AMOT
CONTROLS

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Sept. 19, 1996

Mr. Thomas T. Martin
Director of Reactor Program Management
United States
Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 2055-001

Subject: NRC Information Notice 91-85
"Potential Failure of Thermostatic Control valves for Diesel Generator Jacket Cooling Water"

Dear Mr. Martin,

Recently, AMOT Controls was notified by EDF in France that AMOT thermostatic temperature control valves were not acceptable and their decision was based on NRC Information Notice 91-85.

AMOT Controls was not aware of the U.S. Nuclear Regulatory Commission's notice, NRC: 91-85 until now. In our opinion, the NRC report contains some inaccurate information and conclusions which may lead licensee to believe AMOT products are of poor quality and/or not suitable for the application. The information notice does not define the factors which caused the intergranualar stress corrosion cracking of the AMOT thermostatic element. Furthermore, it appears someone has confused shelf life with service life. We have reviewed the notice and have the following comments:

1. The information indicates the AMOT thermostatic valve elements were original equipment supplied with the engine in 1979. The engine was removed from service on September 10, 1991 for minor corrective and preventive service, which suggests the AMOT product had been in service for 12 years, not on the shelf in storage. The report does not indicate whether the AMOT product was inspected or maintained per our published

ID&R-11C

DF03

manuals. The notice identifies "slow growing intergranular stress cracking" as the root cause of the engine failure and subsequent damage. However, it does not identify what factors caused the intergranular stress cracking.

2. According to the report, the licensee's metallurgical laboratory " attributed the root cause of the failure to slow growing intergranular stress corrosion cracking. There are a number of factors outside of our control which may have caused the intergranular stress corrosion cracking.

   - Ammonia or ammonium compounds are usually responsible for causing stressed copper alloys to crack. Sometimes these compounds are found in the atmosphere or in cleaning compounds. Was the licensee properly monitoring the quality of the cooling water system and /or using cleaning compounds containing ammonia?

   - Mercury compounds can also cause the cracking of copper alloys. Did the cooling system have mercury type pressure measuring devices? Abrupt pressure changes can cause mercury from these devices to enter the system.

Please review the attached Stress Corrosion Cracking paragraph copied from the ASM Metals Handbook, 8th edition, volume 1, Properties and Selection of Metals.

3. Maintenance: **AMOT instruction form 757 states the normal service life is 6- 10 years and the element should be inspected every 2-3 years. The shelf life of elements is 1- 2 years, depending on storage conditions.** Please note the last revision of form 757 was in June 1979. All previous versions of form 757 state a 6-10 service life. AMOT maintains a document library of all literature and instruction manuals manual's dating back to the inception of the company, 1947. **The information in the NRC notice regarding shelf life is inacccurate.**

   The report indicates the thermostatic valve was 12 years old at the time the failure occurred. The report does not state that the thermostatic element was inspected every 2-3 years per AMOT's maintenance manual. It appears proper preventative maintenance may not have been performed.

4. The NRC notice states the vendors documentation indicates the thermostatic valve power elements have a 15 year shelf life but does not state "in- service life". AMOT's stated in service life is 6-10 years. Shelf and service life are distinctively different, and shelf life must not be used to define service life of

a product. The industry standard of "Shelf Life" is defined as un-installed not in-service, and only when the material is properly packaged for storage.

The NRC information notice may lead some licensee's to believe the 15 year shelf life is the service life of the product, and AMOT's products are inferior or unacceptable because they did not meet this stated 15 shelf life when in fact thermostatic element exceeded our stated in-service life. At the Catawba Nuclear Station, the AMOT valve was reportedly in service for 12 years, far exceeding the recommended in-service life of 6-10 years. "Shelf life" must not be confused with "service life".

In our opinion the intergranular stress corrosion cracking is not a defect in materials or workmanship in AMOT's product and was due to factors outside of our control. The true root cause of the intergranular stress cracking of the element was not identified. The NRC reports may lead users of AMOT products to conclude AMOT thermostatic valves are unacceptable products for the intended service.

AMOT Controls is a world wide leading manufacturer of temperature control valves widely used on emergency diesel generators in nuclear power plants. Since the late 1940's, AMOT Controls thermostatic valves have been used on many diesel engine applications and hundred of thousands of AMOT valves are in used within the Marine, Oil & Gas, U.S. Military and industrial markets. Furthermore, our thermostatic valves are currently widely used by emergency diesel engine generator OEM's for the nuclear industry.

I am requesting the NRC to re-examine this informational notice in order to clarify misleading and perhaps damaging information regarding AMOT thermostatic vavles. I look forward to your response regarding this important issue.

Sincerely,

Mark Woltering
Executive Vice President

Enclosures: AMOT Form 757
ASM Metals Handbook, pg. 1000

friable, and weak mass on the metal surface. Corrosion of a similar nature continues beneath the primary deposit of copper, resulting in a gradual replacement of sound metal by weak, porous copper, as in Fig. 5. Action of this kind, unless arrested, eventually penetrates the metal, weakening it structurally and resulting in leakage of liquids or gases through the porous layer. Dezincification that occurs in local areas is known as plug type. When it occurs in a broad area, it is known as the uniform-layer type. The dezincification usually occurs when brasses are in contact with waters that have a high oxygen and carbon dioxide content. It is also encountered in stagnant solutions or in solutions moving at low velocity and accelerates with temperature.

Dezincification is not usually a serious problem, since red brass, and admiralty and aluminum brass containing inhibitors of dezincification can be used where this form of corrosion has been experienced or is anticipated.

Table 36. Corrosion of Copper and Copper Alloys in Ethylene Glycol Solutions

Alloy	Exposure, hr	Test conditions	Average penetration, mpy: Liquid	Liquid-vapor	Vapor
Copper	168	80:20 ethylene glycol – water solution containing 0.1% H_2SO_4; 248 F	1.7	0.9	0.8
			2.5	...	0.9
Monel	168	Same as above	1.4	1.0	0.3
Copper	168	80:20 ethylene glycol – water solution containing 0.7% H_2SO_4; 248 F	10.7	2.5	1.6
			12.0	2.5	1.9
Monel	168	Same as above	12.7	2.9	0.7
			...	3.1	1.6
Copper	1344	Triethylene glycol solution; aerated; room temperature	Nil	...	...
Cartridge brass, 70%	2560	Triethylene glycol air-conditioning system; 347 F	2.0	...	...
Copper	2560	Same as above	1.6	...	...
Monel	2560	Same as above	0.7	...	...
Cartridge brass, 70%	8328	Same as above	0.6	...	...
Copper	8328	Same as above	0.4	...	...
Monel	8328	Same as above	0.2	...	...
Cartridge brass, 70%	3320	Triethylene glycol air-conditioning system; 347 F	1.4	...	...
Copper	3320	Same as above	1.0	...	...
Monel	3320	Same as above	0.7	...	...
Cartridge brass, 70%	2880	Triethylene glycol air-conditioning system (87 to 95% glycol); 320 F	0.3	...	...
Copper	2880	Same as above	0.3	...	...
Monel	2880	Same as above	0.1	...	...
Cartridge brass, 70%	5760	Same as above	0.1	...	...
Copper	5760	Same as above	0.1	...	...
Monel	5760	Same as above	Nil	...	...
Copper	3	Crude ethylene glycol (14% glycol) plus 0.06 to 0.08 H_2SO_4; 210 F	37 to 39	...	...
Copper	4	Same as above	18 to 19	...	...
Copper	19	Same as above	2	...	...
Copper	72	Same as above	0.1	...	...
Monel	5	Same as above	7 to 8	...	...
Monel	21	Same as above	1	...	...
Copper	2880	Ethylene glycol solution (15% glycol, 85% H_2O) plus 0.03% H_2SO_4; 210 F	...	...	...
Silicon bronze	2880	Same as above	0.8 to 1.0	...	...
Aluminum bronze (9.5 Al, 5 Ni, 2.5 Fe, 1 Mn)	2880	Same as above	0.1 to 0.7	...	...
Al bronze (5 Al)	2880	Same as above	0.1 to 0.3	...	...
Phosphor bronze	2880	Same as above	0.3 to 0.4	...	...
Monel	2880	Same as above	0.6 to 4.8	...	...
Copper	2400	15% ethylene glycol, 85% H_2O solution plus 0.03 to 0.05% H_2SO_4; second run; 210 F	23	...	...
Admiralty	2400	Same as above	21	...	...
Al bronze (10 Al)	2400	Same as above	15	...	...
Cupro-nickel, 30%	2400	Same as above	18	...	...
Cupro-nickel, 10%	2400	Same as above	19	...	...
Monel	2400	Same as above	13	...	...
Monel	305	Glycol maleate, 175 F	0.4	...	...
Copper	305	Same as above	0.8	...	...
Copper	66	Polyethylene glycol	1.1	...	...

Table 37. Corrosion in a Diethylene Glycol Gas Dehydration System

Alloy	Exposure, hr	Penetration, mils per yr: Glycol vapor line	Glycol to coils	Glycol still	Glycol separator	Oil separator
Copper	3240	<0.1	23.9	20.5	0.1	<0.1
Commercial bronze	3240	<0.1	1.8	1.8	<0.1	<0.1
Cartridge brass	3240	<0.1	0.7	0.7	<0.1	<0.1
Monel	3240	<0.1	1.1	<0.1	<0.1	<0.1
Copper	1440	0.3	40.5	35.3	0.2	0.3
Commercial bronze	1440	0.2	9.1	10.1	0.1	0.2
Cartridge brass	1440	0.2	1.1	0.8	0.1	0.1
Monel	1440	0.1	0.2	0.3	0.1	0.1

Stress-Corrosion Cracking

Stress-corrosion cracking and season cracking are two names for the same phenomenon — the apparently spontaneous cracking of stressed metal. The cracking is largely intercrystalline, as illustrated in Fig. 5, but in some instances a certain amount of transcrystalline cracking may also be detected. This form of corrosion takes place in a suitably corrosive atmosphere when the metal is in a stressed condition, resulting either from residual stresses from metalworking operations or from externally applied operating stresses.

Ammonia or ammonium compounds are usually responsible for causing stressed copper alloys to crack. Sometimes, these compounds are found in the atmosphere or in cleaning compounds. However, it has been proved that both oxygen and moisture are needed to make ammonia corrosive, and that other compounds, such as carbon dioxide, accelerate the cracking in ammoniacal atmospheres. Moisture films on metal surfaces will dissolve significant quantities of ammonia from atmospheres that are low in ammonia concentration. Thus, ammonia concentration on the surface can increase by a large factor.

Mercury and mercury compounds can also cause the cracking of copper alloys. In practice, it is unusual for these materials to come into contact with copper alloys, although this sometimes happens in heat-exchanger or condenser systems when abrupt pressure changes inadvertently cause mercury from pressure-measuring devices to enter the equipment.

Corrosive environment and stress are the primary requisites for stress corrosion to occur, although microstructure and alloy composition affect the rate of crack propagation. However, these latter factors are easier to control by selection of alloy, metal-forming techniques, or preventive steps after fabrication. Although test results may indicate that a finished part is free from susceptibility to stress-corrosion cracking, such an indication does not absolutely assure freedom from cracking, particularly where service stresses are high.

Both applied and residual differential stresses, with a corrosive environment, can lead to failure by stress-corrosion cracking. The susceptibility to cracking is largely a function of stress magnitude. Stresses near the yield strength of the metal are usually required to cause stress-corrosion cracking, although failures have occurred at lower stress.

Amot

MODELS B, H AND D STEEL BODIED

THERMOSTATIC VALVES

COMMERCIAL STEEL VALVES

NUCLEAR (N) STAMP VALVES

CL 3

Your Amot Thermostatic Valve has been manufactured with extreme care and tested to insure that it had no detectable defects at the time it left the factory. If the valve is correctly applied and installed it will give years of service under reasonable operating conditions. This instruction manual will give you service information for nearly all normal operating conditions, but for unusual situations it may be necessary to contact your Amot representative or the Amot factory.

All Amot B & H series valves use the "expanding wax" type of temperature sensing element. These elements are set to their nominal temperature rating under closely controlled conditions, and cannot be altered once they have been set. If it is ever necessary to change the nominal rating of a valve, a different set of elements must be used. Amot has an element exchange program for new or only slightly used elements, in the event that a different operating temperature is subsequently desired. Form 138 contains the terms and conditions for exchanges.

INSPECTING THE VALVE ON ITS RECEIPT

Immediately on receiving your valve, check it over carefully for any damage received in shipping, and to be sure you have received the proper unit. In checking the model number of the valve against your order, you may find that there are a few more digits on the nameplate than show on the order. These extra letters and numbers merely help us to be able to identify the valve and its type of construction more fully than in the past. For example, you may have ordered a 2BAS Cast Steel Valve at 160°F nominal, but you received a valve identified as 2BAS-160-01. The 160 is the temperature nominal rating, and the 01 indicates a standard 1096X element.

INSTALLATION

B & H Valve dimensions are given on Form 762 (Commercial) and 763 (Nuclear), a certified copy of which is supplied with each valve order, and which should be checked against the actual valve on receipt of the order. If special engineered drawings have been prepared, these drawings should be followed. Any conflict arising between such drawings and Amot standard instructions should be resolved before the valve is put into service.

On Page 3 of this bulletin are several recommended methods of applying Amot valves. In general, a "diverting" system will provide slightly more even temperature control than a "mixing" arrangement. This is because the former introduces a homogenous fluid to the sensing elements whereas a mixing system requires the fluid at two different temperatures to mix in the small volume of the valve.

If severe electrolysis is expected or encountered in the system, a zinc or magnesium waste plug should be installed in the valve at the A port - or as close as possible to it. For direct sea water cooled installations, bronze valves with plated elements must be used. Cast iron housings are not generally satisfactory on sea water.

If the valve is mounted at the high point of any system be sure that the system is properly vented to prevent trapping air at the elements. A good rule to follow on systems is to place air vents at all high points and drains at all low points. Vents can all be connected to a single collection point if feasible, as shown in Fig. 1, Page 3.

OPERATION

After initially placing the valve in operation, system temperatures should be closely watched to be sure that all portions of the circuit are performing properly. A system in which the valves have been properly selected for the anticipated flows and heat rejection rates should operate very close to the valve nominal temperature rating. Water cooling systems will usually operate at or slightly below the nominal temperature. Lubricating oil or other viscous fluids with lower specific heats than water will indicate at or slightly above the nominal temperature.

In any system where the indicated temperatures are more than 5°F from the nominal valve rating, an effort should be made to find the cause. Any system operating at an indicated 10°F or more from the anticipated temperatures could be in trouble and the cause must be located immediately. Standard Amot elements should not be operated continuously at temperatures in excess of 25°F above their nominal rating. On most Amot elements, 10°F above the nominal is the maximum stroke point of the element sliding valve, and beyond that point the valve is directing all of the flowing fluid to the C Port.

The assembled-unit type of construction of the Amot elements make them easy to check if they are suspected of causing erroneous system operation. The following procedure will give you an indication as to whether the element is close to its proper calibration. (For an accurate test, we suggest the elements be shipped prepaid to Amot for checking in our calibrated test tanks. Note! Whenever shipping elements, be sure to wrap them individually for protection against nicks and bumps.)

On most elements in the B & H valve series, the sliding valve starts to lift off the spider seat at 5°F below the nominal temperature rating stamped on the side strap. (This is the only number referencing temperature on the element. All others are production control

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numbers.) At 10°F above the nominal, the element is at or near its full stroke. Place the element in a bucket of water 10°F below the nominal rating and stir the water vigorously with the element for 5 minutes (the sliding valve should not be off its seat). Next, place the element in water at 15°F above the nominal rating and stir vigorously for 5 minutes. The element should now be fully stroked. This is determined by immediately placing the element back in the valve housing, and pushing the element spider fully into its counterbore. If the resistance of the sliding valve overtravel spring can be felt, the element is fully stroked. Perform the last step quickly before the element has cooled, and DO NOT USE OIL AS THE TEST BATH. On very high temperature elements, water and glycol may be used.

MAINTENANCE

Amot thermostatic valves probably require less maintenance than any other type for similar use. Elements in normal service should be good for 6 to 10 years. Excessive temperatures, chemical, electrolytic or cavitation attack will of course shorten the life of the elements and seats (which are replaceable). Water additives may cause swelling of the O-ring seal around the sliding valve, to the point where they may affect element action and require replacement. Synthetic base lubricants will definitely attack the O-ring seals which may be removed, or replaced by rings of alternate material.

Carbonates, scale and other solids must not be permitted to build up on sliding valve or sensing cup surfaces. The valve and elements may be cleaned with mild acid or Oakite solutions. Hard scale may require wire brush buffing. Unless definite trouble is encountered in operation, a valve need not be inspected more than every 2 to 3 years. When replacing elements, a light coating of grease on the O-ring is helpful in re-assembly. Be sure the O-ring is centered in the sleeve before replacing element. When ordering replacement parts for Amot valves, always give the item number, name of the part, the complete valve model number and the correct serial number.

Amot does not recommend that a large stock of spare parts be maintained at the valve installation. Most commonly used elements and seals are immediately available from Amots' stocking area representatives, or from the factory direct. Rubber seals and composition gaskets are rated for a shelf life of one year from date of shipment. If adequately sealed from air, they may be good for longer periods. Shelf life of the Amot elements is from one to two years, depending on storage conditions.

TROUBLE-SHOOTING

In the event that your cooling system does not operate close to the desired temperature, the following check list may point to one or more causes for the problem.

1. SYSTEM TEMPERATURE TOO COLD.
   - A. Insufficient heat rejected to coolant to maintain temperature.
   - B. Wrong nominal temperature selected.
   - C. Bi-metallic type thermometers will indicate low when calibrated in oil, then used in water.
   - D. Thermostatic valve greatly oversized or cooling capacity of system much greater than required.
   - E. Thermostatic valve installed backwards, forces water to cooler and causes engine to run cold under all conditions.
   - F. Worn O-ring seal or broken old style lip-type seal.
   - G. Too great a pressure difference (in excess of 25 psi) between valve ports.
   - H. Foreign material stuck between sliding valve and seat.

2. SYSTEM TEMPERTURE TOO HOT.
   - A. Cooling capacity of system not adequate.
   - B. Thermostatic valve too small for flow rate (also causes high pressure drop and possibly cavitation).
   - C. Valve installed backwards--as temp. increases B port closes, reducing flow to cooler.
   - D. Bypass will not close due to worn or pitted seats, sliding valve, O-ring seal, etc.
   - E. Element may have been over-temperatured sufficiently to affect calibration or rupture wax seal. Requires complete new element.
   - F. Solids buildup on element sliding valve prevents proper action of element.
   - G. Foreign material stuck between sliding valve and seat.
   - H. Excessive pressure differential between ports (very low pressure through bypass leg-very high pressure in cooler).

ADDITIONAL ITEMS THAT MAY BE CHECKED ARE--

- A. Thermometers--A thermometer that reads the same whether system is cold or hot needs replacing.
- B. Location of thermometers--On horizontal pipe runs, these should be in the side of the pipe when possible. (Particularly on oil systems.)
- C. They should be as far as possible downstream from the confluence of two streams of different temperature.
- D. Look for bypasses or "sneak circuits" which prevent thermostatic valve control of the complete system.
- E. Check to see that valve is marked properly. Looking in the B port, one should always see the top of the element sliding valve (see section on Page 4).
- F. Cracked or broken valves may be due to trying to make up piping runs that are too short; using small ring-type gaskets on flat face cast iron flanges and pulling bolts too tight; lack of expansion isolation between valve and piping; excessive weight or mis-alignment of piping; allowing untreated water to freeze in the system.

PIPING DIAGRAMS

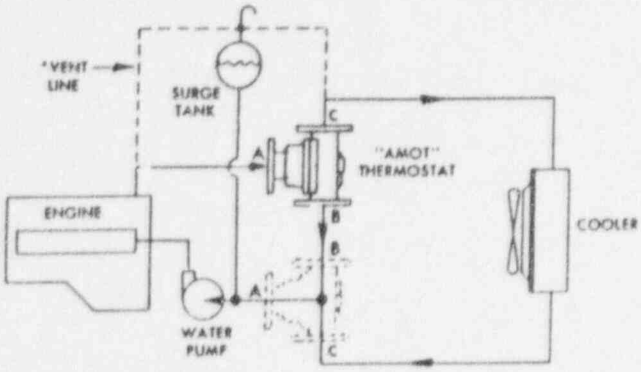


Fig. 1

COOLING WATER CONTROL—RADIATOR

Valve shown in "diverting" position to control outlet temperature. In dotted position, valve will "mix" to control inlet water to engine.

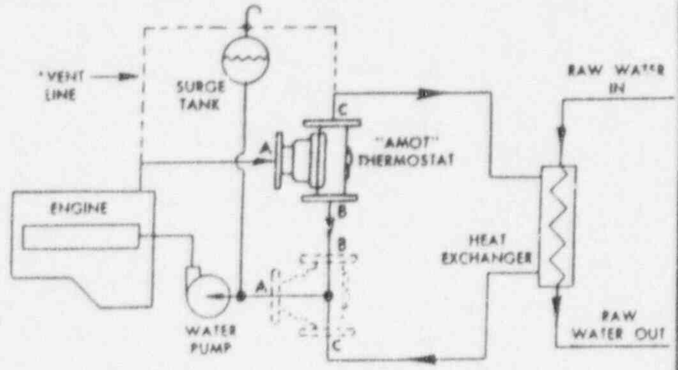


Fig. 2

COOLING WATER CONTROL—HEAT EXCHANGER

Valve shown in "diverting" installation. Mount valve as shown in dotted position for "mixing" applications.

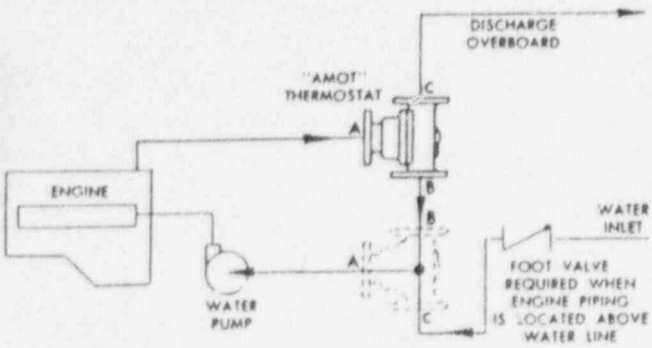


Fig. 3

DIRECT COOLING WITH RAW WATER (140°F OR LESS)

Valve shown in "diverting" installation. Mount valve as shown in dotted position for "mixing" applications.

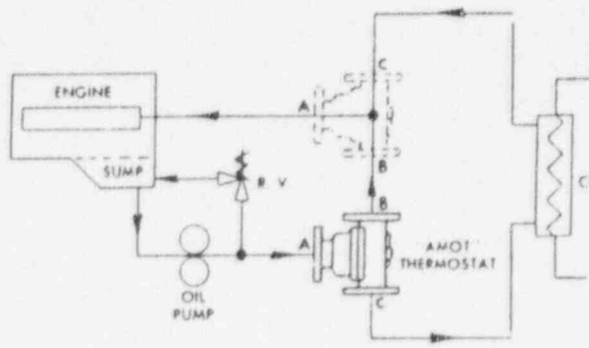


Fig. 4

LUBE OIL CONTROL

Valve shown in diverting position to control oil sump temperature. In dotted position valve will "mix" to control oil temperature to bearings or manifold.

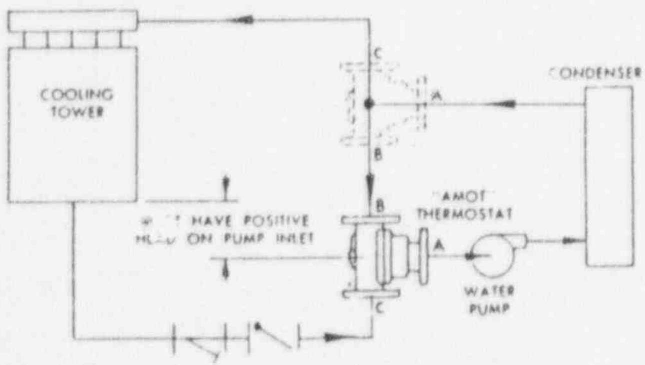


Fig. 5

AIR CONDITIONING

Valve shown in "mixing" position to control temperature of inlet water to refrigeration system condenser. Valve in dotted position controls outlet temperature.

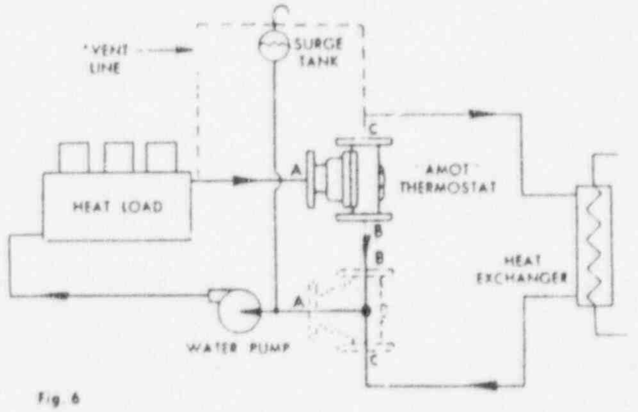


Fig. 6

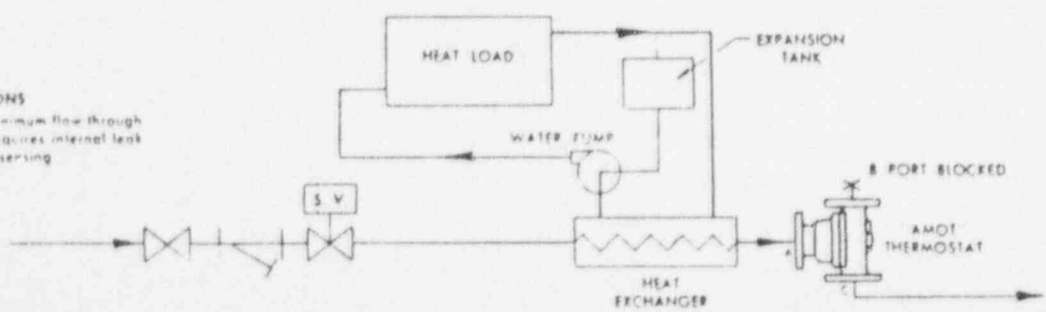
ELECTRIC SYSTEM COOLING

Valve shown in "diverting" position to control max temperatures from tubes, batteries or other heat loads. Valve in dotted position controls inlet temperature.

Fig. 7

WATER SAVING APPLICATIONS

Valve as shown maintains minimum flow through cooler to conserve water, requires internal leak hole to permit small flow for sensing.



*DOTTED VENT LINES ... DEPENDING UPON INSTALLATION AND EQUIPMENT SIZE

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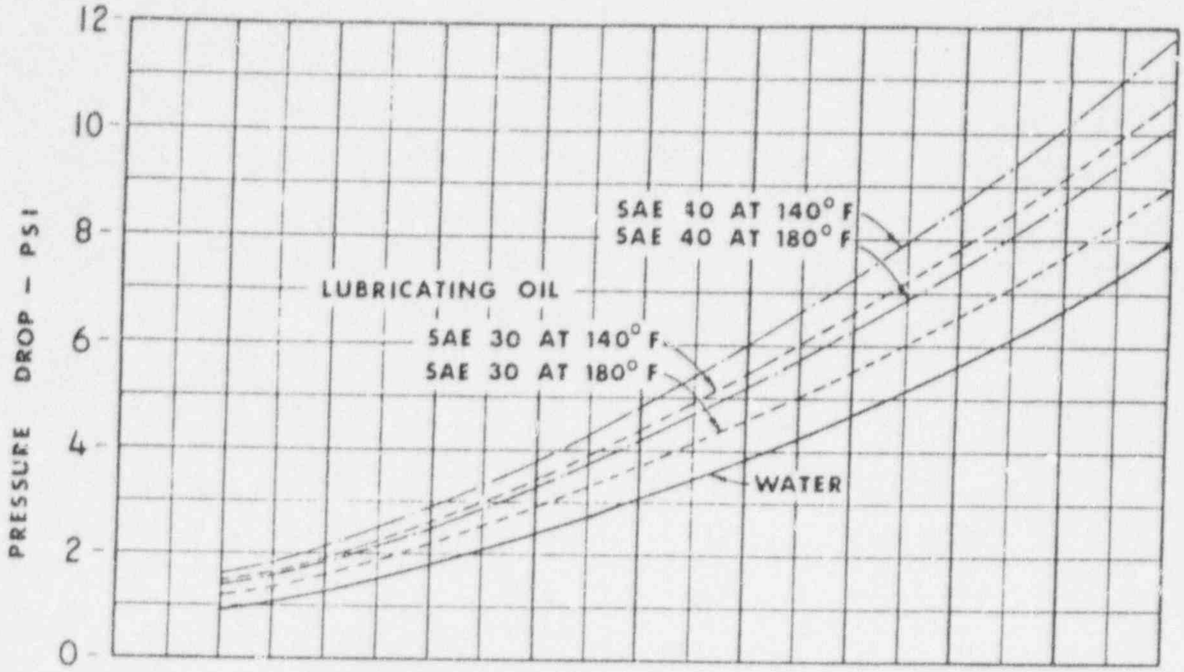
THERMOSTATS
CONTROLS
SWITCHES - VALVES
SAFETY CONTROLS



2B	40	60	80	100	120	140
2 1/2B	75	110	145	180	215	250
3B	80	120	160	200	240	280
4B	160	240	320	400	480	560
5H	240	390	540	690	840	990
6H	340	580	820	1060	1300	1540
8D	600	1100	1700	2200	2500	3000

FLUID FLOW RATE - U.S. GPM

PARTS LIST - DIMENSIONS

FOR COMMERCIAL STEEL VALVES SEE FORM 762.

FOR NUCLEAR "N" STAMP STEEL VALVES SEE FORM 763.

Amot MODELS B AND H STEEL BODIED THERMOSTATIC VALVES COMMERCIAL STEEL VALVES NUCLEAR "N" STAMP VALVES

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In any system where the indicated temperatures are more than 5°F from the nominal valve rating, an effort should be made to find the cause. Any system operating at an indicated 10°F or more from the anticipated temperatures could be in trouble and the cause must be located immediately. Standard Amot elements should not be operated continuously at temperatures in excess of 25°F above their nominal rating. On most Amot elements, 10°F above the nominal is the maximum stroke point of the element sliding valve, and beyond that point the valve is directing all of the flowing fluid to the C Port.

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numbers.) At 10°F above the nominal, the element is at or near its full stroke. Place the element in a bucket of water 10°F below the nominal rating and stir the water vigorously with the element for 5 minutes (the sliding valve should not be off its seat). Next, place the element in water at 15°F above the nominal rating and stir vigorously for 5 minutes. The element should now be fully stroked. This is determined by immediately placing the element back in the valve housing, and pushing the element spider fully into its counterbore. If the resistance of the sliding valve overtravel spring can be felt, the element is fully stroked. Perform the last step quickly before the element has cooled, and DO NOT USE OIL AS THE TEST BATH. On very high temperature elements, water and glycol may be used.

MAINTENANCE

Amot thermostatic valves probably require less maintenance than any other type for similar use. Elements in normal service should be good for 6 to 10 years. Excessive temperatures, chemical, electrolytic or cavitation attack will of course shorten the life of the elements and seats (which are replaceable). Water additives may cause swelling of the O-ring seal around the sliding valve, to the point where they may affect element action and require replacement. Synthetic base lubricants will definitely attack the O-ring seals which may be removed, or replaced by rings of alternate material.

Carbonates, scale and other solids must not be permitted to build up on sliding valve or sensing cup surfaces. The valve and elements may be cleaned with mild acid or Oakite solutions. Hard scale may require wire brush buffing. Unless definite trouble is encountered in operation, a valve need not be inspected more than every 2 to 3 years. When replacing elements, a light coating of grease on the O-ring is helpful in re-assembly. Be sure the O-ring is centered in the sleeve before replacing element. When ordering replacement parts for Amot valves, always give the item number, name of the part, the complete valve model number and the correct serial number.

Amot does not recommend that a large stock of spare parts be maintained at the valve installation. Most commonly used elements and seals are immediately available from Amots' stocking area representatives, or from the factory direct. Rubber seals and composition gaskets are rated for a shelf life of one year from date of shipment. If adequately sealed from air, they may be good for longer periods. Shelf life of the Amot elements is from one to two years, depending on storage conditions.

TROUBLE-SHOOTING

In the event that your cooling system does not operate close to the desired temperature, the following check list may point to one or more causes for the problem.

1. SYSTEM TEMPERATURE TOO COLD.
   - A. Insufficient heat rejected to coolant to maintain temperature.
   - B. Wrong nominal temperature selected.
   - C. Bi-metallic type thermometers will indicate low when calibrated in oil, then used in water.
   - D. Thermostatic valve greatly oversized or cooling capacity of system much greater than required.
   - E. Thermostatic valve installed backwards, forces water to cooler at low temperatures.
   - F. Worn O-ring seal or broken old style lip-type seal.
   - G. Too great a pressure difference (in excess of 25 psi) between valve ports.
   - H. Foreign material stuck between sliding valve and seat.

2. SYSTEM TEMPERTURE TOO HOT.
   - A. Cooling capacity of system not adequate.
   - B. Thermostatic valve too small for flow rate (also causes high pressure drop and possibly cavitation).
   - C. Valve installed backwards--as temp. increases B port closes, reducing flow to cooler.
   - D. Bypass will not close due to worn or pitted seats, sliding valve, O-ring seal, etc.
   - E. Element may have been over-temperatured sufficiently to affect calibration or rupture wax seal. Requires complete new element.
   - F. Solids buildup on element sliding valve prevents proper action of element.
   - G. Foreign material stuck between sliding valve and seat.
   - H. Excessive pressure differential between ports (very low pressure through bypass leg-very high pressure in cooler).

ADDITIONAL ITEMS THAT MAY BE CHECKED ARE--

- A. Thermometers--A thermometer that reads the same whether system is cold or hot needs replacing.
- B. Location of thermometers--On horizontal pipe runs, these should be in the side of the pipe when possible. (Particularly on oil systems.)
- C. They should be as far as possible downstream from the confluence of two streams of different temperature.
- D. Look for bypasses or "sneak circuits" which prevent thermostatic valve control of the complete system.
- E. Check to see that valve is marked properly. Looking in the B port, one should always see the top of the element sliding valve (see section on Page 4).
- F. Cracked or broken valves may be due to trying to make up piping runs that are too short; using small ring-type gaskets on flat face cast iron flanges and pulling bolts too tight; lack of expansion isolation between valve and piping; excessive weight or mis-alignment of piping; allowing untreated water to freeze in the system.

PIPING DIAGRAMS

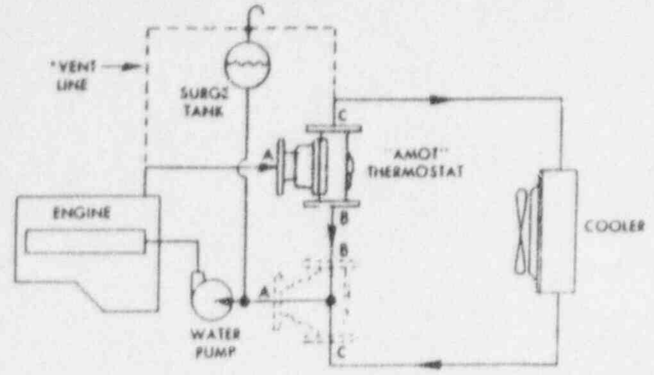


Fig. 1

COOLING WATER CONTROL—RADIATOR

Valve shown in "diverting" position to control outlet temperature. In dotted position, valve will "mix" to control inlet water to engine.

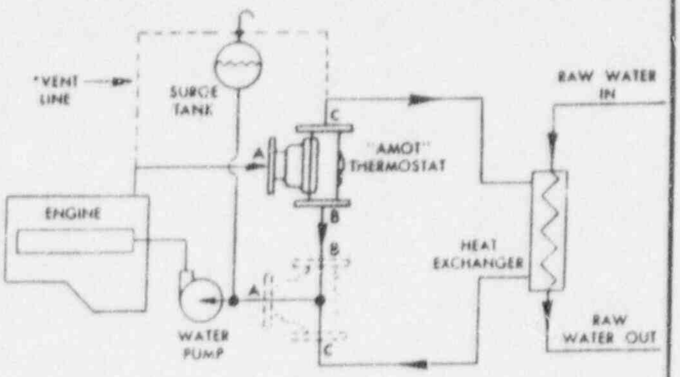


Fig. 2

COOLING WATER CONTROL—HEAT EXCHANGER

Valve shown in "diverting" installation. Mount valve as shown in dotted position for "mixing" applications.

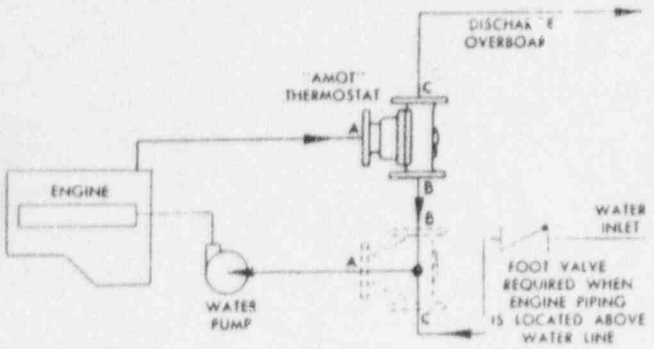


Fig. 3

DIRECT COOLING WITH RAW WATER (140 F OR LESS)

Valve shown in "diverting" installation. Mount valve as shown in dotted position for "mixing" applications.

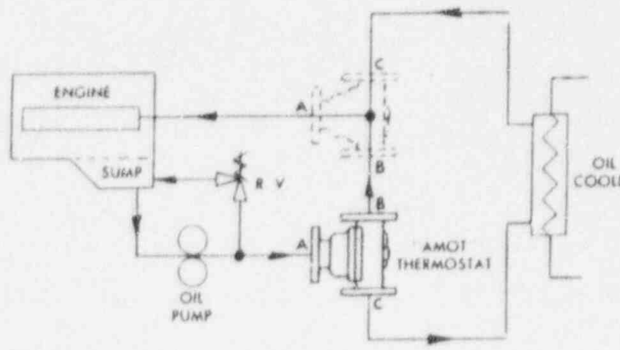


Fig. 4

LUBE OIL CONTROL

Valve shown in diverting position to control oil sump temperature. In dotted position valve will "mix" to control oil temperature to bearings or manifold.

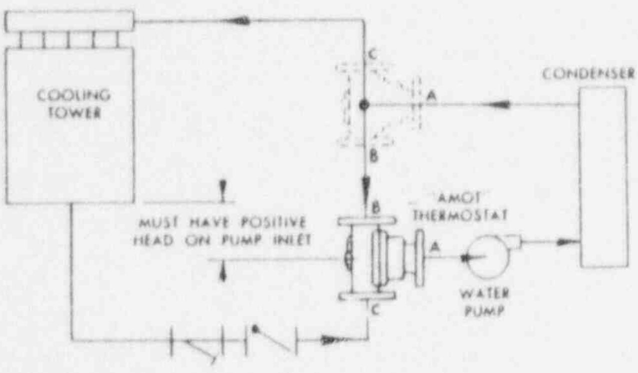


Fig. 5

AIR CONDITIONING

Valve shown in "mixing" position to control temperature of inlet water to refrigeration system condenser. Valve in dotted position controls outlet temperature.

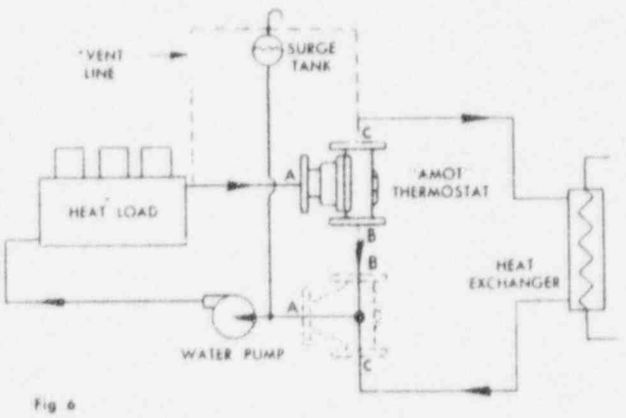


Fig. 6

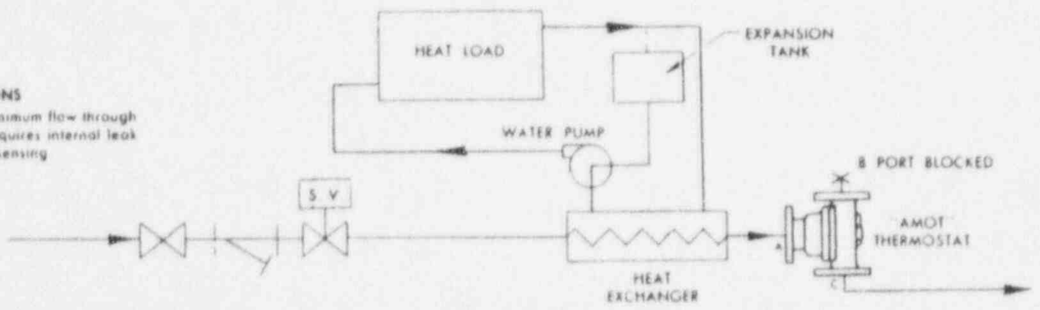
ELECTRIC SYSTEM COOLING

Valve shown in "diverting" position to control max. temperatures from tubes, batteries or other heat loads. Valve in dotted position controls inlet temperature.

Fig. 7

WATER SAVING APPLICATIONS

Valve as shown maintains minimum flow through cooler to conserve water; requires internal leak hole to permit small flow for sensing.



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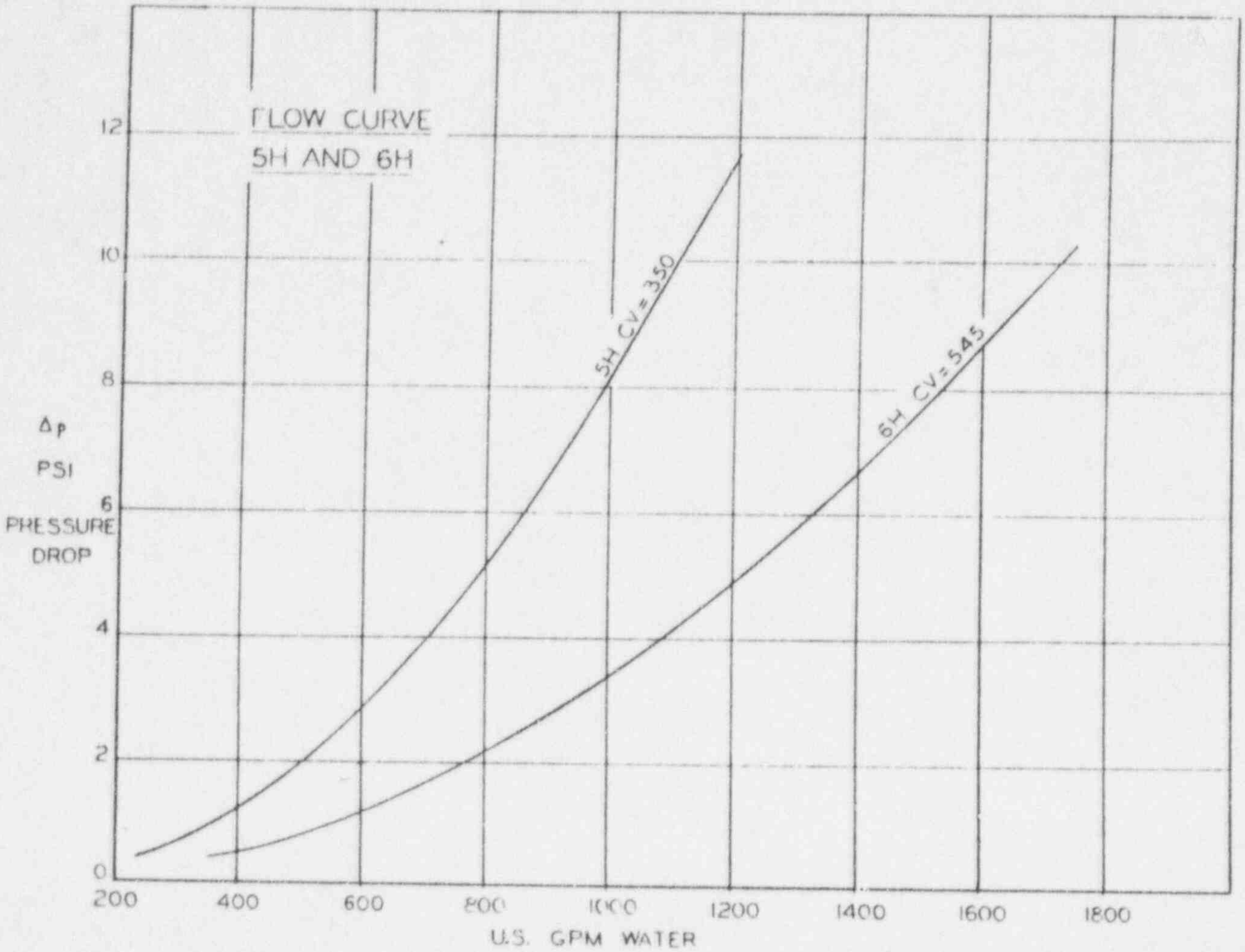

PARTS LIST

For Parts List for 5-HAS see Assembly Drawing 9058X.

For Parts List for 6-HAS see Assembly Drawing 9060X.

Amot

MODELS B, H AND D STEEL BODIED THERMOSTATIC VALVES COMMERCIAL STEEL VALVES NUCLEAR (N) STAMP VALVES

CL 3

Your Amot Thermostatic Valve has been manufactured with extreme ire and tested to insure that it had no detectable defects at the time it left the factory. If the valve is correctly applied and installed it will give years of service under reasonable operating conditions. This instruction manual will give you service information for nearly all normal operating conditions, but for unusual situations it may be necessary to contact your Amot representative or the Amot factory.

All Amot B & H series valves use the "expanding wax" type of temperature sensing element. These elements are set to their nominal temperature rating under closely controlled conditions, and cannot be altered once they have been set. If it is ever necessary to change the nominal rating of a valve, a different set of elements must be used. Amot has an element exchange program for new or only slightly used elements, in the event that a different operating temperature is subsequently desired. Form 138 contains the terms and conditions for exchanges.

INSPECTING THE VALVE ON ITS RECEIPT

Immediately on receiving your valve, check it over carefully for any damage received in shipping, and to be sure you have received the proper unit. In checking the model number of the valve against your order, you may find that there are a few more digits on the nameplate than show on the order. These extra letters and numbers merely help us to be able to identify the valve and its type of construction more fully than in the past. For example, you may have ordered a 2BAS Cast Steel Valve at 160°F nominal but you received a valve identified as 2BAS-160-01. The 160 is the temperature nominal rating, and the 01 indicates a standard 1096X element.

INSTALLATION

B & H Valve dimensions are given on Form 762 (Commercial) and 763 (Nuclear), a certified copy of which is supplied with each valve order, and which should be checked against the actual valve on receipt of the order. If special engineered drawings have been prepared, these drawings should be followed. Any conflict arising between such drawings and Amot standard instructions should be resolved before the valve is put into service.

On Page 3 of this bulletin are several recommended methods of applying Amot valves. In general, a "diverting" system will provide slightly more even temperature control than a "mixing" arrangement. This is because the former introduces a homogenous fluid to the sensing elements whereas a mixing system requires the fluid at two different temperatures to mix in the small volume of the valve.

If severe electrolysis is expected or encountered in the system, a zinc or magnesium waste plug should be installed in the valve at the A port - or as close as possible to it. For direct sea water cooled installations, bronze valves with plated elements must be used. Cast iron housings are not generally satisfactory on sea water.

If the valve is mounted at the high point of any system be sure that the system is properly vented to prevent trapping air at the elements. A good rule to follow on systems is to place air vents at all high points and drains at all low points. Vents can all be connected to a single collection point if feasible, as shown in Fig. 1, Page 3.

OPERATION

After initially placing the valve in operation, system temperatures should be closely watched to be sure that all portions of the circuit are performing properly. A system in which the valves have been properly selected for the anticipated flows and heat rejection rates should operate very close to the valve nominal temperature rating. Water cooling systems will usually operate at or slightly below the nominal temperature. Lubricating oil or other viscous fluids with lower specific heats than water will indicate at or slightly above the nominal temperature.

In any system where the indicated temperatures are more than 5°F from the nominal valve rating, an effort should be made to find the cause. Any system operating at an indicated 10°F or more from the anticipated temperatures could be in trouble and the cause must be located immediately. Standard Amot elements should n be operated continuously at temperatures in excess of 25°F above their nominal rating. On most Amot elements, 10°F above the nominal is the maximum stroke point of the element sliding valve, and beyond that point the valve is directing all of the flowing fluid to the C Port.

The assembled-unit type of construction of the Amot elements make them easy to check if they are suspected of causing erroneous system operation. The following procedure will give you an indication as to whether the element is close to its proper calibration. (For an accurate test, we suggest the elements be shipped prepaid to Amot for checking in our calibrated test tanks. Note: Whenever shipping elements, be sure to wrap them individually for protection against nicks and bumps.)

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Amot controls

Amot

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THERMOSTATIC VALVES

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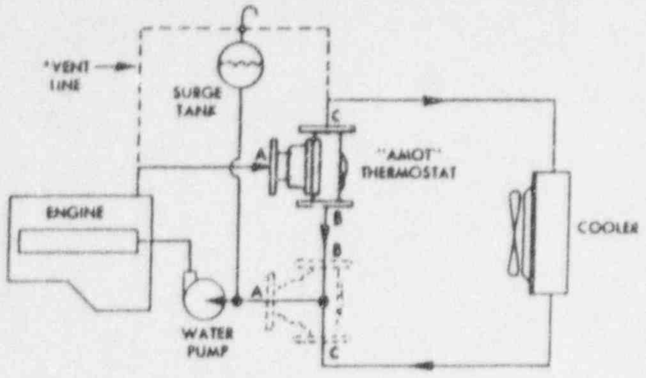


Fig. 1

COOLING WATER CONTROL—RADIATOR

Valve shown in "diverting" position to control outlet temperature. In dotted position, valve will "mix" to control inlet water to engine.

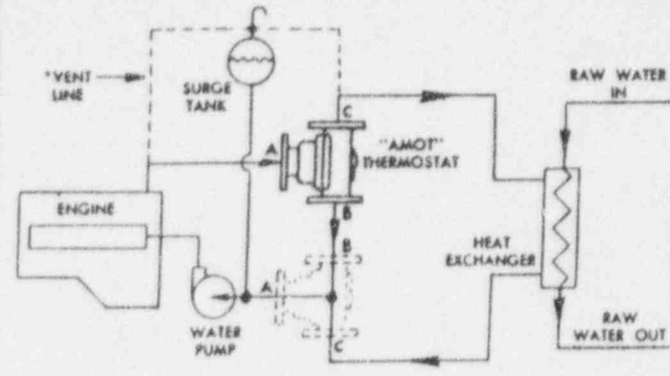


Fig. 2

COOLING WATER CONTROL—HEAT EXCHANGER

Valve shown in "diverting" installation. Mount valve as shown in dotted position for "mixing" applications.

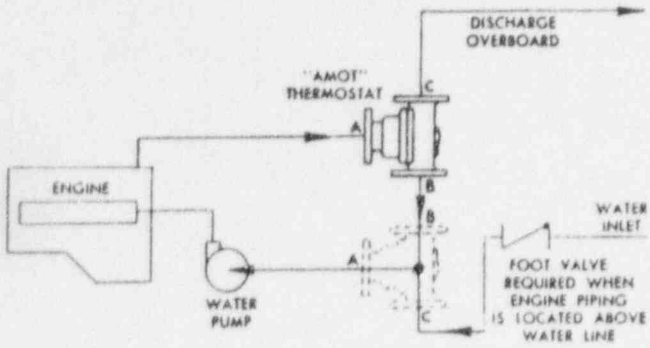


Fig. 3

DIRECT COOLING WITH RAW WATER (140°F OR LESS)

Valve shown in "diverting" installation. Mount valve as shown in dotted position for "mixing" applications.

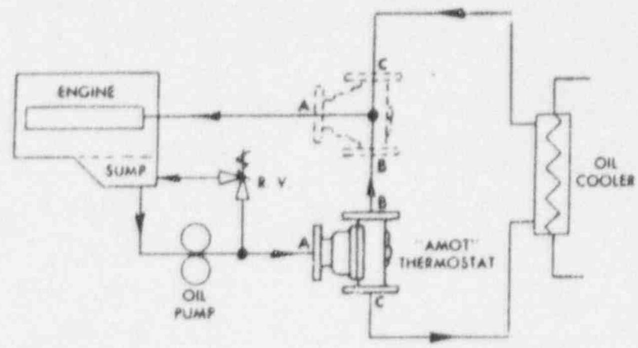


Fig. 4

LUBE OIL CONTROL

Valve shown in diverting position to control oil sump temperature. In dotted position valve will "mix" to control oil temperature to bearings or manifold.

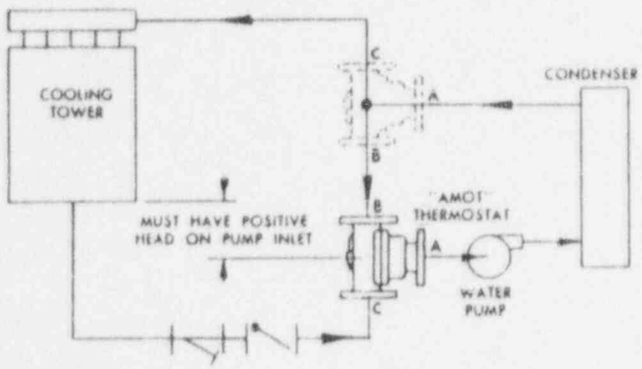


Fig. 5

AIR CONDITIONING

Valve shown in "mixing" posi tion to control temperature of inlet water to refrigeration system condenser. Valve in dotted position controls outlet temperature.

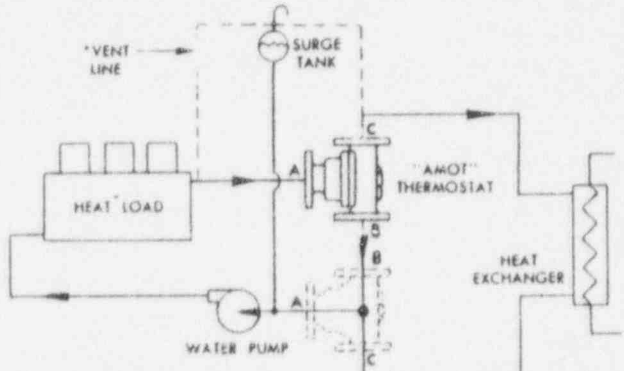


Fig. 6

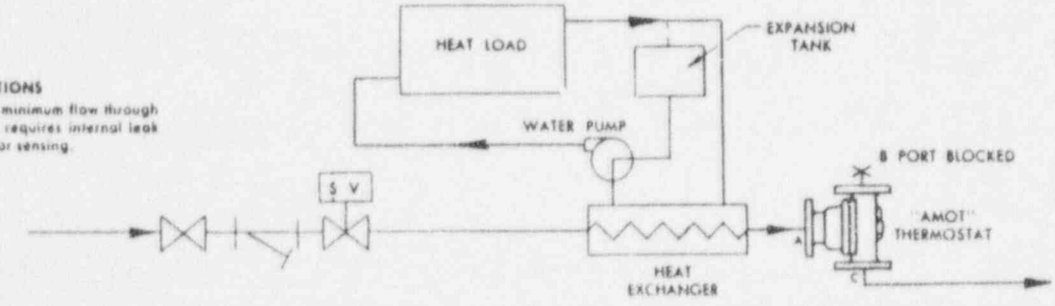
ELECTRIC SYSTEM COOLING

Valve shown in "diverting" position to control max temperatures from tubes, batteries or other heat loads. Valve in dotted p sition controls inlet temperature.

Fig. 7

WATER SAVING APPLICATIONS

Valve as shown maintains minimum flow through cooler to conserve water, requires internal leak hole to permit small flow for sensing.



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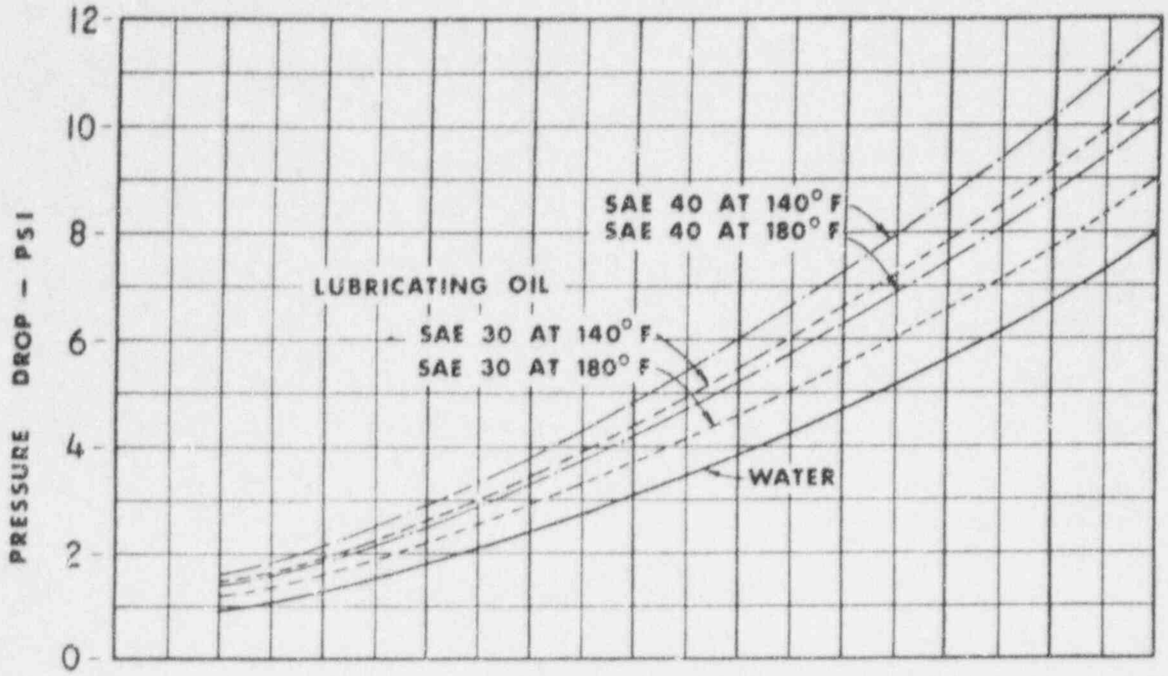
Amot controls
CORPORATION

THERMOSTATS · CONTROLS · SWITCHES · VALVES · SAFETY CONTROLS



2B	40	60	80	100	120	140
2 1/2B	75	110	145	180	215	250
3B	80	120	160	200	240	280
4B	160	240	320	400	480	560
5H	240	390	540	690	840	990
6H	340	580	820	1060	1300	1540
8D	600	1100	1700	2200	2500	3000

FLUID FLOW RATE – U.S. GPM

PARTS LIST – DIMENSIONS

FOR COMMERCIAL STEEL VALVES SEE FORM 762.

FOR NUCLEAR "N" STAMP STEEL VALVES SEE FORM 763.