TRANE® AIR CONDITIONING	FILE INFORMATION: DIVISION TAB-TRANE REFRIGERATION PRODUCTS PRODUCT TAB-RECIPROCATING COMPRESSOR Condenser Units LITERATURE ITEM-Service Bulletin	LITERATURE FILE NO. **HCOM-SB-42** **GENERAL SERVICE BULLETIN**

7/1/81
Supersedes P-137
Dated 10/20/72

SUBJECT: COMPRESSOR CHANGEOUT PROCEDURE

INTRODUCTION:

The purpose of this Service Bulletin is to discuss the causes of repeat compressor failure and to provide a compressor change out procedure.

DISCUSSION:

The chances of repeat compressor failures are remote unless some external influence has caused the failure. Basically, there are two causes for repeat failures:

1. The cause of the initial failure was external to the compressor (i.e. defective capacitor, sticking contactor, etc.). It has been estimated that anywhere from 60-80% of compressor failures are actually the result of malfunctions of other components, poor installation procedures or other external-to-the-compressor causes. If the cause is not corrected when the compressor is replaced, it remains in the system and the replacement compressor will eventually fail in the same manner as the original compressor. Depending on the uncorrected fault, the second failure could occur almost immediately as in the case of defective wiring in a year or more, if say the unit was improperly piped.

2. The cause of repeat failures is improper clean up of the system after a motor burns out. The acid and sludge left in the system will attack the motor insulation of the replacement compressor and the new compressor will fail within a short period of time.

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CORRECTIVE ACTION:

To prevent repeat failures, field action is required to diagnose the failures properly, determine the ultimate cause of failure and correct it, and to clean out the system properly after a burnout has occurred.

The following is an outline of the steps which must be taken after a compressor has failed to prevent repeat failures:

1. The first step is to determine if a failure has actually occurred. Anywhere from 20-30% of returned "failed" compressors show no visible sign of defect at factory teardown. Use the System Fault Analysis (See Figure 1 for Single Phase System and Figure 2 for the Three Phase Systems) to determine if the unit can be made operational without replacing the compressor. If a "good" compressor is replaced as defective, the fault which caused the initial compressor to be diagnosed a "failed" unit will also cause a similar diagnosis on the replacement compressor.

2. If utilization of the system fault analysis determines that a failure has, in fact, taken place, the entire system should be checked out to determine why the failure has occurred.

How to Use the "System Fault Analysis" Chart

1. Determine which of the four compressor problem description blocks at the top of the chart apply.

2. From the chosen block, follow the arrow down the chart to the check blocks. The check blocks describe a check to be made on the system. More than one of these blocks may apply.

3. If the check made does not show a problem, continue down the chart block by block until a solution is reached.

4. If the checks made show a problem, follow the arrow from that check block across the check to the block to the right of the check made. This block will indicate additional checks to be made or a maintenance procedure.

5. Perform the indicated check or maintenance.

6. Move from the check or maintenance block as indicated by the arrows using the same procedure outlined above.

NOTE: The blocks follow a simple rule. The blocks are a guideline to a potential problem. If the guideline is applicable, move to the right following the arrows. If the guideline is not applicable, move down following the arrows to the next block.

Example: "Compressor Runs But Does Not Pump"

1. Move down the chart to "Check System For Proper Charge" and check the charge.

2. If charge is incorrect, move right to block "Recharge If Incorrect" and recharge.

   If charge is correct, move down to block, "Check For Expansion Valve Malfunction" and check the expansion valve.

3. If there is a malfunction, move right to block "Repair Or Replace Valve" and repair or replace.

   If there is no malfunction, move down to block "Check For Suction And Discharge Pressure At Compressor" and check for pressure.

4. If no pressure is developed move right to block "If No Pressure Is Developed Replace Compressor" and replace the compressor.

NOTE: ALL HERMETIC COMPRESSORS CONTAIN AN INTERNAL WINDING THERMOSTAT. ALLOW 1 TO 2 HOURS FOR THE THERMOSTAT TO RESET AFTER ATTEMPTING TO START AND TRIPPING THIS THERMOSTAT.

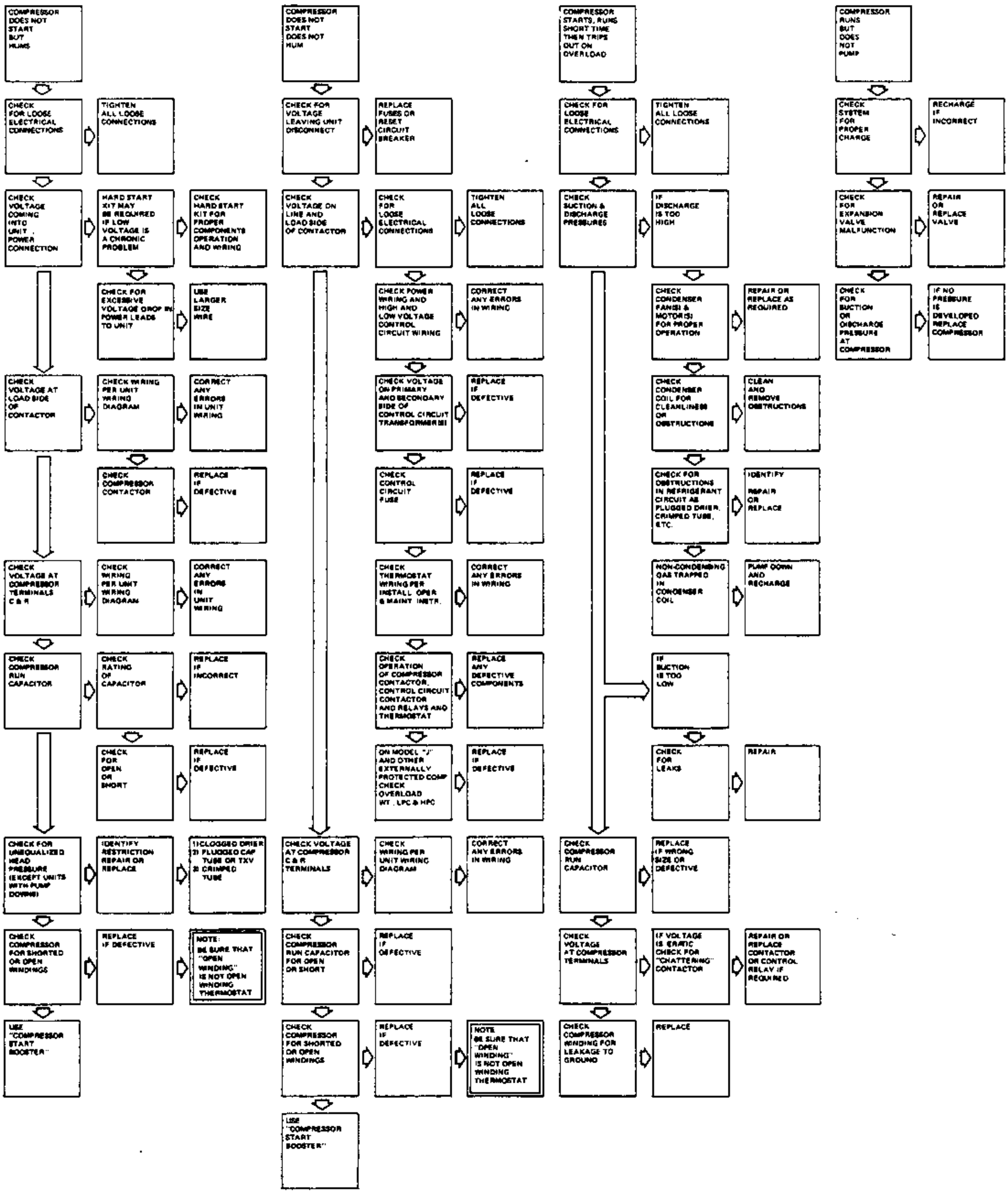

FIGURE 1 - System Fault Analysis
For Single Phase, Unitary Systems

NOTE: ALL HERMETIC COMPRESSORS CONTAIN AN INTERNAL WINDING THERMOSTAT. ALLOW 1 TO 2 HOURS FOR THE THERMOSTAT TO RESET AFTER ATTEMPTING TO START AND TRIPPING THIS THERMOSTAT.

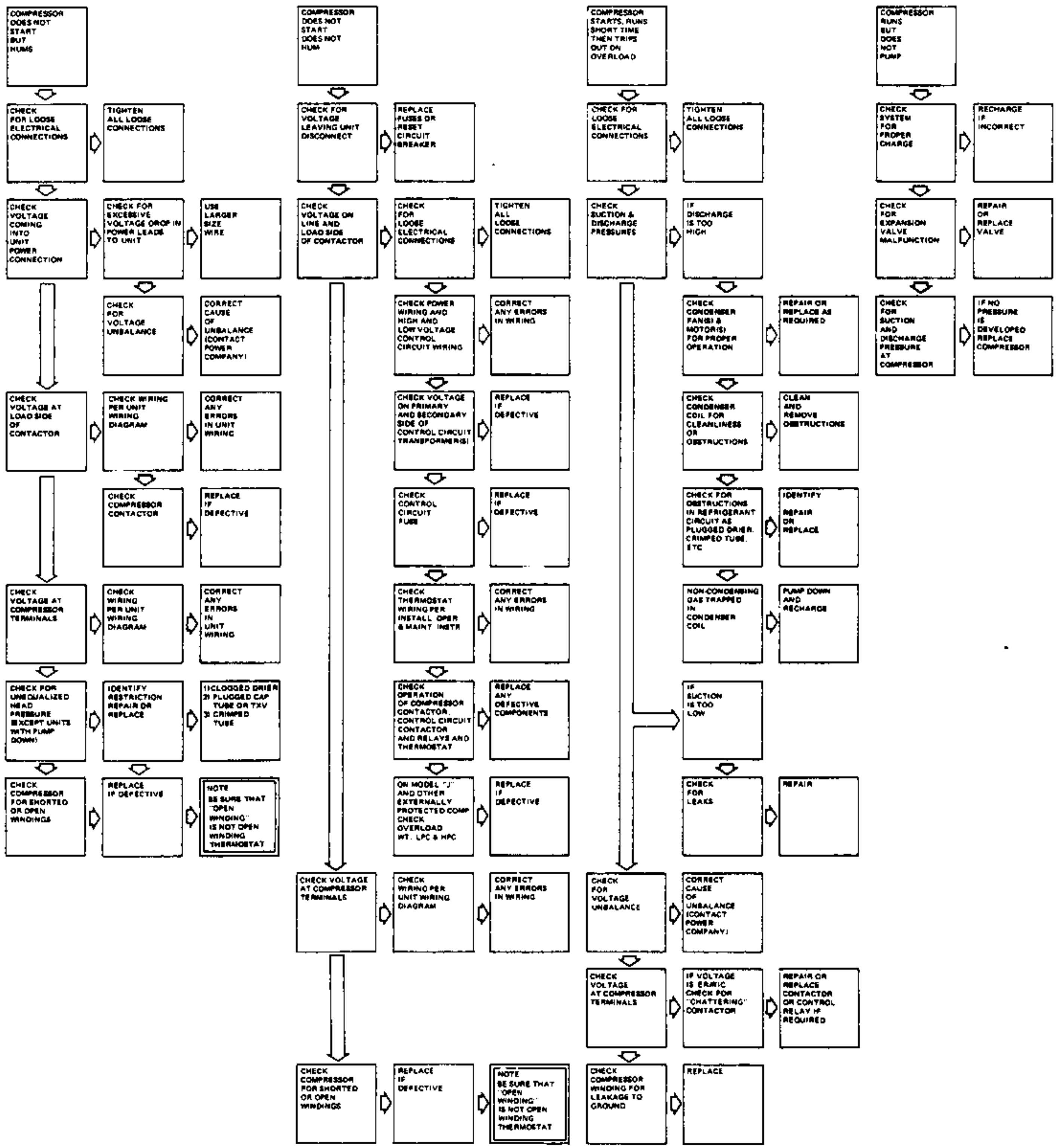

FIGURE 2 - System Fault Analysis
For Three Phase, Unitary Systems

1. Voltage at the compressor terminals must be within ± 10% of the nameplate ratings. Measure voltage WHILE THE COMPRESSOR IS STARTING, to determine if the voltage drops below the minimum value during the locked rotor current surge.

   Measure the voltage at the compressor terminals rather than at the disconnect switch to determine if loose terminals, or defective wiring is causing a voltage problem. Also, an excessively long run of supply wiring or undersized supply wiring can cause low voltage at the unit.

2. Voltage unbalance (3 Phase Systems) can cause motor overheating and eventual failure. Maximum allowable unbalance is 2%. Voltage unbalance is defined as 100 times the sum of the deviation of the 3 voltages from the average without regard to sign, divided by twice the average voltage.

3. For example, if the 3 measured voltages are 221, 230 and 227 the average voltage would be:

$$\frac{221 + 230 + 227}{3} = 226 \text{ Volts}$$

   and the percent voltage unbalance would be:

$$\frac{100 \times (226-221) + (230-226) + (227-226)}{2 \times 226} = 2.2\%$$

   In this example, a 2.2% unbalance is not acceptable and the power company should be notified to correct it. This much voltage unbalance could result in as much as a 20% current unbalance and a 10% increase in motor winding temperature. This results in decreased motor life.

4. One of the prime causes of failure of single phase compressors is a hard start kit malfunction. First check the capacitor and relay to be sure they are correct for the compressor. Next, check the wiring against the unit wiring diagram. Then, check the relay to make sure the contacts close when the relay is de-energized. Apply 230 volts across the voltage relay coil (terminals #2-5). The switch from terminal 1 to terminal 2 should open. Inspect the contacts to make sure they are not welded together or excessively pitted. Inspect the start capacitor for evidence of overheating. Make sure the bleed resistor is in place and the relief diaphragm has not been ruptured. Check the capacitor with an ohmmeter as specified in the system fault analysis. (See Figure 1 and Item 14 following).

5. Check the voltage of the control circuit. Low voltage in the control circuit can cause chattering contactors which will cause mechanical compressor failure.

   The control circuit voltage should be measured with all controls energized. On 24V control circuits, the minimum voltage should be 22V. If the primary voltage is excessively low, 20V can be temporarily tolerated.

On a 230V control circuits the minimum voltage should be 220V with 200V the absolute minimum under low primary voltage conditions.

If control circuit voltage is below the above list of values, either the transformer is defective or the control circuit is overloaded. Replace the transformer with one of a higher "VA" rating.

6. Energize the control circuit and check the operation of each of the controls with a voltmeter. Utilizing the unit wiring diagram, check the function of each control from thermostat through to the compressor

7. Install pressure gauges on the unit and check operating pressures against the tables in the unit installation/operation-maintenance instructions. If the unit is not operating at the prescribed tabulated pressures, check for dirty coils, dirty filters, broken fan belts, defective fan motors, incorrect fan rotation, miswired motors, incorrect system refrigerant charge.

8. Check the operation of the high pressure control by blocking off the condenser coil. The high pressure controls on Trane units are set for 370 psig, 380 psig, or 405 psig. The setting is stamped on the side of the PENN Controls and is given in the part number which is inked stamped on the Texas Instruments controls.

   EXAMPLE: T.I. Part No. 20PS002BA380K031D
   380 psig is the trip setting.

   The unit should trip within ± 10% of the stamped setting.

9. After the high pressure control has been tripped, check the operation of the reset relay which is used on all units above 5 tons. Remove the restriction from the coil and allow the head pressure to normalize. The compressor should not start until the control circuit has been de-energized and then re-energized.

10. If the unit has pumpdown, it is imperative that the low pressure control be checked to be sure that it shuts the compressor off when the low pressure reaches the prescribed setting. Shut the unit off at the thermostat and observe the suction pressure when the LPC shuts off the compressor. Trane employs LPC settings of 30 psig, 20 psig, and 5 psig. The setting is stamped on the side of Penn LPC and appears in the part number of the Texas Instruments controls as shown in the example above under high pressure controls. The compressor should shut off when the suction pressure is within ± 7 psi of the marked setting of the control.

11. Check the compressor contactor.

PROCEDURE FOR CHECKING COMPRESSOR CONTACTORS

a. Determine from the unit wiring diagram what voltage should be applied to the contactor coil. Check the contactor nameplate to be sure the coil voltage complies with the unit wiring diagram. Since most coils are stamped with their operating voltage, check the stamped voltage against the contactor nameplate and unit wiring diagram.

Replace if incorrect for application.

b. With the unit turned on, check the voltage at the coil terminals. On a 24 volt coil the voltage should be between 19 and 26 volts and on a 208/230 volt coil, it should be between 187 and 253 volts.

If the voltage is out of the above range, check for:

1. Incorrect wiring.

2. Defective or overloaded transformer.

3. Excessively high or low primary voltage.

If there is no voltage at the coil, check for:

1. Incorrect wiring.

2. Defective transformer, or control relay or thermostat.

c. Turn off the power. Check the coil for continuity and leakage. Replace if defective.

d. With the power still off, manually work the contacts to determine if there is a mechanical interference problem. On some contactors, a protective cover will have to be removed from over the contact arms. Replace if contact arms do not operate freely.

e. Turn the power back on and visually observe the contacts move. Be sure they move evenly, both closed and back open.

Replace if they do not move evenly or if they do not move.

f. If the contactor closes but no power is transmitted or erractic power is transmitted, check for worn contacts. Replace if worn.

Manually move the armature to ensure that it moves freely (the protective cover will have to be removed on some contactors for this inspection). Examine the contacts, replace them if they are excessively pitted.

12. Check all electrical connections to make sure that they are tight. Check all wires for evidence of overheating.

13. Check compressor windings for continuity and ground.

PROCEDURE FOR CHECKING SINGLE PHASE UNITARY COMPRESSOR WINDINGS

Remove all wires from the three compressor terminals.

a. Check the motor windings for continuity with an ohmmeter.

NOTE: Corrosion on the internal protector contacts may lead to detection of an open circuit when checked with low voltage ohmmeter. Double check all suspected open circuits with a line voltage trouble light.

CAUTION: Be sure than an open internal protector is not diagnosed as an open winding. Compressor should be cool. If compressor has attempted to start, at least an hour must be allowed for the protector to reset.

If a good low reading ohmmeter (0-5Ω scale) is available, the following check can be made:

1. The resistance of the start winding (C to S) should be approximately 3 to 6 times that of the main winding (C to R).

2. The resistance R to S should equal the sum of C to R and C to S.

b. Check motor windings for ground.

The best device for this test is a "hi-pot" tester. This device develops 2500 volts and has an alarm circuit which indicates whenever the current flow exceeds 5-10 milliamps. The recommended test voltage for this test is 2 times rated voltage plus 1000 (for a 230-volt unit - 1460 volts).

Although it is not as effective in detecting leakage to ground as a "hi-pot" tester, a Megohmmeter or "Megger" can be used. The resistance measured from a terminal to ground should not be less than 1000 ohms per volt or 230,000 ohms on a 230 volt machine.

PROCEDURE FOR CHECKING 3 PHASE COMPRESSOR WINDINGS

Remove all wires from the three compressor terminals.

a. Check the motor windings for continuity with an ohmmeter. A good circuit reading will be very low (under 10 ohms) while the resistance reading for an open circuit will approach infinity.

NOTE: Corrosion on the internal protector contacts may lead to detection of an open circuit when checked with low voltage ohmmeter. Double check all suspected open circuits with a line voltage trouble light.

CAUTION: Be sure that an open internal protector is not diagnosed as an opening winding. Compressor should be cool. If compressor has attempted to start, at least an hour must be allowed for the protector to reset.

b. Check motor windings for ground.

The best device for this test is a "hi-pot" tester. This device develops 2500 volts and has an alarm circuit which indicates whenever the current flow exceeds 5-10 milliamps. The recommended test voltage for this test is 2 times rated voltage, plus 1,000 (for a 230 volt unit - 1460 volts).

Although it is not as effective in detecting leakage to ground as a "hi-pot" tester, a Megohmmeter or "Megger" can be used. The resistance measured from a terminal to ground should not be less than 1,000 ohms per volt or 230,000 ohms on a 230 volt machine.

14. On single phase units, make sure the compressors' run capacitor is the correct size for the unit. Check the capacitor as outlined in the system fault analysis. See Figure 1.

PROCEDURE FOR CHECKING CAPACITORS

NOTE: Discharge the capacitor with a screwdriver before touching terminals.

Remove the leads from the capacitor.

Use an ohmmeter set at RX 10,000 scale.

Apply the probes to the capacitor terminals.

The following is an analysis of the results:

a. Needle swings toward 0 and returns slowly to infinity - capacitor is GOOD.

b. Needle does not move - capacitor is open - REPLACE.

c. Needle moves to 0 and remains there - capacitor is shorted - REPLACE.

15. Check the crankcase heater for proper operation. CAREFULLY TOUCH THE HEATER. Detection of heat is sufficient. If the unit is not equipped with a crankcase heater, install one.

16. On split systems, check the interconnecting piping per the Trane Reciprocating Refrigeration Manual. Be sure all suction risers are trapped at the base.

There is a collation between mechanical failures and low oil level in the crankcase. If a mechanical failure has occurred, go over the system completely checking for places where oil could be trapped.

17. If the unit has lost its valves (runs, but will not pump) it probably has been subject to slugging (liquid refrigerant returned to the compressor).

Items to be checked if a compressor has had a valve failure are:

a. Sticking or plugged expansion valve.

b. Low evaporator airflow or no evaporator airflow caused by:

1. Dirty filters.
2. Broken fan belt.
3. Failed fan motor.
4. Wrong rotation of fan.
5. Failed fan.
6. Restrictions in the air duct.

18. Expansion valve units should have superheat checked at the evaporator. It should be 11-14°F.

19. Extreme accuracy must be used when recharging capillary tube systems. Refer to the applicable installation instructions for the proper charge. A charging cylinder should be used.

If a burnout has occurred, the single most important action to be taken to prevent repeat failure is proper system clean out. The entire system must be thoroughly cleaned of all harmful contaminants - moisture, acid, and sludges - left by the burnout. Successive burnouts on the same system can generally be attributed to improper clean-up. Unless this important step is taken, a repeat burnout usually occurs in a short period of time.

The resulting products from the hermetic motor burnout may contain rather large amounts of acid and products of oil decomposition. It is imperative that these be removed from the repaired system to assure a complete system clean-up and adequate service life thereafter.

The suction line filter-driers and replaceable cores are by far the best means of removing these damaging contaminants.

Most authorities stress the importance of oil in the clean-up operation. The oil acts as a scavenger - collecting the acid, sludge, and other contaminants. Therefore, the serviceman should check the color and acid content of the oil . It must be CLEAN and ACID-FREE before the job is finished.

A liquid indicator is of little use in evaluating oil color since the percentage of oil in the liquid line is very small. The color and the acid content of the oil can be checked if an oil sample is obtained from the system. A visual inspection of the oil will determine whether the oil is clean. The acid content can be checked with the Sporlan Acid Test Kit.

Any pressure loss in the suction line reduces system capacity, but even more important is the fact that most hermetic motors rely on refrigerant vapor for cooling. Therfore, the pressure drop across the suction line filter must be limited to a reasonable value. Field experience has shown that if the suction line filter is properly sized, the pressure drop across it should not exceed 15 psi.

While there are many ways of obtaining an oil sample from an operating system that does not have a compressor oil plug, two practical methods that require only minor adaptations to the System Cleaner are illustrated below. A third method, applicable on systems with compressor service valves is also illustrated. Since less than an ounce of oil is required for the acid test, any one of the three methods is satisfactory. The time necessary to obtain an adequate oil sample with any method will vary with the system.

NOTE: Take sufficient amount of oil from trap for test. Purge remaining amount in trap, in order not to contaminate the next sample.

METHOD 1 utilizes a piece of copper tubing and a hand valve attached to the bottom or outlet end of the replaceable core Catch-All shell. As Figure 3 shows, a small amount of oil is trapped there and may be easily drained off. The oil reservoir should be purged just prior to collecting a sample for testing.

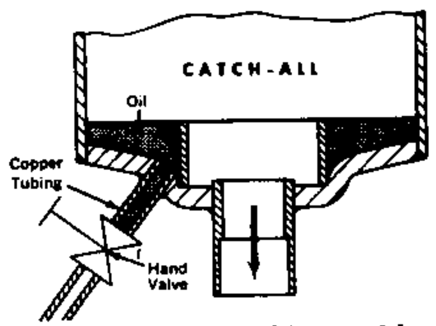

Figure 3 - Method 1 - Oil Sampling

METHOD 2 illustrated in Figure 4, uses an oil sample tube and an adapter in the inlet line of the Catch-All. The adapter may be a Schrader, bristol or capped flare fitting. Again, the oil tubing should be purged just before collecting a sample for testing.

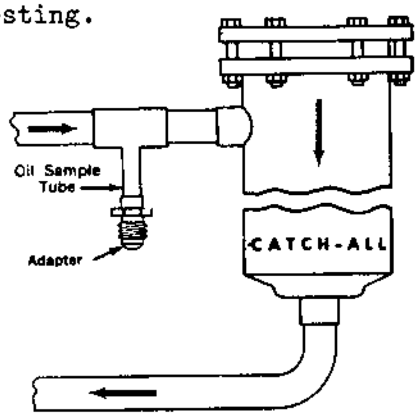

Figure 4 - Method 2 - Oil Sampling

METHOD 3 uses various items readily available in the field, Figure 5. The inlet and outlet fittings are connected with flexible hoses to the discharge and suction service valves, respectively. When the oil level is visible in the sight glass, isolate the oil trap and drain off oil sample.

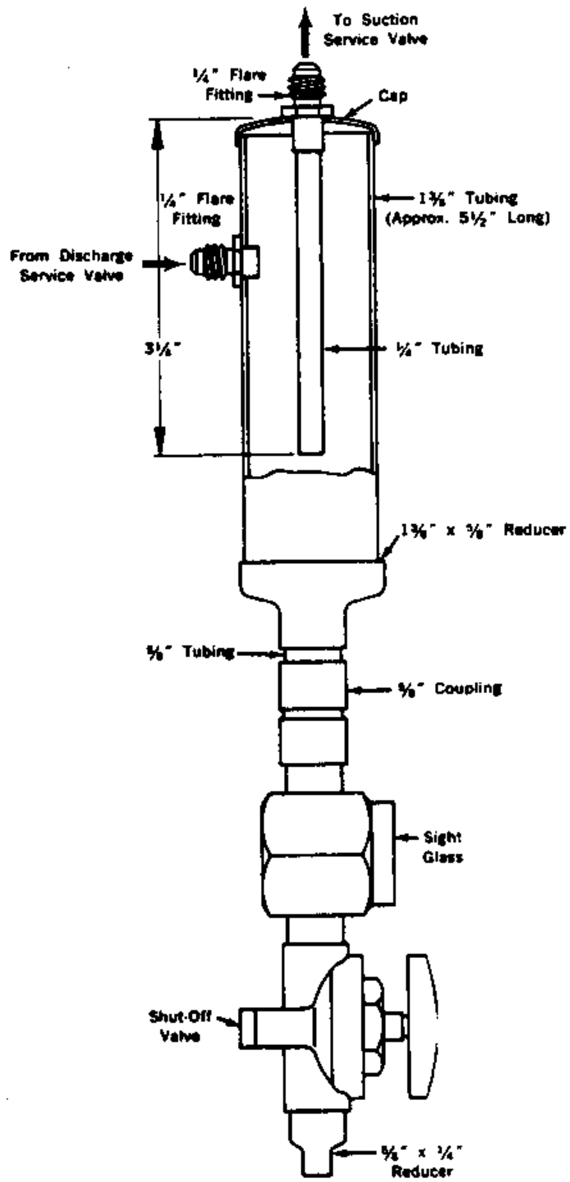

Figure 5 - Method 3 - Oil Sample

Pressure drop CAN be checked during the first hour's operation to determine if the cores need to be changed.

The cleanup should follow the following procedure step by step:

1. Determine the severity of burnout by analyzing the acid content of the oil from the burned out compressor. This can be done on the job with the Sporlan AK-1 ONE TIME Acid Test Kit or Sporlan AK-3 Acid Test Kit.

2. If the analysis shows NO acidity in the oil, then a MILD BURNOUT has occurred, and it can be cleaned up by installing an oversize filter drier in the liquid line. This simplified procedure should only be used when analysis of the oil from the burned out compressor shows it to be free of acid. If any acid is present, or if this analysis cannot be run, then the burnout should be considered SEVERE and cleaned up as described below.

CAUTION: Acid burns can result from touching the sludge in the burned out compressor. Rubber gloves should be worn when handling contaminated parts.

3. ALL SEVERE burnouts should be cleaned up using the SUCTION LINE FILTER-DRIER METHOD. Make an appraisal of the job and plan the steps to be used on the particular system involved. Two sequences are suggested depending upon system size, availability of service valves, and amount of charge.

REFRIGERANT NOT TO BE SAVED (TYPICAL FOR SYSTEMS 5 HP AND SMALLER WITHOUT SERVICE VALVES)	REFRIGERANT TO BE SAVED (TYPICAL FOR SYSTEMS LARGER THAN 5 HP WITH SERVICE VALVES)
4. Normally the amount of refrigerant will not justify saving it. The refrigerant should be discharged out of doors in the liquid phase. If the system is water cooled, care must be taken to prevent freeze-up of the condenser during purging.	4. Close the compressor service valves to trap the refrigerant in the system. Remove the burned out compressor.
5. Remove the burned out compressor and install the new compressor.	5. Install the new compressor and the suction line filter directly ahead of it. Always use the same hose between the System Cleaner and the compressor, and make sure that it is clean.

<u>REFRIGERANT NOT TO BE SAVED</u>
(TYPICAL FOR SYSTEM 5 HP AND SMALLER WITHOUT SERVICE VALVES)

6. Install a sealed model suction line filter drier ahead of the new compressor. The access valve permits the pressure drop to be checked during the first hour's operation. This can be done by installing gauges on the access valve and at the gauge port on the suction service valve.

7. Remove the liquid line drier and install an oversize liquid line filter drier, (at least one size larger than the normal selection size). Check the expansion valve and other controls to see if cleaning or replacement is required.

8. Evacuate the system, using the triple evacuation method. When breaking the vacuum with refrigerant, do it as far as possible downstream from the vacuum pump connection to obtain proper air sweeping.

<u>REFRIGERANT TO BE SAVED</u>
(TYPICAL FOR SYSTEMS LARGER THAN 5 HP WITH SERVICE VALVES)

5. Alternate Step 5 - It is frequently more economical to install the replaceable core suction line filter permanently in the suction line. A permanent installation has the advantages of:
   1. Leaving the suction line filter on the system for future needs and promoting customer satisfaction.
   2. Having the same cost since the extra callback is eliminated as well as cleanup labor and special fittings. Follow the same procedure except that unless it is a particularly bad burnout, the follow-up Steps 9, 10, and 11 may be eliminated.

6. Evacuate the compressor and the system cleaner using the triple evacuation method. Only the compressor and system cleaner need to be evacuated, since the service valves have been closed isolating the refrigerant in the system.

7. Open the service valves and pump down the system with the new compressor. Install an oversize liquid line filter drier in the liquid line, removing the old filter-drier if one was present. Examine the expansion device, solenoid valve, and other controls to see if cleaning or replacement is required. Provide some means of taking an oil sample in the future.

8. Operate the system. Check the pressure drop across the system cleaner during the first hour of operation and change the cores if necessary.

REFRIGERANT NOT TO BE SAVED
(TYPICAL FOR SYSTEM 5 HP AND SMALLER WITHOUT SERVICE VALVES)

9. Recharge the system and put in operation.
   By using a sealed model suction line filter-drier as described above, the cleanup of a small system can be completed with one call. The pressure drop across the suction line filter drier should be measured during the first hour's operation. If the pressure drop is excessive then the suction line filter drier should be replaced. The pressure drop should not exceed 3 psi.

REFRIGERANT TO BE SAVED
(TYPICAL FOR SYSTEMS LARGER THAN 5 HP WITH SERVICE VALVES)

9. In 8 to 24 hours take an oil sample. Observe the color and test with a Sporlan Acid Test Kit. If the oil is clean and free of acid, remove the system cleaner. If the oil is either dirty or acidic, change the cores and leave the system cleaner on for an additional day or two before checking another oil sample.

10. When the system cleaner is removed, replace the liquid line filter drier.

11. In two weeks recheck the color and acidity of the oil where practical, to see if another liquid line filter drier is necessary. Before the job is complete, it is essential that the oil be clean and acid free.