***TECHNICAL MANUAL***
***888-2499-001***
***HIGH POWER DX***
***PUMP MODULE***
***994-9772-001***

T.M. No. 888-2499-001 Rev.D

# *Manual Revision History*

## ***High Power DX Pump Module Technical Manual***

| REV. | DATE | ECN | Pages Affected |
|---|---|---|---|
| Preliminary | - | - | Created |
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| A | - | - | Release Rev. A |
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| C | 01/14/2010 | P46347 | Title page, MRH-1 and pages 1-4 thru 1-10 |
| D | 09/01/2011 | P50947 | Rex Sandidge Revisions |

## Technical Assistance

Technical and troubleshooting assistance for HARRIS Transmission products is available from HARRIS Field Service (factory location: Quincy, Illinois, USA) during normal business hours (8:00 AM - 5:00 PM Central Time). Telephone ***+1-217-222-8200*** to contact the Field Service Department; FAX ***+1-217-221-7086***; or E-mail questions to ***tsupport@harris.com.***
**Emergency service is available 24 hours a day, seven days a week, *by telephone only*.**
Online assistance, including technical manuals, white papers, software downloads, and service bulletins, are available at ***http://www.broadcast.harris.com*** (from there, click on ***Customer Support Portal*** under the ***Services & Support*** tab dropdown menu)**.**
Address written correspondence to Field Service Department, HARRIS Broadcast Communications Division, P.O. Box 4290, Quincy, Illinois 62305-4290, USA. For other global service contact information, please visit: ***http://www.broadcast.harris.com/contact***.
**NOTE:** For all service and parts correspondence, you will need to provide the Sales Order number, as well as the Serial Number for the transmitter or part in question. For future reference, record those numbers here: ___________________/____________________
Please provide these numbers for any written request, or have these numbers ready in the event you choose to call regarding any Service, or Parts requests. For warranty claims it will be required, and for out of warranty products, this will help us to best identify what specific hardware was shipped.

## Replaceable Parts Service

Replacement parts are available from HARRIS Service Parts Department 7:00 AM to 7:00 PM Central Time, Monday through Friday, and 8:00 AM to 1:00 PM Central Time on Saturday. Telephone ***+1-217-222-8200*** or email ***servicepartsreq@harris.com*** to contact the Service Parts Dept.
**Emergency replacement parts are available *by telephone only***, 24 hours a day, seven days a week by calling +***1-217-222-8200***.

## Unpacking

Carefully unpack the equipment and perform a visual inspection to determine if any apparent damage was incurred during shipment. Retain the shipping materials until it has been verified that all equipment has been received undamaged. Locate and retain all PACKING CHECK LISTs. Use the PACKING CHECK LIST to help locate and identify any components or assemblies which are removed for shipping and must be reinstalled. Also remove any shipping supports, straps, and packing materials prior to initial turn on.

## Returns And Exchanges

No equipment can be returned unless written approval and a Return Authorization is received from HARRIS Broadcast Communications Division. Special shipping instructions and coding will be provided to assure proper handling. Complete details regarding circumstances and reasons for return are to be included in the request for return. Custom equipment or special order equipment is not returnable. In those instances where return or exchange of equipment is at the request of the customer, or convenience of the customer, a restocking fee will be charged. All returns will be sent freight prepaid and properly insured by the customer. When communicating with HARRIS Broadcast Communications Division, specify the HARRIS Order Number or Invoice Number.

**WARNING:**
*THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY WARNINGS, INSTRUCTIONS AND REGULATIONS.*

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks. During installation and operation of this equipment, local building codes and fire protection standards must be observed.

The following National Fire Protection Association (NFPA) standards are recommended as reference:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

**WARNING:**
*ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.*

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don’t take chances.

**WARNING:**
*IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.*

**WARNING:**
*IF OIL FILLED OR ELECTROLYTIC CAPACITORS ARE UTILIZED IN YOUR EQUIPMENT, AND IF A LEAK OR BULGE IS APPARENT ON THE CAPACITOR CASE WHEN THE UNIT IS OPENED FOR SERVICE OR MAINTENANCE, ALLOW THE UNIT TO COOL DOWN BEFORE ATTEMPTING TO REMOVE THE DEFECTIVE CAPACITOR. DO NOT ATTEMPT TO SERVICE A DEFECTIVE CAPACITOR WHILE IT IS HOT DUE TO THE POSSIBILITY OF A CASE RUPTURE AND SUBSEQUENT INJURY.*

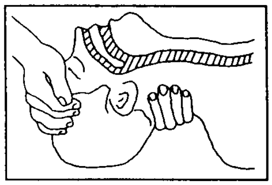
# TREATMENT OF ELECTRICAL SHOCK

1. IF VICTIM IS NOT RESPONSIVE FOLLOW THE A-B-CS OF BASIC LIFE SUPPORT.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

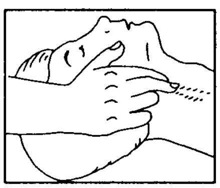
## (A) AIRWAY

IF UNCONSCIOUS,
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

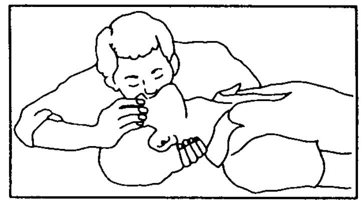
CHECK
CAROTID PULSE



IF PULSE ABSENT,
BEGIN ARTIFICIAL
CIRCULATION

## (B) BREATHING

IF NOT BREATHING,
BEGIN ARTIFICIAL BREATHING



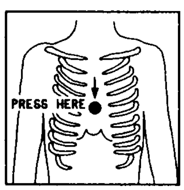
TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL

4 QUICK FULL BREATHS

REMEMBER MOUTH TO MOUTH
RESUSCITATION MUST BE
COMMENCED AS SOON AS POSSIBLE

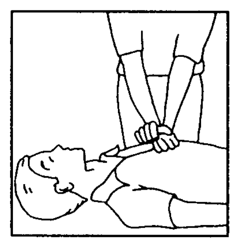
## (C) CIRCULATION

DEPRESS STERNUM 1 1/2 TO 2 INCHES




APPROX. RATE OF COMPRESSIONS --80 PER MINUTE { ONE RESCUER: 15 COMPRESSIONS, 2 QUICK BREATHS

APPROX. RATE OF COMPRESSIONS --60 PER MINUTE { TWO RESCUERS: 5 COMPRESSIONS, 1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS
WHEN SECOND PERSON IS GIVING BREATH

CALL FOR MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

2. IF VICTIM IS RESPONSIVE.

   A. KEEP THEM WARM
   B. KEEP THEM AS QUIET AS POSSIBLE
   C. LOOSEN THEIR CLOTHING
   D. A RECLINING POSITION IS RECOMMENDED

# FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is a brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and there by prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin
    a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
    b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
    c. Treat victim for shock as required.
    d. Arrange transportation to a hospital as quickly as possible.
    e. If arms or legs are affected keep them elevated.

**NOTE:**
If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)
    a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
    b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
    c. Apply clean dry dressing if necessary.
    d. Treat victim for shock as required.
    e. Arrange transportation to a hospital as quickly as possible.
    f. If arms or legs are affected keep them elevated.

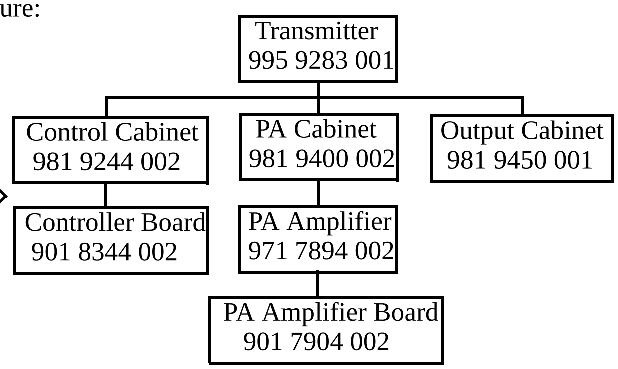
REFERENCE:
ILLINOIS HEART ASSOCIATION
AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

# Guide to Using Harris Parts List Information

The Harris Replaceable Parts List Index portrays a tree structure with the major items being leftmost in the index. The example below shows the Transmitter as the highest item in the tree structure. If you were to look at the bill of materials table for the Transmitter you would find the Control Cabinet, the PA Cabinet, and the Output Cabinet. In the Replaceable Parts List Index the Control Cabinet, PA Cabinet, and Output Cabinet show up one indentation level below the Transmitter and implies that they are used *in* the Transmitter. The Controller Board is indented one level below the Control Cabinet so it will show up in the bill of material for the Control Cabinet. The tree structure of this same index is shown to the right of the table and shows indentation level versus tree structure level.

Example of Replaceable Parts List Index and equivalent tree structure:

| Replaceable Parts List Index | | Part Number | Page |
|---|---|---|---|
| Table 7-1. | Transmitter | 995 9283 001 | 7-2 |
| Table 7-2. | Control Cabinet | 981 9244 002 | 7-3 |
| Table 7-3. | Controller Board | 901 8344 002 | 7-6 |
| Table 7-4. | PA Cabinet | 981 9400 002 | 7-7 |
| Table 7-5. | PA Amplifier | 971 7894 002 | 7-9 |
| Table 7-6. | PA Amplifier Board | 901 7904 002 | 7-10 |
| Table 7-7. | Output Cabinet | 981 9450 001 | 7-12 |




The part number of the item is shown to the right of the description as is the page in the manual where the bill for that part number starts. Each table headings is in the format of; **Table #-#. ITEM NAME - HARRIS PART NUMBER** - this line gives the information that corresponds to the Replaceable Parts List Index entry;

Inside the actual tables, four main headings are used:

- **HARRIS P/N** column gives the Harris part number (usually in ascending order);
- **DESCRIPTION** column gives a 25 character or less description of the part number;
- **Qty UM** column notes the quantity and unit of measure of the item;
- **REF. SYMBOLS/EXPLANATIONS** column 1) gives the reference designators for the item (i.e., C001, R102, etc.) that corresponds to the number found in the schematics (C001 in a bill of material is equivalent to C1 on the schematic) or 2) gives added information or further explanation (i.e., “Used for 208V operation only,” or “Used for HT 10LS only,” etc.).

**NOTE: Inside the individual tables some standard conventions are used:**

- A # symbol in front of a component such as #C001 under the REF. SYMBOLS/EXPLANATIONS column means that this item is used on or with C001 and is not the actual part number for C001.
- In the ten digit part numbers, if the last three numbers are 000, the item is a part that Harris has purchased and has not manufactured or modified. If the last three numbers are other than 000, the item is either manufactured by Harris or is purchased from a vendor and modified for use in the Harris product.
- The first three digits of the ten DIGIT part number tell which family the part number belongs to - for example, all electrolytic (can) capacitors will be in the same family (524 xxxx 000). If an electrolytic (can) capacitor is found to have a 9xx xxxx xxx part number (a number outside of the normal family of numbers), it has probably been modified in some manner at the Harris factory and will therefore show up farther down into the individual parts list (because each table is normally sorted in ascending order). Most Harris made or modified assemblies will have 9xx xxxx xxx numbers associated with them.

The term “SEE HIGHER LEVEL BILL” in the description column implies that the reference designated part number will show up in a bill that is higher in the tree structure. This is often the case for components that may be frequency determinant or voltage determinant and are called out in a higher level bill structure that is more customer dependent than the bill at a lower level.

HARRIS Broadcast Communications Division
P.O. Box 4290, QUINCY, IL 62305

# PARTS ORDER FORM

HARRIS PHONE: 217-222-8200
HARRIS FAX: 217-221-7096

BILLING INFORMATION

CUSTOMER NAME: ____________________

ADDRESS: ____________________

____________________

____________________

____________________

TELEPHONE NUMBER: ____________________

FAX NUMBER: ____________________

PREFERRED PAYMENT METHOD: ____________________

SHIPPING INFORMATION

(if different from billing information)

SHIP TO: ____________________

ADDRESS: ____________________

____________________

____________________

____________________

TELEPHONE NUMBER: ____________________

FAX NUMBER: ____________________

SHIPPING METHOD PREFERRED: ____________________

FREQUENCY (If required): ____________________

EQUIPMENT NAME: ____________________

EQUIPMENT PART NUMBER: ____________________

EQUIPMENT SERIAL NUMBER: ____________________

## GUIDE FOR ORDERING PARTS

- Please use the following parts order form, filling in as much information as possible. The complete informaiton will allow double checking the part number for correctness or locating a substitude if the part is not available.
- The equipment name, part number, and serial number will be found on a metal ID plate on the back of the unit. The serial number MUST be included for any warranty parts.
- Describe the part using the description in the parts list if possible. Include the schematic information, schematic number, or number of next higher assembly. The next higher assembly is usually a 981-xxxx-yyy type.

| ITEM # | QTY | HARRIS PART NUMBER | DESCRIPTION OF PART (PART NAME, DESCRIPTION, SPECIFICATION FROM PARTS LIST IF AVAILABLE) | SCHEMATIC REFERENCE REFERENCE NAME (e.g. C001, R100, etc) | ITEM USED ON (NEXT HIGHER ASSEMBLY IF KNOWN) (e.g. C001 used on 992 8025 001, SCHEMATIC 839 8099 991) | COMMENTS |
|---|---|---|---|---|---|---|
| | | | | | | |
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## Transmitter Cooling System



## Section 2
## Parts List

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# Section 1
# Transmitter Cooling System


## 1.1 Scope and Purpose

The purpose of this section is to identify the integrated Harris Pump Module components and function.

**CAUTION:**
*FOR LOCATIONS WHERE OUTDOOR FREEZING TEMPERATURES MAY BE EXPERIENCED, AN IRON AND CHLORIDE-FREE GRADE ETHYLENE-GLYCOL AND PROCESSED WATER MIXTURE IS THE REQUIRED TYPE COOLANT FOR THIS SYSTEM. FAILURE TO USE THIS ETHYLENE-GLYCOL TYPE WILL CAUSE SERIOUS DAMAGE TO TRANSMITTER COOLING SYSTEM COMPONENTS BOTH INTERNAL AND EXTERNAL TO THE TRANSMITTER. SEE PARAGRAPH 1.5.2 OF THIS SECTION FOR FURTHER DETAILS.*

**CAUTION:**
*A COORDINATED AND INTEGRATED PROGRAM OF (1) REGULARLY ASSESSING AND LOGGING COOLANT SYSTEM QUALITY, (2) APPROPRIATE MEASURED RESISTIVITY DETERMINED REPLACEMENT OF COOLING SYSTEM COOLANT WHEN THAT COOLANT IS EXHAUSTED BEYOND THE POINT OF REJUVENATION, (3) APPROPRIATE MEASURED RESISTIVITY DETERMINED AND APPROPRIATELY TIMED REPLACEMENT OF SIDESTREAM FILTER CARTRIDGES, AND (4) ADDING ONLY REQUIRED QUALITY RESISTIVITY COOLANT TO THE COOLANT OPERATIONAL LOOP AS NECESSARY, WILL RESULT IN THE DESIRED LENGTHY DURATIONS BETWEEN ANY NEEDED COMPLETE SYSTEM COOLANT CHANGES AND FAULT/DAMAGE FREE OPERATION OF THE COOLING SYSTEM. INATTENTION TO THIS DISCIPLINED ROUTINE CRITERIA PROCESS OVER TIME COULD RESULT IN NON-WARRANTY COVERED DAMAGE TO THE STRUCTURAL INTEGRITY OF THE COOLING SYSTEM.*

Refer to the drawings located at the back of this book for clarifying and expanded information.

## 1.2 Function

The function of the pump module is to provide circulatory coolant to the transmitter system.

### 1.2.1 Heat Exchanger System Component Technical Overview

#### 1.2.1.1 Dry Cooler

The dry cooler is used to transfer the stored energy in the coolant to the ambient air via crossflow cooling. Each dry cooler is selected based on installation site requirements. Factors such as total system heat load, required flow rate and environmental conditions are used in determining the proper unit. Typically, although not always, the dry cooler will have four fan units. Single transmitter systems will utilize smaller units. They are equipped with fan and pump cycling control. Service access is located under the access panel at the plumbing input/output end of the dry cooler. Located under the access panel are the system schematic, wiring information and mounting instructions.

The dry cooler is equipped with two basic control systems; flow and temperature monitoring. The control system monitors system flow rate to determine if adequate flow is being supplied. Should low flow be detected, the unit identifies this as a malfunctioning pump and switches the system over to the stand-by pump; if the standby pump option is available.

The second control cycles the dry cooler fans based on input coolant temperatures. At 68$^{o}$F two of the four fans will be in operation and at 80$^{o}$F all four fans will be in operation. Smaller single power block (transmitter) systems will vary in fan cycling sequencing depending on number of fans required for the installation. Fan cycling temperatures can be set by opening the access panel located at the coolant input/output end of the dry cooler. Fan cycle temperatures should be set on site. Thermostat controls are located under the dry cooler access panel. The thermostat can be set by turning the indicator dial on the front to the desired temperature setting in degrees Fahrenheit.

#### 1.2.1.2 Pump Module

The pump module can consist of one or two system pumps, a coolant transfer pump, an air separator, filtration unit, compression tank and flow monitoring equipment. Pump module components will vary depending on installation requirements and models purchased. Electrical connections to the pump module are located internally and can be accessed through removal of the denoted panel in the outline drawing.

##### *1.2.1.2.1 System Pumps*

The pump module follows an integrated cabinet physical format wherein all of its components are located within or attached externally to the cabinet structure. In typical installations a standard 5 horsepower high head pump will be used as the main system pump. In dual pump systems a second pump is supplied as a standby in the event of main pump failure. The dry cooler control provides the logic to activate the standby pump when there is a loss of flow through the system.

##### *1.2.1.2.2 Transfer Pump*

The integral transfer pump is an option which can be supplied as part of the pump module package. The transfer pump is a convenient way to fill and charge the system. The transfer pump is controlled via a switch located next to the system flow monitor.

#### 1.2.1.3 Compression Tank

The compression tank's main purpose in the cooling system is to maintain a constant system line pressure. That is the low side pressure adjusted between 12 to 25 psig, as measured by the pressure gauge attached to the dry cooler return line. An indication of less than 12 psig indicates that more coolant is required in the system. A high reading above 25 psig indicates that the system has been over filled and pressurized.

#### 1.2.1.4 Air Separator

The air separator provides effective separation of free air from the system fluid. The air separator causes turbulence in the flow path which causes this air to be released. The lighter air, as a result of buoyancy, rises up through the top of the air separator and follows the path upward to the compression tank.

#### 1.2.1.5 Filtration Unit

The filtration unit utilized in the high power water cooled DX transmitter system is designed for operation with both pure water systems (distilled or reverse osmosis) and aqueous ethylene-glycol solutions. Initial fill water, coolant mixture and make up coolant must measure 60Kohms/cc or more. Ethylene-Glycol, if used, must be an iron and chloride free grade; available through Walter Lewis Fluid Technologies, or confirmed equivalent product from another supplier.

*1.2.1.5.1 Set Up:*

The filtration system is set-up as a side stream parallel path with the main plumbing system. It is installed across the input and output of the pump module. This will allows the filtration unit to utilize the greatest pressure differential in the system and keep the unit from being exposed to the hot side of the cooling loop. Flow rate through the filtration unit is limited to 1 gallon per minute. Control and monitoring of the flow through the unit is located below the filter unit.

## 1.3 Heat Exchanger System Plumbing Installation

Good plumbing equipment installation practice is required to ensure system integrity. Appropriately measured, cut, deburred, supported and soldered copper pipe sections, facilitate mechanical integrity of the coolant transportation system.

The "glue" that holds the system together is quality soldering. This process includes the need to condition all surfaces to be soldered by thorough cleaning with emery cloth or paper and an even application of flux, liquid flux being preferred. This applies to all common surfaces of plumbing fittings and straight pipe sections. Any improperly cleaned and poorly fluxed surfaces, either one or both, will not allow the solder to flow properly for continuous adherence of the solder to the two surfaces being soldered. After cleaning and fluxing, a continuous and evenly distributed application of heat will result in an evenly distributed flow of solder between the surfaces being soldered. Remember that solder flows from a colder surface to a hotter surface no matter the orientation of the surfaces being soldered.

Clean surfaces, evenly applied flux, sufficient heat without overheating, and evenly applied heat will result in the desired even flow and adherence of solder which produces a plumbed system that does not leak.

**NOTE:**
*Keep in mind that an over application of solder can result in solder balls falling into the associated piping with the possibility of valve travel limitation and/or plugged headers. This could result in water flow restriction and/or blockage, or the inability to totally close off a system segment when necessary. Conversely, an under application of solder can result in water leakage paths between the common surfaces of the fitting being soldered.*

Propane or Mapp gas is the recommended fuel for soldering copper plumbing pieces. These gasses are available in small metallic bottles that mate directly to appropriate torches. Also, a "Turbo Torch" or equivalent with appropriately sized regulator and hose combination can be used with larger gas tanks (large cooking stove tank). If these gas sources are not available, use of acetylene gas with an acetylene only torch is acceptable. In any event, only skilled plumbing and soldering practitioners, knowledgeable of the specific soldering equipment being used, should perform the required work.

**NOTE:**
*A soldering combination of silver bearing solder, i.e. Harris (not Harris Broadcast) Stay-Brite R (086-0004-038), and "Stay Clean" liquid soldering and tinning flux (086-0004-040) or equivalent, is recommended. Also, pipe thread joints should be conditioned with Teflon tape (299-0018-000) and a thin film application of a smooth, non-hardening thread sealing, compound with integrated Teflon is recommended, i.e. "Gasoila" (6900017-000), prior to mating any two threaded pieces together.*

A final comment about the installation process centers around the need for the discipline of personnel in and around the cooling system installation area. Under no circumstances should anyone, cooling system installer and/or workers in other disciplines and areas, walk on pipes and fittings that have or have not been positioned and soldered. Although probably convenient for passage between adjacent work areas, walking on already soldered pipe can and historically has led to premature loss of solder joint integrity, among other self evident undesirable integrity results.

### 1.3.1 Initial Cooling System Leak Tests

These are the procedures to perform initial leak tests prior to any wiring and electrical system checkout.

#### 1.3.1.1 Air Pressure Method

If a source of compressed air is available, initial testing for plumbing leaks can be accomplished by injecting air through the Shrader valve located near the return line coupling of the dry cooler.

a.Connect a hose to the dry cooler Shrader valve.

b.Open the compression tank line valve.

c.Close all System drain valves.

d.Open all other System gate valves (except the cooling system bypass valve, for a DX1000).

e.Close any optional fill valves.

f.Close the vent valve located at the physical high point of the cooling distribution return and supply lines.

g.Activate the compressor to pressurize the system up to a stabilized nominal 20 psig, as monitored on the Dry Cooler return line pressure gauge.

h.Once fully pressurized, the presence of leaks can be detected with a combination of audible air movement, and/or visible air bubbles through the application of a soapy solution to all plumbing joints in the system.

This approach is a good starting point if compressed air is available. However, the following Water Pressure Method is a more thorough evaluation of plumbing integrity, and is recommended whether or not the Air Pressure Method is used.

#### 1.3.1.2 Water Pressure Method

When initially inputting water for coolant leak checking purposes, the external charging pump or optional transfer pump, referred to in "System Cleaning, Flushing, Final Charge" section, must be used. It is recommended, however, that a complete system leak check procedure be completed and satisfied prior to turning on any of the normal system pumps.

a.After cooling system has been plumbed, connect the output of a suitable water source to:

1. The suction port of an external pump; then that external pump's discharge port to the pump module fill line.

Or

2. The optionally supplied fill pump input line.

Normal tap water is suggested for use when charging the system, for this initial testing.

b.Close all in-line gate valves in the system supply and return lines.

c.Open all globe flow regulator valves in each rectifier cabinet return line.

d.Close the compression tank line valve.

e.Close all power block and rectifier cabinet drain valves.

f.Open the power block supply line vent valve.

g.Fill the system via the pump, or otherwise pressurized water supply through the boiler valve mentioned in step (a.); throttling of the flow may be accomplished by adjusting this boiler valve. Avoid applying an excessive amount of pressure during filling. Typically the fill pressure should be in the range of 12 to 25 psig. The pressure may be monitored using the gauge attached to the Dry Cooler outlet discharge port.

h.Fill the system stage by stage, checking for leaks in the just-filled stage before opening the next set of in-line gate valves; continuing the process in the following stages.

1. Cooling system pad equipment
2. Major portion of main trunk supply and return lines
3. Individual power block group branch supply plumbing
4. Power block group internal plumbing
5. Power block drainage plumbing (one power block at a time, drainage system by power block group)
   Upon the establishment of a steady (no air bursts) volume of water through the power block supply line vent valve, that stage or multiple stages is sufficiently filled.

i.Open the compression line tank valve and charge the compression tank plumbing system.
If leaks have developed in a given stage, effect repairs at that point before continuing the process. Depending upon the given leak's personality, some water may have to be drained from the system before making repairs.

**NOTE:**
*Remember that this process is for initial leak detection only, and is a limited dynamic test.*

### 1.3.2 System Electronics/Electrical Installation

Wiring details are noted on drawings specific to the given installation. The conduit to be used varies in type and configuration from job to job. Refer to the Block and Cable, Cable Running List, and Cooling Control Panel wiring drawings/schematics for site specific details.

**NOTE:**
*All three of these drawings are not always provided. Also, for dry cooler wiring details, refer to the dry cooler diagram located inside of the hinged cover of the dry cooler control panel, as well as the more easily followed drawing in the Installation Drawing package.*

**NOTE:**
*For acceptable dry cooler control circuitry operation, the control circuitry transformer primary winding must be tapped to the voltage value closest to the nominal three phase input voltage being applied. Three primary winding tap values are provided for this purpose.*

To make the electrical check-out a bit easier when wiring the individual main pumps, connect the voltage configuration wires and three phase input wires (at TB2 in the integrated pump module cabinet -see drawing #843-5547-054) for both pumps exactly the same way. The pump internal wiring configuration is found on a specification plate mounted on the housing of each pump.

After the cooling system has been plumbed and all wiring is completed, the following outside cooling system pad items must be checked for appropriate operation.

a. Fan Shaft Rotation -Energize the dry cooler unit by momentarily turning on the safety disconnect switch. The fans will begin to rotate. A clockwise rotation of the fan blades is required. This motion draws the air from underneath the cooling coils exhausting that air through the top of the dry cooler. If the rotation is incorrect, with the safety disconnect switch in the off position, reverse two wires of the three phase input in the safety disconnect switch. Re-energize the dry cooler unit to verify accuracy in fan blade rotation.

b. Pump Shaft Rotation -Located on a printed circuit board, located in the upper left hand corner of the dry cooler control panel, is a flow turbulence time delay relay circuit. Rotate the potentiometer, mounted on the front of that PCB board, all the way counterclockwise.
There are two main pumps in the integrated pump module cabinet, but only one is operational at any one time. Which pump is operating is identified by observing the position of the pump selector toggle switch located on a housing located in the upper left hand corner of the dry cooler control panel.
Following the momentary energizing procedure (temporarily positioning the safety disconnect switch in the on position) as described in the Fan Shaft Rotation step above, note the pump shaft rotation direction. The pump shaft must rotate counterclockwise as viewed from the pump end (not motor end) of the shaft. This can be determined as the shaft rotation slows down to a stop.
If the rotation direction is incorrect, with the safety disconnect switch in the off position, reverse two wires of the three phase input at the appropriate pump wiring terminal block labeled pump one or pump two located behind the dry cooler control panel hinged cover in a left of center position. After reversing the two phase wires, re-energize the dry cooler unit momentarily to verify the correct shaft rotation direction.

**NOTE:**

*It is imperative that the pump shaft rotation direction is correct. It must be **counterclockwise**, as viewed from the pump end of the shaft, or the nominal flow rate of 16gpm for each power block will not be attainable.*

c. Shaft Operation of Alternate Pump -With the dry cooler unit de-energized, switch the pump selector switch mentioned previously to the position opposite that used for the pump shaft rotation check just completed, follow the procedure (b) that immediately precedes this paragraph; the procedure used for checking the first pump in this two pump sequence.
If the same pump runs as when the pump selector switch was in the initial position, the associated coolant turbulence time delay relay may be set for too short of a time forcing the default pump to become active. After correcting this timing condition, if it was found to exist, complete the pump shaft rotation check for the alternate pump. Upon completion of pump rotational integrity, restore the pump module cover to its normal position.

d. Located on the lower left side of the dry cooler control panel are two temperature thermostats called Aquastats, AQ1 on the left and AQ2 on the right respectively, that control the operation of the dry cooler cooling fans. Adjust the trip setting of AQ1 for 68 degrees F (20 degrees C) and AQ2 for 80 degrees F (26.7 degrees C).
In addition, the return line temperature sensor/controller housing (not supplied installed in the dry cooler) is placed per field determination, and may have been installed on the left inside side panel of the dry cooler adjacent to the AQ1 and AQ2. Wherever installed, its sensing bulb must be strapped to the return line and the controller set point adjusted to 144 degrees F (62.2 degrees C).

## 1.4 Heat Exchanger System Cleaning, Start-Up and Maintenance

The method for filling the system during initial cleaning and start-up are the same. It is necessary to clean the system for several hours of overall elapsed time, that elapsed time being determined by the number of cooling system purge/flush cycles required to reach the plateau of achieved water quality where the delta of measured water quality changes little from one purge/flush (charge, run, drain) cycle through the next cycle. This can take roughly 8 to 30 hours of actual purge/flush cycle run (not processed elapsed time). Once the plateau, just defined, has been reached the system can be charged with the final coolant solution. This cleaning (purge/flush) process will remove all foreign material which may have been introduced during assembly; i.e. dirt, grease, flux, and other foreign matter. Tri-Sodium Phosphate (TSP) is the recommended cleaning product, although other equivalent commercial cleaning agents can be substituted in the initial cleaning procedure. The TSP is to be mixed in the makeup water tank in the nominal quantity of 1% by volume amount (which for example is 50Lb. of TSP for a tank volume of 600 gallons. TSP is used only in the initial cooling system cleaning procedure (one 600 gallon tank only).

**NOTE:**

*Purging/flushing water electrical resistivity should be at least 60kOhm/cc at a temperature of 25°C if not higher, the only exception being for the first purge/flush cycle where a lesser value is acceptable to as low as that characteristic of clear tap water. However, nominally 75kOhm/cc resistivity processed* *water should be used in this initial and succeeding purge/flush cycles, if possible.*

**NOTE:**
*It is imperative that the source water holding tank be clean. The charging system must not add impurities to the water. The quality of the water flowing through the coolant charge port of the cooling system, normally the discharge port of the air separator, should be the same quality as that measured at the output of the source water holding tank.*

**NOTE:**
*Whenever drawing solution from the makeup water holding tank, there must be a tank port open to air. Failure to open a port to air will result in the collapse of the tank sidewalls due to the resultant vacuum being drawn inside the tank when liquid is being transferred into the cooling system.*

**NOTE:**
*A coolant charging system should include a transfer pump or other adequately sized fill pump (1HP capacity recommended), a holding tank (600 gallon capacity recommended), and an adequate length of hose and supply of plumbing and hose fittings.*

## 1.4.1 Initial System Cleaning

**NOTE:**
*Sidestream filter cartridges are not installed in the cartridge holders during shipping. Furthermore, the filter cartridges are not to be installed in the filtration unit canisters during the total cooling system cleaning process. Filtration system input and output valves are to remain open throughout all of the cleaning process however.*

**Reverse Osmosis Water Processing** -

If a Reverse Osmosis (RO) water processing unit was supplied, please note the following set-up and operational criteria. The use of RO processed water is a critical component of the transmitter system start-up preparation process. The output water quality of the RO unit is subject to the following:

a. RO Pump Pressure Setting -If the pressure setting is too low the water quality will suffer. If that pressure is set too high the pump seals will start leaking necessitating seal replacement; although the RO unit documentation indicates a set point of 200psig, a set point of 175psig is a refined recommendation referenced to historical field practice.

b. Reject (Waste Concentrate) Water Flow Rate -This adjustment is a function of the interrelated adjustments of product water and reject water flow rates which must be measured and adjusted correctly. For making these measurements two ea equal volume bottles will be needed to collect the water samples, i.e., one liter or one quart bottles. Energize the RO system and simultaneously fill one of the bottles with reject water and the other bottle with product water. Be careful to measure the reject flow at the end of the RO unit small diameter reject flow tube, otherwise the measurement will be invalid. Use the formulas provided in the RO unit technical manual for determining the calculated value. As a rough guide there should be equal amounts of product water and reject water once the working high pressure has been set.

c. Raw Water Quality -Although all three of these criteria are important, the raw water resistivity/conductivity is the most important. If this measured resistivity number is very much below 10kohm/cc, it is unlikely that the resultant product water will be of sufficient quality to be used directly as the cooling system solution either as the total coolant solution end product or in a mixed environment of RO product water and Ethylene-Glycol end product. In this case, at least two passes of the water will have to occur (1st pass of raw water and 2nd pass of the just processed 1st pass water) which double pass procedure most often times results in very acceptable water quality, most often times approaching 1megOhm/cc resistivity (1microSiemen conductivity). Progressively the farther the quality of the water is below 10kOhm/cc, the number of needed passes of the previously processed water through the RO system rises. If, the raw water is severely contaminated, extremely low resistivity values (nominally less than 1kOhm/cc) numerous iterative passes of the water will be required to reach an acceptable resistivity/conductivity value.

If an RO unit was supplied, a Digital Conductivity Meter was also supplied to facilitate water quality evaluation. Please note that up to two newly cleaned liquid sample collection containers will also be needed; two containers when adjusting the RO unit reject flow rate, one container when measuring resistivity/conductivity. If needing more equipment specific information, refer to the RO unit and/or conductivity meter technical manuals.

Using a mixture of distilled or reverse osmosis water and a cleaning solution noted in the previous paragraph, proceed with the following steps:

1. Connect a hose to the fill port of the pump module, if fill system is not hard plumbed.
2. Close the tank line valve.
3. Open all other system gate valves.
4. Open the two fill valves located on the pump module. DO NOT OPEN THE DRAIN VALVE OR CHARGE VALVE.
5. Open vent valve at end of Power Block line. Liquid will be expelled from these points, a bucket to catch spillage and a short length of hose no longer than 1 foot will be required.
6. Fill the system via the integral fill pump. With all the valves listed above fully open, turn on the fill pump switch.
7. Continue filling the system until a steady stream of water is flowing from the vent in step 5.

8. Stop filling, close vent and fill valves.
9. Cycle the system pumps for 30 seconds to 1 minute.
10. Repeat steps 4 through 8 until no air is expelled from the vent.
11. With the main system filled, open the bleeder valve at the bottom of the compression tank and the tank line valve.
12. Continue to fill the system until a stream of water flows from the tank bleeder valve.

**CAUTION:**

*DO NOT OVER FILL THE TANK. INITIALLY AIR AND WATER WILL BE EXPELLED FROM THE BLEEDER. ONCE A STEADY STREAM STARTS TO FLOW FROM THE BLEEDER CEASE FILLING AND CLOSE BLEEDER.*

13. In order for the system to function properly, positive pressure must be present at the pump inlet. The pressure gauge located next to the fill pump switch will give this indication. The pressure reading should be 12 to 25 psig (pound-force per square inch gauge is a unit of pressure relative to the surrounding atmosphere). If the pressure reading is lower than this, increase the system charge by adding more cleaning solution through the fill port as done previously. If the gauge reading exceeds these limits, open the tank bleeder valve to relieve the excess pressure.
14. Once the desired pressure has been achieved close both fill valves. This desired pressure is to be present with the individual power block flow meters indicating 16 gallons per minute (GPM) by adjusting the associated rate setting globe valve accordingly and corressponding gate valve set fully open. Additionally the side stream filter network flow rate is to be 1 GPM by adjusting its input valve accordingly with its output valve set fully open.
15. Run the system for norminally 3 hours with the cleaning solution. Check the pressure gauge hourly to ensure positive pressure is maintained.
16. Drain system of cleaning solution.

### 1.4.2 Compression Tank Subsystem Cleaning

Part of Initial Cooling System Cleaning Process.

Compression Tank -After the initial draining of the complete cooling system but prior to otherwise initiating the first of the iterative purging cycles, proceed as follows:

1. Close off the compression tank isolation valve and open the compression tank valve; this action making sure that the compression tank is completely drained.
2. Close the compression tank isolation valve and apply water pressure/volume to the compression tank by way of the open compression tank drain valve filling the compression tank while viewing the site glass.
3. Drain and fill the tank several times in this manner until the water viewed in the site glass is clear.
4. With a container positioned below the area of the pump module air separator drain plug, remove the drain plug allowing the residual liquid and any associated particulate matter in the bottom of the air separator to drain.
5. Once this residual solution is gravity released, open the compression tank isolation valve and apply water pressure/volume to the air separator, by way of the open compression tank drain valve, allowing the piping to the air separator and the air separator itself to be flushed thoroughly; liquid cleanliness to be determined viewing the liquid draining from the air separator into the previously mentioned drain container, which when clear marks the end of the process.

**NOTE:**

*It is preferable to use reverse osmosis processed water for the cleaning of the compression tank, air separator, and associated piping. As an alternative, raw intake water can be used for most of the cleaning until a clear liquid condition results. This, however, must be followed by a couple of complete flushes using reverse osmosis processed water.*

Restore the above plumbing system to that of normal operation

### 1.4.3 System Draining

1. Open drain valves (2) located on the pump module.
2. Open vent valve mentioned in step #5 of the filling section.
3. Drain the system via the drain port which is controlled by the drain valve located on the pump module.
4. Open tank bleeder valve.
5. Power Blocks and rectifier cabinets can be drained though their individual drain valves. The Power Block drains are located under the access panel inside the rear plenum cabinet. Drain valves are located in the front bays. One in each of the two center Power Block bays on the floor and a third in the upper right hand cabinet above the driver section. The valves are open when the handle is oriented parallel with the pipe line.
6. To assist in draining the Power Blocks, the vent plug at the top of the heat coil in the top of the Power Blocks can be removed. Only remove this plug after the external plumbing network has been drained and water has ceased to drain from

the Power Block. It is recommended that two wrenches are used to remove this plug to avoid damaging the heat coil. Compressed air may also be used to pressurize the Power Block plumbing to aid in draining the system. No more than 30 psig should be used.

7. The rectifier drain is located either in the front or rear of the cabinet, depending on installation. The control valve is located in the front above the transformer.
8. Once draining is complete close all cabinet drain valves; rotating the valve handles perpendicular to its associated plumbing pipe. Also close any vent valves opened during the draining process.
9. Once reaching the end of the final purge/flush cycle achieving the desired resistivity plateaued figure, be aware that any excess cleaning solition that may remain in the system will not effect thermal performance or cause corrosion as long as the cleaning agent recommended (TSP or equivalent) earlier, was used. The very limited cleaning agent residue in fact will aid in stabilizing coolant PH.

### 1.4.4 Iterative Fill, Flush/Purge, Drain Cleaning Processes

In preparation for implementing a final coolant charge process either before initial operation of the transmitter or after the transmitter has been in operation for some time, the cooling system must be purged of most of the cleaning solution residue left following either the (1) completion of the cooling system installation process or (2) draining of the coolant following operation of the cooling system for some time. For this purging/flushing process to be effective, the process must be followed methodically and meticulously with no shortcuts. All purging/flushing should be accomplished using reverse osmosis processed quality water (distilled water being acceptable if sufficient volume is available). The use of deionized water is not recommended for purging or operational use in this system. The purging/flushing process is to be accomplished by alternately charging, circulating, and draining the system numerous times, the number of purging/circulating/flushing cycles needed being determined by the measured water resistivity/conductivity after each circulation period but prior to draining the cooling system after each circulation cycle.

**NOTE:**
*The length of flushing (circulation) time, and number of fill/circulation/drain cycles needed to achieve desired water quality will vary with system size (number of Power Blocks and rectifier cabinet combinations). The smaller the system, the shorter length of time and the lesser the number of fill/circulation/drain cycles required. The opposite will be true for larger systems. The length and number of fill/circulation/drain cycles listed here are representative of medium to large systems, but the determining factor as to whether sufficient system purging has occurred must be the resistivity/conductivity value measured and nothing else.*

**NOTE:**
*If this iterative process is not allowed to mature to the point of the water quality plateauing at or near the desired optimum, then during the first year or so there will be several otherwise unnecessary changes of coolant required and particulate filter changes required until the optimum resistivity value for the system is reached. Therefore, please be advised that the optimum coolant resistivity point will eventually be reached, either (1) prior to beginning transmitter on-air operation or (2) following the commencement of regular on-air transmission with the aggravation of off-air time being experienced several times thereafter until the optimum resistivity operating value is finally reached and the attendant several otherwise unnecessary changes of coolant filters having occurred.*

**NOTE:**
*For a coolant replacement process taking place in a physical environment already flushed for a previously purged and operated cooling system, the number of flushing cycles will be less than that normally required for a newly installed system.*

**NOTE:**
*Remember, the optimum cooling resistivity is reached where the delta of measured water quality changes little from one purge/flush (charge, run, drain) cycle through the next cycle over a minimum of three iterative cycles. This will most oftentimes occur between 50kOhm/cc and 100kOhms/cc; the higher the resistivity number achieved the better. Under no circumstance should processed water be used as a final charge solution that has less than a measured 60kOhms/cc value. One should strive for a minimum value of 75kOhm/cc value for systems using only processed water as the system on-going coolant solution.*

After each purging/flushing cycle check the conductivity/resistivity value for the system by use of the Omega Digital Conductance, Temperature and pH Tester No. PHH-10, or equivalent water conductivity/resistivity tester. The Omega instrument is standard provision with the cooling system package. Take a water sample from any convenient point in the closed circulating system. Generally, the conductivity leaving the distilled or reverse osmosis processed water source tank will be 75kOhms/cc or higher. A small residue of the TSP cleaning agent left in the circulating system is acceptable, but that amount should be no more than what would result in conductivity readings as noted here. The minimum in-system starting circulating coolant conductivity should be no less than 60kOhms/cc, with greater than 60kOhms/cc being preferred. In any event, the higher the resistivity magnitude the better, and if the quality of the water presently in the system is lower than 60kOhms/cc (higher than 16.7microSiemens/cc), the purging operation should continue until the plateaued resistivity value is attained even if it is greater than 75kOhms/cc (13.3microSiemens/cc. Circulate each new coolant charge for two hours followed by the drain, recharge and measure resistivity/conductivity process until the just referenced resistivity suitable plateaued value is obtained. When the resistivity value levels off, when at or above 50kOhm/cc, the purging process has reached its optimum for the conditions of the system being worked. Remember, the higher the resistivity value reached the more effective the coolant system and the longer the time period will be between coolant solution changes.

**NOTE:**
*The lower the conductivity value reached when initially charging the system, the longer the duration of time before a coolant recharge will be required. After having purged/flushed and finally charged a cooling system with satisfactory results, if the coolant conductivity falls below 20kOhms/cc (rises above 50microSiemens/cc), the coolant should be drained, the system purged/flushed, and recharged with fresh coolant.*

Once the acceptable nominal resistivity/conductivity value has been reached, de-energize the water source system and the Cooling System. Then drain the system as described in the “System Draining” section for the final time and prepare to work through the next sub section “Particulate Matter Considerations -Rectifier Choke”.

### 1.4.5 Particulate Matter Consideration - Rectifier Choke

Historical data has suggested that, other than the presence of cooling system piping installation process particulate matter, a particulate residue presence can remain if the 250VDC rectifier choke is not addressed specifically and separately at some point in the purging process (one ea per power block rectifier cabinet). The rectifier choke must be disconnected from the system and pressure cleaned. Proceed as follows:

As a part of this purging process and after several flushes, remove the input and output plumbing hose connections from the liquid cooled choke in each power block rectifier cabinet. This removes the otherwise normally plumbed SCR’s from across the choke. Temporarily place a drain hose to the output side of the choke and force compressed air through the choke, which action will break loose and remove most of any buildup of particulate matter from the cooling path within of the choke. Then, prior to restoring the choke to the normally plumbed condition, flush a sufficient volume of properly conditioned water through the choke to optimize the choke cleansing process. Following this individual cleaning process, reconnect the rectifier choke plumbing and insert the organic and deionizing filter cartridges into their sidestream network canisters using the procedure described in “Sidestream Filters Initial Installation”.

### 1.4.6 Sidestream Filters Initial Installation

Filters are not installed in the cartridge holders during shipping. Therefore, the following procedure is to be followed after cooling system installation and final purging/flushing cycle have occurred.

1. Close inlet and outlet valves.

**NOTE:**
*The B-Pure Pressure Cartridge System Assembly is made up of a head component, handle/ring component and a housing cannister/holder component. The following directions are for both assemblies*

2. If system uses the B-pure plastic holder, depress pressure relief button located on top of each holder.
3. Remove the canister/holder from the head by depressing the thumb lever and rotating the handle/ring ¼ turn.
4. Inspect O-ring seal. If worn or torn replace.
5. Remove new cartridge from bag.
6. Install new cartridge with its small opening towards the top of the canister and its large opening at the bottom of the canister.
7. Install holder/handle subassembly into the head component. If utilizing the stainless steel housing, tighten wing nuts in a diagonal pattern to ensure even tension.

### 1.4.7 Filling System with Final Coolant

System coolant to be used is based on environmental conditions. Pure water or an aqueous Ethylene-Glycol solution of up to a 55/45 mixture may be used. The mix ratio is determined per specific site by Harris. Once this ratio figure has been determined, it is not to be changed.

Filling of the coolant is done in the same manner discussed in the Initial Cleaning Section.

It is important to note that the positive pressure must be maintained at the pump inlet. This may fluctuate initially, but will stabilize over time and remain constant. The positive pressure will be maintained whether the system is running or not. This pressure will only decrease as a result of a leak or the introduction of air into the system. An increase would only result if the system is initially over charged.

If proper filling precautions are followed, only small amounts of air will be trapped and or mixed with coolant in the system. It is nearly impossible for all the air to be removed during filling; however precautions have been taken. Included in the system setup is an air separator which uses turbulent force to remove the air from the coolant as it flows through the system. Typically, over a 30 day period all residual air should be removed and evacuated to the tank via the air separator.

### 1.4.8 Procedural Steps Summary For Cooling Renewal

In summary then, here are the basic steps for working through coolant initiation/replacement processes.

1. Turn-off the transmitter to which the work is being done.
2. By switch and/or circuit breaker, remove any AC power normally applied to an operating transmitter.
3. Drain the cooling system completely including all inside and outside system elements.
4. Remove the old sidestream filter cartridges and then reinstall the cartridge holder handle assembly (collar assembly) for each holder housing without inserting replacement filter cartridges at this time. The purging/flushing steps will be accomplished with no cartridges located in the holder housing.
5. Clean the holding container/tank in which the reverse osmosis processed quality water will reside and later the coolant mixture will be prepared.
6. Fill the holding tank, noted in step 6, with reverse osmosis processed quality water.
7. Take a sample of the source purging/flushing water from the holding tank (the stainless steel tank) and measure the resistivity/conductivity of that water sample. The measured value of properly processed water is typically in the 70kOhm/cc to 80kOhms/cc range (a minimum value of 60kOhms/cc being preferred with a value of 70kOhms/cc being highly recommended and much preferred). If the measured value is less than 60kOhms/cc the water supply from which the sample was take should be discarded and replaced with appropriately processed water of an acceptable resistivity.
8. The purging/flushing process -The purging/flushing process is made up of steps 9 -14 of this summary, the end result measured resistivity number to be as noted in the discussion in the preceding Sections 2 and 3, no less than 50kOhm/cc for initial purging with using only reverse osmosis processed quality water as the circulating liquid. This will be a series of cycles, each cycle consisting of the following steps; (1) complete cooling system fill, (2) circulate for one hour minimum, (3) complete cooling system procedure drain procedure including all inside and outside system elements.
9. Begin the purge/flush process for the complete cooling system in a recirculatory (closed loop) manner.
10. After a couple of flushing cycles, using an air compressor blow air through the power block rectifier choke for more effective removal of particulate matter within the choke.
11. Continue the purging/flushing sequences in the recirculatory mode until the measured resistivity/conductivity plateaus above the minimum 60kOhm/cc value, 75kOhm/cc or higher being the preferred value.
12. The final one or two purge/flushing cycles should be non-recirculating. In other words, simply run the water through the system and drain simultaneously at a low point outside in the source line to the system attached to the dry cooler.
13. Drain the cooling system completely for the final time including all inside and outside system elements of the purging water.
14. On an individual basis drain the 250vdc filter choke in each rectifier cabinet followed by blowing air through the chokes individually using an air compressor.
15. Return the cooling system and valve positions to that ready for cooling system operation.
16. Prepare the final coolant mixture ratio {50/50,55/45, other, 100/0 reverse osmosis (ro) processed water} in the container assigned {same container as referenced in step 6 of this summary}.
17. Install the replacement sidestream filter cartridges in their appropriate holder containers (one ea organic removal cartridge and one ea two bed filter cartridge per sidestream filter system) referenced in step 4.
18. Fill (charge) the transmitter cooling system with the solution prepared in step 16.
19. After circulating the coolant through the system for 15 minutes, measure the resistivity of the coolant. If Ethylene-Glycol, expect a measured minimum value in the area of 200kOhms/cc in “Ethylene-Glycol/ro water” mixtures; 60kOhm/cc to 80kOhm/cc in 100% Reverse Osmosis or Distilled processed water systems with a nominal 75kOhms/cc starting point value being definitely preferred.
20. The cooling system is now ready for normal transmitter operation.Double check to see that the individual power block flow rates are 16 GPM and the sidestream filter flow rate is 1 GPM. Adjust if necessary.

### 1.4.9 System Maintenance -General

The closed loop cooling system requires very little maintenance. Since the system is closed to the environment no foreign material will be introduced into the coolant and there will be no loss of coolant through evaporation. Once the system is properly filled and charged, the system will remain in correct operating condition indefinitely with little maintenance. The following four maintenance steps will ensure that the system operates at optimum performance.

1. Check the pressure gauge bi-monthly to ensure that positive system pressure is maintained. Positive pressure should be in the range of 12 to 18 psig.

a. If the gauge reads lower than 12 psig, inspect the system for leaks. If no leaks are present, charge the system with coolant. Charge the system by opening the pump module charge valve and turning on the pump. A pressure reducing valve located within the system will throttle the flow until adequate pressure is achieved. Monitor the gauge regularly until pressure stabilization is achieved.

b. If the gauge reading is above 18 psig, relieve the pressure by opening the relief valve on the bottom of the compression tank. If too much pressure is relieved it will be necessary to recharge the system using the step outlined above. Tank level can be determined by inspection of the sight gauge located on the tank.

2. Inspect the filtration loop. Check flow rate and resistivity indicator. Reference filtration unit operation for information.

3. Inspect the bottom of the dry cooler bi-monthly. this is probably the single most important maintenance step. Inspect the coil itself for any debris that may have become trapped on the coil face. This would block air flow and decrease cooling efficiency of the dry cooler. Debris can be removed using a hose and pressurized water system. In dusty environments or areas where an abundance of vegetation is present this inspection will be required weekly.

4. Additionally, as a general procedure the entire system including Power Blocks and rectifier cabinets should be inspected for leaks on a routine basis. Any indication of a potential leak should be noted and corrected. The Power Blocks and rectifier cabinet are equipped to detect leaks as well as the overall system plumbing; however the presence of a small leak (pin hole type) could miss detection in distribution piping, etc.

**CAUTION:**

*A COORDINATED AND INTEGRATED PROGRAM OF (1) REGULARLY ASSESSING AND LOGGING COOLANT SYSTEM QUALITY, (2) APPROPRIATE MEASURED RESISTIVITY DETERMINED REPLACEMENT OF COOLING SYSTEM COOLANT WHEN THAT COOLANT IS EXHAUSTED BEYOND THE POINT OF REJUVENATION, (3) APPROPRIATE MEASURED RESISTIVITY DETERMINED AND APPROPRIATELY TIMED REPLACEMENT OF SIDESTREAM FILTER CARTRIDGES, AND (4) ADDING ONLY REQUIRED QUALITY RESISTIVITY COOLANT TO THE COOLANT OPERATIONAL LOOP AS NECESSARY, WILL RESULT IN THE DESIRED LENGTHY DURATIONS BETWEEN ANY NEEDED COMPLETE SYSTEM COOLANT CHANGES AND FAULT/DAMAGE FREE OPERATION OF THE COOLING SYSTEM. INATTENTION TO THIS DISCIPLINED ROUTINE CRITERIA PROCESS OVER TIME COULD RESULT IN NON-WARRANTY COVERED DAMAGE TO THE STRUCTURAL INTEGRITY OF THE COOLING SYSTEM.*

### 1.4.10 Further Sidestream Filtration System Coolant Quality Considerations

The side stream filtration system enhances the coolant conductivity/resistivity value through the use of staggered filtration (organic filter followed by a deionizing filter). A portion of the main stream coolant is diverted into the filter sidestream, filtered, and then blended back in with the coolant in the main distribution stream.

After the cooling system purging process is completed, the two just mentioned filter cartridges are to be inserted into their respective cartridge holders and the operating coolant charge takes place. Subsequently, the cooling system is ready for normal operation. Once the side stream filter system is activated, the overall coolant conductivity/resistivity value begins to improve beyond the value initially inputted into the system. After rising for some time, this value will plateau and eventually begin to very slowly decrease.

The overall lifespan of the filter cartridges is essentially a function of:

- Effectiveness of the cleaning and flushing (including particulate removal) processes prior to inputting the final charge
- The quality of the final charge coolant when initially inputted

Coolant quality can eventually reach the desired value, even with the final charge coolant resistivity being mediocre to poor, but at the expense of a higher number of filter cartridges being exhausted prematurely requiring their replacement.

Understanding the sidestream filter function and effects are critical to the on-going successful operation of the sidestream and overall cooling system. The sidestream filter function is to lengthen the cycle time between coolant changes. Properly conditioned physically and manipulated operationally, optimum filter cartridge and coolant life time expectancies through presence of a higher coolant resistivity value over time, as compared with a system without a sidestream filter loop. The integrated operational effects of the sidestream filter loop along with an otherwise (1) initially properly conditioned physical system and coolant (whether processed water or chloride and iron free Ethylene-Glycol), (2) adequately monitored and maintained operating coolant, will provide the operational coolant maximum life span.

**NOTE:**

*Replacement of the sidestream filter cartridges does not and will not, as a result of the filter cartridges change, renew existing bad quality coolant to its initial optimal resistivity state or even close to that state. Replacing the filter cartridges in coolant that has reached the point of needing to be changed will result in (1) temporarily limited improvement in the resistivity value of that coolant and (2) exceedingly premature exhaustion of the newly replaced filter cartridges* *with subsequent additional increasingly premature replacement cycles following with limited and progressively less improvement being achieved with each subsequent change of filter cartridges. Don't make the mistake of repetitively changing sidestream filter cartridges in a system with coolant that cannot be rejuvenated adequately (nominally 35kOhms/cc or less) for reason of continuing occurrences of subsequent progressive premature filter cartridge exhaustion.*

### 1.4.11 Filter Installation and Replacement (On-Going Considerations)

The resistivity indicator lamp for the filtration system will turn on at a nominal value of 50kOhms/cc. If this occurs when the filtration system is first turned on or shortly thereafter, and all the system cleaning and flushing processes were followed completely, let the system continue to operate; eventually the system coolant quality will improve enough to extinguish the indicator lamp.

If, however, the transmitter has been operating normally for several months, in the event of a red light indication on the resistivity monitor, the filter cartridges will likely required being changed probably within 10 to 14 days of that indication or until the coolant resistivity falls to 35kOhms/cc. The resistivity indicator lamp illumination indicates that the organic filter and deionizing filter, will likely need to be changed for reasons of (1) sidestream loop pressure drop across the organic filter limiting coolant flow through that filter cartridge as well as (2) deionizing filter cartridge exhaustion (lowered ionic transfer facilitation by that cartridge). In any event the cooling system is not to be operated with a resistivity value of less than 20kOhms/cc. The organic cartridge change should be routinely accomplished with every deionizing cartridge change.

An about to be needed filter change will be indicated either by the aforementioned red light illumination on the resistivity monitor and/or lessened or loss of flow through the filtration loop; indicated visually on the flow meter.

In the event of flow loss, check to ensure that the inlet and outlet valves are open. If the valves are open and no flow or a small rate is evident, a cartridge change is recommended. Under this situation the change may be only limited to an organic cartridge change. Change the organic cartridge per the outlined procedure. If flow problems still persist, it may be necessary to change the deionizing cartridge as well and or inspect the filtration loop for clogging according to the following instructions.

1. Close inlet and outlet valves.

**NOTE:**
*The B-Pure Pressure Cartridge System Assembly is made up of a head component, handle/ring component and a housing cannister/holder component. The following directions are for both assemblies*

2. If system uses the B-pure plastic holder, depress pressure relief button located on top of each holder
3. Remove the canister/holder from the head by depressing the thumb lever and rotating the handle/ring ¼ turn using an adequate container under the assembly to capture any coolant spillage.
4. Remove old filter cartridge and discard.
5. Inspect O-ring seal. If worn or torn replace.
6. Remove new cartridge from bag.
7. Install new cartridge with its small opening towards the top of the canister and its large opening at the bottom of the canister.
8. Install holder/handle subassembly into the head component.
9. If utilizing the stainless steel housing, tighten wing nuts in a diagonal pattern to ensure even tension.
10. Fully open outlet valve then open inlet valve slowly, allow canisters to fill.
11. Set inlet valve such that the flow meter reads approxmately 1 GPM

**NOTE:**
*Additional Cooling System and Sidestream Filter Cartridges Processing Emphasis*
*After some considerable history logged at several sites, the following requirement has been created as an additional cooling system flushing action item. There have been a number of instances, through several generations, of premature sidestream filter cartridge clogging long before the expected long life characteristic of these filter cartridges becomes a reality. Inspection of several of the failed cartridges showed the presence of far more particulate material, including copper particle residue, than should be the case following the conducting of an appropriate overall flushing/purging process. Therefore, the two following action items are now deemed imperatives for completing the cooling system preparation processing prior to final charge of the system commences: (1) Before inputting any liquid into the cooling system and even before conducting the initial water based leak detection procedure, remove the sidestream filter system cartridges and leave them removed until the cooling system is ready to receive the final charge of coolant, whether the final charge coolant be in the form of properly processed water or a mixture of Ethylene-Glycol and properly processed water (premixed solution or separately introduced solution. (2) Particular attention must be given to achieving the plateaued acceptable nominal 75kOhms/cc (higher than 13.3 microSiemens/cc) starting point for initiating the final system charging process. Depending upon local conditions, this could require several more complete flushing cycles than the typical figure noted previously. Sufficient time must be taken to complete the flushing/purging process as described herein, no matter the pressure(s) of other time constraints that may be in play. Otherwise premature replacement of side-*

*stream filter cartridges and possibly other undesired cooling system artifacts may be experienced as a result of not meeting this flushing/purging process in total.*

### 1.4.12 Coolant Testing

#### 1.4.12.1 Glycol System

The system must annually be analyzed for glycol concentration. Analysis can be provided by the glycol manufacturer or via use of an analytical test kit supplied through the manufacturer.

## 1.5 System Specifications

### 1.5.1 Operating Environment

Ambient air temperatures near the dry coolers should not rise above 45$^{o}$C for standard equipment applications (high temperature capable equipment is available as an option). The dry coolers should be located such that there is a 3 foot unobstructed perimeter around all sides. The dry cooler coils should be free of debris and inspected bi-monthly.

### 1.5.2 Coolant Specification

The following section outlines the quality of the coolant used in the closed loop cooling system for the high power water cooled DX transmitter.

#### 1.5.2.1 Processed Water Quality

Processed water electrical resistivity should be at least a minimum of 60kOhm/cc but preferred 75kOhm/cc following a fresh system charge and purge operation. The coolant, provided by a properly operating reverse osmosis water purification system (Culligan B3L, BP Plus or equivalent), is acceptable as a source of make up water for charging a system. This is true whether the make up water is a coolant mixture of water and glycol, or 100% pure water.

#### 1.5.2.2 Water Only System

Pure water to be used in the cooling system should be distilled or reverse osmosis processed. In a pure water cooling system the water quality must be high; free from solids and living organisms. The water must be low in chloride and sulfate ions; less than 100ppm each being required, and 25ppm being recommended. The use of reverse osmosis or distilled processed water meets these requirements if storage of the processed water product does not introduce foreign elements.

#### 1.5.2.3 Ethylene-Glycol/Water Mixture System

For the Ethylene-Glycol component of the glycol/water mixture, iron and chloride-free Ethylene-Glycol Harris part number 0511010-024 for 100% concentrate solution - WLFT-HP (supplied in 55 gallon drums) or confirmed equivalent is to be used. For the processed water component, the levels of chloride and sulfates should be lower than 25ppm each and the total hardness (“Ca” and “Mg”) should not exceed 100 ppm which criteria are met when using the Walter Lewis Ethylene-Glycol products noted in this section.

**NOTE:**

*The starting point resistivity of a freshly charged cooling system with 50/50 ratio coolant typically is as high as a nominal 200kOhms/cc*

If coolant of this quality is unavailable, the Ethylene-Glycol manufacturer (WALTER LEWIS FLUID TECHNOLOGIES) can supply pre-diluted solutions of iron and chloride free grade Ethylene-Glycol which meets or exceeds the required resistivity. The Harris part numbers being 051-1010-026 for the 50/50 mix ratio - WLFT HP-50 and 051-1010-025 for the 55/45 mix ratio -WLFT HP-55; both supplied in 55 gallon drums.

# Section 2
# Parts List

2

## 2.1 Replaceable Parts List



For table above and in tables that follow in this section the (X) or (XX) after the table title part number is the revision level of that bill of material and is for reference only.

**Table 2-1 *PUMP MODULE, HIGH POWER DX, - 994 9772 001 (U)**

| Harris PN | Description | Qty UM | Ref Des |
|---|---|---|---|
| 0038020030A | *TUBE, COPPER 0.875 OD (TYPE M) | 2 FT | |
| 055 0120 231 | CONN, STRAIGHT 1/2 | 1 EA | |
| 055 0120 517 | CONDUIT LIQUID TIGHT 1/2" | 2 FT | |
| 055 0120 704 | CHASE ADAPTOR 1/2 IN | 1 EA | |
| 063 1030 021 | * PIPE SEALANT "PST" LOCTITE 565 | 3 EA | |
| 302 0532 000 | SCR, 1/2-13 X 1-1/4 | 32 EA | |
| 314 0015 000 | LOCKWASHER, SPLIT 1/2 SST (ANSI) | 32 EA | |
| 358 0712 000 | <*>HOSE CLAMP, SST, SAE-20 | 4 EA | |
| 358 1217 000 | HOSE CLAMP, SST, SAE-12 | 16 EA | |
| 358 1895 000 | CHANNEL NUT, W/SPRING 1/2-13 | 32 EA | |
| 358 3000 000 | PLATE, END STOP, DIN RAIL MT | 2 EA | #TB002 |
| 358 3041 000 | HOSE BARB 1/2H X 3/4 MPT | 1 EA | |
| 358 3186 000 | PLUG, WHT 1.375" HOLE | 3 EA | |
| 358 3490 000 | END STOP, 264 TERM BLOCK | 2 EA | #TB001 |
| 358 3491 000 | END PLATE, ORANGE (264) | 1 EA | #TB001 |
| 358 3597 000 | FITTING, FLAT PLATE, 1-5/8 SQ | 32 EA | |
| 358 3683 000 | BRACKET, FOR STRUT | 8 EA | |
| 359 0495 000 | SNUBBER, PRESSURE | 1 EA | |
| 359 0567 000 | PLUG, 1.0 DIA MALE NPT (STEEL) | 1 EA | |
| 359 0576 000 | TANK VALVE, 1/8 NPT | 1 EA | |
| 359 0594 000 | UNION, 3/4 CXM CAST | 1 EA | |
| 359 0999 000 | BOILER DRAIN VALVE | 1 EA | |
| 359 1011 000 | BUSHING, HEXAGON | 1 EA | |
| 359 1090 000 | SUPPORT CLAMP, 3/4"COPPER | 3 EA | |
| 359 1099 000 | SUPPORT CLAMP, 1/2" | 4 EA | |
| 359 1132 000 | BUSHING, HEX, 1"MPT X 1/2"FPT | 1 EA | |
| 359 1134 000 | <*>PLUG, 0.5 DIA MALE NPT (BRASS) | 1 EA | |
| 359 1194 000 | CLAMP, SUPPORT, | 8 EA | |
| 359 1195 000 | VALVE, PRESSURE REDUCING | 1 EA | |
| 359 1196 000 | FITTING, AIR CONTROL TANK | 1 EA | |
| 359 1197 000 | AIR SEPERATOR | 1 EA | |
| 359 1200 000 | SIGHT GAUGE, FULL VISION, | 1 EA | |
| 359 1380 000 | FITTING, ADAPTER, 3/4" | 1 EA | |
| 359 1552 000 | TANK, COMPRESSION, 304 SS | 1 EA | |
| 384 0702 000 | RECT FW BRIDGE 600V 35A ESD | 1 EA | |
| 386 0429 000 | *ZENER 1N5346B 9.1V 5% 5W | 1 EA | |
| 424 0360 000 | GROMMET 1-3/4 MTG DIA | 3 EA | |

| | | | |
|---|---|---|---|
| 424 0506 000 | HOSE .500 ID, .875 OD | 20 FT | |
| 424 0507 000 | HOSE .75 ID, 1.125 OD | 4 FT | |
| 442 0126 001 | GAUGE, PRESSURE 0-30 PSI | 1 EA | |
| 522 0566 000 | <*>CAP 100UF 63V 20% (10X12.5) | 1 EA | |
| 542 0458 000 | RES 125 OHM 5% 12W | 1 EA | |
| 604 1081 000 | FLOW SWITCH, SPDT, 1 IN | 0 EA | S1002 *SELECT ONLY FOR TWO HEAT EXCHANGER SYSTEM. |
| 604 1239 000 | SWITCH, LIQUID LEVEL, FLOAT | 0 EA | S5 *SELECT IF TRANSMITTER COOLING CONTROL PANEL IS USED. |
| 614 0808 000 | *TERM BLK, THRU, 2-POLE GREY (283) 12MM | 6 EA | #TB002 |
| 614 0892 000 | TERM BLK, THRU, 4-POLE, BLUE (264) | 5 EA | #TB001 |
| 614 0893 000 | TERM BLK, THRU, 2-POLE, GREY (264) | 16 EA | #TB001 |
| 614 0896 000 | TERM BLK, GROUND, 4-POLE, GRN/YEL (264) | 2 EA | #TB001 |
| 614 0898 000 | *TERM BLK, GND, 2-POLE GRN/YEL (283) 12MM | 2 EA | #TB002 |
| 629 0079 000 | FLOW METER, BRONZE, 2 GPM MAX. | 1 EA | |
| 629 0080 000 | FLOW METER, BRONZE, 2" FNPT, | 1 EA | |
| 646 1426 000 | END PLATE 283 FRONT ENTRY | 1 EA | #TB002 |
| 822 1203 956 | SKID, PUMP MODULE | 0 EA | |
| 843 5492 236 | OUTLINE DWG, PUMP MODULE | 0 DWG | |
| 843 5547 054 | SCHEMATIC, PUMP MODULE | 0 DWG | |
| 917 2413 734 | ADAPTER, 1/2" MALE PIPE X | 2 EA | |
| 917 2413 735 | ANGLE, PLUMBING SUPPORT | 2 EA | |
| 917 2413 740 | PUMP MODULE | 1 EA | |
| 922 1238 543 | FITTING, BULKHEAD, FILL PUMP | 1 EA | |
| 922 1238 545 | FITTING, BULKHEAD, DRAIN | 1 EA | |
| 922 1238 546 | WINDOW, FILTER FLOW | 1 EA | |
| 922 1238 547 | WINDOW, DISPLAY | 1 EA | |
| 922 1238 554 | PANEL, IDENTIFICATION | 1 EA | |
| 922 1238 555 | CARRIER RAIL, 0.6 X 8.1 | 1 EA | #TB001 |
| 922 1238 556 | CARRIER RAIL, 1.37 X 10.12 | 1 EA | #TB002 |
| 922 1238 559 | ANGEL, POWER COVER | 2 EA | |
| 939 8154 614 | FLANGE, PANEL SUPPORT, TOP | 4 EA | |
| 939 8154 615 | FLANGE, PANEL SUPPORT, LEFT | 4 EA | |
| 939 8154 616 | FLANGE, PANEL SUPPORT, RIGHT | 4 EA | |
| 939 8154 618 | BRACKET, THERMOSTAT SUPPORT | 1 EA | |
| 939 8154 619 | BRACKET, PLUMBING SUPPORT | 2 EA | |
| 939 8154 625 | PLUMBING, TANK BULK HEAD | 1 EA | |
| 939 8154 626 | ANGLE, PLUMBING SUPPORT | 4 EA | |
| 939 8154 627 | PLATE, PLUMBING CLOSEOUT | 8 EA | |
| 939 8154 628 | BRACKET,DRAIN MANIFOLD SUPPORT | 2 EA | |
| 939 8154 630 | STIFFENER | 3 EA | |
| 939 8154 632 | BRACKET, DRAIN SUPPORT | 1 EA | |
| 939 8154 633 | COVER, VENT | 2 EA | |
| 939 8154 634 | PANEL, ELECTRICAL, PUMP MODULE | 1 EA | |
| 939 8154 635 | BRACKET, PLUMBING SUPPORT | 1 EA | |
| 939 8154 636 | BRACKET, PLUMBING SUPPORT | 1 EA | |
| 939 8154 637 | COVER, POWER, PUMP MODULE | 1 EA | |
| 943 5492 205 | SUPPORT CHANNEL, TANK STAND | 2 EA | |
| 943 5492 206 | BASE, PUMP MODULE | 2 EA | |
| 943 5492 207 | TOP, PUMP MODULE | 1 EA | |
| 943 5492 208 | PANEL, RIGHT OUTER | 1 EA | |
| 943 5492 209 | PANEL, INNER, PUMP MODULE | 2 EA | |
| 943 5492 210 | PANEL, LEFT OUTER | 1 EA | |
| 943 5492 211 | SHELF, RIGHT BAY, PUMP SUPPORT | 1 EA | |

| | | | |
|---|---|---|---|
| 943 5492 212 | PANEL, FRONT RIGHT | 1 EA | |
| 943 5492 213 | PANEL, FRONT LEFT | 1 EA | |
| 943 5492 214 | PANEL, REAR, PUMP MODULE | 2 EA | |
| 943 5492 216 | PLUMBING,HEAT EXCHANGER SUPPLY | 1 EA | |
| 943 5492 217 | PLUMBING,HEAT EXCHANGER RETURN | 1 EA | |
| 943 5492 218 | PLUMBING, XMTR RETURN | 1 EA | |
| 943 5492 221 | PLUMBING, TANK LINE | 1 EA | |
| 943 5492 222 | PLUMBING, DRAIN/FILL MANIFOLD | 1 EA | |
| 943 5492 226 | PLUMBING, TANK FITTING | 1 EA | |
| 943 5492 227 | PLUMBING, FILTER SUPPLY | 1 EA | |
| 943 5492 228 | PLUMBING, FILTER RETURN | 1 EA | |
| 943 5492 232 | SHELF, LEFT BAY, PUMP MODULE | 1 EA | |
| 943 5492 233 | PLUMBING, FILTER SUPPLY | 1 EA | |
| 943 5578 035 | SUPPORT CHANNEL, | 4 EA | |
| 943 5578 036 | SUPPORT CHANNEL, | 2 EA | |
| 973 2100 111 | KIT, MOUNTING, COMPRESSION TANK, | 0 EA | |
| 988 2499 001 | DP, HIGH PWR PUMP MODULE, DX | 1 EA | |
| 992 9937 001 | OPTION, SINGLE PUMP | 0 EA | |
| 992 9937 002 | OPTION, DUAL PUMP | 0 EA | |
| 992 9937 003 | OPTION, FILTER UNIT, | 0 EA | |
| 992 9937 004 | OPTION, FILTER UNIT, | 0 EA | |
| 992 9937 005 | OPTION, FILL PUMP SYSTEM, | 0 EA | |
| 992 9937 006 | KIT, INSTALLATION, | 1 EA | |

**Table 2-2 OPTION, SINGLE PUMP - 992 9937 001 (B)**

| Harris PN | Description | Qty UM | Ref Des |
|---|---|---|---|
| 358 0962 000 | <*>HOSE CLAMP, SST, SAE-20 | 2 EA | |
| 424 0642 000 | HOSE, SILICONE 1-1/4 ID X | 1 FT | |
| 432 0554 000 | PUMP, WATER, 5HP 3 PHASE | 1 EA | |
| 939 8154 631 | BASE, PUMP MOUNTING | 1 EA | |
| 943 5492 229 | PLUMBING, PUMP OUTPUT | 1 EA | |
| 943 5492 230 | PLUMBING, PUMP RETURN, SINGLE | 1 EA | |
| 943 5492 231 | PLUMBING, PUMP SUPPLY, SINGLE | 1 EA | |

**Table 2-3 OPTION, DUAL PUMP - 992 9937 002 (C)**

| Harris PN | Description | Qty UM | Ref Des |
|---|---|---|---|
| 358 0962 000 | <*>HOSE CLAMP, SST, SAE-20 | 4 EA | |
| 359 1194 000 | CLAMP, SUPPORT, | 1 EA | |
| 424 0642 000 | HOSE, SILICONE 1-1/4 ID X | 2 FT | |
| 432 0554 000 | PUMP, WATER, 5HP 3 PHASE | 2 EA | |
| 614 0808 000 | *TERM BLK, THRU, 2-POLE GREY (283) 12MM | 3 EA | |
| 614 0898 000 | *TERM BLK, GND, 2-POLE GRN/YEL (283) 12MM | 1 EA | |
| 939 8154 629 | ANGLE, PLUMBING SUPPORT, | 1 EA | |
| 939 8154 631 | BASE, PUMP MOUNTING | 2 EA | |
| 943 5492 219 | PLUMBING, PUMP RETURN, DUAL | 1 EA | |
| 943 5492 220 | PLUMBING, PUMP SUPPLY, DUAL | 1 EA | |
| 943 5492 229 | PLUMBING, PUMP OUTPUT | 2 EA | |

**Table 2-4 OPTION, FILTER UNIT, - 992 9937 003 (C)**

| Harris PN | Description | Qty UM | Ref Des |
|---|---|---|---|
| 003 8030 061 | *TUBE, COPPER 0.500 OD (TYPE L) | 10 FT | |
| 358 2480 000 | ORGANIC REMOVAL CARTRIDGE | 1 EA | |
| 358 3616 000 | CARTRIDGE, FILTER, TWO BED | 1 EA | |
| 358 3617 001 | MONITOR, WATER PURITY | 1 EA | |
| 358 3618 000 | CARTRIDGE FILTER HOLDER, | 2 EA | |
| 359 1160 000 | FITTING, COMPRESSION, | 4 EA | |

| | | | |
|---|---|---|---|
| 922 1238 546 | WINDOW, FILTER FLOW | 1 EA | |
| 922 1238 557 | ANGEL, FILTER COVER | 4 EA | |
| 922 1238 558 | COVER, FILTER UNIT | 1 EA | |
| 939 8154 620 | COVER, FILTER | 1 EA | |
| 939 8154 624 | HOUSING, FILTER, PUMP MODULE | 1 EA | |

**Table 2-5 OPTION, FILTER UNIT, - 992 9937 004 (C)**

| Harris PN | Description | Qty UM | Ref Des |
|---|---|---|---|
| 003 8030 020 | TBG, CU 0.250 OD ACR | 10 FT | |
| 358 2480 000 | ORGANIC REMOVAL CARTRIDGE | 1 EA | |
| 358 3270 000 | CARTRIGE FILTER HOLDER | 1 EA | |
| 358 3616 000 | CARTRIDGE, FILTER, TWO BED | 1 EA | |
| 358 3617 001 | MONITOR, WATER PURITY | 1 EA | |
| 359 1001 000 | ADAPTOR 90DEG 1/4 MPT TO | 4 EA | |
| 359 1154 000 | BUSHING, 1/2 X 1/4 MALE TO | 2 EA | |
| 922 1238 546 | WINDOW, FILTER FLOW | 1 EA | |
| 922 1238 557 | ANGEL, FILTER COVER | 4 EA | |
| 922 1238 558 | COVER, FILTER UNIT | 1 EA | |
| 939 8154 620 | COVER, FILTER | 1 EA | |
| 939 8154 624 | HOUSING, FILTER, PUMP MODULE | 1 EA | |

**Table 2-6 OPTION, FILL PUMP SYSTEM, - 992 9937 005 (D)**

| Harris PN | Description | Qty UM | Ref Des |
|---|---|---|---|
| 358 3463 000 | SEAL, TOGGLE SWITCH | 1 EA | #S001 |
| 398 0471 000 | FUSE, CART 0.4X1.5" 1.5A SLOW | 3 EA | #F001 #F002 #F003 |
| 402 0130 000 | FUSE HOLDER, 3 POLE | 1 EA | F001 |
| 432 0440 000 | PUMP, 0.5HP 50/60HZ 3PH | 1 EA | |
| 570 0294 000 | CNTOR 40A 24VAC 50/60HZ 3P | 1 EA | K001 |
| 604 0754 000 | SW, TGL SP 2 POS | 1 EA | S001 |
| 614 0808 000 | *TERM BLK, THRU, 2-POLE GREY (283) 12MM | 3 EA | #TB002 |
| 614 0810 000 | JUMPER, ADJACENT 2-POLE (283:283) 12MM | 3 EA | #TB002 |
| 614 0898 000 | *TERM BLK, GND, 2-POLE GRN/YEL (283) 12MM | 1 EA | #TB002 |
| 917 2413 731 | PLATE, SWITCH, PUMP MODULE | 1 EA | #S001 |
| 922 1238 552 | PLUMBING, FILL PUMP INPUT | 1 EA | |
| 922 1238 553 | PLUMBING, FILL PUMP OUTPUT | 1 EA | |
| 939 8154 621 | SUPPORT, FILL PUMP | 1 EA | |

**Table 2-7 KIT, INSTALLATION, - 992 9937 006 (A1)**

| Harris PN | Description | Qty UM | Ref Des |
|---|---|---|---|
| 0038020030A | *TUBE, COPPER 0.875 OD (TYPE M) | 2 FT | |
| 055 0120 476 | CONNECTOR, 1-1/2 | 2 EA | |
| 055 0120 559 | CONNECTOR, EMT, 1" | 2 EA | |
| 063 1030 021 | * PIPE SEALANT "PST" LOCTITE 565 | 2 EA | |
| 358 1131 000 | CHANNEL NUT, W/SPRING 3/8-16 | 10 EA | |
| 358 3026 000 | HOSE BARB, 0.75H X 0.75MPT | 4 EA | |
| 359 0218 000 | ELBOW CU 90DEG 0.750C X 0.750C | 4 EA | |
| 359 0434 000 | UNION C X M 2 IN | 4 EA | |
| 359 0610 000 | ELBOW CU 45DEG 0.750FTG X 0.750C | 4 EA | |
| 359 0952 000 | ELBOW CU 90DEG 0.750C X 0.750FTG | 4 EA | |
| 359 1073 000 | ELBOW, 3/4 UNION 90 DEG | 5 EA | |
| 424 0410 000 | GROMMET 1.375 GROOVE DIA | 1 EA | |
| 917 2413 277 | FITTING, 3/4 SOLDER X 3/4 | 4 EA | |