DEF-Trac® Design and Installation Guide

Important Information Follow All Instructions

DEF-Trac®

Featuring a Flexible Corrugated Stainless Steel Core
TABLE OF CONTENTS

USER WARNINGS.................................................................................................................. 4
DESIGN SPECIFICATIONS........................................................................................................ 4
INSPECTION / HANDLING / STORAGE.......................................................................................... 4
TOOLS REQUIRED FOR INSTALLATION.................................................................................... 4
FITTING ASSEMBLY PROCEDURE
  DEF-TRAC / INSULATED, HEAT TRACED .................................................................................. 4
  DEF-TRAC / UN-INSULATED, NON-HEAT TRACED ................................................................. 8
  DEF-TRAC / INSULATED, NON-HEAT TRACED................................................................. 11
DEF-TRAC PIPE CHASING, PIPE BURIAL, TRENCHING, AND BACKFILL REQUIREMENTS.................. 13
ROUTINE MAINTENANCE AND VISUAL INSPECTION............................................................... 13
HEAT TRACE INSTALLATION & TROUBLESHOOTING............................................................... 14
WARRANTY .................................................................................................................................. 32
DEF-TRAC INSTALLATION CHECKLIST..................................................................................... 33
1. USER WARNINGS

The OmegaFix® DEF-Trac® flexible piping system must only be installed or serviced by a qualified installer who has been trained by an Omega Flex authorized trainer. The use of nontrained personnel or any deviations from these instructions could result in damage to or leakage of the system.

⚠️ WARNING!

**LEAKAGE OF FLUID FROM THE DEF-TRAC® SYSTEM COULD CAUSE CONTAMINATION OF THE GROUND AND/OR GROUND WATER, AND POSSIBLY CAUSE BODILY INJURY. THESE INSTALLATION INSTRUCTIONS AND ALL APPLICABLE CODES AND REGULATIONS MUST BE STRICTLY FOLLOWED.**

This document provides the user with general instructions for the design and installation of piping systems using DEF-Trac® flexible piping. Sound engineering principles and compliance with applicable codes and regulations must be exercised for the proper design and installation of the DEF-Trac® flexible piping of fuel gas piping systems. The installation instructions and procedures contained in this Design Guide must be strictly followed in order to provide a safe and effective flexible piping system or system modification.

This information deals primarily with DEF-Trac® flexible piping. Other components may have their own individual installation instructions provided by the equipment manufacturer. The installation instructions provided by all component manufacturers must be followed for the piping system to operate safely as designed.

At the completion of work this installation information must be given to the site operator or owner.

1.1 DEF-TRAC® FLEXIBLE PIPING SYSTEM

DEF-Trac® flexible piping addresses the emerging needs of the DEF supply industry. Unaffected by corrosive effects of DEF, DEF-Trac® is manufactured from corrugated 316L stainless steel, and is supplied in long coils to streamline the installation of the distribution piping from the storage tank to the dispensing pumps.

2. DESIGN SPECIFICATIONS

Maximum Operating Pressure: 50 psig
Maximum Test Pressure: 75 psig
Operating Temperature Range: -20°F to +120°F

---

### Bend Radius / OD

<table>
<thead>
<tr>
<th>SIZE</th>
<th>PART NO.</th>
<th>MINIMUM BEND RADIUS (INCHES)</th>
<th>WT/FT (LBS)</th>
<th>NOMINAL OD (INCHES)</th>
<th>WT/FT (LBS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>DF-FSP-16</td>
<td>7</td>
<td>0.30</td>
<td>Heat gun</td>
<td></td>
</tr>
<tr>
<td>1½&quot;</td>
<td>DF-FSP-24</td>
<td>12</td>
<td>0.50</td>
<td></td>
<td>1.93</td>
</tr>
<tr>
<td>2&quot;</td>
<td>DF-FSP-32</td>
<td>14</td>
<td>0.75</td>
<td></td>
<td>2.51</td>
</tr>
<tr>
<td>1&quot;</td>
<td>DF-FSPIN-16</td>
<td>18</td>
<td>1.00</td>
<td></td>
<td>2.65</td>
</tr>
<tr>
<td>1½&quot;</td>
<td>DF-FSPIN-24</td>
<td>30</td>
<td>1.30</td>
<td></td>
<td>3.15</td>
</tr>
<tr>
<td>2&quot;</td>
<td>DF-FSPIN-32</td>
<td>35</td>
<td>1.75</td>
<td></td>
<td>3.50</td>
</tr>
<tr>
<td>1&quot;</td>
<td>DF-FSPHT-16</td>
<td>18</td>
<td>1.10</td>
<td></td>
<td>2.65</td>
</tr>
<tr>
<td>1½&quot;</td>
<td>DF-FSPHT-24</td>
<td>30</td>
<td>1.40</td>
<td></td>
<td>3.15</td>
</tr>
<tr>
<td>2&quot;</td>
<td>DF-FSPHT-32</td>
<td>35</td>
<td>1.85</td>
<td></td>
<td>3.50</td>
</tr>
</tbody>
</table>

---

3. INSPECTION / HANDLING / STORAGE

Inspect all piping, fittings and components when they arrive at the job site. Any piping that has been cut, crushed, or otherwise subjected to physical damage during transportation or storage shall be discarded and never used. The piping and fittings shall be handled in such a manner that will not cause any unnecessary damage. Keep all components in the original packaging until ready for use. Inspect fittings prior to installation.

4. TOOLS REQUIRED FOR INSTALLATION

DEF-Trac® can be installed utilizing standard hand tools.

- Adjustable wrenches or pipe wrenches
- Tubing cutter with sharp wheel

---

### FITTING ASSEMBLY PROCEDURE

5. DEF-Trac / INSULATED – HEAT TRACED

⚠️ CAUTION

- DEF-Trac® INSULATED PIPING IS MANUFACTURED USING THERMON BSX 3-1 (1" DEF-Trac) & BSX 5-1 (1½" & 2" DEF-Trac) HEAT TRACE.
- THERMON BSX 3-1, & BSX 5-1 HEAT TRACE CAN ONLY BE POWERED USING 120VAC.
- MANDATORY GFI EPD CIRCUIT BREAKER - PER NEC ARTICLE 427-22, ALL HEAT TRACING CIRCUITS MUST HAVE GFI – EQUIPMENT PROTECTION ON THE CIRCUIT. IN THIS SYSTEM, THE HEATER CABLE MUST BE POWERED FROM AN EPD (30MA GFI TRIP) TYPE CIRCUIT BREAKER.
A. CUT TO LENGTH / REMOVE JACKET FOR FITTING ATTACHMENT

Determine the proper rough cut length, cut with a tubing cutter or reciprocating saw. After measuring and making cut for overall length, remove at a minimum of 20 inches of the outer most black jacket and insulation. More can be removed depending on installation conditions.

Cut through the black plastic layer using a utility knife and remove.

Cut through the insulation and remove. Do not remove the innermost black jacket. Use care to avoid any damage to the heat trace and corrugated piping while removing the insulation.

B. SEAL HEAT SHRINK SLEEVE (Outer Jacket)

Slide up the heat shrink sleeve to cover the tubing bundle. About ½ of the sleeve should be covering the tubing bundle and ½ should be on the corrugated piping. (With plastic jacket) The heat trace cable should be underneath the heat shrink sleeve. Using a heat gun, carefully shrink down the sleeve without overheating the inner jacket.

C. PRECISION CUT

Remove innermost black jacket leaving 11” of bare corrugated piping exposed.

**CAUTION**

HEAT TRACE IS HELICALLY WOUND ON PIPING.

USE CARE WHEN CUTTING JACKET AND INSULATION.

Fully stripped end.

Slide the nut over the core until it bottoms out on the black jacket. Place a mark on the top of the first two corrugations past where the split rings will sit.
Remove the nut and cut through the corrugated piping using a tubing cutter with a sharp wheel. Cut must be centered in the valley between the two marked corrugations.

**Use full circular strokes in one direction and tighten roller pressure slightly after each revolution. DO NOT over-tighten roller which may flatten tube.**

**D. HEAT SHRINK SLEEVE (Inner Jacket)**
Slide the inner jacket heat shrink sleeve over the corrugated piping and underneath the heat trace cable.

**E. INSTALL FITTING NUT**
Slide nut over cut tube end.

Place two split-rings into the valley of the first corrugation. Slide nut forward to trap the split rings.

**F. TIGHTEN FITTING**
Thread the adapter into the mating piece of equipment (elbow, tee, valve etc.). Thread the nut into the adaptor and engage threads. Note that the fitting is designed to form a leak tight seat on the stainless tubing as you tighten the fitting. Using appropriate wrenches; tighten the fitting until the adaptor bottoms and the resistance to wrenching increases greatly. Tighten the nut and adaptor to the torque listed in Table 1.

<table>
<thead>
<tr>
<th>Size</th>
<th>Minimum Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>150 ft-lbs</td>
</tr>
<tr>
<td>1½&quot;</td>
<td>275 ft-lbs</td>
</tr>
<tr>
<td>2&quot;</td>
<td>300 ft-lbs</td>
</tr>
</tbody>
</table>

Note the relation between the hex flats at this point and continue to tighten for two additional hex flats (one-third turn) to obtain required torque and final leak tight seal. The flare has now been created on the tubing end creating the metal to metal seal.

**SEALANTS ARE ONLY TO BE USED ON THE PIPE THREAD.**

**CAUTION**

**DO NOT USE ANY THREAD SEALANTS ON THE STRAIGHT THREADS FOR THIS CONNECTION, THE GREASE ON THE SEALING SEAT IS ANTI SEIZE TO LUBRICATE WHILE TIGHTENING. IF FOR ANY REASON THE GREASE IS REMOVED, LITHIUM BASED GREASE APPLIED TO THE SEALING SURFACE WILL BE ADEQUATE.**
G. Tightness Testing
Before shrinking the heat shrink sleeve over the nut, and prior to backfilling, the piping system must be isolated from the tanks and subjected to a pipe tightness test.

For DEF-Trac® it is recommended the piping be pressurized with air to a maximum of 25 psi. Maintain this pressure for one hour ensuring there is no drop in pressure. Additionally spray fitting with a non-corrosive leak check solution and look for bubbles. Once all heat shrink sleeves (inner and outer) are completed a 75psig max pressure test can be completed if required by code.

H. Seal Heat Shrink Sleeve (Inner Jacket)
Slide up the heat shrink sleeve to fully cover the back hex nut. Using a heat gun, carefully shrink down the sleeve without overheating the inner jacket.

CAUTION
• DEF-Trac® INSULATED PIPING IS MANUFACTURED USING THERMON BSX 3-1 (1” DEF-Trac) & BSX 5-1 (1½” & 2” DEF-Trac) HEAT TRACE.
• THERMON BSX 3-1, & BSX 5-1 HEAT TRACE CAN ONLY BE POWERED USING 120VAC.
• MANDATORY GFI EPD CIRCUIT BREAKER
• PER NEC ARTICLE 427-22, ALL HEAT TRACING CIRCUITS MUST HAVE GFI – EQUIPMENT PROTECTION ON THE CIRCUIT. IN THIS SYSTEM, THE HEATER CABLE MUST BE POWERED FROM AN EPD (30MA GFI TRIP) TYPE CIRCUIT BREAKER.
6. DEF-Trac / INSULATED, NON-HEAT TRACED

A. CUT TO LENGTH / REMOVE JACKET FOR FITTING ATTACHMENT

Determine the proper rough cut length, cut with a tubing cutter or reciprocating saw. After measuring and making cut for overall length, remove at a minimum of 20 inches of the outer most black jacket and insulation. More can be removed depending on installation conditions.

Cut through the black plastic layer using a utility knife and remove.

Cut through the insulation and remove. Do not remove the innermost black jacket. Use care to avoid any damage to the heat trace and corrugated piping while removing the insulation.

Fully stripped end.

B. SEAL HEAT SHRINK SLEEVE (Outer Jacket)

Slide up the heat shrink sleeve to cover the tubing bundle. About ½ of the sleeve should be covering the tubing bundle and ½ should be on the corrugated piping (with plastic jacket). The heat trace cable should be underneath the heat shrink sleeve. Using a heat gun, carefully shrink down the sleeve without overheating the inner jacket.

C. PRECISION CUT

Remove innermost black jacket leaving 11" of bare corrugated piping exposed.

Slide the nut over the core until it bottoms out on the black jacket. Place a mark on the top of the first two corrugations past where the split rings will sit.

Remove the nut and cut through the corrugated piping using a tubing cutter with a sharp wheel. Cut must be centered in the valley between the two marked corrugations.

Use full circular strokes in one direction and tighten roller pressure slightly after each revolution. DO NOT over-tighten roller which may flatten tube.
D. HEAT SHRINK SLEEVE (Inner Jacket)

Slide the inner jacket heat shrink sleeve over the corrugated piping and underneath the heat trace cable.

E. INSTALL FITTING NUT

Slide nut over cut tube end.

Place two split-rings into the valley of the first corrugation. Slide nut forward to trap the split rings.

F. TIGHTEN FITTING

Thread the adapter into the mating piece of equipment (elbow, tee, valve etc.). Thread the nut into the adaptor and engage threads. Note that the fitting is designed to form a leak tight seat on the stainless tubing as you tighten the fitting. Using appropriate wrenches; tighten the fitting until the adaptor bottoms and the resistance to wrenching increases greatly. Tighten the nut and adaptor to the torque listed in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Size</th>
<th>Minimum Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>150 ft-lbs</td>
</tr>
<tr>
<td>1½&quot;</td>
<td>275 ft-lbs</td>
</tr>
<tr>
<td>2&quot;</td>
<td>300 ft-lbs</td>
</tr>
</tbody>
</table>

Note the relation between the hex flats at this point and continue to tighten for two additional hex flats (one-third turn) to obtain required torque and final leak tight seal. The flare has now been created on the tubing end creating the metal to metal seal.

SEALANTS ARE ONLY TO BE USED ON THE PIPE THREAD.

⚠️ CAUTION

DO NOT USE ANY THREAD SEALANTS ON THE STRAIGHT THREADS FOR THIS CONNECTION, THE GREASE ON THE SEALING SEAT IS ANTI SEIZE TO LUBRICATE WHILE TIGHTENING. IF FOR ANY REASON THE GREASE IS REMOVED, LITHIUM BASED GREASE APPLIED TO THE SEALING SURFACE WILL BE ADEQUATE.

G. TIGHTNESS TESTING

Before shrinking the heat shrink sleeve over the nut, and prior to backfilling, the piping system must be isolated from the tanks and subjected to a pipe tightness test.

For DEF-Trac® it is recommended the piping be pressurized with air to a maximum of 25 psi. Maintain this pressure for one hour ensuring there is no drop in pressure. Additionally spray fitting with a non-corrosive leak check solution and look for bubbles. Once all heat shrink sleeves (inner and outer) are completed a 75psig max pressure test can be completed if required by code.
H. SEAL HEAT SHRINK SLEEVE (Inner Jacket)

Slide up the heat shrink sleeve to fully cover the back hex nut. Using a heat gun, carefully shrink down the sleeve without overheating the inner jacket.

TYPICAL INSULATED NON-HEAT-TRACED END CONFIGURATION
7. DEF-Trac / UN-INSULATED, NON-HEAT TRACED

A. CUT TO LENGTH / REMOVE JACKET FOR FITTING ATTACHMENT

Determine the proper cut length, cut with a tubing cutter or reciprocating saw.

Remove the black jacket exposing 5” of bare corrugated piping.

Remove the nut and cut through the corrugated piping using a tubing cutter with a sharp wheel. Cut must be centered in the valley between the two marked corrugations.

Use full circular strokes in one direction and tighten roller pressure slightly after several revolutions. DO NOT over tighten roller which may flatten tube.

B. HEAT SHRINK SLEEVE

Slide on one heat shrink sleeve.

C. INSTALL FITTING NUT

Slide nut over cut tube end.

Place two split-rings into the valley of the first corrugation. Slide nut forward to trap the split rings.
D. TIGHTEN FITTING

Thread the adapter into the mating piece of equipment (elbow, tee, valve etc.). Thread the nut into the adaptor and engage threads. Note that the fitting is designed to form a leak tight seat on the stainless tubing as you tighten the fitting. Using appropriate wrenches; tighten the fitting until the adaptor bottoms and the resistance to wrenching increases greatly. Tighten the nut and adaptor to the torque listed in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Size</th>
<th>Minimum Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>150 ft-lbs</td>
</tr>
<tr>
<td>1½&quot;</td>
<td>275 ft-lbs</td>
</tr>
<tr>
<td>2&quot;</td>
<td>300 ft-lbs</td>
</tr>
</tbody>
</table>

Note the relation between the hex flats at this point and continue to tighten for two additional hex flats (one-third turn) to obtain required torque and final leak tight seal. The flare has now been created on the tubing end creating the metal to metal seal.

SEALANTS ARE ONLY TO BE USED ON THE PIPE THREAD.

E. TIGHTNESS TESTING

Before shrinking the heat shrink sleeve over the nut, and prior to backfilling, the piping system must be isolated from the tanks and subjected to a pipe tightness test.

For DEF-Trac® it is recommended the piping be pressurized with air to a maximum of 25 psi. Maintain this pressure for one hour ensuring there is no drop in pressure. Additionally spray fitting with a non-corrosive leak check solution and look for bubbles. Once all heat shrink sleeves are completed a 75psig max pressure test can be completed if required by code.

F. SEAL HEAT SHRINK SLEEVE

Slide up the heat shrink sleeve to fully cover the back hex nut. Using a heat gun, carefully shrink down the sleeve without overheating the inner jacket.
8. DEF-Trac PIPE CHASING, PIPE BURIAL, TRENCHING, BACKFILL AND CLAMPING REQUIREMENTS

- It is recommended to encase the DEF-Trac pipe in a suitable HDPE corrugated chase pipe (rock guard); to facilitate installation and if necessary removal of pipe at a later date. 1” and 1½” DEF-Trac will easily fit into a 4”ID chase; 2” will require a 5” chase. The chase pipe shall be installed per the manufacturers recommendations.

- Additionally, DEF-Trac pipe can be direct buried. If so, provide a trench width equal to the pipe diameter plus six inches on each side. Separate multiple lines by at least 4 inches. The distance between any piping and the trench excavation walls must be at least 6 inches.

- For an installation of three 2” diameter pipes, the trench would be 26” wide and a minimum of 26” deep.

- Whenever possible, product lines should be run in a single trench between the tank area and pump dispenser island area. Vent lines between the tank and the structure to which the aboveground vent lines are attached should also be installed in a single trench. Where more than one trench is required, piping should not cross over each other or cross over underground tanks.

- The trench bottom must be sloped uniformly from the dispensers back to the tanks or sumps at a minimum slope of 1/8 inch per foot and be free of any sharp or protruding hard objects. The trench bottom must be graded with a minimum of six inches of backfill such as washed sand, or pea gravel.

- For backfilling, provide a minimum of 18 inches of clean backfill between the top of the pipe and unpaved ground surfaces. A minimum of 4 inches of clean backfill is required between the top of the pipe and reinforced concrete pavement (4 inches thick minimum) and a minimum of 8 inches of backfill is required between the top of the pipe and asphalt pavement (2 inches thick minimum).

- DEF-Trac can be installed outdoors above ground. Typically DEF-Trac is mounted to a unistrut which provides continuous support. Clamping to the unistrut is accomplished utilizing a rubber coated hose clamp. Care must be taken to ensure the piping can not be punctured, crushed or damaged in any way.

9. ROUTINE MAINTENANCE AND VISUAL INSPECTION

It is recommended that a visual inspection of the inside of all containment sumps, be completed, at least once per month. Leaks collected in containment sumps must be reported immediately and investigated by the site owner. If leakage or damage to the piping system is suspected, OmegaFlex must be notified immediately.

All sumps must be kept free of fuel, water and debris.

10. ACCESSORIES

All Thermon accessories must be installed per the manufacturer’s instructions.

11. USE OF PRESSURE RELIEF VALVES

Due to temperature extremes, the pipe can become over pressurized due to thermal expansion of the internal media. If the DEF-Trac® piping portion of a system can become isolated by means of a check valve or solenoid valve; it is recommended to install a pressure relief valve which drains to tank in line with the DEF-Trac® piping. This will prevent the over pressurization of the piping.

⚠️ CAUTION

- DEF-Trac® INSULATED PIPING IS MANUFACTURED USING THERMON BSX 3-1 (1” DEF-Trac) & BSX 5-1 (1½” & 2” DEF-Trac) HEAT TRACE.
- THERMON BSX 3-1, & BSX 5-1 HEAT TRACE CAN ONLY BE POWERED USING 120VAC.
- MANDATORY GFI EPD CIRCUIT BREAKER PER NEC ARTICLE 427-22, ALL HEAT TRACING CIRCUITS MUST HAVE GFI – EQUIPMENT PROTECTION ON THE CIRCUIT. IN THIS SYSTEM, THE HEATER CABLE MUST BE POWERED FROM AN EPD (30MA GFI TRIP) TYPE CIRCUIT BREAKER.

NATIVE BACK FILL MATERIALS SHOULD NEVER BE USED.
11. DEF-TRAC HEAT TRACING (THERMON) INSTALLATION AND TROUBLESHOOTING GUIDE

Installation checklist (pages 29-30) must be faxed to OmegaFlex at 610-524-6484

Warranty is conditional upon receipt of installation check list.

⚠️ WARNING

Self-Regulating Cable must be installed by a qualified electrician. All installation and test instructions must be followed. Improper installation can result in property damage, serious injury, or death due to electric shock. Please contact OmegaFlex at 1-800-355-1038 with any installation or operating questions.

• DEF-Trac® insulated piping is manufactured using Thermon BSX 3-1 (1” DEF-Trac) & BSX 5-1 (1¾½” & 2” DEF-Trac) HEAT TRACE.

• Thermon BSX 3-1, & BSX 5-1 heat trace can only be powered using 120VAC.

• Mandatory GFI EPD circuit breaker per NEC article 427-22, all heat tracing circuits must have GFI – equipment protection on the circuit. In this system, the heater cable must be powered from an EPD (30MA GFI trip) type circuit breaker.

• Please read these Installation Instructions and all instructions included with kits prior to installation. Observe all warnings. Visually inspect the cable for damage. The cable, including braid, must not be cut, nicked or worn. DO NOT USE DAMAGED CABLE.

• Install cable in accordance with the prevailing electric code.

• Cables for classified areas should be tagged for specific classifications.

• All related components and controls should be properly rated for the specified location classification.

• Each self-regulating cable circuit will require at least one power connection kit (sold separately) which includes one end termination. All cable ends must be properly terminated per the instructions.

Electrical Codes: Sections 427 (pipelines and vessels) and 500 (classified locations) of the National Electrical Code (NEC), and Part 1 of the Canadian Electrical Code, Sections 18 (hazardous locations) and 62 (Fixed Electric Space and Surface Heating), govern the installation of electrical heat-tracing systems. All heat-tracing-system installations must be in compliance with these and any other applicable national or local codes.

• Thermon heat-tracing systems must be installed correctly to ensure proper operation and to prevent shock and fire. Read these important warnings and carefully follow all the installation instructions.

• To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with Thermon requirements, agency certifications, and national electrical codes, ground fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit breakers.

• Approvals and performance of the heat-tracing systems are based on the use of Thermon specified parts only. Do not substitute parts or use vinyl electrical tape.

• Bus wires will short if they contact each other. Keep bus wires separated.

• Components and cable ends must be kept dry before and during installation.

• The black heating cable core and fibers are conductive and can short. They must be properly insulated and kept dry.

• Damaged bus wires can overheat or short. Do not break bus wire strands when preparing the cable for connection.

⚠️ ELECTRIC SHOCK HAZARD

ANY CABLE WITH AN INSULATION RESISTANCE READING LESS THAN 20 MEGOHMS BEFORE INSTALLATION SHOULD NOT BE INSTALLED.
1. Ambient Control Thermostat (DF-B4X-15140) or (DF-B7-14150)
2. Terminator Power Connection Kit (DF-DP) PETK kit used for connection
3. Terminator Splice Kit (DF-DS/DE) SCTK kit used for connection
4. DEF-Trac Fitting (DF-FST-XX) (Heat shrink removed for clarity)
5. DEF-Trac Heat Traced Piping (DF-FSPHT-XX)
6. Heat Shrink Sleeve (DF-HTFBD-XX)
7. Fixing Tape (DF-FT-1L)
8. Minimum, 3 Insulation Tape/Wrap (DF-FW-KIT)
9. BSX 120 VAC Self-Regulating Heat Tracing Cable
10. 30 MA Trip GFI EPD Breaker
11. 120 VAC Electrical Wire

NOTE
THIS IS A GUIDE FOR LAYOUT ONLY, FOLLOW ALL THERMON INSTRUCTIONS FOR PROPER WIRING, CONNECTION AND INSTALLATION REQUIREMENTS.
1. **Ambient Control Thermostat** – (OmegaFlex Part Number DF-B4X-15140 / non-hazardous location or DF-B7-15140 / hazardous location) Used to control a single heating circuit or as pilot control of a contactor switching multiple heat tracing circuits. Typically installed near a building or structure out of direct sunlight.

2. **Terminator Power Connection Kit** – (OmegaFlex Part Number DF-DP) Used to provide the power connection or can also be used as a splice kit if terminal block connections are required by code. Heat trace connections are made utilizing the cable termination kit (OmegaFlex Part Number DF-PETK-1D / sold separately).

3. **Terminator Splice Kit** – (OmegaFlex Part Number DF-DS/DE) Used to provide splice connection at tee’s or can be used as end of circuit termination. For a tee splice, heat trace connections are made utilizing the cable splice kit. (OmegaFlex Part Number DF-SCTK-1D / sold separately) Or end of circuit heat trace connections are made utilizing the cable termination kit. (OmegaFlex Part Number DF-PETK-1D / sold separately)

4. **DEF-Trac End Fitting** – (OmegaFlex Part Number DF-FST-xx) Field attachable Stainless Steel end fitting with NPT thread.

5. **DEF-Trac Heat Traced Piping** – (OmegaFlex Part Number DF-FSPHT-xx) Flexible Stainless Steel corrugated piping, insulated and heat traced.

6. **Heat Shrink Sleeve** – (OmegaFlex Part Number DF-HTFBD-xx) Provides sealing onto the outer insulated jacket as well as over the back hex nut of the DEF-Trac fitting. One kit includes two heat shrink sleeves, one for the insulated piping and one for the DEF-Trac fitting. The same heat shrink will fit on both, the insulated piping and the DEF-Trac fitting. Alternatively, the Bundle / Fitting Self Sealing Kit (OmegaFlex Part Number DF-FAK-7) can be used to seal the ends. This would be used in place of the heat shrink sleeves.

7. **Fixing Tape** – (OmegaFlex Part Number DF-FT-1L) Used to attach the heat trace to the un-insulated piping, tees, valve or end attachments.

8. **Insulation Wrap** - Minimum of three layers of approved insulation wrap/tape must be applied to any un-insulated stainless steel pipe and components.

---

**EPD (Equipment Protection Device) Circuit Breakers for ground fault Protection in NF Panelboards**

**How EPDs Operate**

An EPD compares outgoing load currents with returning currents to determine if there is leakage of current to ground. If it detects a ground fault greater than 30 mA, the EPD will trip and display the “red flag” of the Trip indicator.

**NOTE**

Unlike residential GFCIs (ground fault circuit interrupters), EPDs are not designed for people protection (UL943 Class A calls for protection above 6 mA). EPDs are designed to meet the UL1053 standard for equipment protection. Although not designed for people protection, they do create a safer environment by reducing the potential for hazards associated with ground faults including fires, and equipment malfunction.
DF-SCTK-1D
Splice Connection Termination Kit

Installation Precautions

- The end termination is used to minimize the potential for arcing and fire caused by product damage or improper installation. Use ground-fault protection. The National Electrical Code (NEC) and Canadian Electrical Code (CEC) require ground-fault protection of equipment for each branch circuit supplying electric heat tracing.
- De-energize all power sources before opening enclosure.
- Keep ends of heating cable and kit components dry before and during installation.
- Individuals installing these products are responsible for complying with all applicable safety and health guidelines. Proper Personal Protective Equipment (PPE) should be utilized during installation. Contact OmegaFlex if you have any additional questions.

Installation Steps

A. REMOVE JACKET

Measure back 3" from the end and remove over jacket using a utility knife.

B. SEPARATE METALLIC BRAID AND FORM A PIGTAIL

C. EXPOSE HEAT TRACE

Measure 2" of primary insulation jacket and expose the black heat trace matrix.

D. EXPOSE THE BUS WIRE LEADS

Skive both edges of the heat trace matrix and expose the bus wire leads.

NOTE

Be careful NOT to damage the metallic braid.
**F. APPLY SEALANT**

Apply an ample amount of the RTV-2 sealant (RED COLOR) to heat trace cable.

**G. INSERT INTO SCTK BOOT**

Insert exposed bus wires into SCTK boot

SCTK termination boot should look as depicted below.
DF-PETK-1D
Power Termination Kit

Installation Procedure

- To minimize the potential for arcing and fire caused by product damage or improper installation use ground-fault protection. The National Electrical Code (NEC) and Canadian Electrical Code (CEC) require ground-fault protection of equipment for each branch circuit supplying electric heat tracing.
- Installation must comply with Thermon requirements and be installed in accordance with the NEC, CEC, or any other applicable national and local codes.
- Component approvals and performance ratings are based on the use of Thermon specified parts only.
- De-energize all power sources before opening enclosure.
- Keep ends of heating cable and kit components dry before and during installation.

Installation Steps
A. REMOVE JACKET

Measure back 6" from the end and remove over jacket using a utility knife.

B. SEPARATE METALLIC BRAID AND FORM A PIGTAIL

C. EXPOSE HEAT TRACE

Measure 4¾" of primary insulation jacket and expose the black heat trace matrix.

D. EXPOSE THE BUS WIRE LEADS

Skive both edges of the heat trace matrix and expose the bus wire leads.

NOTE
Be careful NOT to damage the metallic braid.
F. APPLY SEALANT
Apply an ample amount of the RTV-2 sealant (RED COLOR) to heat trace cable.

G. INSERT WIRES
Insert exposed bus wires into PETK boot.

Template For Power Connection Boot Termination
DF-PETK-1D
Power End Termination Kit

Installation Steps

A. REMOVE JACKET

Measure back ⅜" from the end and remove over jacket using a utility knife.

B. REMOVE METALLIC BRAID

Separate metallic braid and completely remove.

F. APPLY SEALANT

Apply an ample amount of the RTV-2 sealant (RED COLOR) to heat trace cable.

G. INSERT INTO SCTK BOOT

Insert exposed heat trace into PETK end termination boot.

PETK termination boot should look as depicted below.

End Cap Termination Template
B4X-15140 and B7-15140
Adjustable Ambient Control Thermostats

Application
Electric Heat Tracing Control

The B4X-15140 and B7-15140 are designed to provide ambient sensing control of electric heat tracing circuits for freeze protection of piping and vessels. These adjustable thermostats can be used to control a single heating circuit or as pilot control of a contactor switching multiple heat tracing circuits.

DF-B4X-15140 … An epoxy polyamide coated die-cast aluminum NEMA 4X enclosure provides watertight, dust-tight and corrosion-resistant protection to the thermostat switch.

DF-B7-15140 … An aluminum lacquer finished die-cast aluminum enclosure provides NEMA 4 (watertight and dust-tight) and NEMA 7/NEMA 9 (explosion-proof) protection to the thermostat switch. The tamper-resistant, threaded and gasketed aluminum dial cover is externally adjustable. The B4X-15140 thermostat is approved for use in ordinary (nonclassified) locations. The B7-15140 is approved for use in both ordinary (nonclassified) locations hazardous (classified) locations.

Final Connections

1. Follow the circuit fabrication instructions for the specific cable type. Power connection and end-of-circuit termination kits are designed for each type of cable; substitutions should not be made.

2. For ambient controlled power, the heating circuit should be connected directly to the switched power feed wiring.
DF-DP/Terminator
Power Connection Kit

Installation Procedure

The following installation procedures are suggested guidelines for the installation of termination connection systems.

A. LOCATE BUS CONNECTION

Locate bus connection (HPT and FP only) and cable as shown. Cut end of cable at angle to aid in piercing grommet.

B. INSERT CABLE INTO BASE

Insert cable into the base of DF/DP Terminator. Punch out weep hole in rubber grommet.

C. ROUTE CABLE

Slide base toward pipe and route cable through support base entry.

D. INSERT BANDING GUIDE

Insert banding guide into base and snap into place.

E. MOUNT BASE

Mount base to pipe using pipe band. Do not band over cable.
F. EXPOSE CABLE
Cut angle off BSX heat trace cable and expose ample amount in order to prepare end termination.

G. TERMINATE CABLE
Terminate BSX cable with appropriate PETK termination kit. Refer to PETK installation instructions.

H. MOUNT JUNCTION BOX
Mount junction box base on base. Make sure to align slots to properly orient junction box base. Tighten inner lock nut securely.

I. INSTALL POWER CONNECTION FITTINGS
For power connection applications: Install power connection fittings (user supplied) and pull in power and ground wires.

J. INSTALL QUICK MOUNT TERMINAL BLOCKS

K. COMPLETE SYSTEM WIRING
Typical Wiring Detail For DF-DP Terminator
1. DF-PETK-1D Power termination kit
2. Metallic ground braid wire
3. Power/Ground Leads from ambient sensing thermostat (DF-B4X-15140 and DF-B7-15140)
DF-DS/DE Terminator
In-Line Splice/End Termination Kit

**Installation Procedure**

The following installation procedures are suggested guidelines for the installation of DF-DS/DE splice termination kit.

**A. INSERT HEAT TRACE CABLES INTO BASE**

Insert BSX heat trace cables into the bottom of the DF-DS/DE splice terminator base. Cut each end at an angle to aid in piercing the rubber grommet.

**B. ROUTE CABLE**

Slide DF-DS/DE base toward pipe and route cables through support base entry.

**C. INSERT BANDING GUIDE**

Insert banding guide into base and snap into place.

**D. MOUNT EXPEDITER**

Mount expeditor to pipe using pipe band. Do not band over cable.

**E. TERMINATE CABLES**

Terminate cables with appropriate PETK or SCTK termination kit. Refer to kit installation instructions.

**F. CONNECT BUS AND BRAID WIRES**

Connect bus and braid wires using wire nuts.
G. TIGHTEN CAP SECURELY.

Completed DF-DS/DE splice kit
**Beacon Terminator**
**DF-DE-B Pipe Mount**
**LED End of Circuit Light Kit**

**Installation Procedure**

**A. INSERT HEAT TRACE CABLES INTO BASE**
Insert BSX heat trace cable into the base of the (DF-DE-B or DF-DE-B-FAK) splice terminator base. Cut each end at an angle to aid in piercing the rubber grommet.

**B. ROUTE CABLE**
Slide DF-DE-B base toward pipe and route BSX cable through support base entry.

**C. INSERT BANDING GUIDE**
Insert banding guide into base and snap into place.

**D. MOUNT BASE**
Mount base to pipe using pipe band. Do not band over cable.

**E. TERMINATE CABLE**
Terminate cable with appropriate SCTK termination kit. Refer to SCTK installation instructions.

**F. CONNECT BSX BUS WIRES**
Connect BSX bus wires using wire nuts provided.

**G. INSTALL COVER**
Slide the light module cover over the light and tighten cap securely.
Beacon Terminator
DF-DE-B-FAK Flat Mount
LED End of Circuit Light Kit

Installation Procedure

A. PIPE ENTRANCE TOP
1. Green light is on when heat trace is working
2. SCTK kit is used for installation of the flat mount beacon (DF-SCTK-1D)
3. Caulk the base of the beacon for weather resistance
4. Lube O-ring using white lithium/bearing grease
5. 8’ of Thermon BSX 120 VAC self regulating heat trace cable (DF-BSX5-10J)
6. DEF-Trac piping (DF-FSPHT-XX-XXX)

B. PIPE ENTRANCE SIDE
1. Green light is on when heat trace is working
2. SCTK kit is used for installation of the flat mount beacon (DF-SCTK-1D)
3. Caulk the base of the beacon for weather resistance
4. Lube O-ring using white lithium/bearing grease
5. 8’ of Thermon BSX 120 VAC self regulating heat trace cable (DF-BSX5-10J)
6. DEF-Trac piping (DF-FSPHT-XX-XXX)
C. TERMINATE CABLE
Terminate cable with appropriate SCTK termination kit. Refer to SCTK installation instructions.

D. CONNECT BSX BUS WIRES
Connect BSX bus wires using wire nuts provided.

E. INSTALL COVER
Slide the light module cover over the light and tighten cap securely.

DF-DE-B-FAK (FLAT MOUNT) BASE DRILL HOLE TEMPLATE

1/4" CLEARANCE HOLE(S)

3/4" CLEARANCE HOLE
12. FINAL INSPECTION
The heating circuit can now be tested for proper operation. This includes measuring and recording the connected voltage, steady-state current draw, length and type of cable, ambient temperature and temperature of the pipe. The complete system (especially the thermal insulation) should now be visually inspected. Additional insulation should be applied snugly around pipe shoes or other heat sinks and sealed from the weather. Expansion joints on high temperature lines should be examined carefully. There may be exposed insulation where sections fit together or around flanges, valves, pipe hangers or connection kits; these locations should be sealed to prevent ingress of moisture. “Electric Heat Tracing” caution labels should be applied to the outer surface of the weather barrier at regular intervals of 10 feet (or as required by code or specification). The location of splices and end terminations should also be marked with splice and end termination caution labels.

13. THERMAL INSULATION
The value of properly installed and well-maintained thermal insulation cannot be overemphasized. Without the insulation, the heat loss is generally too high to be offset by a conventional heat tracing system.

Before the thermal insulation is installed on a heat-traced pipe, the tracing circuit should be tested for dielectric insulation resistance. This will ensure that the cable has not been damaged while exposed on the un-insulated pipe.

In addition to piping and in-line equipment such as pumps and valves, all heat sinks must be properly insulated. This includes pipe shoes, hangers, flanges and, in many cases, valve bonnets.

There are many different pipe insulation materials, each of which has advantages in particular applications. Regardless of the type or thickness of insulation used, a protective barrier should be installed. This protects the insulation from moisture intrusion and physical damage and helps ensure the proper performance of the heat tracing system.

NOTE
When rigid (non-compressible) materials are used, the inside diameter of the insulation is usually oversized to accommodate the heating cable on the pipe.

Insulating materials are very susceptible to water absorption, which dramatically increases the heat loss and should be replaced if the materials get wet.

14. CABLE TESTING
After a heat tracing circuit has been installed and fabricated, the heating cable should be tested to ensure electrical resistance integrity. The cable should be tested with at least a 1000 VDC megohmmeter (megger) between the heating cable bus wires and the heating cable metallic braid. After properly terminating the cable, connect the positive lead of the megger to the bus wires and the negative lead to the metallic braid. The minimum acceptable level for the megger reading for any polymer-insulated heat tracing cable is 20 megohms. This test should be repeated after the installation is complete but prior to commissioning of the system. If during any test the meter readings vary by +/- 10% from the previous test, stop the installation and investigate. Please check for pinched or crushed cables, test splices, test power connections, test end terminations, and repair accordingly. Check for water in all junction boxes or conduit. Any faults should be repaired by a qualified electrician or factory technician.

15. MAINTENANCE
Once the heat tracing system has been installed, an ongoing preventive maintenance program should be implemented using qualified personnel. Support documentation providing general information and an operating history of the specific circuits in the system should be maintained. The results of the operational testing described above form the testing “base line” or normal range. Subsequent measurements should be recorded periodically and compared to this base-line data to help identify potential malfunctions.
16. DEF-TRAC WARRANTY

LIMITED WARRANTY

Omega Flex, Inc. (the "Manufacturer") warrants that all OmegaFlex DEF-Trac® (the "Product") will be free from defects in material or workmanship for one (1) years; as measured from the date of shipment from OmegaFlex. If upon examination by the Manufacturer, the Product is shown to have a defect in material or workmanship during the warranty period, the Manufacturer will repair or replace, at its option, that part of the Product which is shown to be defective.

This limited warranty does not apply:

• If the Product has been subjected to misuse or neglect, has been accidentally or intentionally damaged, or has been altered or modified in any way.
• If the Product has been repaired by anyone who is not an OmegaFlex authorized service representative.
• If the Product has not been installed in accordance with the DEF-Trac installation guidelines.
• If the Product has been installed with unauthorized third party components, except those components that are recommended for use with DEF-Trac in the DEF-Trac installation guide.
• To any costs or expenses incurred during investigation, removal or reinstallation of the defective Product, including without limitation any costs or expenses for clean-up, downtime, or lost profits.
• To any damage or impairment of the Product caused by any casualty, including without limitation fires, storms, floods, earthquakes, or acts of God.
• To any workmanship of the installer of the Product.

DISCLAIMER

This limited warranty is conditional upon:

• Receipt of a written warranty claim during the applicable warranty period.
• Installment of the Product by an individual who has received factory authorized training on the installation and proper use of DEF-Trac.
• All site and warranty registration forms are completed and received by DEF-Trac within 30 days of installation.
• OmegaFlex receives notice of warranty claim within 24 hours of any known or suspected failure of the Product.

Repair or replacement of any part under this Limited Warranty shall not extend the duration of the warranty with respect to such repaired or replaced part beyond the stated warranty period.

THIS LIMITED WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EITHER EXPRESS OR IMPLIED, AND ALL SUCH OTHER WARRANTIES, INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED AND EXCLUDED FROM THIS LIMITED WARRANTY.

IN NO EVENT SHALL THE MANUFACTURER BE LIABLE IN ANY WAY FOR ANY CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OF ANY NATURE WHATSOEVER, OR FOR ANY AMOUNTS IN EXCESS OF THE SELLING PRICE OF THE PRODUCT OR ANY PARTS THEREOF FOUND TO BE DEFECTIVE. THIS LIMITED WARRANTY GIVES THE ORIGINAL OWNER OF THE PRODUCT SPECIFIC LEGAL RIGHTS. YOU MAY ALSO HAVE OTHER RIGHTS WHICH MAY VARY BY EACH JURISDICTION.

The products illustrated reflect the design characteristics at time of printing. Please contact the factory for certified prints with exact dimensions when required.

The technical data contained herein is a guide to the user of DEF-Trac products. The data contained herein is based upon tests and information believed to be reliable, but users should not rely upon it absolutely for specific applications. It is given and accepted at user’s risk and confirmation of its validity and suitability in particular cases should be obtained independently.

OmegaFlex makes no guarantee of results and assumes no obligation or liability in connection with this data. This publication is not to be taken as a license to operate under or recommendation to infringe any patents.

OmegaFlex policy is one of continuous improvement and development. OmegaFlex reserves the right to change specifications and introduce improved designs without notice.
## 17. DEF-Trac Piping Inspection Checklist (To be Completed Prior to Commissioning System)

**RETURN TO OMEGAFLEX**  
**FAX 610-524-6484**

<table>
<thead>
<tr>
<th>Site #</th>
<th>Date</th>
<th>Location Address</th>
<th>Reference Drawings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Circuit Information

<table>
<thead>
<tr>
<th>Run 2 Circuit Length</th>
<th>Panel No.</th>
<th>Circuit # 120v</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run 1 Circuit Length</td>
<td>Panel No.</td>
<td>Circuit # 120v</td>
</tr>
</tbody>
</table>

- **Ground Fault Protection Device (Type/MFG)**
- **Ground Fault Trip Setting (30mA Recommended)**

<table>
<thead>
<tr>
<th>Site #</th>
<th>Date: Location Address: Reference Drawings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Electrical

**Dielectric Insulation Resistance Testing** (megger) Refer to IEEE 515-1997 Section 7.9

<table>
<thead>
<tr>
<th>Test Voltage</th>
<th>Megger Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 Mohms Min - Use 1000 Vdc MEGGER</td>
</tr>
</tbody>
</table>

### Heater Supply Voltage

<table>
<thead>
<tr>
<th>Value at Power Source Circuit 1</th>
<th>Value at Field Connection Circuit 1</th>
<th>Value at Power Source Circuit 2</th>
<th>Value at Field Connection Circuit 2</th>
</tr>
</thead>
</table>

### Heater Circuit 1 Current Reading

<table>
<thead>
<tr>
<th>Amps Reading at 2-5 min</th>
<th>Amps Reading at 15 min</th>
<th>Ground Fault Current</th>
</tr>
</thead>
</table>

### Comments and Actions

<table>
<thead>
<tr>
<th>Site #</th>
<th>Date: Location Address: Reference Drawings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Visual Inspection

<table>
<thead>
<tr>
<th>DEF Tank Sump</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation of DP Terminator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perform megger test on Heat Trace Circuit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proper Installation of Cable terminations (PETK and SCTK)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTV Sealant used on terminations (PETK and SCTK)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Trace is not bent /crimped or cut</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping Bundle Heat Shrink Sleeve installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitting Nut Heat Shrink Sleeve installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Exposed Stainless Steel on DEF-Trac Pipe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DripStop 940 used on NPT pipe fittings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fittings Sprayed with Leak Check at Pressure Test</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Dispensers / Transition Sump (Check Each Dispenser/Box for Compliance Below)

<table>
<thead>
<tr>
<th>DEF Tank Sump</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation of DS/DE or DP Terminator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perform megger test on Heat Trace Circuit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proper Installation of Cable terminations (PETK and SCTK)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTV Sealant used on terminations (PETK and SCTK)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Trace is not bent /crimped or cut</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping Bundle Heat Shrink Sleeve installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitting Nut Heat Shrink Sleeve installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Exposed Stainless Steel on DEF-Trac Pipe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DripStop 940 used on NPT pipe fittings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fittings Sprayed with Leak Check at Pressure Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DE-B Beacon Installed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Tightness Testing of Piping

<table>
<thead>
<tr>
<th>DEF Tank Sump</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressurized 25psi Test Performed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressurized 75psi Test Performed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Comments and Actions

- Site Electrician
- General Contractor
- Project Manager