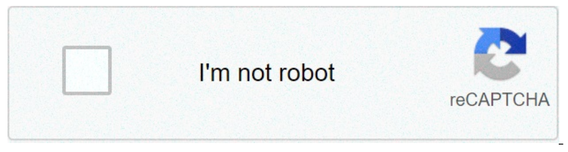

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Thermo king tripac apu service manual

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Wiring diagram SL TCI Move to sunny New Zealand Thermo King RMN II Need Carrier Manager Software Celcius/Fahrenheit setting locked New R1234yf gas only £0.19 gah,twin compartment fault codes cb ci2 hfc CB ci2 hfc manual Carrier Primeline alarm 23 and 24 sb300 Reefers in HIGH ambient temperature zones (+50 to 55*C) How do this work? Information on Thermo King V300??? 12 volt and 24 volt power analyser for measuring power consumption on a truck? Vector 1800mt alarm 21 technician reset required making me mad TXV vs CPR TK sle Spectrum Volvo e240 blc V300 max Tc Wiring diagram for TK SL 400 Thermoking T 600 R price in north Africa !!! TK SL 300 Slow cooling after 50F Epc thermoking thermo king model GA12MR tru tech 01.03.00 CAN communication ? ask for carrier mistral 900 circuit diagram Have problem with Thermo King! Error code 66 in Thermo King SB-III Whisper SR+ UNISAB III Connections Tk ts 200 hah and Hubbard reversing valves failing Auto Air Con Thermo king sb-310 not cooling right Tk s40 evap1 No oil seen in glass in compressor i need to diagnostic software Compressor is crash about Thermo King SB-210 board light I need RM or Tru-Tech PLease!! Car Air Conditioning issue RED HOT Thermo king manuals replace the control box SMX-II Strange leak advice Problems in thermo king sl 200 Supra 750 MT square Run and speed solenoids can they be changed to the round type ? Thermoking sb 190 Looking for ThermoKing and Carrier Transicold suppliers Md ii sr Refrigeration transport rollers System ck on carrier maxima 1000 Something wrong with cooling. Thermoking communication protocol looking for supplier for Transport refrigeration Thermo King V-500 Max TC electric scheme Carrier xarios problem Delphi frigo 4000 New gas! V-280 Controller Alarm Reset MHI Truck Refrigeration fault codes. Workshop / maintenance manuals for TK SL trailer units THERMOKING SB III Charge issues. Hubbard / Zanotti fridge van wiring diagram Can anyone lead me in the right direction on diagnosing this tk unit thanks carrier ultra xl freezing suction pipe ThermoKing SB 210 Alarm 63 and 84 REFRIGERATED CONTAINER: Alarm 15 - Alarm 16 HELP with Alarm list of mitsubishi track unit undermound TK Ts-200 cutting out Eurofrigo c3500 Ask about Korea mechanic 【HWA SUNG】 shop /service manual for tk x430 and x426 TK SB-200 30, fault code 12 carrier vector 1800 Coldchain 2500 s wiring diagram EuroFrigo 2500XT thermo king SL200e 71 & 111 thermoking spectrum duel temp thermo king retrofit from 69l to 404a Supplier for Mitsubishi compressor CR 2318 LWR vector 1350 operation and service manual ? Refrigerant Using a Refrigerated Van as a full time fridge for my business? Thermoking V300 condensor core thermoking/MD200 Recovery machine for 404a Transicold R90 run issues r 22 Carrier Transicold Oasis 250 Help MD200 air locked? MD200 oil blow by make your own download cable CTC / TK Hubbard on a sprinter giving me grief Thermo king sb200 code 41 ?? alert codes which cant be cleared Daikin DECOS III H/E controller eurofrigo Reefer Monitoring System Sl300 problem Gah not chilling down carrier transicold model 50x truck unit V500 Microp xarios 300 al25 fault Euroscan Old ES protocol v.7 i need smartreefer3 D080 - 7870 software Xarios service manual 30S carrier Reset alarm code on thermo king Need help. how to enter guarded access on a sb200 thermo king unit to clear out code Thermoking Trailer SR2 and SR3 controller anyone can explain the modulation cool and Vector 1950 no screen display but the unit still running Hubbard 520 AEL wiring diagram needed IBOX software Low cooling in v500 max10 thermo king unit Thermo king t 500 r Thermo King sl200e v500 MicroP mitsubishi sea container cpe 15 Carrier Vector 1550 Topre Cold Top body parts Carrier Zephyr 200 wiring digram Carrier Genesis R90 help needed selecting components for aircon to chill fuel thermoguard VI TS 300 3 way valve how do i fix code 74 on a TS 300 thermo king unit Wintrac issues with thermoguard IVc Re: error code -help please Thermoking Driver Temp Controller Monitor Not working Carrier Diagnostic Software ThermoKing SB III SR Project: conversion to Electric motor Precedent G600 THERMO KING MDII unit code 10 Thermo KING MDII unit code 10 how to change/ remove the password of guarded access - model TK SB III SR +uP-IV Carrier Supra 550 "FUSE BAD" Frigoblock has anyone got wiring diagrams for a hk 25 carrier transicold viento 200 wiring diagram Carrier XTC Alarm AL28 Thermo King Software Help Thermoking ts-500 box truck blows starter fuse Sl tci yr 2000 flashing controller code .. Topre english alarm code HWASUNG THERMO, What do you think about? Thermo king ts500 code 23 Carrier Supra 550 Starting Issue SLX Display Message tk super 2 30 sr cooling issue GAH standby wiring help / info Rd-11-tle Software to Thermo King reefers carrier pulsor 500 Thermo King sl200e just keeps cooling TK TS500 liquid injection fitting TK md200 code 35 no start, new board. reefer container carrier Software Thermoking slxe 300 first service tk md200 runs fine on electric but wont start on diesel, code 35 Thermo King help Powered by vBulletin® Version 4.2.1 Tripac Evolution - Grease Monkey Road Squad llc Maintenance Manual Ingersoll Rand's Climate Solutions sector delivers energy-efficient HVACR solutions for customers globally. Its world class brands include Thermo King, the leader in transport temperature control and Trane, a provider of energy efficient heating, ventilating and air conditioning systems, building and contracting services, parts support and advanced controls for commercial buildings and homes. Distributed by: Thermo King Corporate 314 West 90th Street Minneapolis, MN 55420 Direct TK 55675-19-MM ©2013 Ingersoll Rand Company Printed in U.S.A. (952) 887-2200 TriPac EVOLUTION AuxiliarySB-210+ Heating/Cooling Additional text information Temperature Management to be placed here System TK 5XXXX-X-PL TK 55675-19-MM (Rev. 1, 03/14) TriPac EVOLUTION Auxiliary Heating/Cooling Temperature Management System TK 55675-19-MM (Rev. 1, 03/14) Copyright© 2013 Thermo King Corp., Minneapolis, MN, USA. Printed in USA. The maintenance information in this manual covers unit models: TriPac EVOLUTION (902485) For further information, refer to: TriPac EVOLUTION Operating Manual TK 55711 TriPac EVOLUTION Parts Manual TK 55668 TriPac EVOLUTION Diagnostic Manual TK 55739 TriPac EVOLUTION Installation Manual TK 55676 International Components Engineering (ICE) Compressor Service Manual ICE No. 51068 Diagnosing Thermo King Refrigeration Systems TK 5984 Evacuation Station Operation and Field Application TK 40612 Tool Catalog TK 5955 Electrostatic Discharge Training Guide TK 40282 The information in this manual is provided to assist owners, operators and service people in the proper upkeep and maintenance of Thermo King units. The above manuals may be purchased from your local Thermo King dealer. Revision History Rev. 0 – TK 55675-19-MM (Rev. 0, 07/13) Original release. Rev. 1 – TK 55675-19-MM (Rev. 1, 03/14) Change PM interval from 1,500 to 2,000 hours. Update Engine Oil Change, Checking Engine Oil Level, and Adding Engine Oil. This manual is published for informational purposes only and the information so provided should not be considered as all-inclusive or covering all contingencies. If further information is required, Thermo King Corporation should be consulted. Sale of product shown in this manual is subject to Thermo King's terms and conditions including, but not limited to, the Thermo King Limited Express Warranty. Such terms and conditions are available upon request. Thermo King's warranty will not apply to any equipment which has been "so repaired or altered outside the manufacturer's plants as, in the manufacturer's judgment, to effect its stability." No warranties, express or implied, including warranties of fitness for a particular purpose or merchantability, or warranties arising from course of dealing or usage of trade, are made regarding the information, recommendations, and descriptions contained herein. Manufacturer is not responsible and will not be held liable in contract or in tort (including negligence) for any special, indirect or consequential damages, including injury or damage caused to vehicles, contents or persons, by reason of the installation of any Thermo King product or its mechanical failure. Recover Refrigerant At Thermo King, we recognize the need to preserve the environment and limit the potential harm to the ozone layer that can result from allowing refrigerant to escape into the atmosphere. We strictly adhere to a policy that promotes the recovery and limits the loss of refrigerant into the atmosphere. In addition, service personnel must be aware of Federal and State regulations concerning the use of refrigerants and the certification of technicians. For additional information on regulations and technician certification programs, contact your local THERMO KING dealer. R-134a and PAG Compressor Oil WARNING: Use only PAG-based refrigeration compressor oil in the TriPac R-134a air conditioning system. See Thermo King Parts Manual for part number. WARNING: With HVAC systems and the use of PAG, it is very important that oil mixing does not take place. PAG and POE oil CANNOT be mixed. Mixing these oils will cause serious system contamination, especially with chlorine based refrigerants. NOTE: When servicing Thermo King R-134a units, use only those service tools certified for and dedicated to R-134a refrigerant and PAG compressor oils. Residual non-HFC refrigerants or oils will contaminate R-134a systems. The proper compressor oil is determined by the refrigerant used and specific air conditioning application requirements. Verify both serial nameplates on the unit and compressor for correct oil to use in a particular system. Because of the many variables in oils, particularly in HVAC systems, compressors may be delivered with an oil that is not specified for the particular unit it is to be fitted to. Unless it is 100% clear it is the correct oil, Thermo King recommends the oil is changed to the correct type. PAG oil is very hygroscopic. Only use oil taken from a fresh container. 3 CHANGES, COMMENTS and SUGGESTIONS You are invited to comment on this manual so it can be updated and improved to better meet you needs. Any corrections, comments or suggestions are welcome. Please complete the following information: Manual Form Number ____________ Section and Page # ____________ Your Name ____________ Company Name ____________ Phone Number ____________ Corrections, Comments and Suggestions ____________ Return to: 4 NORTH AMERICA EUROPEAN SERVED AREA THERMO KING CORPORATION 314 West 90th Street Mail Stop 38 Minneapolis, MN 55420 Attn: Service Department THERMO KING CORPORATION Ingersoll Rand Climate Control Technologies Monivea Road Mervue, Galway, Ireland Attn: Service Department About This Manual Purpose The purpose of this manual is to provide general maintenance information necessary to maintain the TriPac EVOLUTION unit at peak operating standards. This includes safety information, unit information such as bills of material and kit numbers, general unit information, maintenance procedures and related information (such as wiring and schematic diagrams), and some diagnostic and troubleshooting information. NOTE: This manual may cover more than one unit. Therefore, it may contain information not applicable to your unit. Contents This manual is organized into the following chapters: Chapter Purpose Safety Precautions Provides detailed safety information. You should be familiar with the safety precautions before working on any unit. Model Systems and Update Matrices These tables list the bills of material and kit options that make up your unit. Use them for the following purposes: 1. To determine if you have the right manual for your unit: the bill of material (B/M) number on your unit serial plate should match one of the bill of material numbers listed in this publication. If you cannot find your unit B/M, call TK Service for more information.) 2. To communicate with TK Service Department: If you need to call TK Service, you must know your model number so that the service representative to help you. Specifications Lists unit specifications. General Description Gives an overview description of your unit including standard and optional features, illustrations, and general heating and air conditioning information. Operating Instructions Provides unit operating instructions. Maintenance Inspection Schedule Table of routine maintenance procedures. Maintenance Chapters Provide detailed maintenance procedures required for your unit. (Electrical, Air Conditioning, Compressor, Engine, Structural) Wiring and Schematic Diagrams Wiring and Schematic diagrams applicable to the unit. 5 About This Manual Before You Call Thermo King Service! Who to call: Your Thermo King Service Representative. Before you call Thermo King Service, have the following information on hand: • Bill of Material - usually located on the unit serial plate. • Model Number - found on frame inside the APU unit. Blank Pages This manual may contain blank pages at the end of chapters. This is normal. There is no information missing from the manual. Roadside/Curbside Terminology Roadside/Curbside terminology: These terms can be confusing because of differences between North America and Europe. Please note: Curbside: The side of the truck to the driver's right when the driver is in his seat and facing forward. Roadside: The side of the truck to the driver's left when the driver is in his seat and facing forward. Using the Model Tables in "About this Unit" The model tables in this section (called "About this Unit," "Model Systems and Update Matrices," or something similar) list important unit information that you will need to communicate with the Thermo King Service Department. See the table on the previous page for a description of how to use these tables. 6 Table of Contents

10 Safety Precautions The symbol appears next to a point that is particularly important: DANGER: Addresses a circumstance that, if encountered, will lead to death or serious injury. WARNING: Addresses a circumstance that, if encountered, might lead to death or serious injury. CAUTION: Addresses a circumstance that, if encountered, may cause damage to equipment or minor injury. General Practices DANGER: Always turn the TriPac unit off while refueling the truck. Fuel vapors could ignite if they come in contact with TriPac electrical or heater components. DANGER: Never operate the unit with the compressor discharge valve closed. DANGER: Never apply heat to a sealed refrigeration system or container because it could explode, causing death or serious injury. DANGER: Fluorocarbon refrigerants, in the presence of an open flame, spark or electrical short produce toxic gases that are severe respiratory irritants. DANGER: Be careful when working with a refrigerant or refrigeration system in any enclosed or confined area with a limited air supply (for example a truck cab, cargo or storage compartment or garage). Refrigerant tends to displace air and can cause oxygen depletion which may result in death by suffocation. WARNING: Always wear goggles or safety glasses. Refrigerant liquid, refrigeration oil, and battery acid can permanently damage the eyes (see First Aid under Refrigeration Oil). WARNING: Keep your hands, clothing and tools clear of the fans and belts when the unit is running. This should also be considered when opening and closing the compressor service valves. WARNING: Make sure all mounting bolts are tight and are of correct length for their particular application. WARNING: Never drill holes into the unit. Holes drilled into the unit may weaken structural components. Holes drilled into electrical wiring can cause fire or explosion. WARNING: When using ladders to install or service refrigeration systems, always observe the ladder manufacturer's safety labels and warnings. A work platform is the recommended method for installations. WARNING: Make sure your gauge manifold hoses are in good condition before using them. Never let them come in contact with moving belts, fans, pulleys or hot surfaces. Defective gauge equipment can damage components or cause serious injury. WARNING: Turn the unit HMI Controller Off before inspecting any part of the unit. CAUTION: Use caution when working around exposed coil fins. The fins can cause painful lacerations. NOTE: In the USA, EPA Section 609 Certification is required to work on air conditioning systems. 11 Safety Precautions Refrigerant WARNING: Although fluorocarbon refrigerants are classified as safe refrigerants, certain precautions must be observed when handling them or servicing a unit in which they are used. When released to the atmosphere from the liquid state, fluorocarbon refrigerants evaporator rapidly, freezing anything they contact. First Aid • FROSTBITE: In the event of frost bite, the objectives of First Aid are to protect the frozen area from further injury, to warm the affected area rapidly, and to maintain respiration. • EYES: For contact with liquid, immediately flush eyes with large amounts of water and get prompt medical attention. • SKIN: Flush area with large amounts of lukewarm water. Do not apply heat. Remove contaminated clothing and shoes. Wrap burns with dry, sterile, bulky dressing to protect from infection/injury. Get medical attention. Wash contaminated clothing before reuse. • INHALATION: Move victim to fresh air and use CPR if necessary. Stay with victim until arrival of emergency medical personnel. Refrigeration Oil WARNING: Avoid refrigeration oil contact with the eyes. Avoid prolonged or repeated contact of refrigeration oil with skin or clothing. Wash thoroughly after handling refrigeration oil to prevent irritation. First Aid In case of eye contact, immediately flush with plenty of water for at least 15 minutes. Wash skin with soap and water. CALL A PHYSICIAN. 12 Low Voltage WARNING: Control circuits used in the TriPac unit are low voltage (12 volts dc). This voltage potential is not considered dangerous, but the large amount of current available can cause severe burns if shorted or grounded. WARNING: Do not wear jewelry, watches or rings when working on the unit. If these items contact an electrical circuit, severe burns may result. CAUTION: Always disconnect power at the battery before removing or repairing electrical components. Failure to do so may result in personal injury or damage to the equipment. Battery Installation and Cable Routing WARNING: Improperly installed battery could result in a fire or explosion! A Thermo King approved battery must be installed and properly secured to the battery tray. WARNING: Improperly installed battery cables could result in fire or explosion! Battery cables must be installed, routed and secured properly to prevent them from rubbing, chaffing or making contact with hot, sharp or rotating components. WARNING: Do not attach fuel lines or any additional wiring harnesses to the battery cables as this could cause an electrical fire! CAUTION: Do not connect other manufacturer's equipment or accessories to the Thermo King unit. This could result in severe damage to equipment and void the warranty! Safety Precautions CAUTION: Set all unit electrical controls to the OFF position before connecting battery cables to the battery to prevent unit from starting unexpectedly and causing personal injury. CAUTION: Always wear protective clothing, gloves and eye wear when handling and installing batteries. Battery acid can cause serious burns when exposed to eyes or skin. If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters your eye, immediately flood it with running cold water for at least twenty minutes and get medical attention immediately. CAUTION: Always cover battery terminals to prevent them from making contact with metal components during battery installation. Battery terminals grounding against metal could cause the battery to explode. 13 Model Systems (System Designations) Thermo King TriPac Auxiliary Heating & Cooling Temperature Management System System Designation System Number BOM TriPac EVOLUTION 902485 N/A Install Kit Refrigerant 800881 R-134a Wiring Diagram Schematic Diagram 2E32871 2E32872 NOTE: When calling the dealer or factory for information or parts please have the Bill of Material number for your particular unit handy. 14 Specifications TriPac EVOLUTION Engine Engine TK270F (Tier 4) Fuel Type No. 2 Diesel fuel under normal conditions Caution: Use fuel suitable for the climate you operate in (see truck engine manufacturer's recommendations). Blending used engine oil with diesel fuel is not permitted in the TriPac system. It will plug the filters and will not allow the air heater to run properly. Thermo King reserves the right to void all warranty on the unit. No. 1 Diesel fuel is acceptable cold weather fuel Oil Capacity: Crankcase & Oil Filter w/Bypass Oil Filter Oil Type* 6.5 quarts (6.15 liters) Fill to full mark on dipstick. IMPORTANT: The fill port on top of the engine should not be used to add engine oil. To prevent engine lock-up and/or serious internal damage after TriPac engine oil is added or changed always add oil through the lower port on the timing gear cover. API Type CJ-4 or better multigrade oil API Synthetic Type CJ-4 or better multigrade oil is required for units equipped with the optional DPF (Diesel Particulate Filter) Oil Viscosity** 5 to 104 F (-15 to 40 C): SAE 15W-40 -4 to 86 F (-20 to 30 C): SAE 10W-30 Engine RPM: No Load Operation, Compressor Clutch Disengaged 2400 ± 25 RPM Under Load Operation, Compressor Clutch Engaged 2350 ± 25 RPM Engine Oil Pressure 50 psig (345 kPa) at rated output. 18 psig (128 kPa) at low idle. Low Oil Pressure Switch (Normally Closed) 15 ± 2 psig (103 ± 14 kPa) Engine Thermostat 160 F (71 C) Coolant System Capacity*** 0.6 quarts (0.6 liters) Optional Closed Loop Coolant System Capacity 2.75 quarts (2.60 liters) * Thermo King synthetic oil is compatible with petroleum lubricants so there is no danger if accidental mixing occurs or if an emergency required addition of petroleum oil. Mixing is not recommended, however, since it will dilute the superior performance properties of the synthetic oil. ** Multi-viscosity weight oil with the recommended API classification may be used based on the ambient temperature. The above recommendations are written for mineral oil based lubricants. *** Cooling system capacity may vary, depending on installation. Cooling lines carry additional coolant. 0.6 quarts (0.6 liters) is engine only. 15 Specifications R-134a Air Conditioning System Compressor Model TK-15 HD Refrigerant Charge 1.5 lbs. (0.69 Kg) Compressor Oil Charge 8 oz. (236.5 ml)* Compressor Oil Type See Compressor Oil Specifications on following pages High Pressure Cutout (HPCO): Opens: Closes: 360 ± 10 psig (2482 ± 69 kPa) 240 ± 20 psig (1655 ± 138 kPa) Low Pressure Cutout (LPCO): Opens: Closes: 5 ± 3 psig (34 ± 21 kPa) 20 ± 5 psig (138 ± 34 kPa) * When the compressor is removed from the unit, oil level should be noted or the oil removed from the compressor should be measured so that the same amount of oil can be added before placing the replacement compressor in the unit. Belt Tension Tension No. on TK Gauge P/N 204-427 Engine/Compressor/Alternator 75 NOTE: A deflection of 0.25 in. (7 mm) between the alternator and compressor (longest free span of belt) may be used if a gauge is not available to test tension. Electrical Control System Control System Voltage 12 Vdc Alternator (Standard) 12 V 65 amp brush type integral regulator Fuses Fuse Number Location Amp Rating Component Protected / Circuit – Connector F1 Main Controller Interface Board 30 Starter / 8S – J5 F2 Main Controller Interface Board 2 HMI / 8XP – J34 F3 Main Controller Interface Board 30 Glowplugs / H – J5 F4 Main Controller Interface Board 2 HMI / 2P – J34 F5 Main Controller Interface Board 5 Optional Standby Switch / 2A – J14 F6 Main Controller Interface Board 5 Logic Power (Main Controller) / N/A F7 Main Controller Interface Board 40 Fuel Solenoid / 8DP – J5 F8 Main Controller Interface Board 7.5 Engine Switch / 8X – J14 F9 Main Controller Interface Board 5 Engine Start Signal / 7X – J4 F10 Main Controller Interface Board 15 Pre-cooler Fan / PCF – J5 F11 Main Controller Interface Board 20 Condenser Fan / 7CF – J2 F12 Main Controller Interface Board 20 Evaporator Fan / FAN1, FAN2, FAN3 – J1 F13 Main Controller Interface Board 7.5 Compressor Clutch / 7CL – J5 F14 Main Controller Interface Board 5 Heater On / 26/YEL – J13 16 Specifications Electrical Control System (Continued) Fuse Number Location Amp Rating Component Protected / Circuit – Connector F15 Main Controller Interface Board 2 Real Time Clock F16 Fuse Holder in Main Harness from B+ on Alternator 50 System Power / 2 – J15 F17 Main Controller Interface Board 2 Ground / CH – J16 F18 Sense Harness from Starter 3 Voltage Sense / SEN – J14 F19 Fuse Holder in Truck Integration Harness (Option) 1 Truck Ignition Input / SBY – J14 F24 DPF Harness (Option) 150 Main DPF Power / RED F25 DPF Air Box (Option) 10 SECM Power / RED F26 DPF Ignition Harness (Option) 1 Truck Ignition Input to SECM / IGN F28 Heater Harness 5 Heater Power Sense / RED F29 Battery Box 200 Main Power Cable / RED F30 Battery Box 3 Alternator Sense / 2A F90 Main Controller Interface Board 20 Cab Heater / RED – J9 Electrical Components Glow Plugs (Each) Starter Motor Current Draw (Amps) at 12.5 Vdc Resistance— (Ohms) 4.3 2.3 ± 0.2 90 to 105 (cranking) Condenser Fan 11.8 to 12.4 Compressor Clutch 3.6 to 4.2 Pre-Cooler Fan 6.5 to 6.6 Evaporator Blower Fuel Pump 3.0 to 3.5 16.5 (high speed) 1.4 Fuel Solenoid: Pull In Hold In 35 to 45 0.5 0.2 to 0.3 24 to 29 NOTE: Disconnect components from unit circuit to check resistance. 17 Specifications Truck Sleeper Compartment Heater (D2) Heat Output (±10%) 7,500 BTU/hr Boost (2.2 kW) 6,150 BTU/hr High (1.8 kW) 4,100 BTU/hr Medium (1.2 kW) 2,900 BTU/hr Low (0.85 kW) Current at 12v (±10%) 8.3 amps - Start 2.8 amps - Boost 1.9 amps - High 1.0 amps - Medium 0.7 amps - Low Fuel Consumption (±10%) Boost 0.07 gal/hr (0.28 liter/hr.) High 0.06 gal/hr (0.23 liter/hr.) Medium 0.04 gal/hr. (0.14 liter/hr.) Low 0.03 gal/hr (0.10 liter/hr.) Air Flow (±10%) 48 cfm Boost 40 cfm High 27 cfm Medium 19 cfm Low Motor Speed 4800 ± 140 RPM - Boost 4000 ± 120 RPM - High 2800 ± 80 RPM - Medium 2000 ± 60 RPM - Low 600 ± 20 RPM - Adjustment in circulation mode with temperature sensor, internal. 0 RPM - Adjustment in fresh air mode with temperature sensor, external. 4800 ± 140 RPM - Ventilation Operating Voltage Range 10.5 - 16 vdc Overheat Temperature Shutdown (±10%) 240 F (115 C) Resistance Values: 18 Glow Pin 0.42 to 0.70 Ohms at 68 F (20 C) Fuel Metering Pump 10 ± 0.5 Ohms Operator Control Unit Set Value Potentiometer 1750-2080 ± 0.5 Ohms Specifications Truck Sleeper Compartment Heater (D4 - Option) Heat Output (±10%) 13,600 BTU/hr Boost (4.0 kW) 10,200 BTU/hr High (3.0 kW) 6,800 BTU/hr Medium (2.0 kW) 3,400 BTU/hr Low (1.0 kW) Current at 12v (±10%) 8.3 amps - Start 3.3 amps - Boost 2.0 amps - High 1.1 amps - Medium 0.6 amps - Low Fuel Consumption (±10%) Boost 0.13 gal/hr (0.51 liter/hr.) High 0.10 gal/hr (0.38 liter/hr.) Medium 0.07 gal/hr. (0.25 liter/hr.) Low 0.03 gal/hr (0.13 liter/hr.) Air Flow (±10%) 85 cfm Boost 69 cfm High 50 cfm Medium 30 cfm Low Motor Speed 4400 ± 130 RPM - Boost 3600 ± 100 RPM - High 2800 ± 80 RPM - Medium 1600 ± 50 RPM - Low 600 ± 20 RPM - Adjustment in circulation mode with temperature sensor, internal. 0 RPM - Adjustment in fresh air mode with temperature sensor, external. 3600 ± 100 RPM - Ventilation Operating Voltage Range 10.5 - 16 vdc Overheat Temperature Shutdown (±10%) 240 F (115 C) Resistance Values: Glow Pin 0.42 to 0.70 Ohms at 68 F (20 C) Fuel Metering Pump 10 ± 0.5 Ohms Operator Control Unit Set Value Potentiometer 1750-2080 ± 0.5 Ohms Optional Power Inverter See Manufacturer's Specifications 1000 Watts (Standard) 1800 Watts (Option with 120 Amp charging system) 19 Specifications—Compressor Oil COMPRESSOR OILS REFERENCE FOR THERMO KING TRIPAC AIR CONDITIONING SYSTEM OIL VISCOSITY REFRIGERANT USED ISO Method OIL TYPE THERMO KING P/N R-134a 100 Polyalkylene glycol (PAG 100) 203-502 CAUTION: Mixing PAG and POE oils will damage the air conditioning system. NOTE: Because of the many variables in oils, particularly in HVAC systems, compressors may be delivered with an oil that is not specified for the particular unit it is to be fitted to. Unless it is 100% clear it is the correct oil, Thermo King recommends the oil be changed to the correct type. CAUTION: With HVAC systems and the use of PAG, it is very important that oil mixing does not take place. PAG and POE oil CANNOT be mixed. Mixing these oils will cause serious system contamination, especially with chlorine based refrigerants. 20 General Description Introduction The Thermo King TriPac EVOLUTION Auxiliary Heating & Cooling Temperature Management System allows drivers to reduce unnecessary truck engine idling, conserve diesel fuel and save money. TriPac EVOLUTION provides truck engine preheating, battery charging and truck cab sleeper compartment climate control. By using TriPac, drivers can reduce fuel cost, rest comfortably during stops and comply with local, state and federal anti-idle laws. Reducing unnecessary truck engine idling also reduces engine wear and extends engine maintenance intervals. TriPac's own diesel engine uses an automatic start/stop feature for additional fuel efficiency. TriPac's two-cylinder diesel engine is EPA Tier 4 approved. An automotive type air conditioning compressor is used for sleeper compartment cooling. A fuel-fired air heater provides sleeper compartment heat in cold conditions. Voltage sensing automatically charges the truck batteries from TriPac's 12-volt alternator. Noise dampening construction assures quiet operation. Truck engine preheating provides easier cold-climate starts by exchanging coolant between TriPac and the truck engine. An optional inverter provides 120-volt power to operate on-board appliances. • Thermo King TK 15 compressor for air conditioning • Diesel fuel-fired sleeper compartment air heater • 65 amp 12 Vdc alternator standard • Noise-dampening construction for quiet operation • Automatic start/stop operation for maximum fuel efficiency • Optional Standby Truck Integration • Optional dash mounted Truck Integration Selector Switch (select normal or standby operation) • Optional Arctic Package • Optional 12 Vdc to 120 Vac 1000 Watt inverter for on-board appliances • Optional 12 Vdc to 120 Vac 1800 Watt inverter for on-board appliances • Optional bright stainless steel exhaust pipe • Optional stainless steel condenser shroud • Optional Exhaust Diesel Particulate Filter (DPF) • Optional Closed Loop Cooling System • Optional 120 amp 12 Vdc charging system An optional Arctic package aids truck engine startups in cold weather by sensing low coolant temperature. The TriPac is started to heat the coolant as required. TriPac EVOLUTION System Unit Features • An APU (auxiliary power unit) • Easy to operate Human Machine Interface (HMI) Controller in the cab • Condenser • Evaporator • Truck cab sleeper compartment cooling and heating for driver comfort in all climates • Heater • Truck engine preheating for easy starts in cold climates • HMI Controller. • Truck battery charging with automatic low voltage sensing • 7.0 hp 2 cylinder diesel engine - EPA Tier 4 The TriPac EVOLUTION system includes several major components: 21 General Description Auxiliary Power Unit (APU) Evaporator The TriPac EVOLUTION APU contains the diesel engine, air conditioning compressor, alternator and engine power switch. The Air Conditioning evaporator is typically installed under the bunk in the truck cab sleeper compartment. Air ducts from the Evaporator carry conditioned air to the sleeper compartment. ARA1421 AMA653 Figure 3: Evaporator and Air Ducts (Evaporator installed under sleeper cab bunk) Figure 1: TriPac EVOLUTION APU Heater Condenser The Air Conditioning condenser is mounted on the back of the truck cab. The heater is typically installed under the bunk in the truck cab sleeper compartment. It draws fuel from the truck's diesel fuel tank and electric power from the truck's batteries. AMA550 Figure 2: Condenser AMA552 Figure 4: Heater 22 General Description HMI Control Panel Compressor The HMI (Human Machine Interface) is a driver control panel that is typically mounted in the bunk area. The HMI allows the driver to select the desired function of the system. It also provides alarm and system status feedback to the driver. The HMI has three selector knobs and several icons. The HMI also contains an integral Cab Temperature Sensor that helps control cab temperature when the TriPac air conditioning system is operating. The air conditioning compressor is mounted in the TriPac EVOLUTION APU and is driven by the APU engine. Refrigeration lines connect the compressor to the air conditioning condenser on the back wall of the truck cab and the evaporator, usually mounted under the truck cab sleeper compartment bunk. ARA2100 Figure 5: HMI Control Panel Compressor operation is controlled by the Interface Board. The Interface Board receives inputs from the HMI Control Panel and other sensors. The Interface Board starts the APU engine and energizes the compressor clutch when cab cooling is needed. The refrigeration system is protected by separate high pressure cutout (HPCO) and low pressure cutout (LPCO) switches. Refrigerant The air conditioning system uses R-134a refrigerant. Control Circuits The control circuits operate on 12 Vdc supplied by the truck batteries. Protection Devices High Pressure Cutout Switch Interface Board The Interface Board is mounted in the control box, which is typically installed in a storage compartment behind or under the truck sleeper compartment. The Interface Board accepts inputs from the HMI Control Panel and system sensors. It operates TriPac components according to those inputs. The High Pressure Cutout Switch (HPCO) is a normally closed pressure sensitive switch located at the receiver/drier. If the discharge pressure rises above 360 psig (2482 kPa), the switch opens the circuit to stop the unit and generates Alarm Code 10 in the ACS group. When the discharge pressure falls below the 240 psig (1655 kPa), the switch closes to allow the alarm to be cleared and compressor operation to resume. Low Pressure Cutout Switch The Low Pressure Cutout Switch (LPCO) is a normally closed pressure sensitive switch located at the evaporator coil. ARA2105 If the suction pressure falls below 5 psig (34 kPa), the switch opens the circuit to stop the compressor. An alarm code 93 will be logged. The evaporator fan continues to run. Figure 6: Control Box 23 General Description When the pressure rises above 20 psig (138 kPa), the switch closes to allow compressor operation. Fuse Protection The electrical system is protected by a number of fuses (see "Fuses" on page 16). Most of the fuses are located on the interface board shown below. Other fuses are located in fuse holders in wire harnesses. ARA2106 Figure 7: Interface Board Serial Number Locations APU: Unit nameplate is located on front right edge of APU frame near the Engine Switch (APU service access door must be opened to view the nameplate). Engine: Nameplate located on the top of the engine. The engine is mounted in the APU housing. Compressor: Nameplate located on compressor body. The engine driven compressor is located in the APU housing. Heater: Sticker located on the side of the heater (Fabrik No.). 24 Operating Instructions HMI Control Panel The HMI (Human Machine Interface) is the operator control module that is typically mounted in the bunk area of the truck cab. The operator can select the desired function of the system. It has three selector knobs and system condition display. The HMI contains the Cab Temperature Sensor. It communicates with the Controller using the Controller Area Network (CAN). Once the system has been turned on the system mode, temperature or fan speed may then be selected. If no selection is made the system will be in Monitor Mode. See Monitor Mode later in this section. NOTE: Pressing the Mode Selector knob for less than 1 second will not turn the TriPac system on. • Turn system Off: If system is on, press the Mode Selector knob for a minimum of 2 seconds to turn the system off. • Display System Status: If system is on but display has dimmed, press the Mode Selector knob for less than 1 second to restore display to full brightness. The display will automatically dim again in about 90 seconds. Pressing the Mode Selector knob for less than 1 second is referred to as a "Bump". ARA2100 Figure 8: HMI Control Panel HMI Control Panel Display The operator can select these functions from the HMI: • System On/Off • Mode (Cool, Fan, Heat) • Cab Temperature (Cooler/Blue-Warmer/Red) • Fan Speed (Off, Low, Medium, High) When any change of settings is made there is a two second delay before the controller will recognize the new setting. This prevents momentary or accidental mode changes. The HMI indicator LEDs will dim after 90 seconds if no selections are made. Bump the On/Off button to activate bright display for an additional 90 seconds. On/Off Button The On/Off Button is behind the left knob on the HMI. It provides several functions depending on how long the button is pressed. • Turn system On: If the system is off, press the Mode Selector knob for a minimum of 1 second to turn the system on. The mode icon will flash for 10 seconds while the controller completes a boot process. ARA2100 Figure 9: Press Button for ON or OFF Mode Selector Mode selection is accomplished by rotating the left Mode Selector knob. It selects between three operating modes. A mode icon will flash then light indicating the selection. There will be a two second delay before the new mode is activated to prevent momentary or accidental mode changes. When the system is first turned on at the HMI there will be a 10 second delay before the selected mode is activated. • Cool Mode • Fan Only Mode • Heat Mode 25 Operating Instructions 1 selected OFF, the fan speed will default to LOW. When Fan Only or Heat mode are selected Fan Speed will default to OFF. 3 2 1 2 ARA2100 1. Cool Mode 2. Fan Only Mode 3. Heat Mode ARA2100 Figure 10: Mode Selection 1. NOTE: When the system is turned on for the first time after replacing or disconnecting the main controller from power the mode icon will flash for approximately 60 seconds. This is initial boot of the micro processor. Temperature Selector Temperature selection is accomplished by rotating the center Temperature Selector knob. It adjusts the desired cab temperature cooler (blue) or warmer (red). Adjust to operator comfort. The default represented range is approximately 65 - 80 F (20 - 27 C) in Cool Mode and 50 - 80 F (10 - 27 C) in Heat Mode. FAN Selector 2. LEDs Figure 12: Right Knob Adjusts Fan Speed System Condition Display Several LED indicators are on the left side of the HMI. These provide additional System Condition information. Standby Indicator STBY is illuminated when the system is in Standby or Monitor mode. 1 2 3 ARA2100 4 Figure 11: Center Knob Adjusts Temperature Fan Speed Selector Evaporator fan speed selections are Off, Low, Medium and High. Rotating the Fan Speed Selector knob clockwise will increase fan speed, counterclockwise will decrease fan speed. As fan speed increases/decreases, groups of four LEDs will progressively turn on/off. The fan will continue to run at the chosen speed. When Air Conditioning mode is selected and Fan Speed is 26 5 1. ENG Icon 2. Alarm Icon 3. ALT Icon 4. STBY Icon 5. ACS Icon Figure 13: System Condition Display Icons Operating Instructions Alarm Icon If the system has an active alarm the Alarm Icon will illuminate. It will be Red for shutdown alarms and Yellow for Check alarms. Alarm Group Indicator System shutdown alarms have been organized into three general groups to help diagnosis. When a shutdown alarm is generated the red Alarm Icon and the corresponding Alarm Group name will illuminate. • [ENG] are APU engine related alarms. • [ALT] are alternator or charging system alarms. • [ACS] are air conditioning system related alarms. Clearing Alarms Alarm codes can be cleared by turning the controller off and back on again. If the condition that caused the alarm still exists, the alarm will return. Refer to the TriPac EVOLUTION Diagnostic Manual TK 55739 for more information about alarm codes. Operating Modes Cool Mode When Cool Mode is selected at the Mode Selector knob, the HMI Control Panel uses the Cab Temperature Sensor to measure sleeper compartment temperature. If it is above the temperature selected by the Temperature Selector knob, the APU engine will begin a start sequence (if not already running). The evaporator fan is defaulted ON and will run in low or the speed selected by the Fan Speed Selector knob. The compressor clutch will engage 60 seconds after a successful engine start. The system will cool the sleeper compartment until it falls to the selected temperature. The compressor clutch will disengage but the APU engine will continue to run for several minutes based on the Engine Delay Timer setting (default 8 minutes). The evaporator fan will continue to run at the selected speed. If sleeper compartment temperature rises above the selected temperature by more than the Dead Band setting (default 3 F) during this time the compressor clutch will re-engage. During normal air conditioning operation the compressor clutch may cycle on and off with no alarm. The evaporator fan will continue to run. The system is monitoring the Evaporator Coil Temperature sensor to prevent frost buildup on the evaporator coil. If coil temperature falls below 32 F the compressor clutch is de-energized. When coil temperature rises above 45 F the compressor clutch is energized. The APU engine will shut down when the sleeper compartment temperature remains near the selected temperature and the truck batteries are charged. The evaporator fan will continue to run. If sleeper compartment temperature rises above the selected temperature by more than the Dead Band setting (default 3 F) the APU engine will restart and compressor clutch will re-engage. Battery voltage sensing and engine coolant temperature sensing are enabled for the APU. Refer to Monitor Mode. Heat Mode The air heater is a separate module that heats the sleeper compartment to the setpoint selected with the Temperature Selector knob. Sleeper compartment temperature is sensed inside the air heater, it does not use the Cab Temperature Sensor on the HMI. All heater function is controlled by a separate module inside the heater. The TriPac evaporator fan is defaulted to OFF when Heat Mode is selected. It can be turned on to provide additional air circulation. Battery voltage sensing and engine coolant temperature sensing are enabled for the APU. Refer to Monitor Mode. Fan Mode The TriPac evaporator fan can be turned on with the Fan Speed Selector knob to provide additional air circulation in the sleeper compartment and truck cab. Three fan speeds can be selected (Low, Medium, High). LEDs around the Fan Speed Selector will indicate the selected speed. Battery voltage sensing and engine coolant temperature sensing are enabled for the APU. Refer to Monitor Mode. 27 Operating Instructions Standby Mode (Optional) The optional TriPac Standby Mode allows the system to be controlled by an external switch input. This is typically the truck ignition using the optional Standby Truck Integration. The feature is used to disable the TriPac APU when the truck engine is running. When the truck ignition switch is in the run position, a voltage signal is sent to the controller. The TriPac system will enter Standby Mode. The following occurs when the TriPac system is in Standby Mode: • Dash-mounted selector switch is in the Standby position. The TriPac system will enter Standby Mode. This allows the operator to disable the TriPac system without accessing the HMI Control Panel in the sleeper. • The STBY indicator on the HMI will illuminate. • Air conditioning, fan or heat operation will terminate. • The APU engine will stop. Monitor Mode • The TriPac controller remains on but will not respond to any operation requests, such as low battery voltage or low coolant temperature Activate Standby Truck Integration (Optional) An optional wire harness connects the truck ignition switch to an input connection on the TriPac interface board. The board monitors voltage on this circuit. • • Truck ignition switch is in the Off or Acc position. If the TriPac system is turned on the unit operates normally. Truck ignition switch is in the Start or On position. The TriPac unit is forced to Standby mode. The HMI Controller STBY indicator will illuminate. Truck Integration Standby Select Switch (Optional) An optional wire harness connects the truck ignition

switch and dash mounted selector switch to an input connection on the TriPac interface board. The board monitors voltage on this circuit. • 28 Dash-mounted selector switch is in the Normal position. If the TriPac system is turned on the unit operates normally. The system will respond to the truck ignition as with the Standby Truck Integration option. Figure 14: Standby Select Switch By default Monitor Mode is active when the TriPac system is turned on at the HMI Control Panel but a mode has not been selected by the operator. Monitor Mode is also active when the truck ignition has been turned on (Standby) then turned off. The STBY indicator on the HMI will illuminate. Deactivate Monitor Mode will be deactivated and system will begin HVAC operation if the operator presses the On/Off button at the HMI, moves the Mode selector or moves the Fan Speed selector. The selected HVAC mode will activate. The STBY indicator on the HMI will turn off. System will continue to monitor battery voltage and engine coolant temperature. Operation While Monitor Mode is active the APU will continue to start and stop as necessary to maintain battery voltage and engine coolant temperature (if the Arctic Option is installed). While in Monitor Mode the system will not react to changes in cab temperature. TriPac Cool, Heat and Fan modes will remain off. Battery voltage sensing is enabled. When battery voltage falls to the level set by Battery Voltage Restart Value (default 12.1 Vdc) the APU engine Operating Instructions will start so it can charge batteries. It will continue to run until the Charge Current Shutoff Value setting has been reached (default 20 amps). If the Arctic Option is installed and enabled, truck engine coolant temperature sensing will occur. If engine coolant temperature at WT2 falls below 35 F the APU engine will start to warm the truck engine. It will continue to run until returning coolant temperature rises to 55 F. Monitor Mode may be disabled. If disabled the system will return to the mode it was in when the truck ignition was turned on. NOTE: This is not the recommended setting. Refer to the TriPac EVOLUTION Diagnostic Manual TK 55739 Section 3, Software Settings, Switch to Monitor for more information. Engine Load Management To maintain Tier 4 engine emission levels, engine load may be reduced under some conditions. Some TriPac units will have an optional 120 amp charging system. The 120 amp alternators used in this system have a special dual output voltage regulator that is not interchangeable with the standard 65 amp Thermo King alternator. It requires some additional external circuitry, or Load Control Harness, to function. During charging system diagnosis, use TK Monitor, Service Test mode, Alternator Output Test to bypass the load management system. Operation The Load Management system continuously monitors three conditions: • Air conditioning clutch circuit. • Ambient temperature. • Cab temperature. Engine Load Management levels: 1. Air conditioning compressor clutch is disengaged. Full alternator output, FLD1 terminal grounded. 2. Air conditioning compressor clutch is engaged. Ambient temperature is below 95 F. Full alternator output, FLD1 terminal grounded. 3. Air conditioning compressor clutch is engaged. Ambient temperature is above 95 F. Cab temperature below 85 F. Minimum alternator output reduction. FLD2 and FLD3 terminals are grounded. 4. Air conditioning compressor clutch is engaged. Ambient temperature is above 95 F. Cab temperature above 85 F. Additional alternator output reduction. FLD3 terminal is grounded. 5. Air conditioning compressor clutch is engaged. Ambient temperature is above 95 F. Cab temperature above 95 F. Maximum alternator output reduction. FLD2 terminal is grounded. There is a 10 second clutch delay after engine start or Cool Mode selection. Engine On/Off Switch DANGER: Always turn the TriPac system OFF at the HMI Control Panel On/Off button while the truck is being refueled. Fuel vapors could ignite if they come in contact with TriPac electrical or heater components. WARNING: TriPac engine can start automatically without warning if the Engine On/Off switch is in the ON position. Always place the Engine On/Off switch in the OFF position before performing service on the engine or engine accessories. WARNING: Immediately stand clear when the preheat buzzer sounds. This indicates that the engine is preheating. If the engine is hot, preheat time will only be a few seconds. The APU Engine On/Off Switch is located inside the TriPac APU housing on the right side of the frame. This switch must be in the ON position for the TriPac system to operate. The APU Engine On/Off Switch functions as a service switch. It allows maintenance personnel to disable the APU engine. This assures the engine will not crank even if the HMI On/Off button is pressed on. 29 Operating Instructions 1 2 3 4 ARA2124 1 1. ENG Icon 2. Alarm Icon 3. ALT Icon 4. ACS Icon Figure 16: System Condition Display Alarm Icons 1. APU Engine On/Off Switch Figure 15: APU Engine On/Off Switch Location When the Engine On/Off switch is placed in the Off position: • If the TriPac system is OFF and the TriPac HMI On/Off button is pressed, a shutdown alarm (code 35) will generate in the [ENG] group. The engine will not start. • If the TriPac system is ON but the APU engine is not running, a shutdown alarm (code 35) will generate in the [ENG] group. The engine will not start. • If the TriPac engine is running, the engine will stop and a shutdown alarm (code 35) will generate in the [ENG] group. The engine will not restart. Alarm Codes Alarm Notification The TriPac control system continually monitors operation and can generate several alarm codes. If the unit has an alarm condition the operator will be notified by an illuminated Alarm Icon on the HMI Control Panel. The icon can be Yellow or Red. 30 Yellow = Check Alarm. This indicates one or more of the system Check Alarms are active. This level of alarm serves as notice to take corrective action at the earliest convenience before a problem becomes severe. The system will continue to operate but some features and functions may be inhibited or disabled. Red = Shutdown Alarm. This indicates one of the system Shutdown Alarms is active. This level of alarm serves as notice that a potentially severe system problem exists. Immediate corrective action should be taken. The system will not be operating. Along with the Red Alarm Icon, one of the shutdown alarm group names (ENG, ALT, ACS) will illuminate. This indicates the alarm falls into one of the three categories, helping to focus diagnosis and repair. Refer to the TriPac EVOLUTION Diagnostic Manual TK 55739 Section 5 for detailed alarm descriptions. All recent alarm codes can be read and cleared by a technician using the Alarm screen in TK Monitor. See TriPac EVOLUTION Diagnostic Manual TK 55739 Section 6, A51A, Communication Using TK Monitor. Operating Instructions Shutdown Alarm Groups Clearing Alarms The shutdown alarm group indication on the HMI helps to focus preliminary fault diagnosis toward a limited group of potential failure causes. It may be necessary for the technician to determine the actual fault code and other system information to form an accurate diagnosis. See TriPac EVOLUTION Diagnostic Manual TK 55739 Section 5, Diagnostics, Alarm Codes and Section 6, A51A, Communication Using TK Monitor. If the alarm icon is Red, first note the alarm group that is illuminated on the HMI display (ENG, ALT, ACS). Use the HMI Control Panel System On/Off button to turn the TriPac unit off. Resolve the condition that caused the alarm. Use the HMI Control Panel System On/Off button to turn the TriPac unit on. Any active alarms will be cleared. ENG Active alarms and those recently cleared by the operator can be read and cleared by a technician using the Alarm screen in TK Monitor. This screen provides the technician with a list of alarms that have occurred. They may be cleared individually or as the full list. All alarm codes are stored in the unit data logger. Alarms cleared through TK Monitor remain in the data logger memory and may be retrieved with a data logger download. See TriPac EVOLUTION Diagnostic Manual TK 55739 Section 6, A51A, Communication Using TK Monitor. Alarms in this group are engine related. The operator/technician should look for: • Conditions that cause unusually high APU engine coolant temperature. • Conditions that cause unusually low APU engine oil pressure. • Conditions that prevent the engine from starting. • Conditions that may cause fuel starvation. NOTE: If the alarm condition still exists the alarm will return. ALT Alarms in this group are alternator, battery or system voltage related. The operator/technician should look for: • Loose or missing APU drive belt. • Loose or corroded APU power cable connections. • Unusually low or high voltage at the truck batteries. ACS Alarms in this group are air conditioning system related. The operator/technician should look for: • Conditions that cause unusually high air temperature at the condenser coil. • Conditions that reduce or restrict air flow through the condenser coil. 31 Operating Instructions Operating Conditions This flowchart illustrates the conditions that will cause the engine to start, the engine start sequence and the conditions that will allow the engine to shut down. 32 Operating Instructions Circuits The following description of TriPac EVOLUTION circuit function can help with system diagnosis. Understanding the logic of the operating circuits and sequence of events will help with system testing. Based on Schematic Diagram 2E32872. • Source voltage is also available on the interface board to each of the FET controlled outputs: 8X (F8), 7X (F9), 8DP (F7), PCF (F10), 7CL (F13), 7CF (F11), FAN1, FAN2, FAN3 (F12) and YEL (F14). • From the J15 terminal, source voltage is sent through: Power Circuits • F6 to the controller circuits. • F5 to J14-B3 as the 2A output for the Optional Standby Switch. • F90 to the RED circuit (J9-1) to power the heater. Battery • Truck batteries should be connected to provide 12 volt source. • Source voltage is available from the truck batteries through the F29 (200A) main power fuse in the truck battery box. A cable runs to the APU starter solenoid positive terminal and contacts. Voltage is available to the HMI on 2P (F4) through J34-5 and 8XP (F2) through J34-6. System On • Source voltage branches from the main power fuse in the truck battery box through the F30 (3A) fuse. The 2A circuit runs to the alternator voltage regulator S terminal in the 2 wire plug. This provides sense voltage to the alternator that it uses to determine battery level and charge rate. The On/Off button on the HMI is pressed for at least one second. The HMI and microprocessor become active. Cool, Heat or Fan mode may then be selected. If no selection is made the system will be in Monitor Mode. Refer to Monitor Mode earlier in this section. • • Source voltage is available from the starter terminal through the F18 (3A) fuse to the SEN input connection on the interface board (J14-A1). This allows the control system to read battery voltage. The 8X output connection (J14-A3) is powered by the On Relay (OR). It sends voltage to the closed engine toggle switch (ESW) in the APU and returns to the 8X_SW input connection (J14-B4). • • Source voltage is available from the starter solenoid on the RED circuit to the APU alternator B+ terminal. The 2 circuit leaves the alternator B+ terminal and goes through the F16 (50A) fuse to the J15 terminal on the interface board. This provides power for the control system and components. This circuit passes through the board to the 8FET output connection (J4-B2). • Units without the DPF option have a jumper plug in J4. The 8FET connects through the green wire to the 8 input (J4-A3). Circuit provides power to the Run Relay (RR) contacts. • Interface Board • On the interface board from the J15 terminal, source voltage is available to the Starter (SR) and Preheat (PR) relay contacts through F1 and F3. Run Circuits Start Demand An engine start demand can come from any one of three sources. 33 Operating Instructions • • • Battery voltage at the SEN connection (J14-A1) falls below the programmed Battery Voltage Restart Value (default 12.1 volts). An open or disconnected SEN circuit to the interface board will cause a start demand. Air conditioning mode selected on the HMI. Cab temperature sensor 3 F or more above setpoint. NOTE: Anytime there is voltage at the 7A input connection (J4-B3) of the interface board the APU engine will start or continue to run. No voltage at this terminal will cause the engine to stop running or terminate a start attempt. Preheat • • The 8DP connection (J5-4) is powered for 2 seconds to energize the fuel solenoid pull-in coil (FSP). • The D+ connection (J14-B1) is energized 20 seconds after engine start to provide Excite voltage to the APU alternator. • The controller begins to monitor the WT2 water temperature sensor. If returning coolant temperature is above 115 F the controller will power the PCF output connection (J5-6), energizing the Pre-cooler Fan on the APU. When coolant returning from the truck engine falls below 95 F, the controller will turn off the PCF output, stopping the fan. • The controller monitors the voltage at the 8 circuit input connection (J4-A3). No voltage at the 8 circuit input connection when the Run Relay coil is energized will trigger a shutdown alarm code 35 in the [ENG] group. Arctic Option sensor (WT2) measures engine coolant temperature has fallen below 35 F. Each will cause the 7X output connection (J4-A1) to be energized by the controller. Units without the DPF option have a jumper plug in J4 sending the voltage signal through the red wire to the 7A input connection (J4-B3). • • Preheat Relay coil is energized on the interface board by the controller, closing the Preheat relay (PR) contacts. Voltage from F3 is available to the H circuit connection (J5-3). The glow plugs and buzzer in the APU are energized. Start • Start relay coil is energized on the interface board by the controller, closing the contacts. Voltage from F1 is available to the 8S circuit connection (J5-1). The 8S circuit energizes the starter solenoid in the APU. • A fly wheel sensor (FWS) monitors engine RPM. It is connected to the FS1 and FS2 connections (J14-A10 & B10) on the interface board. If the engine does not crank (800 RPM), cranking is terminated. If the engine does not start, cranking is limited to 30 seconds. • If the engine does not start on the first attempt, two additional start attempts will be made. If the engine fails to start the controller will generate a code 20 shutdown alarm in the ENG group. • Begin to read the Oil Pressure Switch (LOPS circuit, J14-A5) 30 seconds after engine start. • Voltage on the D+ circuit (J14-B1) to the alternator excite terminal is delayed for 20 seconds after engine start. Preheat time is based on engine temperature (WT1). • Below 100 F = 33 seconds. • Above 100 F = 10 seconds. Preheat Relay remains energized for 10 seconds after engine start. Run • 34 Run relay coil is energized on the interface board by the microprocessor, closing the Run Relay (RR) contacts. Voltage from the 8 circuit input connection (J4-A3) energizes the 8D output connection (J14-A4). The 8D circuit powers the fuel solenoid hold-in coil (FSH) and electric fuel pump (FP) in the APU. Operating Instructions Air Conditioning Circuits If COOL mode is selected, the HMI monitors cab temperature with a Cab Temperature sensor mounted on the HMI control panel. If this temperature raises more than the number of degrees set by Cooling Dead Band (default = 3 F) above setpoint, the microprocessor on the interface board initiates an engine start. • • • • The Evaporator blower is defaulted on and will run in low or the speed selected by the HMI Fan Speed Selector. If High is selected the FAN3 terminal sends voltage directly to the evaporator fan motor (EFM) in the evaporator box. If Medium is selected the FAN2 terminal sends voltage through the resistor block at the fan motor. If Low is selected the FAN1 terminal sends voltage through the resistor block at the fan motor. After a 60 second delay, the 7CF connection (J2-1) sends voltage to the condenser fan motor (CFM) on the back of the cab. After a 60 second delay, the 7CL connection (J5-2) sends voltage to the high pressure cutout (HPCO) at the receiver/drier. This is a normally closed switch that opens at 360 psig. The circuit changes to 7CLA. 7CLA carries voltage to the compressor clutch (CLU) in the APU. • A branch of the 7CLA circuit provides an input signal to the 7CLA connection (J2-2) on the interface board. If voltage to this connection is lost while the compressor clutch is energized alarm code 10 will generate. • Evaporator coil temperature is monitored with a Coil Temperature Sensor (CTS). When evaporator coil temperature falls below 32 F the 7CL circuit is de-energized, stopping the compressor. When evaporator coil temperature rises above 45 F the 7CL circuit is energized, starting the compressor. No alarm is generated. • A low pressure cutout (LPCO) reads air conditioning system pressure in the evaporator housing. This switch opens below 5 psig, breaking the path to ground. This causes the voltage at the 7CLB terminal (J2-3) to increase to system voltage, stopping the compressor. Code 93 is generated. The 7CF and 7CL circuits are turned off when the cab temperature reaches setpoint. This stops the condenser fan and compressor. The evaporator blower continues to run. The run relay stays energized and the engine continues to run for the number of minutes set by the Engine Off Delay Timer (default = 8) after setpoint is reached. Heat Circuits If Heat mode is selected, cab temperature is controlled by the optional Espar air heater. The Espar heater is a self-contained system. It has its own operating logic and temperature controller. It requires minimal connection to the TriPac control system. The APU engine does not start for a heat demand however may start to charge batteries or warm the engine. • Source voltage is available from the interface board to the Espar heater on the RED wire (J9-1) of the Espar heater harness. This is power for the heater to operate. • The YEL output connection (J13-2) on the interface board sends the ON or enable signal to the heater through the Espar heater harness. • The HMI, through the interface board, sends setpoint information to the heater on the GRY/RED (J13-6) and BRN/WHT (J13-5) wires of the Espar heater harness. This is a variable resistance signal generated by the digital potentiometer on the interface board. NOTE: This circuit is polarity sensitive and must be correctly connected. • The temperature controller inside the heater reads return air temperature with an internal sensor. NOTE: The Espar heater does not use the Cab Temperature Sensor on the HMI. • The heater controller sends pulsed DC voltage to the fuel metering pump (FMP) on the GRN/RED wire of the Espar heater harness. The pump is grounded by the BRN wire of the Espar heater harness. 35 Operating Instructions • The burner function is monitored by an internal Heater Temperature Sensor (HTS). During startup the system looks for rising heat exchanger temperature to verify ignition. During operation the system looks for abnormally high heat exchanger temperature. Shutdown Requirements An engine shutdown can only occur after all three of the following conditions are met. NOTE: Anytime there is voltage at the 7A input connection (J4-B3) of the interface board the APU engine will start or continue to run. No voltage at this terminal will cause the engine to stop running or terminate a start attempt. • Charging amperage measured by the Current Sensor (CS) has fallen to the programmed Charge Current Shutoff Value (default 20 amps). • Air conditioning demand from HMI has been satisfied for number of minutes set by the Engine Off Delay Timer (default = 8). • Arctic Option is installed and enabled. Engine coolant temperature returning to the APU rose above 55 F at Engine Temp Sensor 2 (WT2). Standby Options Truck Integration An IGN wire is connected to the truck ignition switch so that it is energized in the run position only. When the ignition switch is in the run position, voltage is sent through the F19 fuse to the SBY connection (J14-A2) of the interface board. The system will enter Standby mode and STBY will illuminate on the HMI. The APU will not start. When the ignition switch is in the off or accessory position, voltage is removed from the IGN wire and SBY connection. The TriPac system will be active. Standby Select Switch The optional dash mounted Standby Select Switch allows the driver to choose standby modes. 36 Figure 17: Standby Select Switch • Normal Position - System functions the same as with Truck Integration. An IGN wire is connected to the truck ignition switch so that it is energized in the run position only. The IGN wire is connected to the Standby Select Switch (SSW). When the ignition switch is in the run position, voltage sent through the F19 fuse. Voltage passes through the Standby Select Switch contacts to the SBY connection (J14-A2) of the interface board. The system will enter standby mode and STBY will illuminate on the HMI. The APU will not start. When the ignition switch is in the off or accessory position, voltage is removed from the IGN wire and SBY connection. The TriPac system will be active. • Standby Position - Source voltage from the interface board 2A connection (J14-B3) continuously passes through the Standby Select Switch (SSW) contacts to the SBY connection (J14-A2) of the interface board. The system will enter standby mode and STBY will illuminate on the HMI. The APU will not start. The position of the truck ignition switch has no effect. Load Control Harness The Load Control harness is connected to the alternator FLD (field) terminal near the plug connection. It is used to reduce maximum alternator output and engine load under some conditions. The harness runs toward the TriPac control box. It splits into three circuits (FLD1, FLD2 and FLD3) before connecting to the interface board. One or two circuits may be active at any time. There is a 10 second delay after engine start or Cool Mode selection. Operating Instructions NOTE: The Load Control Harness should never be connected to the F2 terminal of a 65 amp single output alternator. Alternator failure will result. • • • FLD1 circuit connects directly to the interface board (J6-A3). When active the circuit provides an un-resisted ground path for the alternator field. The alternator can charge at full output. FLD2 circuit connects through a 2 Ohm resistor to the interface board (J6-B3). When active the circuit provides a resisted ground path for the alternator field. This reduces field voltage, limits maximum alternator output and reduces engine load. FLD3 circuit connects through a 4 Ohm resistor to the interface board (J6-A4). When active the circuit provides a resisted ground path for the alternator field. This reduces field voltage, limits maximum alternator output and reduces engine load. TK Monitor Diagnostic Tool The TriPac EVOLUTION control system provides a diagnostic tool that can be accessed using a PC computer and commonly available USB to Mini-B interconnect cable. Use of this tool is required for most TriPac EVOLUTION system diagnostics. The TK Monitor software is in the TriPac EVOLUTION control system. No special software is required to be loaded on the diagnostic computer. TK Monitor provides the following information and functions. For a more detailed description see TriPac EVOLUTION Diagnostic Manual TK 55739 Section 6, A51A, Communication Using TK Monitor. Dashboard This screen displays an overview of basic system operation information. This includes the hour meters. System Monitoring This screen displays a more detailed view of the information being received by the control system inputs. It also displays what components are currently activated by the control system outputs. Programmable Setup TriPac EVOLUTION has a group of programmable features. This screen allows the feature settings to be viewed and changed. For details of software settings see TriPac EVOLUTION Diagnostic Manual TK 55739 Section 3, Software Description. Service Test The selections on this screen allow operating modes to be selected that will not change for 15 minutes. Allow performing diagnostic procedures while the system is in a known steady state. These test modes are not affected by setpoint, cab temperature or ambient temperature. For example: cool mode may be forced on even though cab temperature is below the 65 F minimum setpoint. The Service Test screen also includes a Run-In Test that will enable cool and heat operation simultaneously. This allows the TriPac EVOLUTION engine to run loaded during break-in when ambient temperature would prevent continuous air conditioning operation. Alarms This screen displays system alarm numbers and names. Alarms may be cleared individually or as a group. See Alarm Codes in the TriPac EVOLUTION Diagnostic Manual TK 55739. Software Upgrade Current software revision level can be viewed on this screen. There are three software sets in the TriPac EVOLUTION system; Controller, HMI and TK Monitor. Upgrading of software by flash loading is also done through this screen. Unit Setup During new unit installation some setup information must be provided to the system controller through this screen. Setup information 37 Operating Instructions includes the alternator type, cooling system configuration, unit serial number and a unit identification number. Tools Access to system restarts and Data Logger download functions are provided by this screen. These functions are password protected. The password is 4444. 38 Maintenance Inspection Schedule NOTE: Thermo King reserves the right to deny warranty coverage on claims due to lack of maintenance or neglect. Claims in question must be supported by maintenance records. NOTE: See the appropriate chapter in this maintenance manual for instructions on how to correctly perform required maintenance. Engine Pre-Trip 500 Hrs Annual 2,000 Hrs Check condition of or service the following: • • • Check engine oil level. • • • Check engine coolant level on units with optional closed loop cooling system. • • • Inspect belts for condition and proper tension. • • • Listen for unusual noises, vibrations, etc. • • Check air cleaner hose for damage. • • Inspect air cleaner. Change as needed or annually. • • Inspect fuel pre-filter screen. Clean as required or annually. • Change fuel filter. Thermo King brand filter is required. • Drain water from fuel tank and check vent. • • Check and adjust engine speed. • • Check condition of engine mounts. • Maintain year-round anti-freeze protection at –30° F (-34° C). Change coolant every two years, or with truck coolant. For units equipped with optional closed loop cooling system and ELC (red) engine coolant, change ELC coolant every 5 years or 12,000 hours. — Adjust engine valves (1000 hours). — Test fuel injection nozzles at least every 3,000 hours. * — Replace fuel return lines between fuel injection nozzles every 10,000 hours or sooner, as required. * Based on EPA 40 CFR Part 89. Engine Oil Change Intervals (Change oil and filters hot) Pre-Trip 500 Hrs Annual 2,000 Hrs Check condition of or service the following: 2,000 Hour 2,000 Hour Interval - Oil change interval is every 2,000 hours of operation Intervals only when using a Thermo King brand oil filter and CJ-4 or better oil. Units with optional DPF require CJ-4 or better oil. 500 Hour 500 Hour Interval - Oil change interval is every 500 hours of operation when Intervals using any other brand oil filter and CI-4 or better oil. Units with optional DPF require CJ-4 or better oil. IMPORTANT: The fill port on top of the engine should not be used to add engine oil. To prevent engine lock-up and/or serious internal damage after TriPac engine oil is added or changed always add oil through the lower port on the timing gear cover. 39 Maintenance Inspection Schedule Electrical Pre-Trip 500 Hrs Annual 2,000 Hrs Check condition of or service the following: • • Check operation of protection shutdown devices. • • Check alternator voltage. • Check alternator bearings. See Note 1. • • Inspect battery terminals. • • Inspect electrical connections. • • Inspect wire harness for rubbing or damage. • • Check electric condenser, evaporator and pre-cooler fans. Note 1 - With belt removed spin alternator by hand. Listen for noise and ensure that bearings roll freely. Structural Pre-Trip 500 Hrs • • • Visually inspect unit for fluid leaks (coolant, oil, refrigerant). • Annual 2,000 Hrs Check condition of or service the following: • • Visually inspect unit for damaged, loose or broken parts. • • Inspect, clean and (if necessary) replace evaporator air filter. It may be necessary to check or replace it more often if conditions require. • • Inspect evaporator drain valves (kazoos) to ensure that they are in place, in good condition and are sealing. • Steam clean condenser and APU pre-cooler coil. Do not bend coil fins. • Blow out evaporator coil and evaporator water drains with air. Do not bend coil fins. • Check APU mounting bolts and brackets for cracks. damage and poor aligment.Verify tightness and torque to 100 ft/lbs (135.6 N•m) for the claw mount, or 200 ft/lbs (271.2 N•m) for the direct frame mount. A/C System Pre-Trip 500 Hrs Annual 2,000 Hrs Check condition of or service the following: • • Check refrigerant level. • • Check refrigerant lines for rubbing or damage. Heater Pre-Trip 500 Hrs • • • Start and run for at least 20 minutes each month. • • • Inspect combustion air intake tube and exhaust pipe for restrictions or blockage. • • • Inspect ducting, air intake screen, and air outlet for restrictions or blockage. • Remove glow pin and inspect for carbon build up. Clean. • Remove glow pin screen and inspect for carbon build up. Replace. • Change fuel pump screen. 40 Annual 2,000 Hrs Check condition of or service the following: Electrical Maintenance Maintenance Inspection Schedule Pre-Trip 500 Hrs Annual 2,000 Hrs • • Check operation of protection shutdown devices. • • Check alternator voltage. • Check alternator bearings. See Note 1. • • Inspect battery terminals. • • Inspect electrical connections. • • Inspect wire harness for rubbing or damage. • • Check electric condenser, evaporator and pre-cooler fans. Check condition of or service the following: Note 1 - With belt removed spin alternator by hand. Listen for noise and ensure that bearings roll freely. WARNING: Take precautions to ensure the unit will not accidentally start while you are servicing the system. Always turn off the APU Engine On/Off Switch when inspecting or servicing any components in the APU enclosure. Charging System Diagnosis • Loose or dirty cable connections at the TriPac alternator B+, starter or battery terminals will prevent alternator output from reaching the batteries. • Loose or dirty connections at the 2A, D+, and CH circuits connected to the alternator will prevent it from providing correct output. • The alternator charging output will be low if the alternator belt or pulleys are defective or the belt is not properly adjusted. The belt should not be loose, worn or cracked and the pulley is in good condition. • The TriPac system circuits or installed truck accessories, such as a power inverter, may be drawing excessive current. Check for excessive power drain before replacing an alternator. • Overcharged batteries are usually caused by a defective voltage regulator in the truck alternator. Use the following information and procedures to help diagnose TriPac charging system issues. General Conditions Poor charging performance may not be caused by a bad alternator. The following conditions can cause improper battery charging, even with a good alternator. Refer to the Diagnostic Procedures (pages 44 through 51) for additional details. • Truck batteries and connections must be in good condition. • Batteries should be charged to 12.5 Vdc or higher before beginning testing. Each battery should be load tested following the recommendations from the manufacturer of the tool being used. • Batteries should be checked for damage and correct electrolyte level. A defective battery may consume the entire alternator charging capacity or not be capable of accepting a charge. • All battery cable connections should be clean and tight. Poor connections will prevent alternator output from reaching the batteries. 41 Electrical Maintenance Alternator Identification 65 Amp Single Output Alternator TriPac standard production alternator. • Thermo King Alternators are painted black. • Uses an orange single output 14.5 Vdc voltage regulator that is not compatible with 120 amp dual output alternators. • F2 terminal should never be grounded or connected to the Load Control harness. Damage to alternator will result. • Alternator Capacity must be set to 65 Amps through TK Monitor, Unit Setup screen. NOTE: 120 Amp Dual Output alternator cannot be used to replace a 65 Amp Single Output alternator. NOTE: The alternators used on TriPac EVOLUTION units have counterclockwise (CCW) fans and 2.25" pulleys. When replacing an alternator, make sure to use the correct fan and pulley. NOTE: Alternators with orange voltage regulators should never be used on any Thermo King Truck/Trailer application. 1 2 3 4 5 7 6 1. B+ Terminal (Positive Output – RED and 2 Wires) 5. F2 Terminal on 65 Amp Alternator (Do Not Ground) 2. B- Terminal (Negative Ground – CH Wire) 6. Voltage Regulator and Brush Assembly 3. S Terminal (Regulator Sense – 2A Wire) 7. W Terminal (AC Output) 4. L Terminal (Regulator Excite – D+ Wire) Figure 18: Thermo King 65 Amp Alternator Terminal and Component Locations 42 Electrical Maintenance 120 Amp Dual Output Alternator TriPac optional charging system • Thermo King Alternators are painted black. • Uses an orange dual output 14.5 Vdc voltage regulator that is not compatible with 65 amp single output alternators. • The Field (FLD) terminal will be connected to the Load Control harness. Will not charge without this connection. • Alternator Capacity must be set to 120 Amps through TK Monitor, Unit Setup screen. • Option will include an Ambient Temperature Sensor (ATS). NOTE: 120 Amp Dual Output Alternator cannot be used to replace a 65 Amp Single Output alternator. NOTE: The alternators used on TriPac EVOLUTION units have counterclockwise (CCW) fans and 2.25" pulleys. When replacing an alternator, make sure to use the correct fan and pulley. NOTE: Alternators with orange voltage regulators should never be used on any Thermo King Truck/Trailer application. 1 2 3 4 5 7 6 1. B+ Terminal (Positive Output – RED, 2, and 2A Wires) 5. FLD (Field) Terminal on 120 Amp Alternator (Must be connected to Load Control harness) 2. B- Terminal (Negative Ground – CH Wire) 6. Voltage Regulator and Brush Assembly 3. S Terminal (Regulator Sense – 2A Wire) 7. W Terminal (AC Output) 4. L Terminal (Regulator Excite – D+ Wire) Figure 19: Optional Thermo King 120 Amp Dual Output Alternator Terminal and Component Locations 43 Electrical Maintenance Alternator Diagnosis Always use accurate test equipment such as the Fluke 179 Digital Multi-Meter and the Fluke Clamp-On Ammeter accessory when checking alternator circuit voltage and amperage. See the table below for Thermo King Service Part numbers. Be sure voltages are measured from the designated terminal to the alternator chassis ground. All voltages are DC voltages unless otherwise noted. Meter Service Part Number Fluke 179 Digital Multi-Meter 204-1079 Clamp-On Ammeter for above Meter 204-947 4. Use TK Monitor, Alarms screen to determine the specific alarm code. Follow the diagnostic procedures for that alarm. Refer to TriPac EVOLUTION Diagnostic Manual TK 55739 Section 5, Diagnostics, Alarm Codes descriptions. Does Not Start for Low Battery Voltage 1. Turn system on at the HMI. 2. Connect to unit with TK Monitor. See TriPac EVOLUTION Diagnostic Manual TK 55739 Section 6, A51A, Communication Using TK Monitor. 3. Go to Programmable Setup screen. Record Battery Voltage Restart Value (default 12.1 volts). Diagnostic Procedure – Truck Batteries Low/Dead 4. Go to System Monitoring screen. Record Sense Voltage. Symptoms 5. Compare Sense Voltage to Battery Voltage Restart Value. • System shutdown alarm in the ALT alarm group. • APU does not automatically start for low battery voltage to maintain battery charge. • APU starts but truck batteries are still low/dead. • Sense Voltage is above the Restart Value. Reduce battery voltage to Reset Value by increasing power drain on batteries. Retest operation. • Sense Voltage is within 0.2 volts of Restart Value and APU engine started. Controller is responding to voltage input. Go to Diagnostic Procedure - Under Charging. • Sense Voltage is below the Restart Value by less than 0.2 volts. APU engine did not start. Raise Reset Value 0.2 volts. Go to next step. • Sense Voltage is below the Restart Value by more than 0.3 volts. Controller is not responding to voltage input. Replace interface board. System Shutdown Alarm 1. Turn system on at the HMI. 2. HMI displays a RED Alarm Icon and the ALT alarm group. • Yes = The system has experienced an alarm condition dealing with system voltage or alternator output. Go to next step. • No = Continue with appropriate Diagnostic based on symptoms. 3. Connect unit to TK Monitor. See TriPac EVOLUTION Diagnostic Manual TK 55739 Section 6, A51A, Communication Using TK Monitor. 44 6. Engine started after Restart Value adjustment. • Yes = Controller is responding to voltage input. Recheck system operation. • No = Controller is not responding to voltage input. Replace interface board. Electrical Maintenance APU Starts but Batteries Low/Dead Inspection Complete the following diagnostic procedures before replacing an alternator or voltage regulator. When testing an alternator, use accurate equipment such as a Thermo King P/N 204-1079 digital multi-meter and a Thermo King P/N 204-947 amp clamp or an equivalent. 1. Measure and record truck battery voltage. The truck batteries must be charged to 12.5 Vdc and in good condition, the battery cable connections must be clean and tight. NOTE: If the batteries are questionable, a known good jumper battery should be substituted during alternator testing. 2. Verify the drive belt and pulleys of the charging system are in good condition and are adjusted properly before testing the alternator. Worn belts, loose belts and worn pulleys will lower the output of the alternator. Make sure the alternator pulley nut is tight. It should be torqued to 50 ft-lb (68 N•m). 3. Determine if the alternator is 65 Amp Single Output or 120 Amp Dual Output. 4. Verify the Red (B+), 2A (sense), D+ (excite) and CH circuits are connected properly. All charging circuit connections must be clean and secure. 4. Go to Service Test screen and select Alternator Output Test. The APU engine will start. A/C will be off. 5. Go to the System Monitoring screen. 6. Record System Voltage reading. • Voltage above battery voltage recorded in Inspection step 1 and rising toward 14.5 Vdc. Go to next step. • Voltage below battery voltage recorded in Inspection step 1. Alternator is not charging enough to overcome system operating load. Go to Diagnostic Procedure - Alternator Check. 7. With a meter measure voltage at truck battery post. Compare to System Voltage. • Less than 1 volt difference. Go to next step. • More than 1 volt difference. Only partial voltage reaching batteries. High resistance in cables or connections. Locate and repair. 8. Note Charge Current reading in TK Monitor. • Charge Current reading started high (16 amps or more) and slowly falls as batteries charge. Go to next step. • Charge Current reading stays high (16 amps or more) and does not fall. NOTE: Optional 120 Amp Dual Output alternators also have a FLD (field) terminal that must be connected to a Load Control harness. • Testing 1. Turn TriPac system on at the HMI. Do not select a mode. System should be in Monitor Mode. 2. Connect unit to TK Monitor. See TriPac EVOLUTION Diagnostic Manual TK 55739 Section 6, A51A, Communication Using TK Monitor. 3. Go to Unit Setup screen. Verify Alternator Capacity is correctly set for the installed charging system. • Individually test truck batteries. • Connect APU to one known good battery and retest. Charge Current reading stays low (less than 16 amps). Go to Alternator Check. 9. Cancel Alternator Output Test on the Service Test screen. Select Fan or Heat mode at HMI. 10. Go to Programmable Setup screen. Note the Charge Current Shutoff Value (Default 20 Amps). 11. Allow APU to run. Periodically monitor Charge Current, • Continues to fall. APU stops when Charge Current Shutoff Value is reached. No fault found. 45 Electrical Maintenance • Continues to fall. APU does not stop when Charge Current Shutoff Value is reached. Replace interface board. • Stops falling, does not reach Charge Current Shutoff Value. • Individually test truck batteries. • Connect APU to one known good battery and retest. 4. Verify the RED, 2A (sense), D+ (excitation) and CH circuits are connected properly. All charging circuit connections must be clean and secure. NOTE: Optional 120 Amp Dual Output alternators also have a FLD (field) terminal that must be connected to a Load Control harness. Testing Diagnostic Procedure – Under Charging Complete the following diagnostic procedures before replacing an alternator or voltage regulator. When testing an alternator, use accurate equipment such as a Thermo King P/N 204-1079 digital multi-meter and a Thermo King P/N 204-947 amp clamp or an equivalent. Symptoms 1. Turn system on at the HMI. 2. Select low fan or heat mode. 3. Connect to unit with TK Monitor. See TriPac EVOLUTION Diagnostic Manual TK 55739 Section 6, A51A, Communication Using TK Monitor. 4. Go to Programmable Setup screen. Record Battery Voltage Restart Value (default 12.1 volts). • APU starts but does not shut down. • Truck must be jump started after APU done charging. 5. Go to Programmable Setup screen. Record Charge Current Shutoff Value (default 16 amps) • APU starts, runs briefly then shuts down. Repeats every few minutes. 6. Go to System Monitoring screen. Record Sense Voltage. APU Does Not Shut Down 7. Compare Sense Voltage to Battery Voltage Restart Value. Inspection • 1. Measure and record truck battery voltage. The truck batteries must be charged to 12.5 Vdc and in good condition, the battery cable connections must be clean and tight. NOTE: If the batteries are questionable, a known good jumper battery should be substituted during alternator testing. Sense Voltage is above the Restart Value. Reduce battery voltage to Reset Value by increasing power drain from truck on batteries. • Sense Voltage is below the Restart Value, engine should start 2. Verify the drive belt and pulleys of the charging system are in good condition and are adjusted properly before testing the alternator. Worn belts, loose belts and worn pulleys will lower the output of the alternator. Make sure the alternator pulley nut is tight. It should be torqued to 50 ft-lb (68 N•m). 3. Determine if the alternator is 65 Amp Single Output or 120 Amp Dual Output. 46 8. After engine starts, go to System Monitoring screen. Monitor Charge Current. • Charge Current begins high (above 16 amps) then gradually decreases to Charge Current Shutoff Value. Engine then shuts down. Normal, review symptoms. • Charge Current begins high (above 16 amps) then gradually decreases but does not achieve Charge Current Shutoff Value. • Alternator charge capacity low. Go to Diagnostic Procedure - Alternator Check. Electrical Maintenance • Current draw through auxiliary truck systems is high. Turn off lights, disconnect inverter load then retest. • No = Check all battery and starter connections. APU Engine Short Cycles APU Runs Until Charge Current Shutoff Value Is Reached, Truck Must Be Jump Started 1. Turn system on at the HMI. 2. Select low fan or heat mode. 3. Connect to unit with TK Monitor. See TriPac EVOLUTION Diagnostic Manual TK 55739 Section 6, A51A, Communication Using TK Monitor. 1. Turn system on at the HMI. 2. Select low fan or heat mode. 3. Connect to unit with TK Monitor. See TriPac EVOLUTION Diagnostic Manual TK 55739 Section 6, A51A, Communication Using TK Monitor. 4. Go to Programmable Setup screen. • Record Battery Voltage Restart Value (default 12.1 volts). • Record Charge Current Shutoff Value (default 16 amps) 4. Go to Programmable Setup screen. • Record Battery Voltage Restart Value (default 12.1 volts). • Record Charge Current Shutoff Value (default 16 amps) 5. Go to System Monitoring screen. Record Sense Voltage. 6. Compare Sense Voltage to Battery Voltage Restart Value. • • Sense Voltage is above the Restart Value. Reduce battery voltage to Reset Value by increasing power drain from truck on batteries. Sense Voltage is below the Restart Value, engine should start 5. Go to System Monitoring screen. Record Sense Voltage. 6. Compare Sense Voltage to Battery Voltage Restart Value. • Sense Voltage is above the Restart Value. Reduce battery voltage to Reset Value by increasing power drain from truck on batteries. • Sense Voltage is below the Restart Value, engine should start 7. After engine starts, monitor Charge Current. • Charge Current stays below Charge Current Shutoff Value. APU shuts down after short run time. Sense Voltage falls rapidly causing a restart. Go to Diagnostic Procedure - Alternator Check. • Charge Current begins high (above 16 amps) then rapidly decreases to Charge Current Shutoff Value. APU then shuts down. Sense Voltage falls rapidly causing a restart. One or more batteries defective and will not hold charge. Load test all batteries 7. After engine starts, monitor Charge Current. • • Charge Current begins high (above 16 amps) then gradually decreases to Charge Current Shutoff Value. APU then shuts down. Go to next step. Charge Current is low or does not fall. Go to Diagnostic Procedure - Alternator Check. 8. With a meter, monitor battery voltage during truck engine start attempt. Voltage drops 2 or more volts. • Yes = One or more batteries defective and will not hold charge. Load test all batteries. 47 Electrical Maintenance Diagnostic Procedure - Alternator Check Symptoms • Alternator does not charge batteries. • Alarm Code 25. Inspection 1. Determine if the HMI displays a RED Alarm Icon and the ALT alarm group. This indicates the system has experienced an alarm condition dealing with system voltage or alternator output. Use TK Monitor to determine the specific alarm code. Follow the diagnostic procedures for that alarm. Refer to the Alarm Codes descriptions in TriPac EVOLUTION Diagnostic Manual TK 55739 Section 5. If there are no alarms continue with Diagnostic Procedure. 2. Measure and record truck battery voltage. The truck batteries must be charged to 12.5 Vdc and in good condition, the battery cable connections must be clean and tight. NOTE: If the batteries are questionable, a known good jumper battery should be substituted during alternator testing. 3. Verify the drive belt and pulleys of the charging system are in good condition and are adjusted properly before testing the alternator. Worn belts, loose belts and worn pulleys will lower the output of the alternator. Make sure the alternator pulley nut is tight. It should be torqued to 50 ft-lb (68 N•m). 4. Determine if the alternator is 65 Amp Single Output or 120 Amp Dual Output. 5. Verify the RED, 2A (sense), D+ (excitation) and CH circuits are connected properly. All charging circuit connections must be clean and secure. NOTE: Optional 120 Amp Dual Output alternators also have a FLD (field) terminal that must be connected to a Load Control harness. 48 Testing - Not Running NOTE: Do not perform these tests with a battery charger connected to the battery. NOTE: All voltage readings should be taken between the chassis ground on the alternator and the terminals indicated, unless stated otherwise. 1. Verify the unit is off at the TriPac HMI. LEDs should all be off. 2. Check and record the voltage at the truck batteries with the TriPac unit and truck turned off. 3. Check and record the voltage at the B+ terminal on the alternator. Battery voltage recorded in step 2 must be present. If not, check the RED circuit for an open. Repair and retest. 4. Disconnect the alternator harness plug from the voltage regulator by carefully pushing on the spring clip to release the plug lock. 5. Check the voltage at the sense circuit (2A) plug terminal. • Battery voltage from step 2 = Normal. Go to next step. • 0 Vdc = Check the sense circuit (2A) to the fuse holder in the truck battery box for an open. Repair and retest. 6. Turn the unit on at the HMI. LED display should be on (lighted). Create an engine start demand. Run relay energized (fuel pump on). 7. Check the voltage at the excitation circuit (D+) plug terminal. It may be helpful to use a remote HMI or a helper so test readings can be taken before the engine cranks. • 10 Vdc or more = Normal. Go to next step. • 0 Vdc = Check the voltage at the D+ connection on the interface board. • Battery voltage is available at D+ board connection = Open in the D+ circuit to alternator. Repair and retest. • Voltage is 0 at D+ board connection = D+ circuit may be shorted to chassis ground. Remove J14 plug from board Electrical Maintenance and retest voltage at D+ board terminal. If D+ rises to 10 Vdc or more the wire is grounded. If voltage remains low the board is defective. 14. Check and record the low load alternator output voltage at the B+ terminal. May use TK Monitor, System Monitoring, Sense Voltage for this reading. 8. Turn the unit off at the HMI and reconnect the alternator harness plug. 15. Increase the charging system load as much as possible by turning on the truck head lights and other auxiliary loads. Testing - Running 9. Connect a digital multi-meter set to read DC Volts between the B+ terminal at the alternator and chassis ground. 10. Attach a clamp-on ammeter around the RED wire between the alternator and the starter. This will read alternator output to the truck batteries. 16. Check and record high load alternator output voltage at the B+ terminal. May use TK Monitor, System Monitoring, Sense Voltage for this reading. 17. Compare the low load voltage, recorded in step 14, to the high load voltage recorded in step 16. • Output voltage decreases less than 0.5 Vdc or increase up to 1.0 Vdc = Normal, go to next step. • Output voltage decreases more than 0.5 Vdc = The alternator is defective if there are no problems in the wiring. Recheck the wiring before replacing the alternator. NOTE: The Current Sensor reading in TK Monitor will provide the same information. 11. Turn the unit on and allow it to start. NOTE: Units with 120 amp alternator should use Service Test mode Alternator Output Test to assure alternator is allowed to charge at maximum. 12. Decrease the charging system load by selecting Fan Mode Low Speed at the HMI. Turn off all auxiliary loads in the truck. 18. Compare to the running voltage at the B+ terminal recorded in step 16 to the voltage recorded during Testing - Not Running step 3. • Running voltage is higher = Alternator is charging and adding voltage to the system. The voltage should increase until it reaches the anticipated voltage regulator setting of about 14.5 Vdc. Go to next step. • Running voltage is the same or lower = Alternator is not charging. Recheck the wiring before replacing the alternator. 13. Check and record the current flow in the RED wire. May use TK Monitor, System Monitoring, Charge Current for this reading. • • A positive reading indicates the alternator is charging and current is flowing to the batteries. On unit startup, the current flow should momentarily increase above 16 amps to allow for battery current used during preheat and cranking. The current should fall as the batteries charge. Go to next step. A zero or negative reading indicates the alternator is not charging or is not charging enough to support TriPac system demand. The alternator is defective if there are no problems in the wiring. Recheck the wiring before assuming the alternator is defective. 19. Check the voltage at the positive battery post. Compare to the voltage reading at the B+ terminal recorded in step 16. • Less than 1.0 volt difference = Cable and connections are good. No problem found. • Greater than 1.0 volt difference = Cable and connections are complete but have high resistance. Prevents full charging current from reaching batteries. Locate resistance and repair then retest. 20. Exit Service Test Mode. 49 Electrical Maintenance Load Control Circuit To Battery Positive Some TriPac units will have an optional 120 amp charging system. Current 120 amp alternators have a special dual output voltage regulator that is not interchangeable with the standard 65 amp Thermo King alternator. It requires some additional external circuitry to function. During charging system diagnosis use TK Monitor, Service Test mode, Alternator Output Test to bypass the load control system To F16/50A To Starter To Truck Negative ALT To F30/3A 2A 2 B+ CH SEN S GND FL FLD L J14 SEN A1 D+ B1 F18-3A D+ FLD Load Control Harness FLD1 LSR_LO J6 The Load Control harness is connected to the 120 amp alternator FLD (field) terminal near the plug connection. It is used to reduce maximum alternator output and engine load under some conditions. The harness runs toward the TriPac Main Controller. It splits into three circuits (FLD1, FLD2 and FLD3) before connecting to the interface board. One or two circuits may be active at any time. NOTE: The Load Control Harness should never be connected to the F2 terminal of a 65 amp single output alternator. Alternator failure will result. FLD1 circuit connects directly to the interface board (J6-A3). When active the circuit provides an un-resisted ground path for the alternator field. The alternator can charge at full output. FLD2 circuit connects through a 2 Ohm resistor to the interface board (J6-B3). When active the circuit provides a resisted ground path for the alternator field. This reduces field voltage, limits maximum alternator output and reduces engine load. FLD3 circuit connects through a 4 Ohm resistor to the interface board (J6-A4). When active the circuit provides a resisted ground path for the alternator field. This reduces field voltage, limits maximum alternator output and reduces engine load. 50 LSR_HI FLD A3 FLD FLD2 B3 FLD2 FLD3 A4 FLD3 ARA2125 Figure 20: Load Control Circuit Schematic Diagnostics The dual output alternator will generally use the same diagnostic method as a single output alternator with the following additions. Alternator does not charge: • Load Control harness is disconnected from the FLD terminal on the alternator. Reconnect and retest. • Load Control harness circuit is open between alternator and interface board. Find and fix open. • Load Control terminals at interface board are inactive. Replace defective interface board. Alternator always charges at full output: • Load Control harness circuit between alternator FLD terminal and Main Controller interface board (J6-A3) is shorted to ground before the resistors. • Main Controller interface board is defective. Alternator always charges at reduced output: • FLD2 or FLD3 circuit is shorted to ground between resistor and interface board connection (J6-B3, J6-B3 A4). • Interface board is defective. Electrical Maintenance Additional Alternator Tests Alternator Diode Quick Check This check confirms proper rectifier diode function. Defective rectifier diodes will reduce alternator charging capacity. 4. Note the ammeter reading. The ammeter reading indicates the field current, which should be 2.0 to 5.0 amps at 12 volts. • No field current or a low field current indicates an open circuit or excessive resistance in the field circuit. Remove the voltage regulator and brush assembly and inspect the slip rings. If the slips rings are acceptable, install a new voltage regulator and brush assembly and repeat the test. If the brushes are not the problem, replace the alternator. • High field current indicates a short in the field circuit. Replace the rotor or the alternator. 1. Connect a digital multi-meter set to read AC Volts between the B+ terminal at the alternator and chassis ground. 2. Turn the unit on and allow it to start. 3. Check and record the alternator output voltage at the B+ terminal. There should be no more than 1.0 Vac present. A reading of more than 1.0 Vac indicates damaged alternator diodes. 4. Turn the unit off. 5. Replace defective alternator. Field Current Test Use this test to determine if the alternator can be repaired. Perform this test with the unit turned off. NOTE: This test must not be performed on the 120 amp dual output Thermo King alternator used with optional 120 Amp Alternator Package. There are no available connections on the alternator that will provide a valid test result. The FLD terminal does not replace the F2 terminal found on the 65 amp alternator. Alternator Load Test Thermo King no longer recommends a full field test for determining the alternator current output. Full fielding an alternator can cause increases in alternator output voltage that may damage internal alternator or unit components. This damage may not be readily apparent. To test the alternator under load, Thermo King recommends the use of a clamp-on ammeter to monitor output current, both on initial startup and under full unit load conditions. For example, the APU should be turned on and operating in the A/C Mode. 1. Verify the unit is off. 2. Attach a clamp-on ammeter to the 2A wire near the B+ terminal on the alternator. 3. Energize the field: • On the 65 amp Thermo King alternator, connect a jumper wire between the F2 terminal and the B+ terminal. Do not connect the F2 terminal to ground or the alternator will be damaged. 51 Electrical Maintenance Harness Fuses Controller Power (F16, 50 amp) Main Power (F29, 200 amp) The Main Power fuse holder is installed in the truck battery box. This 200 amp fuse is in the main power cable from the truck batteries to the TriPac APU starter and alternator. It protects the system if the main power cable is accidentally shorted to chassis ground as it passes through the truck frame and APU. If this fuse is open the TriPac system will have no power to the APU. Inspect the Main Power cable for wear at any point it is in contact with the truck frame or APU housing. Alternator Sense (F30, 3 amp) The 50 amp Controller Power fuse is located inside the APU above the air cleaner. It is in the #2 circuit between the alternator output terminal and interface board 2 terminal (J15) in the control box. It protects the system if the #2 wire is accidentally shorted to chassis ground as it passes through the APU, truck frame and truck cab. If this fuse is open there will be no power to the TriPac control system. However, there will be battery voltage available to the starter and alternator terminals. Inspect the #2 wire for wear at any point it is in contact with the truck cab, truck frame or APU housing. 1 The Alternator Sense fuse holder is installed in the truck battery box. This 3 amp fuse is in the 2A wire from the truck batteries to the Sense terminal on the alternator. It protects the 2A circuit from a short to chassis ground or from a faulty alternator. If this fuse is open, the alternator will not charge properly. Inspect the 2A wire and check the alternator. 1 2 1. Controller Power (F16) Figure 22: Controller Power (F16) Location Glow Plugs Glow plugs heat the combustion chamber to aid in quick starting. The glow plugs are energized when the TriPac system is on and the TriPac controller senses that a startup is required. After the glow plugs preheat, the TriPac engine will be started. If the engine is hot, preheat time will only be a few seconds. 1. Alternator Sense Fuse (F30) 2. Main Power Fuse (F29) Figure 21: Main Power Fuse (F29) and Alternator Sense Fuse (F30) Locations 52 An open glow plug (burned out) can be detected with an ammeter in the H circuit. The ammeter should show 7.0 to 8.5 amps during preheat. A current draw of 7.0 to 8.5 amps means the glow plugs are working. If the current draw drops below 7 amps during preheat, at least one glow plug is bad. Electrical Maintenance To isolate an open circuit glow plug, remove the H wires and test each glow plug individually with an ohmmeter or a jumper wire and ammeter. Each glow plug should have a resistance of 2.3 ohms or a current draw of about 4.3 amps. A shorted glow plug will be indicated by the ammeter showing a very high current draw when the TriPac is preheating. Check each glow plug. A shorted glow plug will have very low resistance. Oil Pressure Switch (OPS) The engine oil pressure should rise immediately after the engine is started. The OPS will close if the oil pressure drops below 15 ± 2 psig (103 ± 14 kPa). This will cause the controller to stop the engine and display the Alarm Icon and the ENG Icon on the HMI. A continuity tester is needed to check the OPS. 1. Remove the LOPS wire from the OPS. 2. The continuity tester should indicate a complete circuit between the terminal and chassis ground. 3. Start the engine. The tester should show an open circuit between the terminal and chassis ground. The OPS is not repairable. It must be replaced if it does not function properly. 53 Electrical Maintenance Condenser and Pre-cooler Axial Fan Motors NOTE: A non-repairable plastic fan motor assembly is used. If this motor malfunctions, it must be replaced. CAUTION: Take precautions to ensure the unit will not accidentally start while servicing the system. The condenser fan and pre-cooler axial fan motors are maintenance free. If erratic or intermittent operation is observed, the current draw of the motor should be measured while proper voltage is applied. The current draw for the motor is: • Condenser fan motor: 11.8 to 12.4 amps ± 10% with 12.5 volts • Pre-cooler fan motor: 6.5 to 6.6 amps ± 10% with 12.5 volts Axial Fan Motor Removal and Installation Removal 1. Turn the TriPac unit off. 2. Disconnect the motor power plug. NOTE: Motor is attached to orifice access panel frame. 3. Remove fan motor mounting bolts (4) from the orifice access panel. 4. Remove axial fan motor from unit. Installation 1. Attach the axial fan motor to orifice panel. Securely tighten fan motor mounting bolts (4). 2. Connect the motor power plug. 3. Start the TriPac and verify correct motor operation. 4. If the unit is operating properly, return the TriPac to service. CAUTION: Fans are polarity sensitive. If not properly connected, the fan may run backwards. 54 1 2 1. Mounting Holes (4) 2. Power Plug Figure 23: Axial Fan Motor Electrical Maintenance Evaporator Blower Motor CAUTION: Take precautions to ensure the unit will not accidentally start. while you are servicing the system. The evaporator blower motor is maintenance free. If erratic or intermittent operation is observed, the current draw of the motor should be measured. The current draw for the motor is approximately 16.5 amps at 12.5 volts, with a rating tolerance of ± 10%. Evaporator Blower Motor Removal and Installation Removal NOTE: The motor and housing are replaced as a unit. No repair is possible to the motor itself. 1. Turn the TriPac unit off. 3. Unscrew the screws attaching the motor housing to the evaporator frame and remove the blower housing from the unit. Installation 1. Position the motor assembly on the frame. 2. Align and replace the motor assembly mounting screws in the frame. Securely tighten all the mounting screws. 3. Connect the power plug to the motor. 4. Start the TriPac and verify correct motor operation. 5. If the unit is operating properly, return the TriPac to service. CAUTION: The blower motor is polarity sensitive. If not properly connected, the blower may run backwards. 2. Disconnect the power plug from the motor. 1 2 1. Blower 2. Mounting Screws (2) Figure 24: Evaporator Assembly (Cover Removed) 55 Electrical Maintenance Optional Arctic Package The optional Arctic Package consists of an additional temperature sensor called the Arctic Option Sensor (WT2). It is used to monitor the engine coolant temperature and enable TriPac engine starts as required to maintain the coolant and truck engine at a temperature that will ensure easy truck engine starts. The Arctic Option Sensor (WT2) is part of the Arctic Option Temperature Tube Assembly. The Temperature Tube Assembly is mounted in the coolant supply line going to the TriPac APU engine. When the Arctic Option is installed, the Arctic Option Sensor (WT2) replaces the Water Temperature Sensor 2 (WT2), which is located on the inlet to the pre-cooler coil inside the APU frame. The Water Temperature Sensor 2 (WT2) is also used to start and stop the Pre-cooler Fan. The Arctic Option Sensor (WT2) operates the same way as the Water Temperature Sensor 2 (WT2) mounted at the inlet to the pre-cooler coil. IMPORTANT: When the Temperature Tube Assembly is installed horizontally, the sensor must face down. On vertical installations the sensor must face towards the APU. NOTE: When the Arctic Option is installed, the Arctic Option Sensor (WT2) on the Arctic Option Temperature Tube Assembly should be used in place of the Water Temperature Sensor 2 (WT2) mounted on the inlet to the pre-cooler coil. The Water Temperature Sensor 2 (WT2) located on the pre-cooler sensor block should be disconnected but left in place. 1 2 3 4 1. Temperature Tube Assembly (Horizontal Installation) 3. Temperature Tube Assembly (Vertical Installation) 2. Sensor Faces Down when Horizontal 4. Sensor Faces APU when Vertical Figure 25: Typical Temperature Tube Assembly Installations 56 Electrical Maintenance Arctic Option Engine Start/Stop Operation The engine in the TriPac APU is used to preheat the truck engine by circulating coolant through the truck engine. The Arctic Option Sensor (WT2) is a temperature sensor used to start and stop the TriPac unit to maintain the coolant and truck engine at a temperature that will ensure easy truck engine starts. The controller monitors the temperature of the coolant returning from the truck engine with the Arctic Option Sensor (WT2). If the truck engine coolant temperature at the Arctic Option Sensor (WT2) falls below 35 F (1.6 C), the APU engine will start to warm the truck engine. It will continue to run until the truck engine coolant temperature rises to 55 F (12.7 C). The TriPac engine will then shut down if no other existing conditions require the engine to run. If other conditions such as a low truck battery or sleeper cab air conditioning loads require continued engine operation, then the TriPac engine will continue to run until those demands are satisfied. Diagnosing Engine Start/Stop Operation with Arctic Option 4. Open TK Monitor. On the DashBoard screen read “WT2 Coolant Temp”. Compare to reading from previous step. a. Less than 5 degrees difference = Sensor circuit is normal. Verify controller is correctly configured for Arctic option. Refer to Diagnostic Manual TK 55739 Section 3, Unit Setup. b. More than 5 degrees difference = Check WT2 sensor circuit. Refer to Diagnostic Manual TK 55739 Section 6, Procedure D01A, Unit Temperature Sensor Test. Engine Does Not Shut Down Driver complains the TriPac engine does not shut down or runs for extended periods. The TriPac APU engine will run to satisfy these conditions: • Air Conditioning, cab temperature is more than 3 degrees above setpoint. • Charge truck batteries or support power demand for driver comfort (Hotel Load). Alternator is charging the batteries at more than 20 amps. • Warm truck engine during cold weather. Returning coolant temperature is still below 55 F. Engine Does Not Start on Cold Temperatures Before beginning a control system diagnosis determine if any of the above conditions exist. Driver complains the TriPac APU engine does not start when ambient temperature is below 35 F (1.6 C). Perform the following checks. 1. Turn TriPac system on at the HMI. Turn all truck accessories off. Unplug all loads from power inverter. 1. Verify truck ignition is off. 2. Select Cool Mode on HMI. APU engine should start. 2. Is the alarm icon illuminated on the HMI? a. Yes = Open TK Monitor. On the Alarm screen note the alarm codes. Diagnose issue based on the alarm codes. Refer to Diagnostic Manual TK 55739, Section 5, Diagnostics - Alarm Codes. a. No = Go to next step. 3. With an external thermometer read and record the temperature at the Arctic Option Sensor (WT2). 3. Select Fan Mode on HMI to remove air conditioning demand. 4. Allow unit to run for 30 minutes. a. APU engine stopped before test run time expired = TriPac normal. Air conditioning or power demand is causing system to run. Reduce power demand and check A/C system. b. APU continues to run = Go to next step. 5. Connect PC computer. Open TK Monitor. 57 Electrical Maintenance 6. On the Dashboard screen note the following. 7. Check System Mode. engine. The PCF will continue to run until the returning truck engine coolant temperature falls to approximately 95 F (35.0 C). a. Reads Fan = Go to next step. b. Reads Cool = Recheck HMI set to Fan mode. Controller may not be responding to HMI. 8. Check Charge Current. a. Below 20 Amps = Go to next step. b. Still above 20 Amps = Go to Charging System Diagnosis. 9. Check WT2 Coolant Temp. a. Still below 55 F. i. Diagnose cause of low coolant temperature returning from truck engine. ii. Check WT2 for incorrect reading. See Diagnostic Manual TK 55739, Section 6, D01A Unit Temperature Sensor Test. b. Above 55 F. i. Verify system is not in Cool mode and that Charge Current is below the programmed Charge Current Shutoff Value. Check TK Monitor Programmable Settings screen. ii. Controller may not be responding to WT2. Replace Interface Board. Pre-Cooler Fan Start/Stop Operation The Pre-Cooler Fan (PCF) is used to reduce the temperature of hot coolant flowing to the TriPac engine. This prevents the TriPac engine from exceeding normal operating temperature and shutting down during high ambient temperatures or when the tractor coolant is very hot (such as when the tractor engine has just been shut down). The controller monitors the temperature of the coolant returning from the truck engine with the Water Temperature Sensor 2 (WT2) or the Arctic Option Sensor (WT2). If the truck engine coolant temperature at WT2 rises above approximately 115 F (46.1 C), the controller will energize the PCF to cool the coolant returning from the truck 58 Diagnosing Pre-Cooler Fan Start/Stop Operation with Arctic Option If the Pre-Cooler Fan does not run when required the TriPac unit may shut down and generate a code 18 in the [ENG] group. This typically will occur with high ambient temperatures or when the tractor coolant is very hot (such as when the tractor engine has just been shut down). NOTE: If the Arctic Option is not installed, the Water Temperature Sensor 2 (WT2) is located inside the APU on the pre-cooler coil. Pre-Cooler Fan Does Not Start If the Pre-Cooler Fan does not start when the coolant temperature is above approximately 115 F (46.1 C) perform the following checks. See the Wiring and Schematic Diagrams for additional details. 1. Is the alarm icon illuminated on the HMI? a. Yes = Open TK Monitor. On the Alarm screen note the alarm codes. Especially note alarm code 254, Inlet Water Temperature Sensor (WT2), which indicates a problem with WT2. Diagnose issue based on the alarm codes. Refer to Diagnostic Manual TK 55739, Section 5, Diagnostics - Alarm Codes. a. No = Go to next step. 2. With an external thermometer read and record the temperature at WT2 and verify that it is warm enough (above approximately 115 F [46.1 C]) to require the Pre-Cooler Fan to run. 3. Open TK Monitor. On the DashBoard screen read “WT2 Coolant Temp”. Compare to reading from previous step. a. More than 5 degrees difference = Check WT2 sensor circuit. Refer to Diagnostic Manual TK 55739 Section 6, Procedure D01A, Unit Temperature Sensor Test. Electrical Maintenance b. Less than 5 degrees difference = Sensor circuit is normal. Verify controller is correctly configured for Arctic option. Refer to Diagnostic Manual TK 55739, Section 3, Unit Setup. If it is, go to next step. 4. In TK Monitor. Go to the Service Test Mode screen and select “Fan Only Mode Test”. b. Less than 5 degrees difference = Sensor circuit is normal. Go to next step. 4. Check PCF circuit for short to a circuit with battery power that would cause the fan to run. 5. If the PCF circuit is not shorted to a circuit with battery power, the controller may not be responding to WT2. Replace Interface Board. a. If the Pre-Cooler Fan starts to run, the controller may not be responding to WT2. Replace Interface Board. b. If the Pre-Cooler Fan does not run, go to the next step. 5. Check Fuse F10 in the PCF circuit. 6. Check the Pre-Cooler Fan. 7. Check the Pre-Cooler Fan circuit for open wires. Pre-Cooler Fan Does Not Stop If the Pre-Cooler Fan does not stop perform the following checks. See the Wiring and Schematic Diagrams for additional details. 1. Is the alarm icon illuminated on the HMI? a. Yes = Open TK Monitor. On the Alarm screen note the alarm codes. Especially note alarm code 254, Inlet Water Temperature Sensor (WT2), which indicates a problem with WT2. Diagnose issue based on the alarm codes. Refer to Diagnostic Manual TK 55739, Section 5, Diagnostics - Alarm Codes. a. No = Go to next step. 2. With an external thermometer read and record the temperature at WT2 and verify that it is cool enough (below approximately 95 F [35.0 C] to cause the Pre-Cooler Fan to stop running. 3. Open TK Monitor. On the DashBoard screen read “WT2 Coolant Temp”. Compare to reading from previous step. a. More than 5 degrees difference = Check WT2

sensor circuit. Refer to Diagnostic Manual TK 55739 Section 6, Procedure D01A, Unit Temperature Sensor Test. 59 Engine Maintenance Maintenance Inspection Schedule Pre-Trip 500 Hrs Annual 2,000 Hrs • • • Check engine oil level. • • • Check engine coolant level on units with optional closed loop cooling system. • • • Inspect belts for condition and proper tension. • • • Listen for unusual noises, vibrations, etc. • • Check air cleaner hose for damage. Check condition of or service the following: • • Inspect air cleaner. Change as needed or annually. • • Inspect fuel pre-filter screen. Clean as required or annually. • Change fuel filter. Thermo King brand filter is required. • Drain water from fuel tank and check vent. • • Check and adjust engine speed. • • Check condition of engine mounts. • Maintain year-round anti-freeze protection at –30° F (-34° C). Change coolant every two years, or with truck coolant. For units equipped with optional closed loop cooling system and ELC (red) engine coolant, change ELC coolant every 5 years or 12,000 hours. — Adjust engine valves (1000 hours). — Test fuel injection nozzles at least every 3,000 hours. * — Replace fuel return lines between fuel injection nozzles every 10,000 hours or sooner, as required. * Based on EPA 40 CFR Part 89. Engine Oil Change Intervals (Change oil and filters hot) Pre-Trip 500 Hrs Annual 2,000 Hrs Check condition of or service the following: 2,000 Hour 2,000 Hour Interval - Oil change interval is every 2,000 hours of operation Intervals only when using a Thermo King brand oil filter and CJ-4 or better oil. Units with optional DPF require CJ-4 or better oil. 500 Hour Intervals 500 Hour Interval - Oil change interval is every 500 hours of operation when using any other brand oil filter and CI-4 or better oil. Units with optional DPF require CJ-4 or better oil. IMPORTANT: The fill port on top of the engine should not be used to add engine oil. To prevent engine lock-up and/or serious internal damage after TriPac engine oil is added or changed always add oil through the lower port on the timing gear cover. CAUTION: Use fuel suitable for the climate you operate in (see truck engine manufacturer's recommendations). Blending used engine oil with diesel fuel is not permitted in the TriPac system. It will plug the filters and will not allow the air heater to run properly. Thermo King reserves the right to void all warranty on the unit. 60 Engine Maintenance Engine Lubrication System The TriPac diesel engine has a pressure lubrication system. Oil is circulated by a trochoid type oil pump driven by the crankshaft timing gear and has several times the capacity required by the engine. Oil is picked up through a suction tube with a screened inlet. Oil to the rocker arm shaft flows through a tube on the outside of the engine and into the head through a restrictor fitting. Oil pressure is affected by oil temperature, viscosity and engine speed. Subnormal oil pressures usually may be traced to lack of oil, faulty relief valve or worn bearings. The use of improper viscosity oil will also produce low oil pressure shutdowns. 2. Remove the dipstick (Item 2 in Figure 26) and wipe with a clean cloth. 3. Fully reinsert the dipstick. 4. Remove the dipstick. The oil level should be between the upper and lower level lines (Items 3 and 4 in Figure 26) on the dipstick. It takes approximately 1.5 quarts (1.4 liters) to move the oil level from the lower line to the upper line. 5. Fully reinsert the dipstick. Do NOT Add Oil Here Add Oil Here Engine Oil Change The engine oil should be changed according to the "Maintenance Inspection Schedule." Drain the oil only when the engine is hot to ensure that all the oil drains out. When changing oil, try to make sure that the unit is not tipped away from the direction that the oil is supposed to flow out of the oil pan. It is important to drain as much of the residual oil as possible because most of the dirt particles are in the last few quarts of oil that are drained from the oil pan. Refill the oil pan (refer to the "Specifications" chapter) and check the oil level. 1 2 CAUTION: The fill port on top of the engine should not be used to add engine oil. To prevent engine lock-up and/or serious internal damage after TriPac engine oil is added or changed always add oil through the lower port on the timing gear cover. NOTE: Starting in the first quarter of 2014 the fill port on top of the engine was removed. Run the unit, and then recheck the oil level. Add oil as necessary to reach the full mark on the dipstick. See the Specifications page for the correct type of oil. Checking Engine Oil Level 1. Make sure the engine is level. 3 4 1. Spin-on Oil Filter 3. Upper Oil Level Line 2. Dipstick 4. Lower Oil Level Line Figure 26: Oil Fill, Oil Filter, and Dipstick Locations Adding Engine Oil 1. Make sure the engine is level. 2. Remove the cap from the lower oil port (Figure 26). 3. Add oil through the lower oil port. Do not add oil through fill port on top of the engine. 61 Engine Maintenance 4. Wait three minutes and check the oil level. 5. Add more oil if necessary. 6. Reinstall the lower oil cap and hand tighten. Over-tightening may damage the cap. Oil Filter Change The oil filter should be changed along with the engine oil. At a minimum of once per year, inspect for small animal/insect nests to ensure full filter element integrity. (Replace filter if there is any evidence of animal ingress.) Clean by blowing clean, dry compressed air from inside filter element. Replace air cleaner element as needed or at least every 2,000 hours or 1 year of normal use (whichever occurs first). TriPac EVOLUTION Total Engine Hours may be read on the Dashboard screen of TK Monitor. Spin-on Filter: 1. Remove the filter. Engine Cooling System 2. Apply oil to rubber ring of new filter and install filter. The engine employs a closed, circulating type, pressurized cooling system. Correct engine temperatures are controlled and maintained by the truck engine cooling system, TriPac pre-cooler, and TriPac engine thermostat. The coolant is circulated through the TriPac engine by a belt-driven centrifugal pump. The pump draws coolant from the truck engine, through the pre-cooler, circulates it through the TriPac engine cylinder block and head, and then sends it back to the truck engine block through a coolant hose. A thermostat is mounted in the water outlet from the TriPac engine cylinder head to the truck engine. 3. Tighten the filter until the rubber ring makes contact, then tighten 1/2 turn more. Crankcase Breather The crankcase breather system ducts crankcase gases formed in the crankcase directly to the intake. Harmful vapors that would otherwise collect in the crankcase and contaminate the oil or escape to the outside, are now drawn back into the engine and burned. The breather should be inspected yearly to make sure it is not plugged. Engine Air Cleaner The air cleaner uses a dry element. The air cleaner filters all of the air entering the engine. Excessive restriction of the air intake system affects horsepower, fuel consumption and engine life. Inspect the element at every oil change. 2 The pre-cooler fan will turn on if the coolant entry temperature exceeds 115 F (46 C) and will turn off when the coolant entry temperature falls below 95 F (35 C). Optional Closed Loop Cooling System An optional closed loop cooling system is available (see Figure 29 on page 64). It is similar to the standard cooling system but has the following differences: • It is not connected to the truck cooling system, it is self-contained. • The pre-cooler functions as the radiator for TriPac engine. • It has a coolant expansion tank mounted above the pre-cooler. 1 3 1. Output Connection to Engine Intake 2. Dry Filter Element 3. Intake Hose Connection Figure 27: Air Cleaner 62 The coolant expansion tank has a window that is used to check the coolant level. The coolant level is OK if coolant is visible in the window when the truck is on a level surface. If coolant is not visible Engine Maintenance in the window, the coolant level is low and coolant should be added until it is visible in the window. 5 6 4 3 7 2 1 8 9 12 11 1. Water Pump 2. Bleed Valve 3. 10 8. Water Temperature Sensor for Pre-Cooler Fan. Not Used with Arctic Option Thermostat 9. Pre-Cooler Fan Cover 4. Thermostat Cover 10. Pre-Cooler Fan 5. Temperature Tube Assembly - Arctic Option 11. Pre-Cooler Frame 6. Ball Valve, Coolant Hose (Outlet, back to truck engine) 12. Pre-Cooler Coil 7. Ball Valve, Coolant Return Hose (Inlet, coolant from truck engine) Figure 28: Engine Cooling System Components 63 Engine Maintenance 4 6 3 2 5 1 7 8 9 12 11 10 1. Water Pump 7. Coolant Expansion Tank 2. Bleed Valve 8. Coolant Manifold 3. Thermostat 9. Pre-Cooler Fan Cover 4. Thermostat Cover 10. Pre-Cooler Fan 5. Water Temperature Sensor (WT2) not used with Closed Loop Cooling. 11. Pre-Cooler Frame 6. Expansion Tank Cap 12. Pre-Cooler Coil Figure 29: Engine Cooling System Components, Optional Closed Loop Cooling System 64 Engine Maintenance Antifreeze Maintenance Procedures As with all equipment containing antifreeze, periodic inspection on a regular basis is required to verify the condition of the antifreeze. Inhibitors become worn out and must be replaced by changing the antifreeze. The standard TriPac shares coolant with the truck engine. The APU is equipped with inlet and outlet coolant fittings. Coolant from the APU is routed to the truck engine where it is circulated through the engine block and returned back to the APU's pre-cooler. TriPac Engine Coolant Maintenance Checks • Inspect all the hoses for deterioration and hose clamp tightness. Replace if necessary. • Loosen the water pump belt. Check the water pump bearing for looseness. Engine Thermostat For best TriPac engine operation, use a 160 F (71 C) thermostat in the TriPac engine year round. A coolant hose is routed from the outlet fitting of the APU to the inlet side of the water pump located on the truck's engine. Another coolant hose is routed from the truck's heater outlet to the APU's pre-cooler inlet. 1 2 APU coolant hoses allow shutoff valves to isolate the APU cooling system from the truck's cooling system. 3 Engine coolant checks and maintenance should follow the truck engine manufacturer's recommendations. (See Caution statement below.) CAUTION: Avoid direct contact with hot coolant. CAUTION: Do not remove the radiator cap while the engine is hot. CAUTION: Do not mix engine coolant types. The original TriPac installation was adapted to the coolant used in the truck engine at the time of installation. Before coolant is added or replaced, make certain that the coolant type and specifications are correct. 1. Thermostat Housing 2. Thermostat 3. Water Pump Figure 30: Water Pump Assembly and Thermostat NOTE: The optional closed loop cooling system does not share coolant with the truck engine, it is self-contained. Thermo King recommends using ELC engine coolant in the closed loop cooling system. 65 Engine Maintenance Bleeding the Standard Cooling System 5. When a steady stream of coolant flows from the bleed line, close the bleed petcock. Often when a TriPac unit cooling system is refilled, air is trapped in the engine block and/or under the thermostat. Use the following procedure to bleed air out of the block and the cooling system: 6. Open the TriPac OUTLET hand valve. NOTE: If an engine runs with air trapped in the block, the engine may be damaged. The high water temperature switch may not protect an engine that has air trapped in the block, because the high water temperature switch is designed to protect an engine from overheating due to failures in the cooling system and the loss of coolant. CAUTION: Do not start the engine without bleeding the air out of the block. 1. Verify the TriPac OUTLET hand valve is CLOSED (tractor inlet, next to water pump). If this valve is left open, coolant will be sitting on top of the TriPac thermostat and not allow the TriPac engine to bleed air. 2. Open the TriPac INLET hand valve. 3. Place a clean container under the TriPac bleed line to catch coolant that is drained. 4. Open bleed petcock on the TriPac engine to allow air to bleed out. 1 2 1. Water Pump Bleeder Bolt 2. Bleed Petcock Figure 31: Water Pump Bleeder Bolt and Bleed Petcock Locations 66 7. Replace drained coolant from the TriPac back into the truck's radiator. 8. Start the TriPac engine and use a non-contact thermometer pointed at the water pump bleeder bolt to monitor the coolant temperature. The water pump bleeder bolt located next to the bleed petcock on the water pump (see Figure 31). CAUTION: Do not start the TriPac engine before a partial refrigerant charge has been added or damage to the A/C compressor will result. 9. When the temperature reaches 150 F (66 C), shut off the engine for 2 minutes to allow the thermostat to heat soak and open completely to purge air out of block, head, and water pump. 10. After 2 minutes, re-start the engine. The remaining air in the system will be forced to the truck radiator and the TriPac APU should now be bled of all air. Engine Maintenance Bleeding the Optional Closed Loop Cooling System Often when a TriPac unit cooling system is refilled, air is trapped in the engine block and/or under the thermostat. Use the following procedure to bleed air out of the block and the cooling system: NOTE: If an engine runs with air trapped in the block, the engine may be damaged. The high water temperature switch may not protect an engine that has air trapped in the block, because the high water temperature switch is designed to protect an engine from overheating due to failures in the cooling system and the loss of coolant. CAUTION: Do not start the engine without bleeding the air out of the block. 1. Place a clean container under the TriPac bleed line to catch the coolant that is drained. 2. Open bleed petcock on the TriPac engine to allow air to bleed out. 1 2 3. Slowly pour coolant into the expansion tank until a steady stream of coolant flows from the bleed line, then close the bleed petcock. 4. Slowly pour coolant to the expansion tank until the coolant level is at the top of the window in the expansion tank. 5. Install the expansion tank cap. 6. Start the TriPac engine and use a non-contact thermometer pointed at the water pump bleeder bolt to monitor the coolant temperature. The water pump bleeder bolt located next to the bleed petcock on the water pump (see Figure 32). CAUTION: Do not start the TriPac engine before a partial refrigerant charge has been added or damage to the A/C compressor will result. 7. When the temperature reaches 150 F (66 C), shut off the engine for 2 minutes to allow the thermostat to heat soak and open completely to purge air out of block, head, and water pump. 8. Slowly remove the expansion tank cap and slowly pour coolant to the expansion tank until the coolant level is at the top of the window in the expansion tank, then reinstall the expansion tank cap. 9. After 2 minutes, re-start the engine. 10. Repeat steps 7 through 9 until the coolant level stabilizes. The TriPac APU cooling system should now be bled of all air. 1. Water Pump Bleeder Bolt 2. Bleed Petcock Figure 32: Water Pump Bleeder Bolt and Bleed Petcock Locations 67 Engine Maintenance Engine Fuel System CAUTION: Use fuel suitable for the climate you operate in (see truck engine manufacturer's recommendations). Blending used engine oil with diesel fuel is not permitted. The fuel filter may become plugged and require replacement before the TriPac will operate. The fuel system used on the Thermo King TriPac EVOLUTION diesel is a high pressure system used in conjunction with a prechamber. 1 2 The components of the fuel system are: • Fuel tank (the truck fuel tank) • Fuel pre-filter • Electric fuel pump, in-line • Fuel filter • Injection pump • Injection nozzles. An electric fuel pump pulls fuel from the fuel tank through the pre-filter, then pushes it to the fuel filter, and to the injection pump. The fuel system is relatively trouble free. If properly maintained it will usually not require major service repairs between engine overhauls. The most common cause of fuel system problems is contamination. It cannot be stressed enough that the fuel must be clean, fuel tanks must be free from contaminants, and the fuel filter must be changed regularly. Any time that the fuel system is opened up, all possible precautions must be taken to keep dirt from entering the system. This means all fuel lines should be capped when open. The work should be done in a relatively clean area, if possible, and the work should be completed in the shortest time possible. 68 4 3 1. Fuel Filter 2. Fuel Injection Pump 3. Electric Fuel Pump, In-line 4. Fuel Pre-filter 5. Fuel Pickup Tube 5 Figure 33: Engine Fuel System Thermo King strongly recommends that any major injection pump or nozzle repairs be done by a quality diesel injection service specialty shop. The following procedures can be done under field conditions: • Bleeding air from the fuel system • Maintenance involving the fuel tank and filter system • Engine speed adjustment • Electric fuel pump replacement • Injection line replacement • Injection pump timing • Injection nozzle testing, adjustment, and minor repair Engine Maintenance Bleeding the Fuel System The fuel system will have to have the air bled out if the engine runs out of fuel, if repairs are made to the fuel system or air gets into the fuel system for any other reason. The HMI Alarm Icon in the ENG group will be displayed if the engine fails to start due to lack of fuel. Proceed as follows: 1. Open the fuel return line banjo fitting to bleed air from the fuel system. 3. The engine will crank. The fuel pump will run only when the engine is cranking. 4. Repeat Steps 1 and 2 followed by Steps 4 and 5 until an adequate amount of fuel is exiting the fuel return line. This indicates that all air has been bled from the line. 5. Stop the engine start sequence by turning system off at the HMI Control Panel. 6. Close the fuel line banjo fitting and retighten. 7. With air bled out of the fuel line, the engine should now be capable of starting. Turn on the system at the HMI and test the engine. Water in the Fuel System AMA613 Figure 34: Fuel Return Line Banjo Fitting Water in the fuel system can damage the injection pump, nozzles and prechamber. This damage will subsequently cause more expensive damage to the engine. A large accumulation of water in the bottom of the fuel tank will stop a diesel engine. Water should be drained off periodically to avoid breakdowns. TriPac draws its fuel from the truck's fuel tank. Follow the truck manufacturer's procedures for removing water from the truck fuel tank. 2. Set the TriPac HMI to a setting that will cause the TriPac engine to attempt to start. For example, select Cool Mode and turn Cab Temperature Selector counter clockwise. NOTE: Several repeat attempts may be required to complete this procedure. The engine will attempt to start for a maximum of 30 seconds. If it does not start after the third attempt, the HMI will display the Alarm Icon in the ENG group and the engine start sequence will end. If the procedure describe here is not successful after the third attempt, there may not be an adequate amount of fuel present to support an engine start. Check the fuel supply in the tank and also inspect fuel lines for leaks. 69 Engine Maintenance Fuel Pre-Filter 1 The fuel pre-filter removes the larger contaminant particles from the fuel before it goes through the fuel pump and the fuel filter. Inspect the fuel pre-filter during pretrip inspections and scheduled maintenance inspections. Remove the bowl and clean the screen if it looks dirty. Fill the bowl with clean fuel when reinstalling the screen and bowl. ARA1897 1 1. Lubricate seal with diesel fuel and reseat seal fully into groove in bowl. Figure 36: Reseat Seal Fully in Groove in Bowl Fuel Filter Replacement 2 3 4 1. Remove the filter and discard. 2. Lubricate rubber ring of new filter with fuel. 3. Install the filter and tighten until the filter is slightly loose (rubber ring not making contact). 4. Bleed the air from the filter by operating the electric pump until fuel bubbles appear at the top of filter. 5. Tighten the filter until the rubber ring makes contact, then tighten 1/2 turn more. ARA2116 1. 2. 3. 4. Head Seal Screen Bowl Figure 35: Fuel Pre-Filter Components NOTE: You must lubricate the seal with diesel fuel and reseat the seal fully into the groove in the bowl when reinstalling the screen and bowl. Proper lubrication of the seal is necessary to insure an air tight seal between the pre-filter head and the plastic bowl. 70 Injection Nozzle Service The injection nozzles must be tested (and repaired if necessary) at least every 3,000 hours in accordance with EPA 40 CFR Part 89. Normal conditions are considered to be the use of clean high quality fuel, no used oil blending, and regular maintenance of the fuel system according to the Maintenance Inspection Schedule. Refer to the TK270, TK370 and TK376 Overhaul Manual TK 53163 for injection nozzle testing and repair procedures. Engine Maintenance Injection Pump Timing This timing procedure requires fuel pressure at the injection pump inlet. This is be accomplished by using the electric fuel pump to supply fuel to the fuel pump inlet. CAUTION: The cylinders on the engine are numbered from the flywheel end to the water pump end. The number 1 cylinder is next to the flywheel and the number 2 cylinder is next to the water pump. The timing marks on the flywheel are matched to this system. 2. Remove the delivery valve spring for the number 1 cylinder by removing the delivery valve holder and the delivery valve spring, and then reinstalling the delivery valve holder without the delivery valve spring in place. 3. Remove the cylinder head cover. 4. Place the engine at top dead center of the compression stroke for the number 1 cylinder. Refer to steps a through d. a. Rotate the engine in the normal direction of rotation (clockwise viewed from the water pump end) until the until the top dead center mark for the number 1 cylinder on the flywheel lines up with the index timing mark on the starter mounting plate. 1 1 2 2 1. Number 1 Cylinder Fuel Injection Line 2. Index Mark on Starter Mounting Plate Figure 37: Component Location CAUTION: Loosen all of the injection lines at the injection nozzles to prevent the possibility of the engine firing while it is being rotated. 1. Remove the injection line for the number 1 cylinder from the delivery valve holder on the injection pump and from the injection nozzle. NOTE: The number 1 cylinder is the cylinder at the flywheel end of the engine. 3 1. Injection Timing Mark 2. Top Dead Center Mark for Number 1 Cylinder 3. Index Timing Mark on Starter Mounting Plate Figure 38: Timing Marks b. Check the rocker arms on the number 1 cylinder to see if they are loose. c. If the rocker arms are loose, the engine is at top dead center of the compression stroke for the number 1 cylinder. d. If the rocker arms are tight, the engine is at top dead center of the exhaust stroke for the number 1 cylinder. Rotate the engine 360 degrees to place the engine at top dead center of the compression stroke for the number 1 cylinder. 71 Engine Maintenance 5. Remove the Starter Fuse (F1) from the interface board to prevent the engine from cranking when the unit is turned On. 6. Energize the fuel solenoid and the fuel pump by turning the unit On and set the TriPac HMI to a setting that will cause the TriPac engine to attempt to start. For example, select a temperature (such as 50 F) that will cause the HMI to enter an air conditioning cycle and signal an engine start. 7. Rotate the engine backwards (counterclockwise viewed from the water pump end) until the injection timing mark (or the 16 degree BTDC mark see Figure 41) is positioned about 1.0 in. (25 mm) below the index timing mark on the starter mounting plate. 8. Use a clean towel to remove the fuel from the top end of the delivery valve holder. 10. Check position of the timing marks. The injection timing mark on the flywheel should be aligned with the index timing mark on the starter mounting plate. Repeat steps 7 through 10 to recheck the timing. 2 1 1. Injection Timing Mark 2. Index Timing Mark on Starter Mounting Plate Figure 40: Correct Injection Timing Mark Alignment NOTE: Some engines have a series of injection timing marks as shown below. The 16 degrees BTDC (before top dead center) mark is the mark that should be aligned with the index timing mark on the starter mounting plate. 1 2 3 4 5 1 1. Delivery Valve Holder Figure 39: Injection Pump 9. Slowly turn the engine in the normal direction of rotation until you see the fuel rise in the end of the delivery valve holder. Stop as soon as you see the fuel rise. 1. 16 Degrees BTDC Mark (Correct Timing Mark) 2. 25 Degrees BTDC Mark 3. 20 Degrees BTDC Mark 4. 15 Degrees BTDC Mark 2. Index Timing Mark on Starter Mounting Plate Figure 41: Correct Injection Timing Mark Alignment With Series Of Injection Timing Marks 72 Engine Maintenance 11. If the timing is off by more than 1 degree (0.1 in. [2.5 mm]), loosen the mounting nuts on the studs that fasten the injection pump to the engine and rotate the injection pump to change the timing. a. Pull the top of the injection pump away from the engine to advance the timing. b. Push the top of the injection pump toward the engine to retard the timing. 12. Tighten the injection pump mounting nuts and recheck the timing. Repeat steps 7 through 12 until the timing is correct. 1 13. Install the delivery valve spring for the number one cylinder by removing the delivery valve holder, installing the delivery valve spring, and then reinstalling the delivery valve holder. 14. Install the injection line for the number one cylinder, the cylinder head cover, tighten the other injection lines, and replace the Starter Fuse (F1) in the interface board when finished with the procedure. 1. Index Marks Figure 42: Index Mark Location Injection Pump Removal and Installation Injection Pump Removal 1. Note the alignment of the index marks on the injection pump and the gear case. If they are not marked, mark them so the injection pump can be returned to the same position when it is reinstalled. 1 2 1. Index Mark on Injection Pump 2. Index Mark on Gear Case Figure 43: Index Mark Alignment 2. Remove the fuel lines, wire harness, and mounting hardware from the injection pump. 3. Remove the injection pump timing cover from the gear case. 4. Loosen the injection pump gear mounting nut, but do not remove it yet. NOTE: The injection pump gear assembly is made of two pieces, the flange and the gear. Do not loosen or remove the four bolts that fasten the gear to the flange because that changes the timing. 73 Engine Maintenance 2. Place the injection pump in the gear case. Rotate the injection pump shaft to mate the key in the shaft with the keyway in the injection pump gear. Take care to make sure the key mates with the keyway. 5. Use a suitable puller to loosen the injection pump gear from the injection pump shaft. 6. Remove the injection pump gear mounting nut and lock washer. Use a shop rag to prevent the lock washer or nut from falling into the gear case. 3. Secure the injection pump to gear case with previously removed hardware. Make sure to align the index marks on the injection pump and the gear case like they were in step 1 of "Injection Pump Removal". 7. Remove the injection pump from the gear case, but leave the injection pump gear in the gear case. This keeps the teeth on the injection pump gear aligned properly with the teeth on the idler gear. If you remove the injection pump gear from the gear case you will have to remove the gear case cover to realign the timing marks on the injection pump gear and the idler gear. NOTE: If a different injection pump is being installed, see "Injection Pump Timing" on page 71 to set the timing. 4. Secure the injection pump gear to the injection pump shaft with the lock washer and mounting nut. Use a shop rag, as before, to prevent the lock washer or nut from falling into the gear case. Torque the nut to 43.5 to 50.9 ft-lb (59.0 to 69.0 N•m). Injection Pump Installation 1. Place a new O-ring on the injection pump and lubricate it with engine oil. 5. Install the injection pump timing cover on the gear case cover, and reinstall all components removed previously to facilitate the injection pump removal. 1 2 3 4 8 7 6 5 1. Injection Pump 5. Injection Pump Gear Mounting Nut 2. Gear Case 6. Lock Washer 3. Gear Case Cover 7. Injection Pump Gear 4. Injection Pump Timing Cover 8. O-Ring Figure 44: Injection Pump Removal and Installation 74 Engine Maintenance Integral Fuel Solenoid The fuel stop solenoid is located on the end of the fuel injection pump. Operation of the TK270F engine is controlled by the operation of the fuel solenoid. The fuel solenoid consists of a spring loaded plunger and electro-magnetic coil. When the engine is OFF, spring tension on the plunger maintains the plunger's "out" position. When pushed out, this causes the governor linkage to move the injection pump rack to the "Fuel Off" position. When the fuel solenoid is energized, current is applied to the coil creating an electro-magnetic field,. When in the "pulled-in" position, the plunger releases tension on the governor linkage. The governor linkage then moves the fuel injector rack, thus controlling the fuel flow and placing it in the "Fuel On" position. 1 If you suspect that the engine does not run because the fuel solenoid is not operating correctly, use the following procedure: 1. Check system for an alarm code 35, Run Relay. No alarm, go to next step. 2. Check for an open F7 (40A) fuse on the interface board. a. Fuse is open = Fuel solenoid hold winding or 8DP circuit is shorted to ground. b. Fuse is not open = Go to next step. 3. Disconnect fuel solenoid harness at solenoid. 4. At the fuel solenoid harness connector place DC voltmeter leads on the 8DP pin and chassis ground. 2 1. Pull-In Coil 8DP Color: White 2. Hold-In Coil 8D Color: Red 3. Common Ground Color: Black CH Figure 46: Fuel Solenoid Pin Identification AMA726 1. Fuel Solenoid 2. Fuel Injection Pump Figure 45: Integral Fuel Solenoid Components Troubleshooting the Integral Fuel Solenoid System NOTE: The fuel solenoid pull-in coil will require 35 to 45 amps to turn on the fuel. The unit's battery must be in good condition. If the battery has enough power to crank the engine over, it has enough power to energize the fuel solenoid pull-in coil. 5. Turn on the TriPac system at the HMI. Select a setting that will cause an APU engine start attempt. NOTE: The engine will crank for 30 seconds but should not start. 6. Just before the starter engages there should be a momentary (2 seconds) voltage spike on the 8DP pin. a. No voltage spike = open 8DP circuit or no output from interface board. Repeat test at pin J5-5 on the interface board. i. No voltage = Replace interface board. ii. 12+ volts = Open in 8DP harness circuit. 75 Engine Maintenance b. Voltage stays on = Timer circuit on interface board is defective. Fuel solenoid pull winding is likely burned. Replace interface board and fuel solenoid. c. Momentary voltage = Go to next step. 6. Install the new fuel solenoid. 7. Turn the unit off. 8. Replace the Starter Fuse (F1) in the interface board. 7. At the fuel solenoid harness connector place DC voltmeter leads on the 8D and CH-05 pins. Measure voltage while starter is cranking. a. 0 volts = 8D or CH-05 circuit is open. Go to next step. b. 12+ volts = 8D circuit is complete and powered, ground circuit is complete. Replace fuel solenoid. 8. At the fuel solenoid harness connector place DC voltmeter leads on the 8D pin and chassis ground. Measure voltage while starter is cranking. a. 12+ volts = 8D circuit is complete; CH-05 circuit is open. Locate and repair open circuit. b. 0 volts = 8D circuit is open. Locate and repair open circuit. Fuel Solenoid Replacement 1. Remove the Starter Fuse (F1) from the interface board. 2. Disconnect the fuel solenoid harness connector and remove the old fuel solenoid. 3. Connect the fuel solenoid harness connector to the new fuel solenoid. 4. Energize the fuel solenoid by turning the unit On and set the TriPac HMI to a setting that will cause the TriPac engine to attempt to start. NOTE: The fuel solenoid must be energized when it is being installed. If it is not, the plunger and the linkage may not line up correctly and the fuel solenoid will not function properly. 5. Place the O-ring in the groove in the end of the fuel injection pump. Make sure that the O-ring is positioned correctly during installation to avoid damage and leaks. 76 1. Fuel Stop Solenoid 2. O-Ring 3. Fuel Injection Pump Groove Figure 47: Fuel Solenoid Components Valve Clearance Adjustment The valve clearance should be checked after every 1000 operating hours, maximum. It is important that valves be adjusted to the correct specifications for satisfactory engine operation. Insufficient valve clearance will result in compression loss and misfiring of cylinders resulting in burned valves and seats. Excessive valve clearance will result in noisy valve operation and abnormal wear of the valves and rocker arms. The intake and exhaust valves are adjusted with the valve in the closed position. NOTE: The cylinders these engines are numbered from the flywheel end to the water pump end. The number 1 cylinder is next to the flywheel. The number 2 cylinder is next to the water pump. The timing marks on the flywheel are also numbered this way. Engine Maintenance The timing marks on the flywheel of the two cylinder engines are stamped 180 degrees apart. The top dead center marks have the cylinder number stamped next to them. The injection timing marks have no identification marks (see Figure 48). 2 1 The index timing mark is stamped on the side of the starter mounting plate that faces the flywheel. This index timing mark is on the intake side of the engine. 1. Remove the cylinder head cover. CAUTION: Loosen all of the injection lines at the injection nozzles to prevent the possibility of the engine firing while it is being rotated. 2. Place the engine at top dead center of the compression stroke for the number 1 cylinder. a. Rotate the engine in the normal direction of rotation (counterclockwise viewed from the flywheel end) until the top dead center timing mark for the number 1 cylinder on the flywheel lines up with the index timing mark on the starter mounting plate. b. Check the rocker arms on the number 1 cylinder to see if they are loose. c. If the rocker arms are loose, the engine is at top dead center of the compression stroke for the number 1 cylinder. 1. Top Dead Center Mark for Number 1 Cylinder 2. Index Timing Mark on Starter Mounting Plate Figure 48: Timing Marks 3. Use a feeler gauge to check the valve clearance on both valves for the number 1 cylinder. The valve clearance for both the intake valves and the exhaust valves should be 0.006 to 0.010 in. (0.15 to 0.25 mm). NOTE: Check to make sure that the valve stem cap is in good condition and is positioned squarely on the top of the valve stem. Replace the valve stem cap if it shows significant wear. 4. Adjust the valves if necessary by loosening the lock nut and turning the adjustment screw until the valve clearance is correct. 1 2 d. If the rocker arms are tight, the engine is at top dead center of the exhaust stroke for the number 1 cylinder. Rotate the engine 360 degrees to place the engine at top dead center of the compression stroke for the number 1 cylinder. AGA148 1. Adjustment Screw 2. Lock Nut Figure 49: Valve Clearance 77 Engine Maintenance 5. Hold the adjustment screw in place and tighten the lock nut. Engine Speed Adjustment (Compressor Clutch must be engaged) 1. Start the unit and let it run until the engine is warmed up. Use the HMI Control Panel to cause the engine to run if necessary. May use TK Monitor Service Test Mode to force air conditioning to engage. 2. The engine speed should be 2350 ± 25 RPM while the compressor clutch is engaged. May use TK Monitor to read Engine RPM. AGA114 Figure 50: Adjusting Valves 6. Recheck the valve clearance. 7. Place the engine at top dead center of the compression stroke for the number 2 cylinder. a. Rotate the engine in the normal direction of rotation (counterclockwise viewed from the flywheel end) until the top dead center timing mark for the number 2 cylinder on the flywheel lines up with the index timing mark on the starter mounting plate. 3. Engine speed is controlled by the governor lever. If the engine speed is not correct, loosen the jam nut on the low speed limiting bolt. 4. Turn the low speed limiting bolt to change the engine speed. Turn the screw in to increase the engine speed. Turn the screw out to decrease the engine speed. 5. Set the engine speed at 2350 ± 25 RPM with engine loaded and tighten the jam nut. (Under no-load operation, the engine speed will be approximately 2400 ± 25 RPM). b. Check the rocker arms on the number 2 cylinder to see if they are loose. c. If the rocker arms are loose, the engine is at top dead center of the compression stroke for the number 2 cylinder. d. If the rocker arms are tight, the engine is at top dead center of the exhaust stroke for the number 2 cylinder. Rotate the engine 360 degrees to place the engine at top dead center of the compression stroke for the number 2 cylinder. 2 1 AMA613 8. Check and adjust both valves for the number 2 cylinder. 9. Replace the cylinder head cover. 1. Low Idling Speed Limiting Bolt 2. Governor Lever Figure 51: Engine Speed Adjustment 78 Engine Maintenance Belt Adjustment CAUTION: The unit may start automatically and at any time when the unit switches are On. Be sure to turn switches Off before inspecting or working on any part of the unit. Engine/Compressor/Alternator Belt Tension/Adjustment 1. Loosen the alternator pivot bolt and the alternator adjusting bolt. 2. Use a pry bar to position the alternator to the correct belt tension and tighten the alternator adjusting bolt and the alternator pivot bolt. a. Adjust the belt tension to 75 on the belt tension gauge. b. Check belt tension after 36 to 48 hours of initial operation. The belt may stretch slightly during the first hours of use. c. Do not overtighten the belt. Proper belt tension should allow the belt to be deflected 0.25 in. (7 mm) at center of span with no compressor movement. NOTE: A belt that is too tight causes severe overload on the compressor and motor bearings. This will shorten belt and bearing life. Use only approved Thermo King Service Parts replacement belts. 1 2 1. Alternator Pivot Bolt 2. Alternator Adjusting Bolt (Hex Head on Back Side) Figure 52: Belt Adjustment 79 Air Conditioning Maintenance Maintenance Inspection Schedule Pre-Trip 500 Hrs Annual 2,000 Hrs • • Check refrigerant level. • • Check refrigerant lines for rubbing or damage. Check condition of or service the following: Safety DANGER: Breathing refrigerant reduces the oxygen level in the blood. Inhaling high concentrations of refrigerant vapor is harmful and can cause heart irregularities, unconsciousness, or death. Intentional misuse or deliberate inhalation may cause death. WARNING: Make sure the TriPac can not start while servicing the system. Turn the APU Engine On/Off switch to Off. Many service procedures are regulated by federal, state, and local laws. EPA Section 609 certified technicians must perform regulated air conditioning service procedures using approved equipment and complying with all federal, state, and local laws. Refrigerant Service Safety Procedures WARNING: Do not use a Halide torch to test for leaks. When refrigerants come in contact with a flame, a highly toxic gas is produced. This toxic gas is extremely dangerous and may cause death! • Do not breathe refrigerant fumes or vapor. Conduct test procedures in areas with good ventilation. Observe these precautions while performing refrigerant procedures: • Use the recommended procedures found in this manual when servicing equipment. • Avoid skin contact with refrigerants. Refrigerant contact on skin causes frostbite. • Do not apply open flame or heat the refrigerant tank above 125 F (52 C). If needed to charge the A/C system, immerse the tank in 70 F to 80 F (21 to 27 C) water. • • Do not fill refrigerant tanks to more than 80%. Allow space for liquid expansion. To monitor the amount of liquid in a tank, weigh the tank before and during the filling operation. Do not vent refrigerants to the atmosphere. Recovery of refrigerant is required by most government regulations. Refer to local laws for the proper handling of refrigerants and refrigerant oils. • Wear the proper clothing when handling refrigerants. Wear goggles to prevent exposure from liquid refrigerant to face and eyes. Use butyl-lined gloves when handling refrigerants. • • 80 Do not weld or steam clean near A/C lines and components. Excessive heat builds up dangerous system pressures. Reinstall refrigerant tank cap after each use. This provides protection to the valve and safety plug. General Air Conditioning System Service Procedures • Use clean tools to prevent contamination when opening a refrigeration system or oil containers. • Purge A/C service tools to prevent system contamination with air. • Do not expose refrigerant oil to air longer than necessary. Refrigerant oil absorbs moisture when exposed to air. Use sealed containers when storing refrigerant oil. Air Conditioning Maintenance • Do not pour oil into another container unless absolutely necessary. If you must use another container, make sure it is clean and dry. • Do not mix different refrigerants. Different refrigerants and oils are incompatible. • Limit system open time. • Replace receiver-drier whenever system in opened. • Evacuate any system that has been opened. 1. Figure 54: Hand Valves Closed to Center Port PAG Oil Handling Procedures • Do not mix PAG oil with other compressor oils. • Do not use equipment contaminated with Polyolester oils. Hand Valves Closed to Center Port Gauge Connections • You must leave Schrader valves in access ports, although this lengthens the time required for evacuation. Gauge Manifold Connections Use fittings designed for R-134a refrigerant. 1 Gauge Manifold Positions The gauges indicate low and high side pressures. Operate one or both hand valves to perform the different service operations. 1. 1. Hand Valves Opened to Center Port R-134a Fittings Figure 55: Connecting the Gauge Manifold Figure 53: Hand Valves Opened to Center Port 81 Air Conditioning Maintenance 1. Compressor 2. Suction 1. Compressor 3. Discharge 2. Suction 4. Hose Looped to Dead Head of Manifold 3. Discharge 4. Recover/Recycle Machine Figure 56: Balancing the Pressure Figure 58: Recovering Refrigerant 1. Compressor 2. Suction 1. Compressor 3. Discharge 2. Suction 4. Vacuum Pump 3. Discharge Figure 57: Evacuating the System 4. Refrigerant Bottle Figure 59: Liquid Charging the System 82 Air Conditioning Maintenance Gauge Manifold Attachment and Purging NOTE: This procedure describes attaching and purging for the gauge manifold set on units without compressor service valves. Inspect the gauge manifold for correct hose and fitting connections. 1. Clean dirt and moisture from around the service ports. 2. Ensure that both gauge manifold hand valves are in the closed (front-seated) position. 3. Attach the center gauge manifold hose to the "Dead Head." Tighten the fitting finger tight. 4. Remove the caps from the suction and discharge service ports. 5. Attach the high side hose (pressure gauge) to the discharge service port. Tighten the fitting finger tight. 6. Attach the low side hose (compound gauge) to the suction service port. Tighten the fitting finger tight. 7. Open the gauge manifold hand valves fully. 8. Loosen the center hose. Purge the air from discharge line. Tighten the fitting. 9. Close (front seat) the gauge manifold discharge hand valve. 10. Loosen the center hose. Purge the air from suction line through the center hose. Tighten the fitting. 11. Close (front seat) the gauge manifold suction hand valve. 12. You are now ready to use the gauge manifold to check system pressures and perform most service procedures. Removal NOTE: To minimize refrigerant leaks, run the system during gauge removal if possible. 1. Close (front seat) the discharge and suction manifold hand valves snugly. 2. Ensure the "Dead Head" fitting is tight. CAUTION: Air allowed into the system will cause serious damage. 3. Quickly remove manifold set from service ports. 4. Cap the service ports with the correct sealing caps. 5. Leak test service connections and repair all leaks. NOTE: To minimize refrigerant loss, use sealing-type quick connectors. These fittings restrict flow during evacuation. Refrigerant Recovery NOTE: There are many recovery machines that remove refrigerant from a system, run it through a filter cartridge once, and pump it into a refrigerant drum. This type of recovery machine will not remove the air from the refrigerant. If the recovery machine is capable of circulating the refrigerant and actually running it through a condensing coil and has provisions for venting air from its internal system, then it does clean the refrigerant. If you are unsure of this function in your machine, read the manual. If the machine removes only the refrigerant from the unit to a drum, then the air can still be removed by allowing the drum to sit for several hours, then venting the air from the top of the drum. CAUTION: Venting refrigerant may be illegal in your area. Check with your local government agencies for definition of venting and your legal responsibilities. Measure the drum temperature and pressure, then refer to a Temperature-Pressure chart to verify that there is only refrigerant in the drum. If air is 83 Air Conditioning Maintenance in the drum, you may wish to only draw liquid from that drum even after the air has been vented out. This precaution ensures that air is not put back into the system. Since machines are different, Thermo King recommends that the manufacturer's instructions are followed exactly. NOTE: These evacuation procedures have been written to be used with the Thermo King Evacuation System (see Tool Catalog). However, the principles of evacuation and the use of a micron gauge during evacuation should always be practiced. Evacuation See the diagram of the Thermo King Evacuation Station and note the location of the valves. Evacuation is Important and is Critical to System Performance! It has been determined through testing and system analysis that refrigeration systems which contain non-condensables such as nitrogen and/or air can be overcharged with refrigerant when charged using the sight glass method. An overcharge of refrigerant will cause compressor damage. Air and moisture cause contamination leading to system failure. Therefore, Thermo King recommends that all repairs to the refrigeration system include the removal and recycling (cleaning) of the refrigerant, followed by a thorough evacuation using the proper tools and procedures. The primary objective of evacuation is to bring the system's pressure to a low micron level to ensure the removal of moisture and non-condensables. Never attempt evacuation without a micron or vacuum gauge. The micron gauge will help determine: a. If the pump is capable of pulling a deep vacuum. b. When the vacuum pump oil is contaminated. c. If the vacuum hoses and valves are leak free. d. If the unit is leak free. e. How long you should evacuate the unit. f. That the unit is still in a deep vacuum before any lines are disconnected or refrigerant is added. 84 Valve #1 (V-1): Is in the open position when the pump is running to evacuate the hoses and/or the unit. When V-1 is closed, the pump has been isolated from the hoses and/or the unit. Valve #2 (V-2): Is in the open position during unit evacuation. In the closed position, V-2 isolates the micron gauge and thermistor assembly from the hoses and/or the unit. Valve #3 (V-3): Is in the open position during unit evacuation. When closed, V-3 isolates the micron gauge and the vacuum pump from the other evacuation hoses. Valve #4 (V-4): Is in the open position during unit evacuation. When closed, V-4 isolates the evacuation hoses and the unit from the evacuation system. Air Conditioning Maintenance 2 1 3 4 9 5 8 AGA654 6 7 1. V-4 6. Two Stage Vacuum Pump 2. Thermistor 7. To 110 Vac Power 3. V-3 8. Calibration Standard 4. V-2 9. Vacuum or Micron Gauge 5. V-1 Figure 60: Evacuation Station 85 Air Conditioning Maintenance 1. 100 Microns 2. 500 Microns 3. 1000 Microns 4. 2500 Microns 5. 5000 Microns 6. 20,000 Microns 7. Atmospheric Pressure 8. Calibration Adjustment Screw 9. Example: Meter needle shown at calibration position when Calibration Standard specifies 0.15 mm Hg. Figure 61: Vacuum Gauge 86 Air Conditioning Maintenance • NOTE: Refer to the illustrations on the two preceding pages while reading the following instructions. 1. Connect the evacuation system to a 110 Vac power supply. Connect a gauge manifold and refrigerant supply to the fitting above valve V-4. Turn the micron gauge On. Pressure Rise 2. Close valves V-1, V-3 and V-4. Valve V-2 is open. is e Pr e NOTE: If the vacuum pump is okay, and there are no leaks between V-1 and V-3, the micron gauge should show less than 500 microns. If not, locate and correct the problem. 6. With the vacuum pump still operating, open valve V-4. The micron level will rise momentarily. If the micron reading does not return to a level of less than 500 microns, locate and correct the problem before continuing. Moisture ss 4. Open valve V-1 at the pump. The micron gauge needle will move to the left. (See micron gauge scale diagram—previous page). Levels Off R 3. Turn the vacuum pump On. 5. With the pump still operating, open valve V-3. If the micron reading does not return to a level of less than 500 microns, locate and correct the problem before continuing. Isolate the pump from the system by closing the proper valve. Watch the movement of the vacuum gauge needle. If the needle continues to rise, this is an indication that a leak exists in the unit or the connecting line. The leak must then be located and eliminated. ur e Test of Evacuation Equipment Time Figure 63: Moisture • Should the needle show a pressure rise but finally level off to practically a constant mark, this is an indication that the system is vacuum tight but is still too wet, requiring additional dehydration and pumping time. 7. Evacuate hoses to 100 microns or lowest achievable level below 500 microns. 8. Once 100 microns is reached, close valve V-1 at the pump. Turn the vacuum pump Off. R is e re su re s C on st an tP Pressure Rise 9. Observe the micron gauge reading. The vacuum rise should not exceed 1500 microns in 5 minutes. Leak 10. If the rise is above 1500 microns in 5 minutes, check all hoses and connections for leaks. Hoses with moisture present will require additional evacuation time to achieve satisfactory results. NOTE: Dirty vacuum pump oil or a defective vacuum pump will prevent a low micron reading. Hoses and fittings can be isolated individually to identify leaks. Time Figure 62: Leak 87 Air Conditioning Maintenance Unit Evacuation Procedure NOTE: Do not attempt to evacuate the unit until the evacuation equipment has been tested and its performance has been verified. 1. Perform all needed service or maintenance. 2. Test the system for leaks. 8. If the vacuum level is acceptable, start the pump and open valve V-1 to evacuate the pressure rise (5 minutes). 9. Close valve V-1 and stop the pump. Observe the micron gauge to confirm that the system remains in a deep vacuum. Close valve V-4. The unit is ready to charge. 3. Prepare the unit for evacuation. Recover refrigerant to 0 psig (0 kPa) or EPA equivalent. 1 NOTE: Federal Regulations may require your recovery machine to pull the system's pressures lower than 0 psig [0 kPa]. CAUTION: Do not attempt to evacuate a unit until you are certain that the unit is leak free. A unit with less than a full refrigerant charge should be thoroughly leak checked and all leaks must be repaired. 2 1. Connect one hose from the evacuation station valve manifold to a refrigerant supply bottle. Keep bottle valve closed. 2. Install gauge manifold on the suction and discharge service ports of the TriPac. 3. Connect the gauge manifold to the spare access port on valve V-4. 4. Start the vacuum pump and open valves V-1, V-2, V-3, V-4. 5. Evacuate the system to 500 microns. After the system reaches 500 microns, evacuate for one additional hour. 6. After the additional one hour of evacuation, close valve V-1 at the pump. Turn the pump to Off. 7. Observe the reading on the micron gauge after 5 minutes have elapsed. The vacuum rise should not exceed 2000 microns. If the vacuum level exceeds 2000 microns after 5 minutes, a leak is present or additional evacuation time is required. 88 1. R-134a Fittings 2. Gauge Manifold Connection Figure 64: Connect Gauge Manifold Charging Procedure CAUTION: When charging with liquid refrigerant, do not allow the suction pressure to rise by more than 20 psig (138 kPa) above running pressure. Some compressor designs are sensitive to larger quantities when charged with liquid refrigerant. CAUTION: Different refrigerants require different types of oil to operate correctly. Do not mix these oils or the refrigerants. Consult the compressor oil chart in the front of this manual for additional information. Air Conditioning Maintenance 1. Evacuate the system using a vacuum pump and micron gauge following the procedures in this manual. (See "Unit Evacuation Procedure"). 2. Close both gauge manifold hand valves. Verify that Valve V-4 on the Thermo King evacuation station is closed off. 3. Set scale to weigh refrigerant.Open the refrigerant supply bottle valve to deliver liquid refrigerant to the gauge manifold. 4. With the unit off, open the high side gauge manifold valve to allow liquid refrigerant to flow into the discharge side of the unit. 5. When 1.5 lbs. (0.69 Kg) of refrigerant has flowed into the unit, close the high side gauge manifold hand valve. IMPORTANT: Before starting the APU engine, oil and coolant levels must be checked to prevent damage to the engine and the A/C system must have a charge of refrigerant added to prevent damage to the A/C compressor. 6. Start unit and select Cool mode. Verify compressor clutch is engaged. 7. Slowly open the low side valve of the gauge manifold. Draw refrigerant remaining in the gauge manifold and charging line into the system. 8. Close the low side valve of the gauge manifold. 9. Remove the gauge manifold. 1. Verify Cool mode is selected at HMI. Change Setpoint to lowest setting. Verify there are no active alarms. Clear alarms if present then recheck operation. If alarms reoccur the system has detected a condition that must be corrected. Access the alarm codes using the TK Monitor diagnostic tool. Refer to TK Monitor in the Operating Instructions section of this manual. 2. Check air ducts for restrictions or obstructions. Flexible ducts are not kinked or crushed. Check for driver personal belongings blocking vents. Verify flexible duct connections to OEM tractor ducts are tight and sealed. Clear or repair as required. 3. Check return air grill for obstructions. Remove and clean return air filter. Check for driver personal belongings blocking return air. Verify evaporator cover is in place. Clear or repair as required. 4. Verify evaporator fan is running and good airflow from vents. Note: The evaporator fan may not start if cab temperature is below 65 F. System Testing If the Inspection is normal proceed to system testing. CAUTION: An EPA 609 Mobile Air Conditioning certification is required to perform air conditioning system diagnosis and repair. 11. Release the TriPac back into service. 1. Connect manifold gauges at compressor in APU. Refer to Gauge Manifold Attachment and Purging in this manual. Air Conditioning Diagnosis 2. Remove the cover from the evaporator housing. 10. Reinstall the service caps. Operator is complaining about air conditioning capacity. Use the following information to evaluate if the air conditioning system is performing properly. Inspection Before proceeding to System Testing first verify the physical condition of the system. 3. Connect a PC computer to the system and start TK Monitor. Refer to TK Monitor in the Operating Instructions section of this manual. For additional information refer to Diagnostic Manual (TK 55739-19-OD) Section 6, A51A, Communication Using TK Monitor. 4. In TK Monitor select Service Test Mode from the menu. Then select the Cool Test. This will force the system to full cool. 89 Air Conditioning Maintenance 5. Verify condenser fan, evaporator fan and compressor are all running in high speed. 6. In TK Monitor select System Monitoring from the menu. The system will continue to operate in full cool. 7. Temporarily install the cover on the evaporator housing. 8. Operate the system in full cool for about 5 minutes. 9. Record the following information: • Return Air Temperature (RA). Place a thermometer in front of the return air vent. Do not use an infrared thermometer. • Discharge Air Temperature (DA). Place a thermometer in a discharge air vent. Do not use an infrared thermometer. • Coil Temp. From System Monitoring. • Discharge Pressure. From service gauges. • Suction Pressure. From service gauges. • Did the compressor run for the entire 5 minutes? 10. In TK Monitor select Service Test Mode from the menu. Select Cancel Test. The system should return to normal operation. System Evaluation Use the information gathered during System Testing to evaluate system operation. Use the following information to determine if readings are in the normal range. Air Temperature Return Air Temperature (RA). This is the air temperature that is entering the evaporator. It is not necessarily cab temperature which is read by the Cab Temperature Sensor on the HMI. This will depend on how the Evaporator is mounted under the bunk. Discharge Air Temperature (DA). This is the temperature of the air blowing into the cab. It is what the driver feels. DA is dependent on RA and TD. Higher RA will generally produce higher DA. On a normally operating system, if it is hot in the cab, the air out of the vent will be warmer than when the cab is cool. Lower TD will generally produce higher DA. If DA is in the normal range the air conditioning system is working properly. Temperature Differential (TD). To find TD subtract DA from RA. It indicates the ability of the system to remove heat from the air as it passes through the evaporator coil. A lower than normal TD indicates reduced cooling capacity. This is the most important number to determine if an air conditioning system is working properly. Ambient Air Temperature (AA). This is the outside air temperature. Normal Temperature Return Air (RA) Discharge Air (DA) Temp Differential (TD) 65ºF 40 - 45ºF 21 - 25ºF 75ºF 45 - 53ºF 24 - 28ºF 80ºF 49 - 56ºF 25 - 30ºF System Pressures Air conditioning system pressures are measured at the compressor. They are an indication of what is happening inside the air conditioning system. Discharge Pressure. This is the pressure of refrigerant flowing out of the compressor toward the condenser coil. It is primarily affected by Ambient Air Temperature and condenser coil airflow. If discharge pressure is high check condenser fan operation or a dirty condenser coil. Low discharge pressure may be caused by low suction pressure. Normal Discharge Pressure Ambient Air Temperature (AA) Discharge Pressure 90 80ºF 135 - 153 psig 90ºF 151 - 175 psig 100ºF 174 - 199 psig Air Conditioning Maintenance Suction Pressure. This is the pressure of the refrigerant returning to the compressor from the evaporator coil. It is primarily affected by return air temperature and the temperature of the evaporator coil. If suction pressure is low check evaporator fan operation or restricted return air flow. It may also indicate low refrigerant charge. High suction pressure may be caused by high cab temperature or refrigerant overcharge. Testing System for Leaks 1. Use an electronic leak detector to leak test the refrigeration system. Carefully inspect the entire system for refrigerant oil leaks (which indicate refrigerant leaks), component damage, and the audible release of refrigerant. DANGER: Due to environmental concerns and personal safety, do not use a Halide torch. Using this torch creates a poisonous gas which may cause death. Normal Suction Pressure Return Air Temperature (RA) Suction Pressure 65ºF 42 - 50 psig 75ºF 46 - 56 psig 80ºF 50 - 56 psig Compressor Cycling The compressor clutch will disengage and compressor will stop under the following conditions: • Cabin Temp reaches setpoint, this is normal. • Evaporator coil temperature falls to 32 F. • Suction pressure falls below 5 psig. An alarm code 93 will also generate. • Discharge pressure exceeds 360 psig. An alarm code 10 will also generate. During Service Test Mode the compressor should not stop. Setpoint temperature is ignored and does not affect operation. If the compressor stopped while testing check the following: • Evaporator coil temperature has fallen below 32 F. Evaporator fan may have stopped, air flow to the evaporator coil may be restricted or refrigerant charge is low. Suction pressure may also be low. • Suction pressure is very low and an alarm code 93 was generated. May be caused by low return air temperature or low refrigerant charge. • Discharge pressure was very high and an alarm code 10 was generated. Condenser fan may have stopped, condenser coil air flow may be restricted, fresh air may not be available to the condenser coil or possible refrigerant overcharge. NOTE: The leak tester must be capable of detecting fluorine-based refrigerants. NOTE: To perform a proper leak check, the air conditioning system should be charged with sufficient refrigerant to have a gauge pressure of at least 50 psi (340 kPa) when not in operation. At temperatures below 59 F (15 C), leaks may not be measurable because this pressure may not be reached. 2. Install a gauge manifold set. 3. Check low side pressure gauge reading. The manifold gauge will have a reading that falls into one of three ranges: 0 PSI Reading There is no pressure in the system with no obvious signs of a major leak. Pressurize the system to 25 psi with refrigerant. Monitor system pressure for one minute. • Pressure reading does not change or falls slowly. The leak is small. You may add more refrigerant to this system and know that it will not rapidly vent to the atmosphere. Proceed to the 1 to 50 psi procedure. • Pressure drops rapidly. The leak is large. Further inspection is required. Do not add more refrigerant to the system because it will vent to the atmosphere. 91 Air Conditioning Maintenance 1 to 50 PSI Reading Since the system is holding some pressure, you can add refrigerant to the system without it being vented to the atmosphere. 1. Add refrigerant to the system to increase pressure. 2. Add enough refrigerant to raise system pressure up to bottle pressure. Keep track of how much refrigerant you add. NOTE: This refrigerant will be recovered when the leak check is complete. You may use refrigerant from a recovery tank to raise pressure. AMA700 Figure 65: Receiver-Drier 3. Perform a complete and thorough leak check. Removal 4. Recover refrigerant from the system. 1. Turn the unit off. Over 50 PSI Reading The low side reading must show at least 50 psig of pressure. 1. Using the existing system pressure, perform a complete and thorough leak check. 2. If no leaks are found, but the system has lost some of its refrigerant pressure, proceed to the 1 to 50 psi procedure. This leak check procedure gives the technician a good opportunity to locate a refrigerant leak. Because nothing is lost or vented, the procedure is both economical and environmentally friendly. Receiver-Drier Removal and Installation NOTE: It is recommended that the receiver-drier be replaced when the system is opened. CAUTION: Use extreme care when working near the exposed coil fins. Coil fins are very sharp and can cause painful lacerations. Use gloves when handling coil. 2. Recover all refrigerant from the system. 3. Disconnect the refrigeration and electrical connections. Cap the refrigeration connections to prevent contamination. 4. Locate the receiver-drier and loosen the mounting hardware. NOTE: When removing or replacing the fitting nuts on the receiver-drier, always hold the body of the receiver-drier near the fittings to prevent twisting the tubing when the nuts are being loosened or tightened. 5. Use two wrenches (tubing wrenches recommended) to disconnect the connections, and remove the receiver-drier. 6. Discard the old receiver-drier. Installation NOTE: Replace receiver-drier as last service step before beginning system evacuation. NOTE: The longer the receiver-drier remains open to the air, the more moisture it will absorb. That moisture shortens the usable life of the receiver-drier. 1. Clean all fittings. Remove the protective caps from the new receiver-drier and oil the threads with the same type of refrigerant oil that is used in the compressor. Install the new receiver-drier as quickly as possible. 92 Air Conditioning Maintenance 2. Tighten the receiver-drier mounting hardware. 3. Replace refrigerant lines and electrical connections. 4. Evacuate the system and check for leaks. Repair as needed. 5. Recharge the system per procedures recommended in this manual. NOTE: Whenever a major loss of refrigerant has occurred or when a filter-drier is installed, additional oil may be required. Refer to oil charging procedures found in this manual. 6. Run the TriPac and verify proper operation. 93 TK-15 Compressor Maintenance NOTE: For compressor specifications, see the Specifications chapter in this manual. 1. Armature Bolt 16. Front Valve Plates 2. Armature Plate 17. Front Suction Valve 3. Shim 18. Cylinder Shaft Assembly 4. Snap Ring 19. Rear Suction Valve 5. Cover 20. Rear Valve Plate 6. Pulley Assembly 21. Rear Gasket 7. Coil Screw 22. O-ring, Body 8. Coil 23. Rear Cylinder Head 9. Body Bolt 24. O-ring, Drain Plug 10. Washer 25. Drain Plug 11. Snap Ring 26. O-ring, PRV 12. Shaft Seal 27. PRV 13. Front Cylinder Head 28. Pin, Alignment 14. O-ring, Body 29. O-ring, Oil Fill Plug 15. Front Gasket 30. Oil Fill Plug Figure 66: Compressor Components 94 TK-15 Compressor Maintenance Compressor Handling and Storage CAUTION: Do not turn the compressor upside down. If the compressor is turned upside down, rotate the armature plate several times to circulate oil. Store new and rebuilt compressors: • With the correct oil charge • Horizontally • With a holding charge of nitrogen to a pressure of 7 to 21 psig (48 to 145 kPa). This protects internal parts from moisture and corrosion Removing the Compressor 1. Remove the refrigerant from the unit following procedures in the Refrigeration Maintenance chapter in this manual. 2. Remove the hose connections from the compressor manifold. 3. Inspect hoses for wear, hardness, and traces of oil. Replace if necessary. 4. Remove the compressor from the mount, noting the location of all brackets and adjustment bolts. 7. Inspect the oil for contamination. See "Checking Compressor Oil for Contamination" in this chapter for more information. 8. Add oil as needed to the compressor. See the Specifications chapter in this manual for oil amount. See procedure for adding compressor oil in this manual. 9. If necessary, place a new Thermo King oil label on the compressor. Compressor Installation Procedures Installation Precautions Thermo King replacement compressors can be shipped with one of three oil configurations: PAG oil, POE oil, or no oil and a nitrogen holding charge. If the oil in the compressor does not match your system, it must be changed to the correct type for use in the TriPac system. When mounting the compressor, take the following precautions: 1. Loosen the discharge side connector cap if equipped. Slowly release the holding charge. 5. Drain and measure the oil from the compressor. The correct oil amount is listed in the Specifications chapter of this manual. (Thermo King P/N 203-544) 6. Consult specifications for correct oil. AUA0032 Figure 68: Loosen Caps Slowly CAUTION: Do not let oil escape. Figure 67: Read the Label 2. Rotate the armature plate several times to circulate oil that has settled in the cylinders. 95 TK-15 Compressor Maintenance Compressor Oil Caution Statements CAUTION: Do not leave a system or oil containers open to the air longer than necessary. Compressor oils (POE and PAG) absorb moisture. Moisturecontaminated oil will damage system components. AUA0033 Figure 69: Rotate Armature Plate 3. Verify that the compressor oil type matches the system oil type. If not, drain the compressor oil and replace it with the oil type in the system. CAUTION: Do not open refrigeration system unnecessarily. Doing so increases chances of contamination. CAUTION: Discard used oil containers. These containers are hazardous. CAUTION: Do not store PAG oil in plastic containers. PAG oil absorbs moisture through the plastic container. Installing the Compressor Oil Charge Considerations To install the compressor: Most compressors come with a factory oil charge, which is listed on the label. This oil charge is not necessarily the correct amount. See the Specifications chapter in this manual for oil charge information. 1. Mount the compressor 2. Secure the mounting hardware. Tighten adjustments as required for proper belt tension. (See specifications.) 3. Install new suction and discharge line O-rings. Connect the suction and discharge hoses. 4. Perform a leak test on the system using the same refrigerant used in the system. See Refrigeration Maintenance chapter in this manual for leak testing procedures. 5. Evacuate the system using the micron gauge method. 6. Charge the system with the correct refrigerant. See system charge specification. 7. When the system is charged, confirm that the system is functioning correctly by operating for several minutes. 96 CAUTION: Not using the correct oil charge will damage your system. TK-15 Compressor Maintenance Oil Type Considerations Your compressor comes with an oil charge that may not be compatible with your system. Check system decals and operation manual for correct oil type. See "Compressor Installation Procedures." If the oil charge in a new compressor is not compatible with your air conditioning system, remove and replace the oil. CAUTION: Mixing incompatible oils will damage your system. 6. Remove the compressor from the system. See "Removing the Compressor" on page 95. 7. Drain the oil as described. Oil Check Procedure: Draining, Measuring, and Inspecting the Oil 1. Perform the "Returning Oil to Compressor, Recovering Refrigerant, and Removing Compressor" procedure above. 2. Remove the drain plug from the compressor. Oil Check Interval Check compressor oil: • Per maintenance schedule • When the compressor, evaporator, condenser, or receiver-drier is replaced • When refrigerant has leaked from the system (for example, high pressure relief valve discharges) • When refrigerant leaks from the compressor 3. Drain oil from the compressor drain plug and all other ports. Returning Oil to Compressor, Recovering Refrigerant, and Removing Compressor During operation, oil circulates with refrigerant in a system. Before checking the oil, you must return as much as possible to the compressor. Not doing so will result in an incorrect measurement. Figure 70: Draining the Oil 4. Remove remaining oil through the discharge side connector by manually rotating the armature plate until all oil is removed. To return oil to the compressor: 1. Open the cab doors and windows to raise the interior air temperature to 75 to 80 degrees (25 to 27 C). The ambient air temperature should be above 85 degrees F (29 C). If not, partially block the condenser air flow to raise the compressor discharge pressure above 170 psig (1172 kPa).) 2. Run the A/C system for approximately 20 minutes. 3. Turn the A/C system off. 4. Stop the unit and disconnect the battery for safety. 1. Rotate Armature Plate Several Times Figure 71: Armature Plate Rotation 5. Recover the refrigerant. See the Refrigeration Maintenance chapter in this manual. 97 TK-15 Compressor Maintenance 5. Measure oil in a graduated cylinder or measuring cup. • If the oil amount is less than 3/4 of a full oil charge, replace with a full charge of new oil • If the oil charge is more than 3/4 of the required oil charge, replace only the amount of oil you removed Adding Compressor Oil To add oil: 1. Verify the correct oil type on the compressor label. 2. Verify the correct oil amount. See the Specifications chapter in this manual or, for replaced components, use the chart shown. Oil Amounts per Replaced Components1 NOTE: See the Specifications chapter in this manual for correct oil charge. Component Replaced 6. Inspect oil for contamination. Refrigerant Charge in Pounds (kg) 1-3 (0.5 to 1.4) 7. Replace the oil drain plug and tighten it per specifications (see "Torque Values" in the Specifications chapter). Condenser 8. If necessary add oil. Oil to Add in Ounces (ml) 0.3 (9) Evaporator 1 (29) Receiver-Drier 0.3 (9) These amounts are approximations. Individual systems may vary. 1 9. Change the receiver-drier. See the Air Conditioning Maintenance chapter in this manual for procedure. 10. Install the compressor. Tighten the mounting bolts. Checking Compressor Oil for Contamination Inspect extracted oil for the following: 3. Add oil to the compressor through the suction port as shown in Figure 72. Use fresh oil taken only from a sealed metal container. 4. Turn the armature plate manually several times while adding oil to distribute oil evenly. NOTE: Replace the system receiver-drier if the system was opened for service. . • Dirt • Color changed to dark brown, gray, or black • Presence of foreign substances, metal shavings, etc. in the oil Dark brown oil indicates high compressor temperatures. Gray oil indicates metal contamination. Black oil indicates severe contamination. To determine the extent of contamination, remove the receiver-drier and check the oil color there. If the oil is contaminated at the receiver-drier, flush the system with industry approved materials. If the oil is clean at the receiver-drier, install a new filter-drier and replace the oil with new oil.

See “Adding Compressor Oil”. 98 Figure 72: Small Compressor Oil Fill Procedure TK-15 Compressor Maintenance Clutch Procedures Clutch Test 1. If the field coil lead wire is broken, replace the field coil. 2. Check the amperage and voltage. The amperage range should be 3.6 to 4.2 amps at 12 volts. Note the following symptoms and conditions: a. A
very high amperage reading indicates a short within the field coil. b. No amperage reading indicates an open circuit in the winding. c. An intermittent or poor system ground results in lower voltage at the clutch. Check for tight fit on the coil retaining snap ring or for a good ground at the coil retaining screws. AUA0034 Figure 73: Remove Center Bolt
2. Remove the armature plate using the armature plate puller. Then remove the shims from either the drive shaft or the drive plate. 1 3. Air Gap—An incorrect air gap can cause erratic engagement or disengagement, and/or clutch rattle. Check the air gap with a feeler gauge. The air gap should be 0.016 to 0.031 in. (0.4 to 0.8 mm). See “Clutch
Installation” for information about adjusting the air gap. Clutch Removal, Inspection, and Installation NOTE: Make sure the proper tools are available before performing maintenance procedures. Contact your local Thermo King dealer for further information. 1. Armature Plate Puller Figure 74: Remove Armature Plate Removal 1. Remove the center
armature bolt. Use the pulley arbor TK No. 204-804 to prevent armature plate rotation. 99 TK-15 Compressor Maintenance 3. Remove the snap ring using external snap ring pliers (TK No. 204-808). NOTE: DO NOT hold the coil by the lead wire. 4. Remove the cover (if equipped). Figure 77: Remove Coil Inspection 1. Snap Ring 2. Cover (If Equipped)
Figure 75: Remove Snap Ring and Cover 5. Remove the pulley assembly using the pulley remover (TK No. 204-806) and the spacer positioned on the cylinder head hub. CAUTION: To avoid damaging the pulley groove, the pulley claws should be hooked into (NOT UNDER) the pulley groove. 1. Armature Plate: If the contact surface is scorched, the
armature plate and pulley should be replaced. 2. Pulley Assembly: If the pulley’s contact surface is excessively grooved due to slippage, both the pulley and armature plate must be replaced. There should also be no foreign matter, such as oil or grit, lodged between the armature plate and pulley. Thoroughly clean these contact surfaces and the
armature plate. 3. Coil: Inspect the coil for a loose connector or cracked insulation. If the insulation is cracked, replace the coil. Repair or replace the wire or the connector if either is loose or damaged. Figure 76: Remove Pulley 6. Remove the coil’s lead wire from the holder on the top of the compressor. 7. Remove the three screws that attach the coil
to the compressor and remove the coil. 100 1. Drive Plate 2. Pulley Assemble 3. Coil Figure 78: Inspect Clutch Components TK-15 Compressor Maintenance Installation NOTE: Before installing the clutch, perform the “Inspection” procedures described previously. 1. Confirm that the felt is installed (if equipped) on the front of the cylinder head. 5.
Install the cover (if equipped) and the snap ring using external ring pliers. NOTE: The snap ring should be installed with the chamfered inner edge outward (facing away from seal). 2. Install the coil on the compressor (with the lead wire on top). At this time, confirm that the coil’s concave portion is aligned with the felt (if equipped) and then torque
the mounting screws to 2.9 to 4.3 ft-lb (4 to 6 N•m). 3. Install the lead wire in the wire holder on the compressor. 1. Snap Ring 2. Cover (If Equipped) Figure 81: Install Cover and Snap Ring 6. Install the driver plate on the drive shaft, together with the original shim(s). Press the drive plate down by hand. 1. Felt (If Equipped) NOTE: If replacement or
additional shims are required, a clutch hardware kit is available (ICE No. 2530109) Figure 79: Install Coil 4. Install the pulley assembly using the Installer (TK No. 204-890) and a hand press. 1. Shims Figure 82: Install Shims and Drive Plate Figure 80: Install Pulley 101 TK-15 Compressor Maintenance 7. Install the armature bolt and torque it to 8.7 to
10.1 ft-lb (12 to 14 N•m). Use the pulley arbor TK No. 204-804 to prevent armature plate rotation. After tightening the bolt, ensure that the pulley rotates smoothly. 8. Check the air gap with a feeler gauge. The air gap should be 0.016 to 0.031 in. (0.4 to 0.8 mm). If necessary, adjust the air gap by adding or removing shims. Adjusting shims are
available in the Clutch Hardware Kit (ICE No. 2530109). Pulley and Belt Alignment (Engine-Driven Compressor) The compressor clutch must be perfectly aligned with the engine pulley and any idler or pulley components. 1. Make sure the clutch is installed properly. 2. Verify pulley alignment by making sure the belt goes from pulley to pulley in
perfect alignment, with no indication of a sideward bend. Belt Tension 1. Adjust the belt tension to 75 on the belt tension gauge. 2. Check belt tension after 36 to 48 hours of initial operation. The belt may stretch slightly during the first hours of use. Figure 83: Check Air Gap Electrical Connection 1. Connect the lead wire to the electrical circuit.
NOTE: The stationary field is grounded at the factory; therefore, it is necessary only to connect the hot (lead) wire. 2. Engage and disengage the clutch several times to check the clutch engagement. The armature plate should snap firmly against the pulley. 102 3. Do not overtighten the belt. Proper belt tension should allow the belt to be deflected
0.25 in. (7 mm) at center of span with no compressor movement. CAUTION: A belt that is too tight causes severe overload on the compressor and motor bearings. This will shorten belt and bearing life. Use only approved Thermo King Service Parts replacement belts. Sleeper Cab Air Heater Maintenance Maintenance Inspection Schedule Pre-Trip 500
Hrs Annual 2,000 Hrs Check condition of or service the following: • • • Start and run for at least 20 minutes each month. • • • Inspect combustion air intake tube and exhaust pipe for restrictions or blockage. • • • Inspect ducting, air intake screen, and air outlet for restrictions or blockage. • Remove glow pin and inspect for carbon build up. Clean. •
Remove glow pin screen and inspect for carbon build up. Replace. • Change fuel pump screen. AMA552 Sleeper Cab Air Heater Maintenance (D2 shown) CAUTION: Use fuel suitable for the climate you operate in (see truck engine manufacturer’s recommendations). Blending used engine oil with diesel fuel is not permitted in the TriPac system. It will
plug the filters and will not allow the air heater to run properly. Thermo King reserves the right to void all warranty on the unit. • Remove the glow pin screen and inspect for carbon buildup. Clean. See Air Heater Service Operations chapter. • Make sure vent hole is open. Use non detergent 100% volatile carburetor cleaner. An air gun will also help.
Remove loose carbon from the glow pin chamber. • Inspect the ducting, the air intake screen and air outlet for restriction or blockage. • Inspect combustion air intake and exhaust for blockage. • Operate heater for a minimum of 20 minutes each month • Maintain batteries and all electrical connections in good condition. The heater will not start with
insufficient power. Low and high voltage cutouts will shut the heater down automatically. 103 Sleeper Cab Air Heater Service Operations WARNING: To prevent personal injury, make sure that unit switches are in the Off position before servicing the unit. CAUTION: Use fuel suitable for the climate you operate in (see truck engine manufacturer’s
recommendations). Blending used engine oil with diesel fuel is not permitted. NOTE: The Cab Air Heater contains an EEPROM that monitors the functions and operating status of the air heater’s circuitry, inputs & outputs, and components. Whenever a fault occurs, the air heater EEPROM is programmed to recognize dozens of fault codes. The five
most-recent fault codes are retained in the EEPROM memory. Older fault codes are deleted from memory as new fault codes occur. Fault codes can be retrieved, in chronological order, and read using a special Fault Reader (TK P/N 204-1143). Complete instructions on the use of the fault code reader and resolution of air heater fault codes are found
in the TriPac Operating and Diagnostic Manual, TK 53024. Remove the Air Heater Cover 1 Removing the Control Unit 2 4 3 1 AMA577 1. Fastening screw 2. Retaining brackets 3. Control unit 4. Bushing Figure 85: Removing Control Unit 1. Remove the heater cover. 2. Unscrew fastening screw, press retaining brackets together, lift out control unit. 3.
Unclip the lines from the holder of the control unit (observe the positions of the lines). 2 AMA576 1. Cover 2. Seal Plates Figure 84: Remove Air Heater Cover NOTE: The cover must always be removed from the heater for all repair stages. You may have to wait for the heater to cool down. 1. Unlock both seal plates, lift cover and pull to the front. 2.
The cable harness can exit from the left or right of heater shell. 104 4. Remove the bushing (lower part) from the outer case. 5. Disconnect the control unit from the controller. The control unit can now be removed. NOTE: When reassembling the control unit, ensure that the lines are correctly clipped in the holder of the control unit, and that the
connectors are plugged into the control unit (non-interchangeable). Sleeper Cab Air Heater Service Operations Glow Pin Removal NOTE: Do not use any abrasive or a scraper to clean the glow pin. 2 1 3. Using a good quality ohmmeter, check the resistance of the glow pin. It should be 0.42 to 0.70 ohms. Removing the Glow Pin Support Screen
AMA578 Inspect the screen before removal for carbon buildup. The presence of carbon may indicate carbon buildup in the combustion chamber. AMA579 1 3 2 AMA581 4 AMA580 AMA582 1. Rubber bushing 2. Connector of glow pin cable harness 3. Glow pin 4. Glow Pin removal tool 3 Figure 86: Heater Casing Disassembly and Glow Pin Removal 4
AMA583 1. Remove the heater cover. 2. Remove the control unit. 3. Disconnect the connector of the glow pin cable harness from the controller. 4. Remove the rubber bushing and use the special tool to unscrew the glow pin. Do not cut the wires. The special tool is included with the glow pin. Tighten torque of the glow pin: 4.8 ft-lb. NOTE: When the
glow pin has been removed, check the screen of the support in installed state for any contamination. The screen must be replaced if the surface is covered with carbon. Glow Pin Clean and Test 1. Special tool with screen 2. Position of recess 3. Screen 4. Bore (Ø 2.7 mm) for glow pin ventilation Figure 87: Removing Glow Pin Support Screen 1. Pull the
screen out of the support with pointed pliers. Blow out the support with compressed air. If necessary, carefully pierce with a wire. 2. The special tool must be used to install the new screen. The special tool is included with the screen. Push the screen onto the special tool, watching the position of the recess. The recess must be positioned at right
angles (90°) to the axis of the heater. 1. Inspect the glow pin for physical damage. 2. Wipe off carbon residue with a rag. Brake-clean or other appropriate solvent may be used. 105 Sleeper Cab Air Heater Service Operations NOTE: The latest version of the screen is shorter and does not have the recess. Therefore, it is not necessary to consider its
alignment to the axis of the heater when installing the latest version of the screen (without the recess). Checking the Overheating / Flame Sensor Observe a maximum temperature of 320° C for checking the sensor. 1 3. Push in the tool with the screen carefully as far as it will go, ensuring that the bore (Ø 2.7 mm) for the glow plug ventilation is clear.
Removing the Overheating Sensor / Flame Sensor 3 4 2 AMA595 1. Connector blue 2. Connector green 3. NTC 50 ohm = overheating sensor 4. PT=flame sensor Figure 89: Checking Overheating / Flame Sensor 1 Overheating Sensor 2 AMA584 1. Cable harness for overheating/flame sensor 2. Clip Figure 88: Removing the overheating sensor / flame
sensor Check the overheating sensor with a digital multimeter. If the resistance value is outside the set point indicated in the values in the table, then the sensor must be replaced. (See table below.) Values for Overheating Sensor Temp. Temp. F C Resistance k ohms Minimum Resistance k ohms Maximum -40 -40 1597.0 1919.0 1. Remove the heater
cover -4 -20 458.8 533.4 2. Remove the control unit 32 0 154.7 175.5 3. Disconnect both connectors of the overheating / flame sensor cable harness from the control unit. 68 20 59.3 65.84 104 40 25.02 28.04 140 60 11.56 13.16 4. Unlock clip from sensor. 176 80 5.782 6.678 5. Remove overheating/flame sensor. 212 100 3.095 3.623 248 120 1.757
2.061 284 140 1.050 1.256 320 160 0.665 0.792 356 180 0.425 0.518 392 200 0.285 0.351 106 Sleeper Cab Air Heater Service Operations Flame Sensor Check the flame sensor with a digital multimeter. If the resistance value is outside the set point indicated by the values n the table, then the sensor must be replaced. (See table below.) Values for
Flame Sensor Temp. Temp. F C Resistance ohms Minimum Resistance ohms Maximum -40 -40 825.9 859.6 -4 -20 903.2 940.0 32 0 980.0 1020.0 68 20 1056.4 1099.5 104 40 1132.3 1178.5 140 60 1207.8 1257.1 176 80 1282.8 1335.1 212 100 1357.4 1412.8 248 120 1431.5 1489.9 284 140 1505.1 1566.6 320 160 1578.3 1642.8 392 200 1723.4 1793.7
464 240 1866.6 1942.8 536 280 2008.1 2090.0 608 320 2147.7 2235.4 680 360 2285.5 2378.8 752 400 2421.5 2520.3 Installing the Overheating / Flame Sensor 2. Place the sensor on the heat exchanger using the special tool. 3. The special tool slides on the heat exchanger until the sensor meets the collar (installation site of the sensor) 4. Lock the
sensor in place and remove the purpose made tool. It is important to make certain that the sensor sits flat on the heat exchanger. If necessary use a mirror and lamp to aid correct assembly. 5. Route the cable harness sensor along the clip eyelet to the control unit and connect. 2 1 AMA587 3 4 1 AMA588 3 1. Mount the special tool on the sensor. 1 2 2
1. Special tool 2. Overheating sensor / flame sensor Figure 90: Overheating Sensor and Flame Sensor AMA589 1. Special tool 2. Overheating sensor / flame sensor 3. Clip 4. Cable harness -overheat/ flame sensor Figure 91: Installing the overheating / flame sensor 107 Sleeper Cab Air Heater Service Operations Dismantling the Heat Exchanger and
Removing the Combustion Air Blower 1. Remove the heater cover. 2. Remove the control unit. 3. Remove the flange seal. 4. Take the heater out of the outer case (lower part). 5. Unscrew the 4 fastening screws from the combustion air blower. 3 2 6. Remove the combustion air blower and the seal from the heat exchanger. AMA590 1 IMPORTANT:
When reassembling the combustion air blower a new seal is always required. 7. Tighten the 4 fastening screws of the combustion air blower in the series shown in the drawing with a tightening torque of 3.3 ft-lb. AMA591 b d 5 AMA596 a c 1. Combustion air blower 2. Heat exchanger 3. Fastening screws 4. a - d: Tighten the fastening screws in this
sequence with a tightening torque of 3.3 ft-lb. 5. Always replace the seal between combustion air blower and heat exchanger Figure 92: Dismantling the Heat Exchanger and Removing the Combustion Air Blower 108 Sleeper Cab Air Heater Service Operations Removing the Combustion Chamber 1. Remove the heater cover. 2. Remove the flange seal.
3. Take the heater out of the outer case (lower part). • remove control unit (see previous pages) • remove glow pin (see previous pages) • remove combustion air blower (see previous pages) 4. Unscrew the 3 fastening screws. 5. Pull the combustion chamber out to the front and remove the seal from the heat exchanger. AMA592 2 1 NOTE: When
reassembling the combustion chamber, the thermal insulator must always be replaced. 3 6. Tighten the fastening screws of the combustion chamber with a torque of 4.8 ft-lb. AMA593 NOTE: If the heat exchanger is being replaced, the overheating sensor / flame sensor must be dismantled and mounted to the new heat exchanger. 4 1. Combustion
chamber 2. Heat exchanger 3. Fastening screws (3) 4. Thermal insulator (always replace) Figure 93: Removing the Combustion Chamber 109 Optional Power Inverter DANGER: Do not use an inverter in life support or health care applications where a malfunction or failure of the inverter could cause failure of a life support device or medical
equipment or significantly alter the performance of that equipment. DANGER: Potentially lethal voltages exist within the inverter as long as the battery supply is connected. During any service work, the battery supply should be disconnected. DANGER: Do not connect of disconnect batteries while the inverter is operating from the battery supply.
Dangerous arcing may result. CAUTION: Protect against possible electrical shock hazards. If the inverter is operated in wet or damp conditions a user-supplied, portable GFCI (ground fault circuit interruptor) must be connected between each inverter receptacle and the equipment it powers. CAUTION: You may experience uneven performance
results if you connect a surge suppressor, line conditioner or UPS system to the output of the inverter. 110 Optional Power Inverter A 12 volt DC to 120 Volt AC inverter is available as an option for TriPac. The inverter is normally connected directly to the truck batteries. Inverter features will vary, depending upon the brand and model used. Typically,
when the inverter detects an AC load, it automatically turns on and converts DC to AC to power onboard 120 Volt devices. If the TriPac is enabled and the inverter draws truck battery voltage down below the voltage limit established for the installation, the TriPac will start and attempt to recharge the truck batteries back to the level specified. If the
TriPac is not enabled, the inverter could drain the truck batteries below the level required to start the truck or the TriPac. Manufacturer’s instructions for the optional inverter are provided separately. It is important to read and follow those instructions for proper use of the inverter. Structural Maintenance Maintenance Inspection Schedule Pre-Trip
500 Hrs Annual 2,000 Hrs Check condition of or service the following: • • • Visually inspect unit for fluid leaks (coolant, oil, refrigerant). • • • Visually inspect unit for damaged, loose or broken parts. • • Inspect, clean and (if necessary) replace evaporator air filter. It may be necessary to check or replace it more often if conditions require it. • •
Inspect evaporator drain valves (kazoos) to ensure that they are in place, in good condition and are sealing. • Steam clean condenser and APU pre-cooler coil. Do not bend coil fins. • Blow out evaporator coil and evaporator water drains with air. Do not bend coil fins. • Check APU mounting bolts and brackets for cracks. damage and poor
alighment.Verify tightness and torque to 100 ft/lbs (135.6 N•m) for the claw mount, or 200 ft/lbs (271.2 N•m) for the direct frame mount. WARNING: Take precautions to ensure the unit will not accidentally start while you are servicing the system. Evaporator Coil Clean the coils during scheduled maintenance inspections. Remove any debris (e.g.,
paper or plastic wrap) that reduces the air flow. Clean dirty coils with compressed air. Be careful not to bend the fins when cleaning a coil. If possible, blow the air or water through the coil in the direction opposite the normal air flow. Repair bent fins and any other noticeable damage. Evaporator Coil Air Filter 1 2 3 4 AMA623 CAUTION: The air
pressure should not be high enough to damage coil fins. 1. Evaporator Coil Air Filter 2. Air Filter Cover 3. Front of Sleeper Compartment Bunk 4. Evaporator Drain Valve (Kazoo) Figure 95: Evaporator Coil Air Filter The evaporator coil air filter is accessible from inside the truck cab sleeper compartment. 1. Unscrew filter cover and remove the filter.
Figure 94: Evaporator (Cover Removed) 2. Using compressed air, blow in the direction opposite normal air flow to remove accumulated dust. 3. Wash filter material in warm soapy water. Flush water in the direction opposite to normal air flow. 111 Structural Maintenance Condenser Coil 4. Remove excess water and install filter. Replace filter if
necessary. Clean the coils during scheduled maintenance inspections. Remove any debris (e.g., leaves or plastic wrap) that reduces the air flow. Clean dirty coils with compressed air or a pressure washer. Be careful not to bend the fins when cleaning a coil. If possible, blow the air or water through the coil in the direction opposite the normal air flow.
Repair bent fins and any other noticeable damage. 5. Replace and secure filter cover. Evaporator Drain Valves 2 1 1 1. Evaporator Drain Valve 2. Evaporator Drain Valve Clamp AMA624 Figure 96: Drain Valves Two evaporator coil drain valves (“kazoos”) are accessible under the truck cab sleeper compartment exterior. Inspect each evaporator coil
drain valve to ensure that they each have a rubber check valve in place. Missing or damaged evaporator drain check valves may allow air to be drawn up the drains and prevent evaporator condensate water from draining. Also, dirt and engine fumes may be drawn up the drains. Install new check valves if they are missing. Replace them if they are
damaged or hardened. Loosen and remove the drain valve clamps to replace the drain valves. 112 AMA550 Figure 97: Condenser APU Mounting Bolts Check during the pretrip inspection for damaged, loose or broken parts. Torque the unit mounting bolts yearly to 100 ft/lbs (135.6 N•m) for the claw mount, or 200 ft/lbs (271.2 N•m) for the direct
frame mount. TriPac System Components Diagrams Figure 98: TriPac System Components 113 TriPac System Components Diagrams Figure 99: TriPac System Components for Optional Closed Loop Cooling System 114 Index A about this manual 5 air conditioning system general service procedures 80 alternator diode quick check 51 field current test
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Page 1 of 2 12 11 10 9 8 7 6 5 4 3 2 1 REVISIONS CHANGE ORDER REV 1 P1 2A STANDBY IGN NORMAL F19-1A 2A A A 2A SBY B B SBY RELEASED 19-APR-13 P LOOMIS 741335 B UPDATED SYMBOLS, FLD2 AND FLD3 SIGNALS 17-JUL-13 P LOOMIS FLD2 HSEN_RTN HSEN_LO STANDBY WITH SWITCH OPTION 2 PART OF 120A
ALTERNATOR OPTION 3 NOT USED WITH CLOSED LOOP OPTION STANDBY WITHOUT SWITCH OPTION, 2A WIRE IS 4 B5 B5 B3 B3 B2 B2 B4 B4 FLD3 HSEN_PWR WT2-RTN B1 B1 A5 A5 A4 A4 FLD1 HSEN_HI A2 A2 WT2 MAIN LOW POWER J14 A3 A3 J6 A1 A1 J3 FS2 B10 B8 B8 B6 B6 B7 B7 B5 B5 B4 B4 B3 B3 B2 B2 B1 B1 B10 WT1
COILSEN_RTN 2A 8X_SW D+ FS1 COILSEN 8X 8D2 WT1-RTN A7 A7 A9 A9 A10 A10 A8 A8 A6 A6 A5 A5 A4 A4 A3 A3 J1 6 A2 A2 5 A1 A1 4 5 6 4 3 3 MAIN HIGH POWER J5 RED 1 ABSENT AND WIRE 'SBY' IS CONNECTED TO F19 5 MAIN LOW POWER J6 OPTIONAL HEATER TEMPERATURE CONTROL SENSOR 6 OPTIONAL ENGINE HOUR
METER 7 OPTIONAL HEATER HIGH PRESSURE SENSOR G J15 BLK J14 HEATER TEMP SENSOR 5 2 J2 8D 2-01 E G J5 OPTIONAL 1 COILSEN_RTN 2A - LOPS COILSEN SBY D SEN C D 8DP C PCF COILSEN COILSEN_RTN CH-01 7CLA 8S 7CL B H1 A B 7CL P1 A B9 B9 J3 7CL 7CLA S2 7CLA1 7CLA2 2 + A H OPTIONAL ENGINE HOUR METER
CH APPROVED 653630 4 OPTIONAL STANDBY SWITCH 6 DATE SBY IGN 1 H P2 DESCRIPTION CAB SECTION J3 1 1 CANL CH-07B 1 1 1 1 CH 2 2 CANH FAN2 2 2 1 1 7CF 2 2 2A 3 3 SHLD FAN3 3 3 2 2 7CLA1 3 3 4 4 FAN1 4 4 3 3 7CLB 4 4 5 5 2P 4 4 ATS 5 5 6 6 8XP J1 5 5 ATS_RTN 6 6 7 7 OFF EVAP FAN 6 6 7CF_RTN 8 8 CH S06 RED RED 2
P13 FLD + - BLK RED P14 P8 P8 H2 1 1 CH-02 2 2 S02 2-01 P15 T9 + POS ALTERNATOR 12VDC BLK T4 GND S05 S03 B 8D CH-04 P7 A A B B P3 B A A B FLD P16 P16 A A B B A FLYWHEEL B SENSOR P11 - A A PCF B B CH-03 WATER TEMP SENSOR 2 3 FUEL SOLENOID A WT2 B B WT2-RTN A RED A A WT1 B B WHT B B WT1-RTN CH-05 C C
BLK H 14 12 13 14 SPLICE TO HTR HARNESS 11 12 13 11 9 10 8 10 9 8 6 7 7 6 4 3 5 5 4 3 J13 1 2 2 RED GREY/RED GREY BLK BLU/WHT BLUE-YELLOW BROWN/WHITE YEL 6 6 7 7 8 8 9 9 7 E AIR PRESSURE SENSOR FAN2 FAN1 P4 A A B B P10 3+ T2 2+ T1 MIN 1+ 3 4 4 5 5 6 6 BROWN/WHITE 7 BRN GREY 7CF A A B B 8 9 9 10 10 11 11 7CL
A A B B SENSOR C 13 15 15 P2 7CLA2 HEATER TEMP 14 14 + CFM - 16 16 F28-5A RED S01 P2 7 8 HEATER 12 12 P1 7CF_RTN RED B2 RED RED RED HPCO S02 BRN BRN BRN BRN 2 S2 RED 1 1 YEL 2 2 3 3 4 4 BRN 5 5 BLU/WHT 6 6 7 7 8 8 BRN P10 THIS DRAWING MAY BE USED ONLY BY ITS RECIPIENTS FOR A 8X B B 8X_SW 1 THE
PURPOSE FOR WHICH IT IS PROVIDED AND ONLY BY THE RECIPIENT, WHO AGREES THAT IT WILL NOT, TRUCK FUEL TANK P9 A 7CLA WITHOUT INGERSOLL-RAND'S PRIOR WRITTEN PERMISSION: 1) DISCLOSE NOR USE THIS DRAWING OR THE INFORMATION B3 S3 IN IT EXCEPT AS SPECIFIED ABOVE; OR 2) MAKE ANY 1 1
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DIAGNOSTIC CONNECTOR Thermo King REGARDING EXPORTING INFORMATION OUTSIDE OF THE U.S. A P9 COMPRESSOR CLUTCH 9 1 2 YEL GREY/RED EVAPORATOR SECTION S1 1 GRN/RED ATS_RTN FUEL METER PUMP 10 YEL HEATER SECTION COIL TEMP SENSOR T4 T6 11 5 B1 DRAWN M SHASIDHAR DATE 1-FEB-13 CHECKED
M VANOUS 19-APR-13 APPROVED P LOOMIS 19-APR-13 ENG APPVL REQUEST. 12 4 5 RED INGERSOLL-RAND IS THE SOLE OWNER OF THIS DRAWING GLOW PLUG 1 OIL PRESSURE SWITCH LOPS 4 LPCO COPYRIGHT AND OTHER LAWS AND MAY BE SUBJECT TO LAWS P12 1 B AND ALL INFORMATION IN IT, WHICH ARE PROTECTED BY
ENGINE ON/OFF SWITCH 1 3 P6 WATER TEMP SENSOR 1 A P12 A B COILSEN_RTN P1 ATS A FAN3 ORG P4 8D1 H 2 3 13 2 P5 PRECOOLER FAN GLOW PLUG 2 S04 CH LOAD SHED RESISTOR HIGH CONDENSER SECTION 8DP A OFF CH-07 P3 B 1 J13 8 8 7 7 6 6 4 5 5 4 3 3 2 1 2 AMBIENT TEMP SENSOR A 2 BLU/WHT BLU/WHT D+ B A
COILSEN A + FS2 YEL YEL 1 BLUE-YELLOW ORG CH P3 7CLB CH-07A P4 LOAD SHED RESISTOR LOW FLD FLD3 FUEL PUMP FS1 P11 H1 H2 1 T4 P15 ENGINE GND T1 P7 8D2 8D1 J34 J34 J9 J9 B3 B3 B1 B1 CH T8 RED FLD2 PREHEAT BUZZER RED RED MAX 4+ T3 F FRAME GND MOTOR E F T7 F16-50A P3 - EFM + E CH-06 SEN CH-07A
CH-07B D S01 S1 C D BLK T2 B C F15-3A SEN 2A B CH-05 8S P13 CH-03 1 A A A P17 1 FLD1 CH-02 CH-01 P17 J5 J5 BRN 1 D RED RED SEN CH-06 STARTER SOLENOID STARTER 8XP HSEN_LO 2P 4 ON 4 RED SHLD HSEN_RTN CANL HSEN_PWR 3 CANH HSEN_HI 2 3 RED 1 2 SENSOR T3 D 1 CURRENT CH-04 BAT_NEG A BAT_POS BATTERY
12VDC RED HTR CNTL J13 GREEN DPF JUMPER PLUG (NON DPF MODE) S4 B4 HMI J34 BRN J4 2A1 RED C GND RED J4 2 J16 HTR PWR B2 B2 J4 RED RED A3 A3 2A RED F29-200A A2 A2 J4 F30-3A A1 A1 E 8D J9 DPF J4 F J3 HOUR METER / TEST POINTS 2 ON J39 USB J2 J2 J3 2 CONTROLLER INTERFACE BOARD J2 AC HARNESS 1 HMI J1 J1
1 F P1 2 P1 8 7 6 5 TITLE DIAGRAM WRING TRIPAC SIZE CODE IDENT NO A1 SIZE : NONE 4 3 2 DWG NO REF DWG : A REV B 2E32871 SHEET : 1 1 OF 2 TriPac EVOLUTION Wiring Diagram - Page 2 of 2 10 J 9 8 FROM 12VDC WHEN TRUCK IGNITION IS ON 7 TO STANDBY INTEGRATION SWITCH F26-1A IGN 6 A A 2A B B SBY 5 S09 SBY 4 3
2 1 J SBY1 IGN AC HARNESS MAIN HARNESS I FS2 WT1 COILSEN_RTN 2A 8X_SW D+ B4 B4 FS1 B1 B1 B3 B3 COILSEN A10 A10 WT1-RTN A9 A9 8X 8D2 LOPS A5 A5 SBY A4 A4 SEN A2 A2 A3 A3 A1 A1 PCF D H D 8DP COILSEN CH-01 7CLA C 8S 7CL B C 7CLA A B B10 B10 B9 B9 B6 B6 B8 B8 B7 B7 B5 B5 B2 B2 6 6 A6 A6 5 5 DPF CONTROL
SECTION MAIN LOW POWER J5 H A7 A7 4 4 MAIN HIGH POWER A8 A8 3 J14 2 3 J14 1 2 COILSEN_RTN J5 A 1 I P1 J5 J3 J14 H J2 5 5 ATS_RTN 6 6 J1 4 4 P8 B1 FAN1 2B-01H 2B-01G P CAN1 1 CAN2 2 CAN INTERFACE DPF CONNECTOR F EPN-1 EPN-2 *null* RED *null* 87A RED F24-150A 30 86 BAT_NEG BATTERY 12VDC 87A SBY2 CH09A
S08 2B-01F 2B-01D 87 30 86 2B-01E 2B-01C 7A7X 2B-01B 2B-01C 63 63-01 85 67 S04 E EPN *null* 87A 7A-01 87 2B 2B1 85 BATTERY SECTION *null* 87A 2C-01 2C 87 BLK BAT_POS EP1 C CAB SECTION E RED EPN-1 B C G B3 B3 3 B2 B2 2 3 B1 2 FAN3 8-02 FAN2 RRSW YEL-1 YEL A B P EVAP FAN J1 SBY2 1 7A-01 1 A3 A3 6 A EP1 P7 8-01A 5
EPN 7CF_RTN CH-07B P1 PARTIAL SECTION A2 A2 C YEL-1 ATS 8D-01 B C B 2B-01D P3 A A P5 4 J1 CH09B CH09A 8 RED 4 INTERFACE BOARD A1 4 7 D 7CLB J4 RED/PPL BLU/WHT GRN/WHT 3 F 7CLA1 3 2B1 2B-01G 2B-01A 2 G 7CF 2 3 A1 1 1 2 7A7X DPF DRIVER SWITCH 1 J4 AC HARNESS J2 J15 CAB DISPLAY P1 87 30 86 2B-01B 2B-01A
85 63-01 30 86 SBY1 85 S05 CH-09 8-02 8-01A 8-01 P1 2B-01 2B-01H EPN 64 8-01 2 2 3 3 2C 4 5 5 6 6 RRSW 7 7 RED 2B - RED HTRV P1 C P DPF HEATER ENGINE SECTION RED RED BLK 1 1 2 2 P3 AIR SOLENOID 2C-02 S07 CH09E 2C-01 2C-03 1 1 2C-03 BLK 2 2 CH09D S06 CH09B CH09E CONTROLLER 14 14 15 15 IGN 17 17 C P 18 18
CAN2 19 19 69 21 21 63 22 22 20 20 67 23 23 64 24 24 SECM CONNECTOR P3 RED ET BLK P2 12 12 16 16 BRN C P2 DPF 11 11 13 13 B S01 EP1 8 9 EPN-2 B + B 2B-01E CH-09 HTRV - EPN S02 B A BLOWER TriPac A 2B-01 AMBIENT TEMP SENSOR +T1 YEL S03 BRN BLK RED T3 CONTACTOR F25-10A T2 8 9 10 10 69 APU PRESSURE
TRANSDUCER D 4 EP1 CAN1 DPF VALVE BOX SECTION C P1 1 8D-01 ET BLK 1 DPF OPTION A A Thermo King SIZE CODE IDENT NO DWG NO A1 SIZE : NONE 10 9 8 120 7 6 5 4 3 2 REF DWG : REV 2E32871 SHEET : 1 B 2 OF 2 TriPac EVOLUTION Schematic Diagram - Page 1 of 2 1 2 3 4 5 6 7 STANDBY WITH SWITCH OPTION NOTES : 1
OPTIONAL INTERIOR LIGHT CONNECTION CUSTOMER SUPPLIED COMPONENT 3 FOR DPF OPTION SEE SHEET 2. 2 4 STANDBY WITHOUT SWITCH OPTION, 2A WIRE IS ABSENT OPTIONAL REMOTE HEATER TEMPERATURE CONTROL SESNOR. OPTIONAL ENGINE HOUR METER. AND WIRE "SBY" IS CONNECTION TO F6. 5 6 7 WITH
DPF OPTION SBY WIRE FROM INTEGRATION OPTION WITH DPF REMOVE JUMPER PLUG(J4), REPLACE WITH DPF HARNESS. OPTIONAL HIGH PRESSURE ALTITUDE SENSOR 9 8 10 BE AWARE IN RETROFIT SITUATION THERE IS SPLICED INTO DPF HARNESS. 11 INCLUDED IN 120A ALTERNATOR OPTION POSITION, 12VDC IS APPLIED
TO THE SBY TERMINAL ON THE TO BE TEMPORARILY DISABLED. WHEN THE IGNITION IS IN THE ON THIS CONTROLLER HAS AN OPTIONAL MODE THAT ALLOWS THE SYSTEM MAY BE REDUNDANT FUSING FOR CERTAIN I/O. 12 13 7X SBY IGN RELEASED 23/May/2013 HM1 HEATER ESPAR D2 HIGH PRESSURE CUTOUT SWITCH HMI
CONTROLLER 30-31 LOCATION HPCO HEATER TEMP SWITCH (ESPAR) DESCRIPTION HTR LOW PRESSURE CUTOUT SWITCH CODE HTS LOCATION 35 11-12 LPCO ON RELAY, INTERFACE BOARD OIL PRESSURE SWITCH DESCRIPTION 24 9-10 OR OPS 20 22 CODE 23-24 PRE-COOLER FAN CFM BATT ATS CONDENSER FAN MOTOR
BATTERY AMBIENT TEMP SENSOR SBY 26-27 PR STARTER MOTOR RUN RELAY, INTERFACE BOARD PREHEAT RELAY, INTERFACE BOARD STARTER RELAY, INTERFACE BOARD RR SR SM SS 22 28 SSW 13-14 15 WATER TEMP SENSOR 1 F29-200A FLD L GND ALT S B+ FLD 8D 8DP H 8D (SEE LOCATION 19 FOR BOARD CONNECTIONS)
HALL CURRENT SENSOR RED 0-25Amp 0-200Amp F30-3A STANDBY SWITCH STARTER SOLENOID 21-22 WATER TEMP SENSOR 2 F18-3A ON OFF ESW FWS WT1 CTS LSR_HI FLYWHEEL SENSOR 12 WT2 - 33 29-33 24-25 14 14-15 16 21-22 11 12 20-21 9-10 19 14 BATT 2 CH CH CH CH-07 CH CH-01 CH-03 CH-05 CH-02 CH CH FP SM M - +
STARTER SS - PHB GP2 GP1 OPS + FSP FSH CLU LPCO + EFM GRN/RED FUEL PUMP ENABLE EWP DIAG SET POINT 17-APR-2013 S.P.RETURN EXT SENSE RETURN DATE REVISIONS REV A TRIPAC +12V POWER RELEASED 653630 CHANGE ORDER 1 HTR 2 3 4 6 5 7 14 13 12 11 10 9 8 BRN/WHT GRY BLU/WHT BRN BLU/WHT GRY/RED
YEL YEL BLU/YEL RED CH BATT SHEET2 (LOC 13) DPF OPTION WT2 FS2 FS1 COILSEN FLD2 RED WT1 A9 FLD3 PCF 7CLA MED LOW CH 19-20 A10 B3 HSEN_PWR + HPCO H 15-16 8X D+ 2A RED (SHEET2 LOC 13) DPF OPTION J14 A2 B3 B1 A1 2A SEN B7 A3 D+ 8X WT1 8X_SW COILSEN_RTN B8 B9 B10 WT1_RTN B4 A7 A6 FS1 B6 8D LOPS
A4 WT2 0-25Amp 0-200Amp 7CL CFM - (SEE LOCATION 10 FOR BATT CABLE POSITION) + 12 7CF_RTN ATS HIGH H/W FMP 23-24 15-16 PREHEAT BUZZER AIR PRESSURE SENSOR (ESPAR) COMPRESSOR CLUTCH PCF ALTERNATOR EVAP COIL TEMP SENSOR PHB APS CLU 25-27 32-34 ALT CTS EVAPORATOR FAN MOTOR DIAGNOSTIC
CONNECTOR (ESPAR) ENGINE HOUR METER (OPTION) 2 - R172- 300%%185 OR WT1 NC COILSEN_RTN NC WT1_RTN 8X_SW FS2 COILSEN B2 A8 NC A5 NC NC B5 A4 NC LOPS 8D A1 8S HSEN_RTN 1 H HALL CURRENT SENSOR LSR_LO FLD2 B1 12 FLD3 A5 FLD1 WT2 HSEN_HI HSEN_LO A3 J6 WT2_RTN B2 WT2_RTN HSEN_PWR A2 B5
HSEN_HI HSEN_RTN B4 8S 3 PCF 8DP J5 NC HSEN_LO FLD 26 EFM DIAC EHM GLOW PLUG 1 & 2 FLYWHEEL SENSOR 2A SBY J15 7X - - F16-50A FUEL SOLENOID PULL IN COIL FUEL PUMP FUEL METERING PUMP (ESPAR) FUEL SOLENOID HOLD COIL ENGINE ON/OFF SWITCH FSH ESW FMP FP FWS FSP GP1-GP2 SSW STANDBY
NORMAL 1 F5-5A F8-7.5A F9-5A FET RR SR PR H 4 7CL 7CF FAN3 BRN F28-5A GRY 15 16 1 DIAC 2 ABOVE; OR 2) MAKE ANY COPIES OF OR EXTRACTS, DIAGNOSTIC CONNECTOR - SHEET 1 OF 2 REF DWG: SCALE: NONE P LOOMIS APPROVED 1 2 REV 2E32872 A DWG NO CODE IDENT NO P LOOMIS HAVE BEEN PROVIDED OR UPON
ANY EARLIER REQUEST. D UPON COMPLETION OF THE WORK FOR WHICH THEY ENG APPVL COPIES MUST BE RETURNED TO INGERSOLL-RAND 26-FEB-13 SIZE 17-APR-13 REVISIONS, OR UPDATES FROM THE DRAWING. ALL APPROVED OR THE INFORMATION IN IT EXCEPT AS SPECIFIED 17-APR-13 PERMISSION: 1) DISCLOSE NOR
USE THIS DRAWING REGARDLESS OF THE IGNITION SWITCH POSITION.THE DISPLAY B1 8FET 7A F6-5A F19-1A 1 POWER SUPPLY A1 J4 B3 8S 6 CH-01 8DP 5 2 CH PCF 7CLA J2 1 7CF 2 7CF_RTN 7CLB 3 FAN1 FAN2 RED RED BRN HTS YEL RED 3 5 4 6 7 BRN 8 THE RECIPIENT, WHO AGREES THAT IT WILL NOT, CHECKED PURPOSE FOR
WHICH IT IS PROVIDED AND ONLY BY M SHASHIDHAR MAY BE USED ONLY BY ITS RECIPIENTS FOR THE M VANOUS WITHOUT INGERSOLL-RAND'S PRIOR WRITTEN SCHEMATIC DIAGRAM INFORMATION OUTSIDE OF THE U.S. THIS DRAWING TITLE DATE DRAWN BE SUBJECT TO LAWS REGARDING EXPORTING A PROTECTED BY
COPYRIGHT AND OTHER LAWS AND MAY WILL SHOWN "SBY" WHENEVER IN STANDBY MODE. 2A 9 B2 8 H J16 7CL 7CLA 3 2 ATS_RTN ATS 6 4 CH ATS 5 7CLB ATS_RTN 4 J1 1 FAN3 FAN1 2 1 YEL CH-07 CH-07 FAN2 1 J9 RED 2 BLU/YEL J13 BRN 26 GRY/RED BRN/WHT BLU/WHT 3 4 BRN GRY 5 7 6 8 9 10 13 14 11 12 SEN CONTROL
BOARD AND THE SYSTEM GOES INTO STANDBY MODE RED GREEN A3 8D F1-30A F3-30A F7-40A F10-15A F13-7.5A F17-2A GROUND PLANE F11-20A F12-20A RED DO NOT MANUALLY UPDATE DRAWING AND ALL INFORMATION IN IT, WHICH ARE CAUTION : STANDBY MODE SHOULD NEVER BE USED TO DISABLE THE SYSTEM WHEN
PERFORMING MAINTENANCE. IGN FROM 12VDC WHEN TRUCK IGNITION IS ON FOR DPF OPTION JUMPER PLUG REMOVED A2 2A F90-20A F15-2A REAL TIME CLOCK 2A 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 2 J3 26 CH F14-5A + 3 4 5 6 24 2A 6 2A 1 8D 3 4 2 8X 8 25 EHM + -- CAD GENERATED DRAWING, BLU/WHT 121 26 8D E -
8D CH 8FET SEN CANL F4-2A BRN 5 1 CANH 9 6 2 RED + + F2-2A 6 27 1 28 2 29 3 CANL HMI 4 CANH 30 31 3 J34 CANL 4 2P 8XP RED 5 ON SHLD -- ON 5 SHLD 2P 6 INTERFACE BOARD APS YEL 7 CANH 8XP 7 8 BLU/WHT 5 + TO CONTROLLER CIRCUITS BRN 4 32 33 OFF 8 3 BRN RED 2 6 7 8 RED 1 7 2P B BLK B 8 8XP INGERSOLL-RAND
IS THE SOLE OWNER OF THIS A CH BLU/WHT C C 34 35 RED D CH OFF D 1 2 3 4 5 6 7 8 TriPac EVOLUTION Schematic Diagram - Page 2 of 2 1 2 3 4 ASIR - 2B CODE DPF HEATER CONTACTOR STANDBY INTERRUPT RELAY 28 13-14 13 32 33-34 14 30-31 20 33-34 22 ALT 17 16-17 20-22 26 25-34 18 8D-01 8-01 8-02 7A-01 7A7X SBY2
LOCATION RELEASED 23/May/2013 DESCRIPTION ASOL AIR SOLENOID RELAY AIR SOLENOID CAB DISPLAY BLOWER AMBIENT TEMP SWITCH ASR ATS BLW CABD CAN CONNECTOR ENGINE START INTERRUPT RELAY EXHAUST PRESSURE TRANSDUCER DRIVER SWITCH EPT DS CCON ESIR DPF HEATER FAULT RELAY ENGINE
ON/OFF SWITCH HC INTERFACE BOARD FR ESW IFB HTR STANDBY SWITCH 7A7X 2C RED SMALL ENGINE CONTROL MODULE SIR SECM SSW DS 2A ESIR CUT SBY WIRE FROM MAIN HARNESS TO PCB 7A-01 8-02 2C 2C J14 RRSW 2A SBY - BLW + - - - - - DS HTR ASOL FR SIR ESIR + + + HC ASR + + 1 CCON 2 DS CH-09 BLK CH-09 CH-
09 CH-09 2B-01 2B-01 2B-01 2B-01 2B-01 2B-01 DPF OPTION ONLY J4 A2 INTERFACE BOARD PART OF B3 B1 A2 A3 B2 A1 63 69 67 64 63 B3 YEL SCALE: NONE REF DWG: - SHEET 2 OF 2 A D REV 2E32872 DWG NO CODE IDENT NO SIZE 1 2 5 6 7 8 2B F25-10A HC - 2B-01 9 10 11 12 SSW 2A STANDBY NORMAL SIR SBY2 FR 2B-01 63 64 67
69 YEL RED CAN1 CAN2 CH-09 EPN CABD 2B-01 BLK, BATT SHEET1 (LOC 9) BLK 13 F24-150A 2A 1 RED SPLICE SBY WIRE FROM MAIN HARNESS TO DPF SBY1 8-01 A A 14 15 16 17 18 19 20 21 2C 2C 3 4 5 6 8-01 8-01 SECM 22 24 23 21 12 11 6 19 1 14 YEL 22 2 13 7 2B-01 4 18 8-01 17 P RRSW 15 3 HTRV 8 IGN 8D-01 5 2C EP1 ET RED 23
HTRV B B 24 25 ATS ET RED YEL CH-09 122 26 EPN P EPN POWER INPUTS 27 28 29 30 31 32 EPT EP1 EPN RRSW D EPN OUTPUTS CAN GROUND 7 8 33 34 35 + C C + P FROM 12VDC WHEN TRUCK IGNITION IS ON IGN IGN RED, BATT SHEET1 (LOC 9) RED D D1 F26-1A FROM 12VDC WHEN TRUCK IGNITION IS ON IGN IGN IGN EPN 1 2
3 4 5 6 7 8 F19-1A SBY Maintenance Manual Ingersoll Rand’s Climate Solutions sector delivers energy-efficient HVACR solutions for customers globally. Its world class brands include Thermo King, the leader in transport temperature control and Trane, a provider of energy efficient heating, ventilating and air conditioning systems, building and
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information Temperature Management to be placed here System TK 5XXXX-X-PL TK 55675-19-MM (Rev. 1, 03/14)

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