ensure all sensors are placed in the right location and all pipe temp sensors are clamped to copper pipes with mechanical gear clamps & insulated.	
- Confirm oil levels in the compressor and oil separator	
-Open all refrigeration valves. CONFIRM ALL VALVE STEM PACKINGS ARE TIGHTENED.	
-Connect the high-side gauge to the refrigerant receiver outlet valve and the suction fitting on the compressor	
-Verify the rotation direction of all motors.	
-Confirm electrical connections and voltage	
-Check that all temperature sensors and pressure transducers are reading accurately on all Sensori PLCs.	

REFRIGERANT	RECOMMENDATIONS
-Before adding refrigerant, ensure a successful leak test/evacuation is completed.	
-For blends: start the compressor and add refrigerant through a calibrated restrictor in the suction connection of the compressor until the sight glass is clear and proper sub-cooling is obtained from the condenser.	
-In winter months, select a cold day to verify adequate charge.	

SERVICING

Only a certified technician should service the unit. Always disconnect power and follow all safe working procedures.

INSPECTION	RECOMMENDATIONS
-Check for abnormal vibrations after start-up	
-Inspect anchors for compressors	

CLEANING	RECOMMENDATIONS
-Check condensers/evaporators for dirt accumulation	
-Fin Cleaning- Dust the fins and use mild detergent and warm water spray.	
-Condenser coil may be cleaned through the access panel	
**** alkaline/acid solution will damage coils. Completely rinse after using detergent.**	

FAN MOTORS – ADDING OIL	RECOMMENDATIONS
****If motors are inoperative, first check the supply voltage at motor leads**	
-Allow the system to pump down.	
-Ensure power is off.	
-Suction/Discharge valves at the compressor should be closed.	
- Partially unscrew the filler hole pipe plug. Allow pressure to bleed before totally removing the plug to add oil.	

COMPRESSOR	RECOMMENDATIONS
****Maintain oil level at 1/2 to full**	**Recommended Oil:**
-check oil levels periodically after filling.	
-Do not over-fill to avoid potential damage.	
-If oil levels do not stabilize, inspect the piping.	

TECHNICAL SUPPORT

Oxford Energy Solutions Inc. provides 24/7 technical support for emergency situations.

Contact information: **(226)242-5674**

Oxford Group of Companies – Oxford Energy Solutions Inc., Oxford Refrigeration Inc., Oxford Gas Compression Systems Inc., Oxford CO2 Technologies Inc. – is an original equipment manufacturer (OEM) specializing in commercial/industrial/agricultural and ice-making refrigeration equipment, heat recovery systems for large- and small-scale projects as well as central Heating/Cooling plant equipment, service and build specific equipment.