DuPont™ ISCEON® 9 Series

REFRIGERANTS

Technical Information

Retrofit Guidelines for DuPont™ ISCEON® MO49*Plus*™ for Medium and Low Temperature Refrigeration

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Retrofit Guidelines for DuPont™ ISCEON MO49*Plus*™ Refrigerants

Table of Contents

Introduction

ISCEON® MO49*Plus*™ (R-437A* Pending) is an HFC retrofit refrigerant for R-12 and HCFC-containing refrigerant blends (e.g., MP39, MP66, and R-409A) in stationary refrigeration systems. ISCEON® MO49*Plus*™ also replaces ISCEON® MO49 (R-413A). ISCEON® MO49*Plus*™ is compatible with traditional and new lubricants; in most cases no change of lubricant type during retrofit is required.

ISCEON® MO49*Plus*™ is also an HFC retrofit refrigerant for R-12 in automotive air-conditioning systems. See the Retrofit Guidelines for Automotive AC for more information.

ISCEON® MO49*Plus*™ is not recommended for use in centrifugal compressor systems or for chillers with flooded evaporators or low pressure receivers.

Note: ISCEON® MO49*Plus*™ is not available for automotive air-conditioning in the U.S.

Easy Steps to Retrofit

The following provides a summary of the basic retrofit steps for ISCEON® MO49*Plus*™.

Refer to the Retrofit Checklist in the Appendix.

1. Establish baseline performance with existing refrigerant
2. Remove all refrigerant from the system into a recovery cylinder. Weigh the amount removed.
3. Replace the filter/drier and elastomeric seals that are exposed to liquid refrigerant.

Components commonly affected are Schrader core seals, liquid level receiver gaskets, solenoid valves, ball valves and flange seals but all external seals in contact with liquid refrigerant should be viewed as a potential leak source post refrofit.

4. Evacuate system and check for leaks.
5. Charge with DuPont™ ISCEON® MO49*Plus*™.
   - Remove liquid only from charging cylinder.
   - Typical initial charge is about 85% of standard R-12 charge.
6. Start up system, adjust TXV and/or charge size to achieve optimum superheat.
7. Monitor oil levels in compressor. Add oil as required to maintain proper levels

8 Label system for the refrigerant and lubricant used.

Retrofit Complete

After retrofit, ISCEON® MO49*Plus*™ can be topped off during service without removing the entire refrigerant charge.

Important Safety Information

Like CFCs, and other retrofit HFC blends, ISCEON® MO49*Plus*™ is safe to use when handled properly. However, any refrigerant can cause injury or even death when mis-handled. Please review the following guidelines before using any refrigerant.

- Do not work in high concentrations of refrigerant vapors. Always maintain adequate ventilation in the work area. Do not breathe vapors. Do not breathe lubricant mists from leaking systems. Ventilate the area well after any leak before attempting to repair equipment.

- Do not use handheld leak detectors to check for breathable air in enclosed working spaces. These detectors are not designed to determine if the air is safe to breathe. Use oxygen monitors to ensure adequate oxygen is available to sustain life.

- Do not use flames or halide torches to search for leaks. Open flames (eg. Halide detection torches, or brazing torches) can release large quantities of acidic compounds in the presence of all refrigerants, and these compounds can be hazardous. Halide torches are not effective as leak detectors for HFC refrigerants; they detect the presence of Chlorine, which is not present in ISCEON® MO49*Plus*™. Consequently, these detectors will not detect the presence of these refrigerants. Use an electronic leak detector designed to find the refrigerants you are using.

- If you detect a visible change in the size or color of a flame when using brazing torches to repair equipment, stop work immediately and leave the area. Ventilate the work area well and stop any refrigerant leaks before resuming work. These flame effects may be an indication of very high refrigerant concentrations, and continuing to work without adequate ventilation may result in injury or death.

Note: Any refrigerant can be hazardous if used improperly. Hazards include liquid or vapor under pressure, and frostbite from the escaping liquid.

- Overexposure to high concentrations of refrigerant vapor can cause asphyxiation and cardiac arrest and potentially be fatal. Please read all safety information before handling any refrigerant.

For more detailed information on the properties, uses, storage, and handling of ISCEON® refrigerants, see DuPont Technical Bulletin K-10926 or other literature specific to these products. Refer to the appropriate Material Safety Data Sheet (MSDS) for more safety information about each refrigerant. DuPont Safety Bulletin AS-1 also gives additional information for safe handling of refrigerants.

Flammability

DuPont™ ISCEON® MO49*Plus*™ has an ASHRAE safety classification of A1 and is non-flammable as formulated and under leakage scenarios as specified in ASHRAE standard 34-2007. See the Safety of DuPont™ Suva® and ISCEON® 9 Series Refrigerants (AS-1) bulletin and the DuPont™ ISCEON® MO49*Plus*™ MSDS for proper storage, handling and use details.

ISCEON® MO49*Plus*™ is non-flammable in air under normal conditions. However, mixtures of ISCEON® MO49*Plus*™ with high concentrations of air or oxygen at elevated pressure and/or temperature can become combustible in the presence of an ignition source. This product should not be mixed with air to check for leaks.

Lubricant and Filter Drier Information

Lubricants

Lubricant selection is based on many factors, including compressor wear characteristics, material compatibility, and lubricant/refrigerant miscibility (which can affect oil return to the compressor). ISCEON® MO49*Plus*™ is compatible with traditional and new lubricants – in most retrofit situations no change of oil type is required.

ISCEON® MO49*Plus*™ will work successfully with the existing mineral oil in most systems. In systems where oil return is a potential concern or in systems where the suction line accumulator acts as a low pressure receiver, replacement of all, or part (~25%) of the compressor oil charge with an OEM approved polyol ester is recommended.

Filter Drier

Change the filter drier during the retrofit. This is a routine system maintenance practice. There are two types of filter driers commonly used, solid core and loose filled. Replace the drier with the same type currently in use in the system. The drier label will show which refrigerants can be used with that drier. Select a drier specified to work with HFC refrigerants. (Many driers sold today are "universal" – they will work with most fluorocarbon refrigerants.) Check with your DuPont Distributor for the correct drier to use in your system.

General Retrofit Information

System Modifications

The composition of ISCEON® MO49*Plus*™ has been selected to provide performance comparable to the refrigerants being replaced in terms of both capacity and energy efficiency. As a result, minimal system modifications are anticipated with retrofitting. ISCEON® MO49*Plus*™ is a non-azeotrope. Therefore, the vapor composition in the refrigerant cylinder is different from the liquid composition. For this reason, this refrigerant should be transferred from the container from the liquid phase during system charging (or when transferring from
one container to another).

Retrofits of R-12 systems with a non-ozone-depleting alternative refrigerant such as R-134a will require multiple oil changes and possibly more extensive modifications to the existing equipment. For some systems, the cost of conversion may be large. ISCEON® MO49*Plus*™ provides the service contractor and equipment owner with a cost- effective way to retrofit an existing R-12 system.

Note: ISCEON® MO49*Plus*™ should not be mixed with other refrigerants or additives. Mixing this refrigerant with CFC or HCFC refrigerants, or mixing two different refrigerants, may have an adverse effect on system performance. "Topping off" a CFC or HCFC refrigerant with ISCEON® MO49*Plus*™ is not recommended.

System Superheat

Desired system performance after a retrofit with ISCEON® MO49*Plus*™ requires correct setting of the system superheat. This is discussed in the detailed retrofit procedures given below.

System Oil Management

In many situations, systems retrofitted with ISCEON® MO49*Plus*™ have operated routinely using the lubricant that was used with the original CFC or HCFC refrigerant. In systems with complex piping, in a small number of cases, the oil may not return consistently to the compressor (or compressor rack).

It is important that oil levels in the compressors (or oil management system in the case of compressor racks) be monitored during initial operation with the ISCEON® MO49*Plus*™. If the oil level falls below the minimum allowed, top up the oil to the minimum level with the existing oil type. Do not fill to maximum as the level may rise again. Should the oil level fall continuously, or suffer large oscillations during an operating cycle, addition of POE lubricant has proven effective in restoring adequate oil return rates.

POE lubricant should be progressively added to the system. An initial addition of 10% (of the total oil charge) should be made. This should be followed by 5% increments until the oil level returns to normal.

It is important to ensure that, when adding POE oil to the system, the oil level (immediately after addition) is kept below the system mid-point (e.g. mid-sight glass) oil level.

It is also important to keep accurate records of how much oil is added to avoid over-filling.

Refrigerant Recovery Information

Most recovery or recycle equipment used for R-12 can be used for ISCEON® MO49*Plus*™. Use standard procedures to avoid cross -contamination when switching from one refrigerant to another. Most recovery or recycle machines can use the same compressor oil that was used for R-12. However, some modifications may be necessary, such as a different kind of drier or a different moisture indicator. Consult the equipment manufacturer for specific recommendations.

Contact your DuPont refrigerant distributor for details of the refrigerant reclaim program.

Expected Performance After Retrofit

Based on thermodynamic property data. Actual results may vary due to system design and operating conditions.

ISCEON® MO49*Plus*™ provides up to 11% cooling capacity and similar to slightly lower energy efficiency in R-12 systems. ISCEON® MO49*Plus*™ operates at lower discharge temperatures vs. R-12.

Table 1
ISCEON® MO49*Plus*™ Performance Comparison in Automotive Air-Conditioning System

	Automotive Air-Conditioning
	41°F (5°C) Evaporator T 129°F (54°C) Condensor T 59°F (15°C) Return Gas T 70% Comp Eff With 7°F (4K) subcooling
Performance Relative to R-12:	**MO49*Plus*™ R-437A***
Compressor Discharge Temperature, °F (°C)	–11 (–6)
Compressor Discharge Pressure, psia (kPa abs)	+45 (+312)
Cooling Capacity %	+11
Energy Efficiency %	–6
Temperature Glide, °F (K)	+3 (+1.7)

+ is increase and – is decrease in performance vs. R12

Table2
ISCEON® MO49*Plus*™ Performance Comparison in Medium Temperature Refrigeration System

	Medium Temperature			
	22°F (–5.6°C) Evaporator T 120°F (48.9°C) Condenser T 59°F (15°C) Return Gas T 70% Comp Eff with 10°F (5.6 K) subcooling			
Performance Relative to R-12	**MO49*Plus*™ R-437A***	**MP39 R-401A**	**MP66 R-401B**	**R-409A**
Compressor Discharge Temperature, °F (°C)	–14 (–8.1)	+18 (+10)	+22 (+12)	+18 (+10)
Compressor Discharge Pressure, psia (kPa abs)	+38 (+267)	+24 (+162)	+35 (+244)	+28 (+193)
Cooling Capacity %	+11	+10	+17	+12
Energy Efficiency %	–4	–1	–2	–2
Temperature Glide, °F (K)	+3 (+1.8)	+8 (+4.6)	+8 (+4.3)	+11 (+6.3)

+ is increase and – is decrease in performance vs. R-12

Table 3
ISCEON® MO49*Plus*™ Performance Comparison in Low Temperature Refrigeration System

	Low Temperature			
	–13°F (–25°C) Evaporator T 113°F (45°C) Condenser T 59°F (15°C) Return Gas T 70% Comp Eff with 10°F (5.6 K) subcooling			
Performance Relative to R-12	**MO49*Plus*™ R-437A***	**MP39 R-401A**	**MP66 R-401B**	**R-409A**
Compressor Discharge Temperature, °F (°C)	–23 (–13)	+23 (+13)	+29 (+16)	+25 (+14)
Compressor Discharge Pressure, psia (kPa abs)	+34 (+237)	+21 (+142)	+32 (+218)	+25 (+172)
Cooling Capacity %	+ 5	+ 4	+11	+6
Energy Efficiency %	–3	–2	–2	–3
Temperature Glide, F ° (K)	+3 (+1.8)	+8 (+4.6)	+8 (+4.3)	+11 (+6.3)

+ is increase and – is decrease in performance vs. R-12

Retrofit of R-12 Medium and Low Temperature Refrigeration Systems to ISCEON® MO49Plus™

(Refer to the retrofit checklist at the back of this bulletin)

1. Establish baseline performance with current refrigerant. Collect system performance data while the old refrigerant is in the system. Check for correct refrigerant charge and operating conditions. The baseline data of temperatures and pressures at various points in the system (evaporator, condenser, compressor suction and discharge, superheat and subcool, etc.) at normal operating conditions will be useful when optimizing operation of the system with the ISCEON® MO49*Plus*™. A System Data Sheet is included at the back of this document to record baseline data.

2. Remove refrigerant from the system into a recovery cylinder. The existing charge should be removed from the system and collected in a recovery cylinder using a recovery device capable of pulling 10–15 in Hg vacuum (50-67kPa absolute). If the recommended charge size for the system is not known, weigh the amount of refrigerant removed. The initial quantity of ISCEON® MO49*Plus*™ to charge to the system can be estimated from this amount. (See step 5)

   Ensure that any residual refrigerant dissolved in the compressor oil is removed by holding the system under vacuum. Break the vacuum with dry, Nitrogen.

3. Replace the filter drier and any seals that are past their service life. It is routine practice to replace the filter drier during system maintenance. Replacement filter driers are available that are compatible with ISCEON® MO49*Plus*™. See page 2 of this manual for additional information on driers. Some systems may require expansion valve adjustments. Experience shows conversions in older refrigeration systems often require replacement of seals to minimize risk of leaks. (Replace O rings on solenoid valves, etc. if needed. Replacement is likely to be needed in old systems)

4. Evacuate system and check for leaks. Use normal service practices. To remove air or other noncondensables and any residual moisture from the system, evacuate the system to near full vacuum (29.9 in. Hg vacuum [500 microns] or less than 0.1 kPa absolute), isolate the vacuum pump from the system and observe the vacuum reading. If the system does not maintain vacuum it is an indication that there might be a leak. Pressurize the system with nitrogen taking care not to exceed the system design maximum pressure and check for leaks. Do not use mixtures of air and refrigerant under pressure to check for leaks; these mixtures can be combustible.

5. Charge with ISCEON® MO49*Plus*™. Remove liquid only from charging cylinder. The proper cylinder position for liquid removal is indicated by arrows on the cylinder and cylinder box. Once liquid is removed from the cylinder, the refrigerant can be charged to the system as liquid or vapor as desired. Use the manifold gauges or a throttling valve to flash the liquid to vapor if required.

   WARNING

   Do not charge liquid refrigerant into the compressor. This will cause serious irreversible damage.

   In general, the refrigeration system will require less weight of the ISCEON® MO49*Plus*™ than that of the original CFC refrigerant . The optimum charge will vary depending on the system design and operating conditions.

   When converting an R-12 system to ISCEON® MO49*Plus*™ the initial charge of ISCEON® MO49*Plus*™ should not normally exceed 85% of the standard charge weight of R-12, provided no changes to mechanical components of the system (which could significantly affect the system's internal volumetric capacity) will be made during the retrofit. The final charge will be about 95% of the standard charge weight of R-12.

6. Start up system, adjust charge size. Start the system and let conditions stabilize. If the system is undercharged (as indicated by the level of superheat at the evaporator exit, or by the amount of sub-cool at the condenser exit) add more ISCEON® MO49*Plus*™ in small amounts (still by transferring as liquid from the charging cylinder) until the system conditions reach the desired level. See the pressure-temperature charts in this bulletin to compare pressures and temperatures in order to calculate superheat or sub-cooling for the refrigerant you are using.

   Sight glasses in the liquid line can be used in most cases as a guide to system charge, but correct system charge must be determined by measuring system operating conditions (discharge and suction pressures, suction line temperature, compressor motor amps, super-heat, etc.). Attempting to charge until the sight glass is "clear" may result in over-charging the refrigerant. Please read "How to Determine Suction Pressure, Superheat and Subcool."

   Ensuring that the correct compressor suction superheat is set is very important for reliable system operation with ISCEON® MO49*Plus*™. Experience has shown that superheat (at the compressor inlet) for ISCEON® MO49*Plus*™ should be the same as for the refrigerant being replaced.

7. Monitor oil levels. During initial operation of the system it is very important to monitor the level of oil in the compressor (or compressor oil management system) to verify that oil is returning to the compressor (or compressor rack) in an adequate manner.

   - If the oil level falls below the minimum allowed level, top up to the minimum level with the existing oil type. Do not fill to the maximum level as the level may rise again.

   - Should the oil return appear to be erratic as evidenced by large swings in oil level during the refrigeration system cycle it is recommended that some of the oil be removed from the system and replaced with POE oil. Replacement of up to 25% of the oil with POE will help maintain oil return. The exact amount of oil to be changed will depend on the system itself (evaporating temperatures, physical geometry, etc.)

   - POE lubricant should be progressively added to the system. An initial addition of 10% (of the total oil charge) should be made. This should be followed by 5% increments until the oil level returns to normal.

   - It is important to ensure that, when adding POE oil to the system, the oil level (immediately after addition) is kept below the system mid-point (e.g. mid-sight glass) oil level.

8. Label the system to clearly and permanently show the refrigerant in the system and any oil(s) present in the system.

Pressure/Temperature Charts

How to Read the Pressure/ Temperature Tables

The following pages contain pressure/temperature charts for the refrigerants discussed in this bulletin.

Three temperatures are shown at a given pressure:

- Saturated Liquid Temperature (Bubble Point)—In the condenser, this is the temperature at which the last bit of vapor has condensed. Below this temperature, the refrigerant will be subcooled liquid. This temperature should also be used when determining the pressure/temperature value of product in a refrigerant cylinder.

- Saturated Vapor Temperature (Dew Point)—In the evaporator, this is the temperature at which the last drop of liquid has just boiled. Above this temperature, the refrigerant will be superheated vapor.

- Average Coil Temperature (for ISCEON® MO49*Plus*™)—The evaporator or condenser will perform like it is operating at this constant temperature. It is an average of the bubble and dew point temperatures determined from either the suction or condenser pressure. Use this average temperature to compare coil temperatures with the refrigerant you are replacing. Note: this is an approximation of the average temperature for the low glide refrigerants.

How to Determine Suction Pressure, Superheat, and Subcool

Suction Pressure

Determine the expected evaporator temperature using the R-12 column (from the baseline data you collected prior to the retrofit). Find the same expected evaporator temperature in the Average Coil Temperature column for ISCEON® MO49*Plus*™. Note the corresponding pressure for this temperature. This is the suction pressure at which the system should operate.

Superheat

Using the saturated vapor pressure tables for ISCEON® MO49*Plus*™, determine the saturated vapor temperature (dew point) for the measured suction pressure. Measure the suction temperature and subtract the previously determined dew point temperature for ISCEON® MO49*Plus*™ to give the amount of vapor superheat.

Subcool

Using the saturated liquid pressure tables for ISCEON® MO49*Plus*™ determine the saturated liquid temperature (bubble point) for the measured discharge temperature. Measure the refrigerant liquid line temperature and subtract it from the previously determined bubble point temperature for ISCEON® MO49*Plus*™ to give the amount of liquid subcool.

Retrofit Checklist for Converting CFC-12 Systems to DuPont™ ISCEON® MO49*Plus*™

_____ 1. Establish baseline performance with existing refrigerant.

- Use the System Data sheet given below.
- Note the oil type in use and system operating data (if system is operating properly).
- Check for existing leaks and repair.

_____ 2. Remove existing refrigerant charge from system. (Need 10–15 in Hg [50–67 kPa absolute] vacuum to remove charge.)

- Use recovery cylinder (DO NOT vent to atmosphere).
- Weigh amount removed (if possible): _____.
- Break the vacuum with dry nitrogen.

_____ 3. Replace the filter dryer.

- Check elastomeric seals (O-rings, sight glasses, etc.).
- Evaluate need to change TXV.
- Check that oil is in good condition; replace if necessary.

_____ 4. Evacuate system and check for leaks
(29.9 in. Hg vacuum [500 microns] or less than 0.1 kPa absolute)

- Does the system hold a vacuum?
- Break vacuum with dry nitrogen, pressurize to below the system design pressure.
- Does the system hold pressure?
- Check for any leaks.

_____ 5. Charge system with ISCEON® MO49*Plus*™.

- Remove *liquid only* from cylinder.
- Initial charge:
  – ISCEON® MO49*Plus*™ – 85% by weight of original R-12 charge.
- Note amount of refrigerant charged_____.

_____ 6. Adjust TXV and/or refrigerant charge to achieve the same superheat as the original system.

_____ 7. Monitor oil levels in compressor. If necessary add original oil to attain normal operating level (mid-sight glass).

- If a sudden surge in oil level occurs (e.g., during/just-after defrost) remove a small (approximately 10%) quantity of the mineral oil and replace with POE oil. Repeat if necessary.
- If the oil levels falls below the minimum, top-up to the minimum level with the existing oil type.
- If the oil level continuously falls or large oscillations occur during operation, add a sufficient amount of an equivalent POE until oil return becomes normal.

_____ 8. Label system clearly. Ensure System Data sheet is completed and filed securely.

Retrofit is complete!

System Data Sheet

Type of System/Location: _____

Equipment Mfg.: _____ Compressor Mfg.: _____

Model No.: _____ Model No.: _____

Serial No.: _____ Serial No.: _____

Original Charge Size: _____ Lubricant Type: _____

_____ Lubricant Charge Size: _____

Drier Mfg.: _____ Drier Type (check one):

Model No.: _____ Loose Fill: _____

_____ Solid Core: _____

Condenser Cooling Medium (air/water): _____

Expansion Device (check one): Capillary Tube: _____

Expansion Valve: _____

Manufacturer: _____

Model No.: _____

Control/Set Point: _____

Location of Sensor: _____

Other System Controls (ex.: head press control), Describe: _____

_____

(circle units used where applicable)

Date/Time				
Refrigerant				
Charge Size (lb, oz/g)				
Ambient Temp. (°F/°C)				
Relative Humidity				
Compressor:				
Suction T (°F/°C)				
Suction P (psi/kPa/bar)				
Discharge T (°F/°C)				
Discharge P (psi/kPa/bar)				
Box/FixtureT (°F/°C)				
Evaporator:				
Refrigerant Inlet T (°F/°C)				
Refrigerant Outlet T (°F/°C)				
Coil Air/H_2O In T (°F/°C)				
Coil Air/H_2O Out T (°F/°C)				
Refrigerant T at Superheat Ctl. Pt. (°F/°C)				
Condenser:				
Refrigerant Inlet T (°F/°C)				
Refrigerant Outlet T (°F/°C)				
Coil Air/H_2O In T (°F/°C)				
Coil Air/H_2O Out T (°F/°C)				
Exp. Device Inlet T (°F/°C)				
Motor Amps				
Run/Cycle Time				
Comments: _____				
_____				

Table 4
Physical Properties of ISCEON® MO49*Plus*™

Physical Property	Unit	ISCEON® MO49*Plus*™	R–12
Boiling Point (1 atm.)	°C °F	–29 –20	–30 –22
Vapor Pressure at 25°C (77°F)	kPa abs psia	743 108	652 95
Liquid Density at 25°C (77°F)	kg/m^3 lb/ft^3	1176 73.4	1311 81.8
Density, Satd. Vapor at 25°C (77°F)	kg/m^3 lb/ft^3	37.8 2.36	37 2.32
Ozone Depletion Potential	CFC-11 = 1.0	0	1
Global Warming Potential* (SAR Values)	CO_2 = 1	1684	8500

Table 5
Composition of ISCEON® MO49*Plus*™ (Wt. %)

Component	Chemical Name	Formula	Weight Percent
HFC-125	Pentafluoroethane	CF_3CHF	19.5
HFC-134a	1,1,1,2-Tetrafluoroethane	CF_3CH_2F	78.5
Butane	n-butane	C_4H_{10}	1.4
Pentane	n-pentane	C_5H_{12}	0.6

Appendix

Table 6
Pressure – Temperature Chart (ENG Units): R–12 and ISCEON® MO49*Plus*™

Temp. (°F)	R-12 Pressure (psia)	ISCEON® MO49*Plus*™ Liquid Phase Pressure (psia)	ISCEON® MO49*Plus*™ Vapor Phase Pressure (psia)
–50	7.1	7.7	6.4
–49	7.3	8.0	6.6
–48	7.5	8.2	6.8
–47	7.7	8.4	7.0
–46	7.9	8.7	7.2
–45	8.1	8.9	7.4
–44	8.4	9.2	7.6
–43	8.6	9.4	7.8
–42	8.8	9.7	8.1
–41	9.1	10.0	8.3
–40	9.3	10.3	8.6
–39	9.5	10.5	8.8
–38	9.8	10.8	9.1
–37	10.0	11.1	9.3
–36	10.3	11.4	9.6
–35	10.6	11.7	9.9
–34	10.8	12.0	10.1
–33	11.1	12.4	10.4
–32	11.4	12.7	10.7
–31	11.7	13.0	11.0
–30	12.0	13.4	11.3
–29	12.3	13.7	11.6
–28	12.6	14.1	12.0
–27	12.9	14.4	12.3
–26	13.2	14.8	12.6
–25	13.5	15.2	12.9
–24	13.9	15.6	13.3
–23	14.2	16.0	13.7
–22	14.5	16.4	14.0
–21	14.9	16.8	14.4
–20	15.2	17.2	14.8
–19	15.6	17.6	15.1
–18	16.0	18.1	15.5
–17	16.3	18.5	15.9
–16	16.7	19.0	16.3
–15	17.1	19.4	16.8
–14	17.5	19.9	17.2
–13	17.9	20.4	17.6
–12	18.3	20.9	18.1
–11	18.7	21.4	18.5
–10	19.2	21.9	19.0
–9	19.6	22.4	19.4
–8	20.0	22.9	19.9
–7	20.5	23.4	20.4
–6	20.9	24.0	20.9
–5	21.4	24.5	21.4
–4	21.9	25.1	21.9
–3	22.3	25.7	22.5
–2	22.8	26.2	23.0
–1	23.3	26.8	23.5
0	23.8	27.4	24.1
1	24.3	28.1	24.7
2	24.8	28.7	25.2
3	25.4	29.3	25.8
4	25.9	30.0	26.4
5	26.4	30.6	27.0
6	27.0	31.3	27.6
7	27.6	32.0	28.3
8	28.1	32.7	28.9
9	28.7	33.4	29.6
10	29.3	34.1	30.2
11	29.9	34.8	30.9
12	30.5	35.5	31.6
13	31.1	36.3	32.3
14	31.7	37.1	33.0
15	32.4	37.8	33.7
16	33.0	38.6	34.4
17	33.7	39.4	35.2
18	34.3	40.2	35.9
19	35.0	41.0	36.7
20	35.7	41.9	37.5
21	36.4	42.7	38.3
22	37.1	43.6	39.1
23	37.8	44.5	39.9
24	38.5	45.4	40.7
25	39.3	46.3	41.6
26	40.0	47.2	42.5
27	40.8	48.1	43.3
28	41.5	49.1	44.2
29	42.3	50.0	45.1
30	43.1	51.0	46.0
31	43.9	52.0	47.0
32	44.7	53.0	47.9
33	45.5	54.0	48.9
34	46.3	55.0	49.8
35	47.2	56.1	50.8
36	48.0	57.2	51.8
37	48.9	58.2	52.9
38	49.8	59.3	53.9
39	50.7	60.4	54.9
40	51.6	61.6	56.0
41	52.5	62.7	57.1
42	53.4	63.9	58.2
43	54.4	65.0	59.3
44	55.3	66.2	60.4
45	56.3	67.4	61.6
46	57.3	68.7	62.7
47	58.3	69.9	63.9
48	59.3	71.1	65.1
49	60.3	72.4	66.3

Table 6
Pressure – Temperature Chart (ENG Units): R–12 and ISCEON® MO49*Plus*™ *(continued)*

Temp. (°F)	R-12 Pressure (psia)	ISCEON® MO49*Plus*™ Liquid Phase Pressure (psia)	ISCEON® MO49*Plus*™ Vapor Phase Pressure (psia)
50	61.3	73.7	67.6
51	62.3	75.0	68.8
52	63.4	76.3	70.1
53	64.5	77.7	71.3
54	65.5	79.0	72.6
55	66.6	80.4	74.0
56	67.8	81.8	75.3
57	68.9	83.2	76.7
58	70.0	84.7	78.0
59	71.2	86.1	79.4
60	72.3	87.6	80.8
61	73.5	89.1	82.3
62	74.7	90.6	83.7
63	75.9	92.1	85.2
64	77.1	93.7	86.7
65	78.4	95.2	88.2
66	79.6	96.8	89.7
67	80.9	98.4	91.2
68	82.2	100.1	92.8
69	83.4	101.7	94.4
70	84.8	103.4	96.0
71	86.1	105.1	97.6
72	87.4	106.8	99.3
73	88.8	108.5	100.9
74	90.1	110.2	102.6
75	91.5	112.0	104.3
76	92.9	113.8	106.0
77	94.4	115.6	107.8
78	95.8	117.5	109.6
79	97.2	119.3	111.4
80	98.7	121.2	113.2
81	100.2	123.1	115.0
82	101.7	125.0	116.9
83	103.2	127.0	118.8
84	104.7	128.9	120.7
85	106.3	130.9	122.6
86	107.9	132.9	124.6
87	109.4	135.0	126.5
88	111.0	137.0	128.5
89	112.7	139.1	130.6
90	114.3	141.2	132.6
91	116.0	143.4	134.7
92	117.6	145.5	136.8
93	119.3	147.7	138.9
94	121.0	149.9	141.1
95	122.7	152.1	143.2
96	124.5	154.4	145.4
97	126.2	156.7	147.6
98	128.0	159.0	149.9
99	129.8	161.3	152.2

Temp. (°F)	R-12 Pressure (psia)	ISCEON® MO49*Plus*™ Liquid Phase Pressure (psia)	ISCEON® MO49*Plus*™ Vapor Phase Pressure (psia)
100	131.6	163.7	154.5
101	133.5	166.0	156.8
102	135.3	168.4	159.1
103	137.2	170.9	161.5
104	139.1	173.3	163.9
105	141.0	175.8	166.3
106	142.9	178.3	168.8
107	144.9	180.9	171.3
108	146.8	183.4	173.8
109	148.8	186.0	176.3
110	150.8	188.6	178.9
111	152.8	191.3	181.5
112	154.9	194.0	184.1
113	156.9	196.7	186.8
114	159.0	199.4	189.5
115	161.1	202.2	192.2
116	163.3	204.9	194.9
117	165.4	207.8	197.7
118	167.6	210.6	200.5
119	169.8	213.5	203.3
120	172.0	216.4	206.2
121	174.2	219.3	209.0
122	176.5	222.3	212.0
123	178.7	225.3	214.9
124	181.0	228.3	217.9
125	183.3	231.3	220.9
126	185.7	234.4	223.9
127	188.0	237.5	227.0
128	190.4	240.7	230.1
129	192.8	243.9	233.3
130	195.2	247.1	236.4
131	197.7	250.3	239.6
132	200.2	253.6	242.9
133	202.7	256.9	246.1
134	205.2	260.2	249.4
135	207.7	263.6	252.8
136	210.3	267.0	256.1
137	212.9	270.4	259.5
138	215.5	273.9	263.0
139	218.1	277.4	266.4
140	220.7	280.9	269.9
141	223.4	284.5	273.5
142	226.1	288.1	277.1
143	228.8	291.7	280.7
144	231.6	295.4	284.3
145	234.4	299.1	288.0
146	237.2	302.8	291.7
147	240.0	306.6	295.5
148	242.8	310.4	299.3
149	245.7	314.3	303.1
150	248.6	318.2	307.0

Table 7
Pressure – Temperature Chart (SI Units): R–12 and ISCEON® MO49*Plus*™

Temp. (°C)	R-12 Pressure (kPa)	ISCEON® MO49*Plus*™ Liquid Phase Pressure (kPa)	ISCEON® MO49*Plus*™ Vapor Phase Pressure (kPa)
–40	64.1	70.7	59.0
–39	67.2	74.3	62.1
–38	70.3	77.9	65.3
–37	73.6	81.8	68.7
–36	77.0	85.7	72.3
–35	80.6	89.9	75.9
–34	84.3	94.2	79.8
–33	88.1	98.6	83.7
–32	92.0	103.2	87.9
–31	96.1	108.0	92.2
–30	100.3	113.0	96.6
–29	104.6	118.1	101.2
–28	109.1	123.4	106.0
–27	113.8	128.9	111.0
–26	118.5	134.6	116.2
–25	123.5	140.5	121.5
–24	128.6	146.6	127.0
–23	133.9	152.9	132.8
–22	139.3	159.4	138.7
–21	144.9	166.1	144.8
–20	150.7	173.0	151.2
–19	156.7	180.2	157.8
–18	162.8	187.6	164.5
–17	169.1	195.2	171.6
–16	175.6	203.0	178.8
–15	182.3	211.1	186.3
–14	189.2	219.5	194.0
–13	196.3	228.1	202.0
–12	203.6	236.9	210.2
–11	211.1	246.1	218.6
–10	218.8	255.5	227.4
–9	226.7	265.1	236.4
–8	234.8	275.1	245.6
–7	243.2	285.3	255.2
–6	251.8	295.8	265.0
–5	260.6	306.7	275.2
–4	269.6	317.8	285.6
–3	278.9	329.2	296.3
–2	288.4	340.9	307.3
–1	298.1	353.0	318.7
0	308.2	365.4	330.3
1	318.4	378.1	342.3
2	328.9	391.1	354.6
3	339.7	404.5	367.3
4	350.7	418.2	380.3
5	362.0	432.3	393.6
6	373.6	446.8	407.3
7	385.4	461.6	421.4
8	397.6	476.7	435.8
9	410.0	492.3	450.6
10	422.7	508.2	465.8
11	435.7	524.5	481.3
12	449.0	541.3	497.3
13	462.5	558.4	513.6
14	476.4	575.9	530.4
15	490.6	593.8	547.6
16	505.1	612.2	565.1
17	520.0	630.9	583.1
18	535.1	650.1	601.6
19	550.6	669.8	620.5
20	566.4	689.9	639.8
21	582.6	710.4	659.5
22	599.1	731.4	679.8
23	615.9	752.9	700.5
24	633.1	774.8	721.6
25	650.6	797.2	743.3
26	668.5	820.1	765.4
27	686.7	843.5	788.0
28	705.3	867.3	811.1
29	724.3	891.7	834.7
30	743.7	916.6	858.9
31	763.4	942.0	883.5
32	783.5	967.9	908.7
33	804.0	994.4	934.5
34	824.9	1021.4	960.7
35	846.2	1048.9	987.5
36	867.9	1077.0	1014.9
37	890.0	1105.7	1042.9
38	912.5	1134.9	1071.4
39	935.5	1164.7	1100.5
40	958.8	1195.1	1130.2
41	982.6	1226.0	1160.5
42	1006.8	1257.6	1191.4
43	1031.5	1289.8	1222.9
44	1056.6	1322.6	1255.0
45	1082.1	1356.0	1287.8
46	1108.1	1390.0	1321.2
47	1134.5	1424.7	1355.3
48	1161.4	1460.0	1390.0
49	1188.8	1495.9	1425.3

Table 7
Pressure – Temperature Chart (SI Units): R–12 and ISCEON® MO49*Plus*™ *(continued)*

Temp. (°C)	R-12 Pressure (kPa)	ISCEON® MO49*Plus*™ Liquid Phase Pressure (kPa)	ISCEON® MO49*Plus*™ Vapor Phase Pressure (kPa)
50	1216.6	1532.5	1461.4
51	1244.9	1569.8	1498.1
52	1273.7	1607.8	1535.6
53	1303.0	1646.4	1573.7
54	1332.7	1685.8	1612.6
55	1363.0	1725.8	1652.1
56	1393.8	1766.6	1692.4
57	1425.0	1808.1	1733.5
58	1456.8	1850.3	1775.3
59	1489.1	1893.2	1817.9

Temp. (°C)	R-12 Pressure (kPa)	ISCEON® MO49*Plus*™ Liquid Phase Pressure (kPa)	ISCEON® MO49*Plus*™ Vapor Phase Pressure (kPa)
60	1521.9	1936.9	1861.2
61	1555.3	1981.3	1905.3
62	1589.2	2026.6	1950.3
63	1623.6	2072.5	1996.0
64	1658.6	2119.3	2042.5
65	1694.1	2166.9	2089.9
66	1730.2	2215.3	2138.2
67	1766.8	2264.5	2187.2
68	1804.1	2314.5	2237.2
69	1841.9	2365.4	2288.1
70	1880.2	2417.1	2339.8

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