DuPont™ ISCEON® 9 Series

REFRIGERANTS

Technical Information
ART-43

Retrofit Guidelines for DuPont™ ISCEON® 9 Series Refrigerants

DuPont™ ISCEON® MO49 (R-413A)

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Retrofit Guidelines for DuPont™ ISCEON® 9 Series Refrigerants

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Introduction

DuPont™ ISCEON® MO49 has proven to be a easy-to-use, reliable, and cost-effective non-ozone-depleting retrofit refrigerant. In many cases, systems retrofitted with this refrigerant are operating with the same mineral oil or alkylbenzene lubricant that was used with the previous CFC or HCFC refrigerant, and have been shown to provide similar system performance (as when operating with the previous refrigerant). Using these retrofit guidelines stationary air conditioning and medium temperature direct expansion refrigeration systems containing R-12 can be easily and economically retrofitted to ISCEON® MO49. This allows existing equipment to continue operating safely and effectively for the remainder of its useful life.

Note: ISCEON® MO49 is not available in the U.S

Retrofit Choice for R-12 Air Conditioning and Direct Expansion (DX) Medium Temperature Refrigeration Systems

ISCEON® MO49 is an easy-to-use, non-ozone depleting HFC retrofit refrigerant designed as a cost-effective replacement for R-12 in automotive* and stationary air conditioning (AC) and direct expansion (DX) refrigeration systems. **ISCEON® MO49 is compatible with traditional and new lubricants, in most cases no change of lubricant type during retrofit is required.**

*** Note:** Refer to "ISCEON® MO49 Conversion Guidelines – Automobile Air Conditioning Systems" for guidance.

ISCEON® MO49 provides slightly better cooling capacity and similar energy efficiency in R-12 systems, and operates at lower discharge temperatures vs. R-12. Actual performance depends on a number of system design and operating conditions.

ISCEON® MO49 can be topped off during service without removing the entire refrigerant charge.

Easy Steps to Retrofit

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

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.

Note: Experience shows conversions in old refrigeration systems often require changes in seals to minimize risk of leaks.

4. Evacuate system and check for leaks.
5. Charge with ISCEON® MO49.
   - 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

Important Safety Information

Like CFCs, ISCEON® MO49 is safe to use when handled properly. However, any refrigerant can cause injury or even death when mishandled. 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, and 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. 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

ISCEON® MO49 has an ASHRAE safety classification of A2. It can be used safely when proper storage and use guidelines are followed. As formulated, this refrigerant is non-flammable in air at atmospheric pressure and at temperatures up to 100°C (212°F). The vapor can become flammable under worst case leakage scenarios at temperatures between –25°C and 10°C (–13°F to 50°F). See the Safety of Suva® and ISCEON® Refrigerants (AS-1) bulletin and the MSDS for proper storage, handling and use details.

ISCEON® MO49 is non-flammable in air under normal conditions. However, mixtures of these products 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 is compatible with traditional and new lubricants – in most retrofit situations no change of oil type is required.

Field experience has shown that ISCEON® MO49 will work successfully with the existing mineral oil in most systems. In systems where oil return is a potential concern such as flooded evaporators 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 compositions of the ISCEON® MO49 has been selected to provide performance comparable to the refrigerants they are replacing in terms of both capacity and energy efficiency. As a result, minimal system modifications are anticipated with retrofitting. ISCEON® MO49 is near-azeotropes, 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).

In general, ISCEON® MO49 is not recommended for use in centrifugal compressor systems or for chillers with flooded evaporators or low pressure receivers.

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 provides the service contractor and equipment owner with a cost effective way to retrofit an existing system.

Note: ISCEON® MO49should not be mixed with other refrigerants or additives that have not been clearly specified by DuPont or the system equipment manufacturer. Mixing this refrigerant with CFC or HCFC refrigerants, or mixing two different alternative refrigerants, may have an adverse effect on system performance. "Topping off" a CFC or HCFC refrigerant with ISCEON® MO49 is strictly not recommended.

System Superheat

Desired system performance after a retrofit with ISCEON® MO49 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 have operated routinely using the mineral oil or alkylbenzene that was used with the original CFC or HCFC refrigerant. With complex systems, 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. 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. 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

These tables shows approximate system performance changes following a retrofit and are general guidelines for system behavior. These values are based on field experience, calorimeter testing and thermodynamic property data; and assume equal compressor efficiency. Actual performance will vary depending on system design and operating conditions.

Cooling capacity and energy efficiency depend greatly on system design , operating conditions and the actual condition of the equipment. ISCEON® MO49 will provide slightly higher cooling capacity, and similar energy efficiency compared to R-12.

Table 1
ISCEON® MO49 vs. R-12;
Discharge Temperature: °F (°C)

	At 40°F (4°C) Evaporator Temp.	At 0°F (–18°C) Evaporator Temp.
R-12	174 (79)	247 (119)
ISCEON® MO49	162 (72)	223 (106)

Condensing Temperature = 110°F (43°C)

Table 2
ISCEON® MO49 vs. R-12;
Discharge Pressure: psia (bar)

R-12	161 (1.1)
ISCEON® MO49	192 (1.3)

Condensing Temperature = 110°F (43°C)
Evaporator Temperature = 40°F (4°C)

Retrofit of R-12 Air Conditioning and Medium Temperature DX Refrigeration Systems to ISCEON® MO49.

(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. 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 (30–35 kPa). If the recommended charge size for the system is not known, weigh the amount of refrigerant removed. The initial quantity of ISCEON® MO49 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. It is routine practice to replace the filter/drier during system maintenance. Replacement filter-dryers are available that are compatible with ISCEON® MO49. See page 2 of this manual for additional information on dryers. (Replace "O"rings on sight glasses, 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 inHg vacuum [500 microns] or less than 10 kPa), 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. 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 than 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 the *initial* charge of ISCEON® MO49 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 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, superheat, etc.). Attempting to charge until the sight glass is "clear" may result in overcharging 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. Experience has shown that superheat (at the compressor inlet) for ISCEON® MO49 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)—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. 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, 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 to give the amount of vapor superheat.

Subcool

Using the saturated liquid pressure tables for ISCEON® MO49, 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 to give the amount of liquid subcool.

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

_____ 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] 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.

- 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.

- Remove *liquid only* from cylinder.
- Initial charge:
  - ISCEON® MO49 – 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: _____

If 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 3
Physical Properties of ISCEON® MO49

Physical Property	Unit	ISCEON® MO49	R-12
Boiling Point (1 atm.)	°C	–33	–30
	°F	–28	–22
Vapor Pressure at 25°C (77°F)	kPa abs	778	652
	psia	113	95
Liquid Density at 25°C (77°F)	kg/m^3	1157	1311
	lb/ft^3	72.3	81.8
Density, Satd. Vapor at 25°C (77°F)	kg/m^3	36	37
	lb/ft^3	2.25	2.32
Ozone Depletion Potential	CFC-11 = 1.0	0	1
Global Warming Potential	CO_2 = 1	1775	8500

Table 4
Composition of ISCEON® MO49 (Wt.%)

	HFC-134a	PFC-218	isobutane
ISCEON® MO49	88	9	3

Appendix

Table 5
Pressure – Temperature Chart (ENG Units): R–12 and ISCEON® MO49

Pressure psig	R-12 Sat. Temp °F	ISCEON® MO49 Sat. Liquid Temp °F	ISCEON® MO49 Sat. Vapor Temp °F	ISCEON® MO49 Avg. Coil Temp °F
20*	–63	–55	–44	–49
15*	–49	–44	–34	–39
10*	–38	–35	–25	–30
5*	–29	–28	–18	–23
0	–21	–27	–18	–22
2	–15	–22	–13	–17
4	–10	–17	–8	–13
6	–6	–13	–4	–9
8	–2	–9	0	–5
10	2	–5	3	–1
12	6	–2	7	3
14	10	2	10	6
16	13	5	13	9
18	16	8	16	12
20	19	11	19	15
22	22	14	21	17
24	25	16	24	20
26	27	19	26	22
28	30	21	28	25
30	32	24	31	27
32	35	26	33	29
34	37	28	35	31
36	39	30	37	34
38	42	32	39	36
40	44	34	41	38
42	46	36	43	39
44	48	38	45	41
46	50	40	46	43
48	52	42	48	45
50	53	43	50	47
55	58	48	54	51
60	62	52	58	55
65	66	55	61	58
70	70	59	65	62
75	74	63	68	65
80	77	66	71	69
85	81	69	74	72
90	84	72	77	75
95	87	75	80	78
100	90	78	83	80
105	93	81	86	83
110	96	83	88	86
115	99	86	91	88
120	102	88	93	91
125	104	91	96	93
130	107	93	98	96
135	110	96	100	98
140	112	98	102	100
145	114	100	104	102
150	117	102	106	104
155	119	104	109	106
160	121	106	111	109
165	124	108	113	110
170	126	110	114	112
175	128	112	116	114
180	130	114	118	116
185	132	116	120	118
190	134	118	122	120
195	136	120	123	122
200	138	122	125	123
205	140	123	127	125
210	142	125	129	127
215	143	127	130	128
220	145	128	132	130
225	147	130	133	132
230	149	132	135	133
235	150	133	136	135
240	152	135	138	136
245	154	136	139	138
250	156	138	141	139
255	157	139	142	141
260	159	141	144	142
265	160	142	145	144
270	162	143	146	145
275	163	145	148	146
280	165	146	149	148
285	166	148	150	149
290	168	149	152	150
295	169	150	153	152
300	171	152	154	153
310	174	154	157	156
320	176	157	159	158
330	179	159	162	160
340	182	162	164	163
350	184	164	166	165
360	187	166	169	167
370	190	169	171	170
380	192	171	173	172
390	194	173	175	174
400	197	175	177	176

Note: Saturated Liquid Temperature = Bubble Point
Saturated Vapor Temperature = Dew Point

* Inches Hg, vacuum

Table 6
Pressure – Temperature Chart (SI Units): R–12 and ISCEON® MO49

Pressure Bar (g)	R-12 Sat. Temp °C	ISCEON® MO49 Sat. Liquid Temp °C	ISCEON® MO49 Sat. Vapor Temp °C	ISCEON® MO49 Avg. Coil Temp °C
–0.7	–55	–58	–51	–55
–0.6	–50	–53	–46	–50
–0.5	–45	–48	–42	–45
–0.4	–41	–45	–39	–42
–0.3	–38	–42	–36	–39
–0.2	–35	–39	–33	–36
–0.1	–33	–36	–31	–33
0	–30	–34	–28	–31
0.1	–28	–32	–26	–29
0.2	–26	–29	–24	–27
0.3	–24	–28	–23	–25
0.4	–22	–26	–21	–23
0.5	–20	–24	–19	–22
0.6	–18	–22	–18	–20
0.7	–17	–21	–16	–19
0.8	–15	–20	–15	–17
0.9	–14	–18	–14	–16
1	–12	–17	–12	–15
1.1	–11	–15	–11	–13
1.2	–10	–14	–10	–12
1.3	–9	–13	–9	–11
1.4	–7	–12	–8	–10
1.5	–6	–11	–7	–9
1.6	–5	–10	–6	–8
1.7	–4	–9	–5	–7
1.8	–3	–8	–4	–6
1.9	–2	–7	–3	–5
2	–1	–6	–2	–4
2.1	0	–5	–1	–3
2.2	1	–4	0	–2
2.3	2	–3	1	–1
2.4	3	–2	2	0
2.5	4	–1	3	1
2.6	5	0	3	2
2.7	6	0	4	2
2.8	7	1	5	3
2.9	7	2	6	4
3	8	3	6	5
3.1	9	4	7	5
3.2	10	4	8	6
3.3	11	5	9	7
3.4	11	6	9	8
3.5	12	6	10	8
3.6	13	7	11	9
3.7	14	8	11	10
3.8	14	9	12	10
3.9	15	9	13	11
4	16	10	13	12
4.2	17	11	14	13
4.4	18	12	16	14
4.6	20	14	17	15
4.8	21	15	18	16
5	22	16	19	17
5.2	23	17	20	18
5.4	24	18	21	20
5.6	26	19	22	21
5.8	27	20	23	22
6	28	21	24	23
6.2	29	22	25	24
6.4	30	23	26	24
6.6	31	24	27	25
6.8	32	25	28	26
7	33	26	29	27
7.2	34	27	29	28
7.4	35	28	30	29
7.6	36	28	31	30
7.8	37	29	32	31
8	37	30	33	31
8.2	38	31	34	32
8.4	39	32	34	33
8.6	40	33	35	34
8.8	41	33	36	35
9	42	34	37	35
9.5	44	36	38	37
10	46	38	40	39
10.5	48	39	42	41
11	49	41	43	42
11.5	51	43	45	44
12	53	44	47	45
12.5	55	46	48	47
13	56	47	49	48
13.5	58	49	51	50
14	59	50	52	51
14.5	61	52	54	53
15	62	53	55	54
15.5	64	54	56	55
16	65	56	57	56
16.5	67	57	59	58
17	68	58	60	59
17.5	69	59	61	60

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

Pressure Bar (g)	R-12 Sat. Temp °C	ISCEON® MO49 Sat. Liquid Temp °C	ISCEON® MO49 Sat. Vapor Temp °C	ISCEON® MO49 Avg. Coil Temp °C
18	71	60	62	61
18.5	72	62	63	62
19	73	63	64	64
19.5	74	64	65	65
20	75	65	66	66
20.5	77	66	68	67
21	78	67	69	68
21.5	79	68	70	69
22	80	69	71	70
22.5	81	70	72	71
23	82	71	72	72
23.5	83	72	73	73
24	84	73	74	74
24.5	85	74	75	75
25	86	75	76	75
25.5	87	76	77	76
26	88	77	78	77
26.5	89	78	79	78
27	90	78	80	79
27.5	91	79	80	80
28	92	80	81	81
28.5	93	81	82	81
29	94	82	83	82
29.5	95	83	84	83
30	96	83	84	84
30.5	97	84	85	85
31	98	85	86	85
31.5	98	86	87	86
32	99	86	87	87
32.5	100	87	88	88
33	101	88	89	88
33.5	102	89	89	89
34	103	89	90	90
34.5	103	90	91	91
35	104	91	92	91

Note: Saturated Liquid Temperature = Bubble Point
Saturated Vapor Temperature = Dew Point

For Further Information: (800) 235-7882

www.refrigerants.dupont.com

DuPont Fluorochemicals
Wilmington, DE 19880-0711

Europe
DuPont de Nemours
International S.A.
2 Chemin du Pavillon
P.O. Box 50
CH-1218 Le Grand-Saconnex
Geneva, Switzerland
41-22-717-5111

Canada
DuPont Canada, Inc.
P.O. Box 2200, Streetsville
Mississauga, Ontario
Canada
L5M 2H3
(905) 821-3300

DuPont México, S.A. de C.V.
Homero 206
Col. Chapultepec Morales
C.P. 11570 México, D.F.
52-55-57 22 11 00

South America
DuPont do Brasil S.A.
Alameda Itapecuru, 506
Alphaville 06454-080 Barueri
São Paulo, Brazil
55-11-7266-8263

DuPont Argentina S.A.
Casilla Correo 1888
Correo Central
1000 Buenos Aires, Argentina
54-1-311-8167

Asia Pacific
Philippines
DuPont Fareast Inc Philippines
19th floor Gt Tower International
6815 Ayala Avcorner Hv Costast
Makati City
Philippines
1227
63-2-8189911
63-2-8189659

Thailand
DuPont (Thailand) Co.,Ltd
6-7th Floor, M. Thai Tower, All Seasons Place,
87 Wireless Road, Lumpini, Phatumwan
Bangkok
Thailand
10330
66-2-6594000
66-2-6594001-2
Lapee Thempongpattana
thempongpattana.lapee@tha.dupont.com
www.dupont.co.th

Malaysia
DuPont Malaysia Sdn Bhd
6th Floor, Bangunan Samudera,
No.1 Jalan Kontraktor U1/14
Sek U1, Hicom-Glenmarie Industrial Park
Shah Alam
Selangor
40150
60-3-55693006
60-3-55693001
Nicholas Leong
Nicholas.Leong@mys.dupont.com

Singapore
DuPont Company (Singapore) Pte Ltd
1 HarbourFront Place #11-01
HarbourFront Tower One
Singapore
098633
65-65863688
65-62727494
Shawn Wang / Jenny Chua
shawn.wang@chn.dupont.com
jenny.chua@sgp.dupont.com

Indonesia
PT DuPont Indonesia
Menara Mulia 5th Floor
Jl Jend. Gatot Subroto Kav. 9-11
Jakarta
Indonesia
12930
62-21-5222555
62-21-5222565

Taiwan
DuPont Taiwan Ltd.
13Fl., No. 167, Tun Hwa N. Rd.,
Taipei
Taiwan, R. O. C.
105
886-2-27191999
886-2-25457098
Jackie Wu
jackie.wu@twn.dupont.com
www.dupont.com.tw

India
E I DuPont India Private Ltd
DLF Cyber Greens, Tower "C" 7th Floor
Sector 25A, DLF City
Phase III
Gurgaon 122002
INDIA
91-124-2540900
91-124-2540891
Mr. Upal Roy
Upal.Roy@ind.dupont.com
in.dupont.com

Korea
DuPont(Korea) Inc.
4th Floor, Asia Tower
#726, Yeoksam-dong, Kangnam-Ku
Seoul, Korea
135-719
82-2-22225207
82-2-22225483
Jae Young Park
jae-young.park@kor.dupont.com
www.dupont.co.kr

Hong Kong
DuPont China Limited
26/F., Tower 6, Gateway
Canton Road
Tsimsha tsui
HongKong
852-27345345
852-23683516
Tim Leung
Tim-S.T.Leung@hkg.DuPont.com

Australia/New Zealand
DuPont (Australia) Ltd
168 Walker street North Sydney
PO Box 930 North Sydney
Sydney
NSW
2060
61-2-99236111
61-2-99236135
John McCormack
john.mccormack@aus.dupont.com

China
DuPont China Holding Co.,Ltd.
15th Floor, Shui On Plaza,
333 Huai Hai Road (Central)
Shanghai
200021
86-21-63866366
86-21-63853542
Stacy Wang
stacy.wang@chn.dupont.com

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