BSM # 821B

ANTI-FREEZE SOLUTIONS

CONTENTS

1. GENERAL

1.01 This section provides information on the use of various anti-freeze solutions for protecting the water-cooling systems of automotive type engines and of portable air compressors against freezing.

1.02 This information is provided for the use of garage attendants, motor vehicle inspector-repairmen, operators of motor vehicles and any others who may be required to examine and service the cooling systems.

2. TYPES OF ANTI-FREEZE

2.01 The following anti-freeze materials are covered in this Section.

(a) *ETHYLENE GLYCOL ANTI-FREEZE*

(1) Anti-freeze in which the principal constituent is ETHYLENE GLYCOL and which is approved for Bell System use. The anti-freeze does not evaporate from the solution and thus, if a proper solution is installed initially and there is no loss of the solution due to leaks or overflow, it will not require additional anti-freeze.

(b) *METHANOL (METHYL ALCOHOL) ANTI-FREEZE*

(1) Anti-freeze in which the principal constituent is a synthetically produced wood alcohol, commonly called METHANOL. It is identified from other anti-freezes such as ETHANOL anti-freeze by its deep purple or violet color.

(2) METHANOL anti-freeze approved for Bell System use contains about 97 per cent METHANOL by volume. Its containers are marked "Contains over 90 per cent METHANOL," in order to distinguish it from lower strength methanol anti-freezes.

(c) *ETHANOL (ETHYL ALCOHOL) ANTI-FREEZE (Seldom Used)*

(1) Anti-freeze in which the principal constituent is denatured ethyl alcohol. It is known as ETHANOL anti-freeze.

(2) ETHANOL anti-freeze approved for Bell System use would be 188 proof and its containers so marked in order to distinguish it from lower strength ETHANOL anti-freezes. Because of price in relation to its lesser ability to protect as compared to METHANOL, it is seldom used.

2.02 Use only approved anti-freeze. Never mix different types of anti-freeze as testing the solution with an anti-freeze solution tester would then be impossible. Mixing different makes of the same type of anti-freeze should also be avoided. However, small quantities of the same type but of other makes may be used as make-up.

3. INHIBITORS

3.01 The inhibitor referred to in this section as "approved inhibitor" is DuPont No. 7 Acid and Rust Inhibitor which is a white powder supplied in 5-ounce containers, not DuPont No. 7 Anti-rust and Water Pump Lubricant which is a liquid, nor Bell System Rust Inhibitor which is an orange-colored powder. Bell System Rust Inhibitor may be used when only water is used in the cooling system.

3.02 When required, use one 5-ounce container of DuPont No. 7 Acid and Rust Inhibitor in a cooling system of less than 23 quarts capacity, and two 5-ounce containers in cooling systems of larger capacity.

4. SAFETY PRECAUTIONS

4.01 All the anti-freezes and inhibitors are poisonous. METHANOL and ETHANOL are extremely poisonous. None must ever be taken internally. (See Antidote for Alcohol Poisoning, Part 5.) Care must be taken at all times to avoid spilling them on any part of the body including the hands, into the eyes or on the clothing. If any does get onto the skin, or into the eyes, wash with an abundance of water immediately. If thought necessary, rubber gloves and goggles should be worn when handling these materials. Do not inhale fumes.

4.02 METHANOL and ETHANOL are volatile liquids, the fumes of which are inflammable. Avoid spilling any of the solution on a hot engine in order to prevent the possibility of a fire. Do not permit any open flame or sparks to be brought near the liquid or solutions of it, or near any empty METHANOL or ETHANOL containers which might contain residual vapors. If either METHANOL or ETHANOL is spilled accidentally, wipe it up immediately. Wash out thoroughly with water any rags soaked with either METHANOL or ETHANOL anti-freeze before discarding them. If the METHANOL or ETHANOL is spilled on the clothing, drench the clothing immediately with water.

4.03 Observe all ordinances and regulations for transporting, storing, dispensing and otherwise handling METHANOL and ETHANOL.

5. ANTIDOTE FOR ALCOHOL POISONING

5.01 If METHANOL or ETHANOL is accidentally taken internally, immediately induce vomiting by forcing the patient to drink, as quickly as possible, all of a mixture of two quarts of milk and 6 to 12 raw eggs. When vomiting has subsided induce sweating by covering the patient with blankets and administer large quantities of sodium bicarbonate or baking soda solution—eight teaspoonfuls per pint of water. Call a doctor at the earliest opportunity.

6. PREPARING COOLING SYSTEM FOR ANTI-FREEZE SOLUTION

6.01 Make sure cooling system is tight and clean. If cooling system requires cleaning follow instructions in the section entitled "Engine Cooling Systems—Rust Prevention."

6.02 If the cooling system does not require cleaning, and does not contain ETHYLENE GLYCOL anti-freeze which would be worth while to re-use, completely drain radiator, engine block and heater. Refill with water, see that all valves in the hot water heater lines are open, run engine for a few minutes in order to circulate the water through the system and completely drain again. Then close all drain cocks, and leave all valves in the hot water heater lines open.

6.03 If the cooling system contains ETHYLENE GLYCOL anti-freeze follow instructions in Paragraph 9.01.

7. QUANTITY OF ANTI-FREEZE REQUIRED

7.01 The amount of anti-freeze required in cooling systems of various capacities is given in the following Figs. 1, 2 and 3. If the vehicle is equipped with a hot water heater, be sure to make allowance for it in determining the capacity of the cooling system.

ETHYLENE GLYCOL

COOLING SYSTEM CAPACITY QUARTS	QUARTS OF ETHYLENE GLYCOL REQUIRED FOR PROTECTION DOWN TO						
	+20°F.	+10°F.	0°F.	−10°F.	−20°F.	−30°F.	−40°F.
10	2	2-1/2	3-1/2	4	4-1/2	5	5-1/2
12	2	3	4	5	5-1/2	6	6-1/2
14	2-1/2	3-1/2	4-1 2	5-1/2	6-1/2	7	7-1/2
16	3	4	5-1/2	6-1/2	7-1/2	8	8-1/2
18	3	4-1/2	6	7	8	9	9-1/2
20	3-1/2	5	6-1/2	8	9	10	10-1/2
22	4	5-1/2	7-1/2	8-1/2	10	11	12
24	4	6	8	9-1/2	11	12	13
26	4-1/2	6-1/2	8-1/2	10	12	13	14
28	5	7	9-1/2	11	12-1/2	14	15

Note: A 60% solution has a freezing point of 62°F. below zero which is the lowest obtainable. Adding more ETHYLENE GLYCOL type anti-freeze will raise the freezing point. 100% ETHYLENE GLYCOL type anti-freeze freezes at 0°F.

Fig. 1

METHANOL

COOLING SYSTEM CAPACITY QUARTS	QUARTS OF FULL STRENGTH (97 PER CENT BY VOLUME) METHANOL ANTI-FREEZE REQUIRED FOR PROTECTION DOWN TO						
	+20°F.	+10°F.	0°F.	−10°F.	−20°F.	−30°F.	−40°F.
10	1-1/2	2	3	3-1/2	4	4-1/2	5
12	1-1/2	2-1/2	3-1/2	4-1/2	5	5-1/2	6
14	2	3	4	5	5-1/2	6-1/2	7
16	2	3-1/2	4-1/2	5-1/2	6-1/2	7-1/2	8
18	2-1/2	3-1/2	5	6-1/2	7-1/2	8	9
20	2-1/2	4	5-1/2	7	8	9	10
22	3	4-1/2	6-1/2	8	9	10	11
24	3-1/2	5	7	8-1/2	9-1/2	11	12
26	3-1/2	5-1/2	7-1/2	9	10-1/2	12	13
28	4	5-1/2	8	10	11-1/2	12-1/2	14

Caution: If there is any doubt regarding the strength of the METHANOL anti-freeze, mix a solution of one part of it with two parts water and test with a METHANOL anti-freeze hydrometer. If its freezing temperature tests appreciably higher than 8 degrees below zero bring the matter to the attention of your supervisor.

Fig. 2

ETHANOL

COOLING SYSTEM CAPACITY QUARTS	QUARTS OF 188-PROOF ETHANOL ANTI-FREEZE REQUIRED FOR PROTECTION DOWN TO						
	+20°F.	+10°F.	0°F.	−10°F.	−20°F.	−30°F.	−40°F.
10	2	3	4	4-1/2	5	6	7
12	2-1/2	3-1/2	4-1/2	5-1/2	6	7	8-1/2
14	3	4	5-1/2	6-1/2	7	8-1/2	10
16	3	5	6	7	8	9-1/2	11-1/2
18	3-1/2	5-1/2	7	8	9	11	12-1/2
20	4	6	7-1/2	9	10	12	14
22	4-1/2	6-1/2	8-1/2	10	11	13	15-1/2
24	4-1/2	7	9	10-1/2	12	14-1/2	17
26	5	7-1/2	10	11-1/2	13	15-1/2	18-1/2
28	5-1/2	8-1/2	10-1/2	12-1/2	14	16-1/2	19-1/2

Caution: If there is any doubt regarding the strength of the ETHANOL anti-freeze, mix a solution of one part of it with one part water and test with an ETHANOL anti-freeze hydrometer. If its freezing temperature tests appreciably higher than 20 degrees below zero bring the matter to the attention of your supervisor.

Fig. 3

8. MIXING AND PLACING NEW ANTI-FREEZE

8.01 All types of approved anti-freeze when new contain a satisfactory inhibitor. None should, therefore, be added.

8.02 Do not spill any anti-freeze on finished surfaces since they all, particularly the METHANOL and ETHANOL types, are harmful to motor vehicle finishes. If any is accidentally spilled on a finished surface, it should immediately be flushed off with water.

8.03 METHANOL and ETHANOL. Pour the required amount of METHANOL or ETHANOL anti-freeze into the previously prepared cooling system. Then fill with water so that the liquid level can just be seen in the radiator.

8.04 ETHYLENE GLYCOL. Pour about one gallon of water into the previously prepared cooling system. Then pour in the required amount of ETHYLENE GLYCOL anti-freeze and fill with water so that the liquid level can just be seen in the radiator.

8.05 Air trapped in the cooling system prevents complete filling and this may result in serious overheating later. After filling the radiator in accordance with Paragraph 8.03 or 8.04, run the engine to mix the liquids and to heat the solution sufficiently so that the thermostat will open and allow any air that might be trapped in the engine block to escape. After this has been done, test the solution to see that it is of the required strength and examine the radiator to make sure that the liquid is up to the required level (see Paragraph 10.03). Make sure that the radiator cap fits properly and is of the proper pressure rating.

8.06 Carefully examine the cooling system for leaks. In the case of METHANOL or ETHANOL a leak is a serious fire hazard. In the case of ETHYLENE GLYCOL, leaks into the engine can be destructive.

9. USING ETHYLENE GLYCOL SAVED FROM PREVIOUS WINTER

9.01 ETHYLENE GLYCOL solution which was not drained at the end of the previous winter shall be examined for appearance and tested for strength and alkalinity. If rusty or otherwise unclean in appearance, if it does not test alkaline (see Part 14) or if it is so weak that bringing it up to strength is not worth while, drain and discard the solution. Then follow the applicable instructions of Parts 6, 7 and 8. However, if the solution is satisfactory in appearance, alkalinity and strength, bring it up to the required strength, if necessary, by adding anti-freeze preferably of the same make already in the system. Then add the approved inhibitor (see Part 3) and follow the instructions in Paragraphs 8.05 and 8.06. Attach a tag marked "Drain in Fall, 19____" to the radiator filler opening.

9.02 ETHYLENE GLYCOL solution is sometimes drained and saved in containers during the summer months. However, the labor cost usually makes this operation impractical.

9.03 ETHYLENE GLYCOL solution which was saved in containers shall be examined for appearance and tested for alkalinity (see Part 14). If rusty or otherwise unclean in appearance or if it does not test alkaline, don't use; discard it. If clean and alkaline, test it with solution tester, bring it up to the required strength, if necessary, by adding anti-freeze preferably of the same make in the solution, prepare the cooling system in accordance with the instructions in Part 6, fill the cooling system with the saved solution, add approved inhibitor (see Part 3) and follow the instructions in Paragraphs 8.05 and 8.06. Attach a tag marked "Drain in Fall 19____" to the radiator filler opening.

10. ADDING LIQUID TO RADIATOR TO MAKE UP FOR EVAPORATION LOSSES

10.01 Solutions of METHANOL or ETHANOL anti-freeze gradually become weaker due to evaporation of the anti-freeze. Evaporation becomes rapid when the motor is doing heavy work and on relatively warm days which sometimes occur during the winter months. Therefore, never add water to the solution without adding the required proportion of whichever type alcohol is in the solution unless anti-freeze is stronger than necessary (see Part 12).

10.02 Whenever, because of loss due to evaporation, it is necessary to add liquid to a radiator containing ETHYLENE GLYCOL, add water only since very little ETHYLENE GLYCOL is lost by evaporation. If loss was appreciable, however, make sure loss was not due to leakage or overflow. If there was no loss due to leakage or overflow the solution should be stronger than required so that, after the necessary amount of water has been added, it will have the required strength.

10.03 Avoid overfilling the radiator. Examine the liquid level when hot and then add more liquid until the liquid level can just be seen. Carrying a higher liquid level results in appreciable loss of liquid through overflow, which contains anti-freeze.

11. TESTING STRENGTH OF SOLUTION

11.01 Use an anti-freeze solution tester for determining the freezing point of the solution, making sure that the tester being used is the correct type for the anti-freeze being tested.

11.02 When using METHANOL or ETHANOL anti-freeze, the solution should be tested about once a week in winter and each time it is necessary to add liquid to the radiator however. Test anti-freeze immediately upon any sudden drop in temperature, especially after a comparatively warm spell.

11.03 Sometimes ETHYLENE GLYCOL anti-freeze may be lost through leakage, and only water has been added to make up the loss thus weakening the solution. Therefore the strengths of ETHYLENE GLYCOL solutions should be tested about once each month during winter.

11.04 Tests should be made while the radiator liquid is warm and the liquid level is high enough to permit taking a sample with the tester. If the liquid level is too low, add just enough water to permit taking tester reading but, after adding water, the liquid in the cooling system

should be circulated several minutes by running the engine before taking the tester reading.

11.05 Whenever testing a solution, examine its condition and also the condition of the cooling system. Repair leaks and correct any other unsatisfactory conditions found including a rusty or otherwise unclean radiator solution. If leaks can not be repaired or any unsatisfactory conditions found can not be corrected, report them to your supervisor.

12. BRINGING SOLUTION UP TO STRENGTH

12.01 If, when testing an anti-freeze solution, the tester indicates that the anti-freeze solution in the cooling system will not give the required protection, add the estimated amount needed to bring it up to the required strength using the same type and preferably the same make of anti-freeze in the solution.

12.02 After adding anti-freeze, run the engine to mix the new anti-freeze with the radiator liquid and again test. If radiator is full and it is necessary to add more anti-freeze, drain enough of the radiator liquid to permit adding the required amount. The solution thus drained can be used for make-up mixture later or in other radiators.

13. DRAINING AND STORING ANTI-FREEZE

13.01 METHANOL and ETHANOL anti-freeze solutions may be drained from the cooling system at the end of the cold weather season and disposed of in accordance with local regulations.

13.02 ETHYLENE GLYCOL anti-freeze which has served for two winters, indicated by a tag marked "Drain in Fall 19____" secured to the radiator filler opening, shall be drained at the end of the cold weather season, disposed of in accordance with local regulations, and the tag removed.

13.03 ETHYLENE GLYCOL anti-freeze which has been used for only one winter may be used a second winter provided that it is in satisfactory condition. In order to determine this examine the solution for appearance and test it for alkalinity and strength at the end of the cold weather season. If the solution is rusty or otherwise unclean, or if it does not test alkaline it is unfit for further use. Drain it immediately and discard it. If solution is clean, tests alkaline and is not too weak to save, it may be left in the cooling system, or drained and stored. Clean glass or glass lined vessels, if available, should be used for storing. Other vessels, if used, should be clean and unpainted inside. All vessels should be covered.

13.04 Cooling systems which have been drained should be refilled with water in accordance with applicable instructions provided in the section entitled "Engine Cooling Systems — Rust Prevention."

14. TESTING ETHYLENE GLYCOL SOLUTIONS FOR ALKALINITY

14.01 The solutions may be tested for alkalinity with either red litmus paper or Fisher alkacid paper whichever is available.

14.02 Litmus paper is usually supplied in test strips packed in a small glass tube. The test strips are 1/4" wide and 1-7/8" long and either red or blue. Red strips are used to determine whether a solution is alkaline and blue strips are used to determine whether a solution is acid. Only red litmus is supplied as a System item. In order to test a solution for alkalinity, wet part of a red strip with the solution. If it turns violet or blue the solution is alkaline.

14.03 Fisher alkacid paper is supplied in ribbon form 1/4" wide and 15 feet long rolled in order to permit carrying it in a circularly shaped plastic dispensing case called Fisher Alkacid Tester. One face of the case carries a comparative color chart and the other is transparent which permits a view of the quantity of paper still in the case. The color of the tape is a light buff. Tests are made by tearing off a piece of the tape about 2" long and wetting part of it with the solution to be tested. The alkalinity or acidity of the solution is indicated by the information in the color block of the chart on the tester which most nearly matches the color of the wet portion of the

paper. The chart indicates that if the color is green or blue the solution is "Basic" which means alkaline.

14.04 In testing the anti-freeze solution in a cooling system it is desirable to draw a small sample of the solution from the bottom of the radiator into a clean glass jar. This sample can then be tested by dipping a strip of litmus or alkacid paper part way into the solution to wet it, withdrawing the strip and interpreting its color change as explained in Paragraphs 14.02 and 14.03. If it is impracticable to draw a solution sample as described above, a sample may be taken with a syringe or hydrometer from the top of the radiator provided that it is done immediately after the solution has been thoroughly circulated before-hand by running the engine, as for example, just after returning from a trip.

14.05 Any ETHYLENE GLYCOL solution which does not test alkaline is unfit for further use. Drain it immediately.

14.06 The litmus and alkacid papers are very sensitive. When using either of them the hands should be clean and dry. Use a new strip for each test.