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The Army is for the Environment

U.S. Army Tank-automotive and Armaments Command
Research , Development and Engineering Center
Warren, Michigan 48397-5000

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USERS GUIDE FOR RECYCLING MILITARY ANTIFREEZE

I. Purpose. This Users Guide provides recommendations to military/civilian personnel on appropriate procedures to be followed for recycling used military antifreeze which initially was procured under Military Specifications MIL-A-46153 entitled Single Package, Heavy Duty, Inhibited Ethylene Glycol Antifreeze and MIL-A-11755 entitled Arctic-Type Antifreeze. The guidance within this User Guide is to be used in conjunction with those detailed instructions provided by the manufacturer of the commercial recycling units identified under paragraphs III B.1 and III B.2 of this User Guide.

II. Background. The three main reasons for recycling used antifreeze are to conserve our natural resources, reduce the cost of new antifreeze purchases, and reduce both the cost and problems associated with used antifreeze disposal. The latter reason is becoming a stronger impetus for recycling due to the increasing trend of federal, state and local governing agencies enacting more restrictive legislation on environmental protection matters. In some states, these more limiting regulations include identifying ethylene glycol (EG), the base material for most of today's antifreezes, as a hazardous material. Such a designation substantially raises the handling and storage expenses of new as well as used antifreeze.

Because of its less restricting chemistry when compared to automotive oils and fluids (e.g., transmission fluids, engine oil, etc), antifreeze is easier to recycle. This however does not eliminate the requirement for a recycling method that effectively reclaims the EG by complete removal of all contaminants, oxidation products, and depleted/residual inhibitors that typically are present in used antifreeze. New antifreeze is a precise balance of water and EG, which provides both low and high temperature protection, and is treated with chemical inhibitors that provide both corrosion protection to the engine's cooling system and protection against foaming. This balance is changed during normal use and therefore must be carefully reestablished for a recycled antifreeze to be reliable and effective as new antifreeze.

The recommendations contained within paragraph III of this guide are intended for use by government organizations operating vehicles and equipment using MIL-A-46153 and MIL-A-11755 military antifreezes. Where the information in this User Guide is in conflict with other published data, the recommendations and guidance provided by this publication should prevail. For vehicles and equipment that may be under warranty, the manufacturer's instructions relative to use or non-use of recycled antifreeze take precedent during the engine's warranty period.

III. Recommendations for Recycling Used MIL-A-46153 and MIL-A-11755 Military Antifreeze.

A. Used Antifreeze Feedstock

Avoid contaminating used antifreeze intended for recycling with engine oil, brake fluid, transmission fluid, hydraulic fluid, gear oil, solvent, gasoline, diesel fuel, aviation turbine fuel, heating oil, kerosene, and preservative oils by collecting the used antifreeze in a labeled, dedicated 55-gallon drum. Petroleum based fuels, fluids/oils, brake fluids, etc., will clog the recycling system if admixed with used antifreeze.

B. Certified Recycling Units

1. The Cool'r Clean'r® Coolant Purification System manufactured by BG Products Inc has been evaluated and found to perform satisfactorily for reclaiming military antifreeze. A diagram of this system is provided on Attachment A. Details on the Cool'r Clean'r system are as follows:

Manufacturer - BG Products Inc, PO Box 1282, Wichita, Kansas 67201, POC: Mr. Harold Erwin, (316) 265-2686

Model - Cool'r Clean'r Coolant Purification System

Process - Ion Exchange (IE)

Process Rate - 180 gal/hour

Power Requirements - 110V - 10A

Number of Operators Required - One (1)

Inhibitor Required - BG 570A & BG 570B (Heavy Duty)

Hazardous Waste - Used Filters

National Stock Number's (NSN's):

System w/one set of IE tanks	6850-01-380-9047
System w/two set of IE tanks	6850-01-380-9034
Heavy Duty Additive (BG 570A) Part A	6850-01-383-0366
Heavy Duty Additive (BG 570B) Part B	6850-01-383-0343

a. The BG unit instructions are for single vehicle recycling. For example, the unit is attached directly to the vehicle's cooling system. However, the unit can be used for batch processing by recycling the used antifreeze using 55-gallon drums. For simplicity and logistical reasons, it is recommended that antifreeze be recycled directly from drums as follow:

- (1) Place inlet hose into drum with used antifreeze.
- (2) Place outlet hose into clean drum.

Warning: It is important that a clean plastic or plastic lined metal drum is used to avoid contamination of the recycled antifreeze.

b. Use of BG Unit:

- (1) For first time use of the BG unit, prime the unit pump using 5 to 7 gallons of with a water/ethylene glycol solution containing 50% to 60% ethylene glycol (EG). The source of EG can be obtained from used antifreeze, new antifreeze or virgin (uninhibited) ethylene glycol so long as the priming solution is 50% to 60% EG.
- (2) Turn unit on and allow antifreeze from the outlet hose to flow back into the drum containing the used antifreeze.
- (3) Check antifreeze for cleanliness. Fluid from the outlet hose should be as clear as clean water.
- (4) When the fluid is clean, stop unit and place outlet hose in clean drum and continue recycling.
- (5) Continue to check the cleanliness (i.e., clarity) of the recycled antifreeze from the outlet hose. If it starts to become turbid, murky or oily in appearance, immediately stop the unit and examine the basket strainer and filters. Replace filters and clean strainer as necessary.

c. After the used antifreeze has been recycled:

- (1) Check the freeze point protection of the clean antifreeze/water mixture with an Antifreeze Coolant and Battery Tester (NSN 6630-00-105-1418) or the Antifreeze Freeze Point and Corrosion Test Kit (NSN 6630-01-011-5039)
- (2) Adjust the freeze point of the antifreeze/water mixture to -62°F (-52°C) or approximately 60% anti-freeze and 40% water with the appropriate amount of new MIL-A-46153 antifreeze, new MIL-A-11755 and/or water.

(3) Add the two part heavy-duty inhibitor package (BG 570A & BG 570B) according to manufacturer instructions.

(4) Mix thoroughly to completely disperse the additive package.

(5) Check the Reserve Alkalinity (RA) with an Antifreeze Freeze Point and Corrosion Test Kit to insure the antifreeze has been prepared correctly. A properly processed antifreeze will be identified by a RA pad color in the "O.K. or satisfactory" range of the test kit color chart. A recycled antifreeze having a color not in the O.K. or unsatisfactory range should be reprocessed until a satisfactory RA reading is obtained.

d. After the proper RA has been verified, the recycled antifreeze is now ready for use.

2. The BE Series Engine Coolant Recyclers manufactured by Finish-Thompson Inc (FTI) has been evaluated and found to perform satisfactorily for reclaiming military antifreeze. A diagram of this system is provided on Attachment B. Details on the BE Series recyclers are as follows:

Manufacturer - Finish-Thompson Inc, 921 Greengarden Road,
Erie, Pennsylvania 16501-1591, POC: Mr. Peter
Scantlebury, (814) 455-4478

Models - BE-15C and BE-55C

Process - Distillation

Process Rate - BE-15C: 1gal/hr, BE-55C: 3.2gal/hr

Power Requirements - BE-15C: 240V - 10A, BE-55C: 240V - 40A

Number of Operators Required - One (1)

Inhibitor Required - REMILFTH-55

Hazardous Waste - Distillation Bottoms

National Stock Number's (NSN's):

BE-15C	6850-01-387-5654
BE-55C	6850-01-387-2551
BE Series Military Heavy Duty Additive Part A (REMILFTH-55)	6850-01-397-1959
BE Series Military Heavy Duty Additive Part B (REMILFTH-55)	6850-01-397-1960

- a. Follow instruction manual for the BE unit. No modification of instructions is necessary.
- b. After the used antifreeze has been recycled:
 - (1) Add FTI additives in the amounts prescribed in the manufacturer instructions to the recovered ethylene glycol (EG). Mix thoroughly to completely disperse the additive package.
 - (2) Combine the inhibited EG with FTI recovered water and/or other clean water available to adjust the freeze point to -62°F (-52°C) or approximately 60% antifreeze and 40% water. Of necessary new MIL-A-46153 or new MIL-A-11755 can be use to adjust the freeze point. Check the freeze point protection of the antifreeze/water mixture with an Antifreeze Coolant and Battery Tester (NSN 6630-00-105-1418) or the Antifreeze Freeze Point and Corrosion Test Kit (NSN 6630-01-011-5039).
 - (3) Check the Reserve Alkalinity (RA) with an Antifreeze Freeze Point and Corrosion Test Kit to insure the antifreeze has been prepared correctly. A properly processed antifreeze will be identified by a RA pad color in the "O.K. or satisfactory" range of the test kit color chart. A recycled antifreeze having a color not in the O.K. or unsatisfactory range should be reprocessed until a satisfactory RA reading is obtained.
- c. After the proper RA has been verified, the recycled antifreeze is now ready for use.
- d. To determine malfunctions for the Finish-Thompson Inc BE Series units, the recovered water and recovered ethylene glycol should be visual examined for cleanliness. If either solution contains debris unit should be checked for possible problems. In addition, the used antifreeze should be examined for excessive engine oil, transmission fluid, etc., contamination.

C. Recommendations and Precautions

1. The recycled antifreeze can be employed in vehicles until the solution tests below the O.K. or satisfactory, color chart range of the Antifreeze Freeze Point and Corrosion Test Kit or contains excessive debris as determined visually. After which time, the antifreeze should be recycled using either system.

Each system is designed to recycle used antifreeze continually as long as the sufficient glycol is present and engine oil, transmission fluid, solvent, etc., contamination is kept at a minimum level.

2. Do not use MIL-A-53009 Additive, Antifreeze Extender Liquid Cooling Systems with the recycled antifreeze. MIL-A-53009 was designed to extend the service life of MIL-A-46153 military antifreeze only and is not designed to be used with recycled antifreeze. Use of MIL-A-53009 with recycled antifreeze may result in compatibility problems.

3. This Guide recommends using only those recycling systems which have been evaluated against an established testing protocol which determines the clean-up capability and the compatibility of individual systems with recycling used military antifreeze. The "Testing Protocol and Evaluation Methodology for Commercial Recycling Units" is provided as Attachment C. A list of those commercial systems which have been examined by the Army thus far is shown in Attachment D. Use of the certified units with other than MIL-A-46153 and MIL-A-11755 Military Antifreeze will be the sole responsibility of the user. This includes commercial antifreezes (e.g., Prestone, Zerex, Texaco, Compleat, etc.) and other specification products (e.g., Commercial Item Description, A-A-870).

4. A new Commercial Item Description (CID) covering the performance requirement for both portable and off-site commercial antifreeze recyclers is being developed. The CID will include a new testing protocol that addresses the performance capabilities for both types of recycling systems. A copy of the current draft CID is provided as attachment E.

D. Disclaimer

The recommendation given in this Guide relative to use of the recycling systems listed is not meant as an endorsement of these systems as such, but merely to identify commercially-marketed recycling systems that collectively were found to produce a satisfactory quality of recycled military antifreeze, MIL-A-46153. If it can be demonstrated by use of the established Testing Protocol (Attachment C) that new systems effectively reclaim and are compatible with military antifreeze, this Guide will be revised to include those units.

IV. Point-of-Contact

Should questions arise relative to this User Guide and its contents, the following individual should be contacted:

Ms Maria Goetz

Any comments, recommendations, etc to improve the overall utility of this User Guide should be sent to the following address:

AMSTA-TR-R/210 (JOHN DOE)
U S ARMY TANK AUTOMOTIVE AND ARMAMENT COMMAND
WARREN MI 48397-5000

V. References

The following references were used to write this guide and should be consulted for additional information concerning recycling used antifreeze:

1. U.S. Army Tank-Automotive Command, Mobility Technology Center-Belvoir, Ft Belvoir VA, Letter Report #96-6, "Certification Testing Results On Central Texas Diesel Injection Service Reverse Osmosis Antifreeze Recycling System", by Dwayne Davis, February 1996.
2. U.S. Army Tank-Automotive Command, Mobility Technology Center-Belvoir, Ft Belvoir VA, Technical Report #TR-13638, "Second Military Antifreeze Recycling Study", by Dwayne Davis, May 1994.
3. General Motors Service Technology Group, Taken from a presentation given by Wayne H. Bradley and Dale Jurette, November 1992.
4. Society of Automotive Engineers, SAE Paper #921636, "Heavy-Duty Coolant Regeneration by Dual-Resin Deionization", by Rene D. Wiebe and John M. Dick, September 1992.
5. Society of Automotive Engineers, SAE Paper #921634, "An Evaluation of Engine Coolant Recycling Technology", by Wayne H. Bradley, September 1992.

6. Society of Automotive Engineers, SAE Paper #921633, "Recycling Coolants From Heavy-Duty Engines", by Richard D. Hercamp, September 1992.
7. U.S. Army Belvoir Research, Development, and Engineering Center, BRDEC Report #2520, "An Evaluation of Three Commercial Processes for Recycling Used Military Antifreeze MIL-A-46153", by Dwayne Davis, June 1992.
8. U.S. Environmental Protection Agency, Office of Research and Development, "Automotive and Heavy-Duty Engine Coolant Recycling by Filtration" by Arun R. Gavaskar, Robert F. Olfenbuttel, Jody A. Jones, and Paul R. Webb, Battelle, October 1991.
9. U.S. Environmental Protection Agency, Office of Research and Development, "Automotive and Heavy-Duty Engine Coolant Recycling by Distillation" by Arun R. Gavaskar, Robert F. Olfenbuttel, and Jody A. Jones, Battelle, October 1991.
10. U.S. Army Belvoir Research, Development, and Engineering Center, BRDEC Letter Report #90-4, "Evaluation of Octagon Antifreeze Clean-Up Using a Glyclean Antifreeze Recycler" by Dwayne Davis, May 1989.
11. Society of Automotive Engineers, SAE Paper #881270, "Filtration of Coolants for Heavy Duty Engines", by R. D. Hudgens and Richard D. Hercamp, September 1988.
12. Society of Automotive Engineers, SAE Paper #790415, "Research and Development Efforts in Military Antifreeze Formulations", by James H. Conley and Robert G. Jamison, February 1979.
13. U.S. Army Mobility Equipment Research and Development Command, MERADCOM Report #2265, "Development of An Antifreeze Extender and Water Inhibitor for Automotive Cooling Systems", by James H. Conley and Robert G. Jamison, December 1978.
14. U.S. Army Mobility Equipment Research and Development Command, MERADCOM Report #2168, "Reclaiming Used Antifreeze", by James H. Conley and Robert G. Jamison, March 1976.
15. Military Specification MIL-A-46153 Antifreeze, Ethylene Glycol, Inhibited, Heavy Duty, Single Package.

16. Military Specification MIL-A-11755 Antifreeze, Arctic-Type Antifreeze.
17. Military Specification MIL-A-53009 Additive, Antifreeze Extender Liquid Cooling Systems.
18. Commercial Item Description A-A-870 Antifreeze/Coolant, Engine: Ethylene Glycol, Inhibited Concentrated.
19. Commercial Item Description A-A-53426 Tester, Antifreeze and Battery Electrolyte Solution.
20. Commercial Item Description A-A-51461 Test Kit, Antifreeze Freeze Point and Corrosion.

ATTACHMENT A

**"DETAILS/DIAGRAM of BG
PRODUCTS INC SYSTEM"**

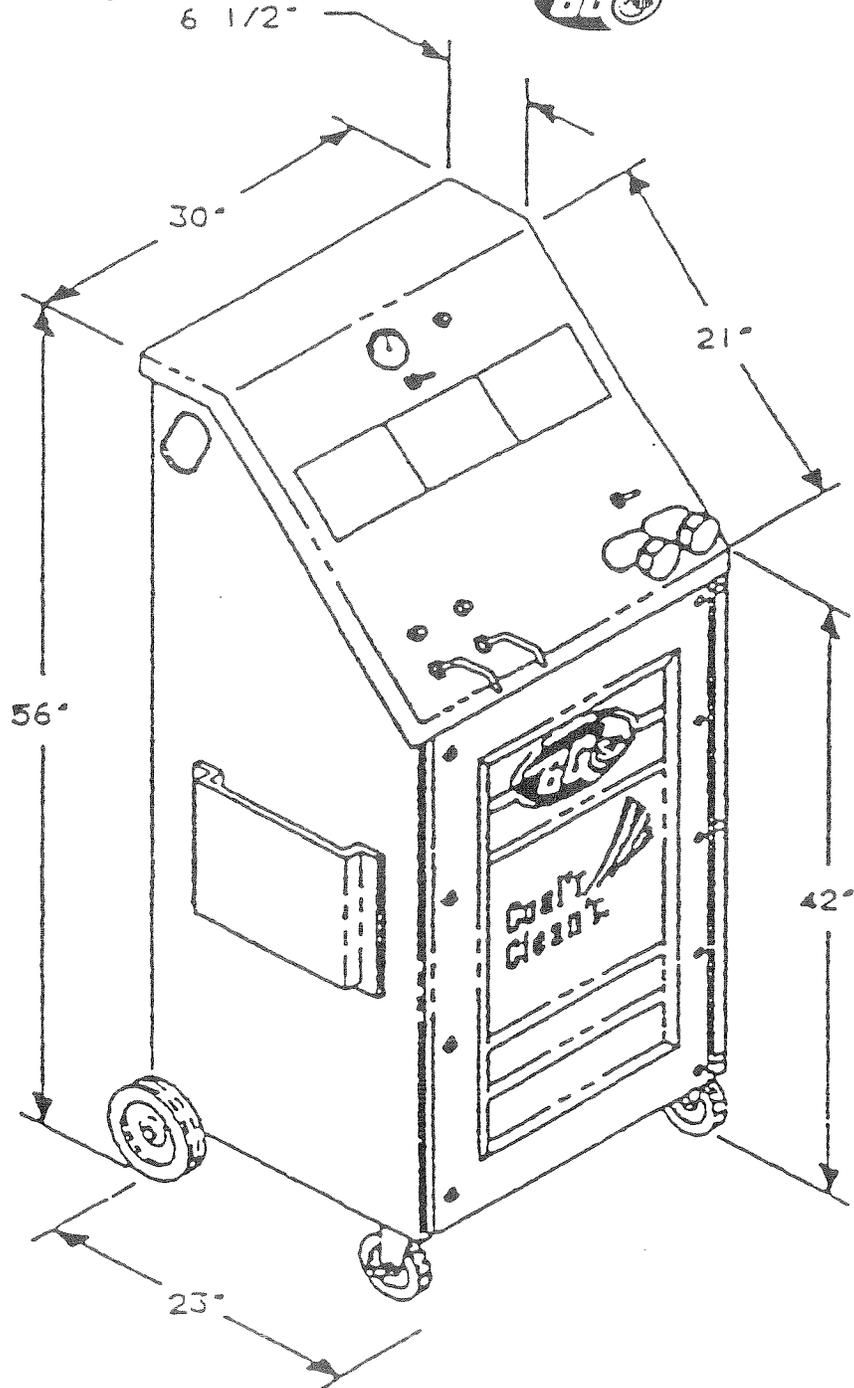
BG Cool'r Clean'r^R Coolant Purification System (CCCPS) OPERATING INSTRUCTIONS

1. Carefully remove radiator cap to relieve pressure.
2. Pinch off the inlet heater hose in two places, about 8" apart. (See Operating Tip #1)
3. Cut the heater hose between the pinch points. Install a flush tee using two clamps.
4. After removing the flush tee cap, attach the CCCPS inlet hose to the flush tee and remove the pinch clamps.
5. Add BG Cool'r Clean'r Flush (BG Part #541) to the radiator.
6. Connect the CCCPS outlet hose to the radiator using the proper radiator cap adapter, or if the "hook" is used, be sure to clamp or tie it in place.
7. Turn the heater switch (control valve) to "high" with fan on. Start engine and run 20 to 30 minutes after the thermostat opens. (**NOTE:** Some overflow may occur when using the outlet "hook".)
8. Be sure the CCCPS Main ON/OFF switch is in the "OFF" position. Connect the power cord to any suitable **GROUND**ED 110V AC outlet.
9. With the engine still running and the heater still on full, turn the CCCPS Main ON/OFF switch to "ON" and the Process/Pump//Bypass/Pump switch to "**Process/Pump**" to begin purifying coolant.
10. When the coolant in the inlet hose clears, turn the Process/Pump//Bypass/Pump switch to "OFF." The CCCPS has completed processing. Turn engine off.
11. Place a graduated container under the bypass outlet on the right side of the machine and turn the Process/Bypass switch to "**Bypass**" to relieve cooling system pressure.
12. Carefully remove the radiator cap adapter from the radiator. (**NOTE: Use extreme caution to prevent being burned by hot coolant!**) Place the outlet hose in the graduated container which is under the bypass outlet.
13. Remove a sample of coolant from the radiator and check it for freeze protection.
14. Check the owner's manual or any suitable reference chart to determine the capacity of the cooling system.
15. Refer to the CCCPS Blending Chart to ascertain what amount of BG Cool'r Clean'r Ethylene Glycol (BG Part #556), antifreeze, or water must be added to reach the desired freeze protection.
16. Restart engine. Turn Process/Pump//Bypass/Pump switch to "**Bypass/Pump**" and remove enough coolant from the system to make room for the BG Cool'r Clean'r Completer Kit (BG Part #5502A and #5502B OR BG Part #5702A and #5702B) and any additional BG Cool'r Clean'r Ethylene Glycol (BG Part #556), antifreeze, or water that was determined to be needed in Step 15. Turn Process/Pump//Bypass/Pump switch to "**OFF.**"
17. Remove the CCCPS inlet hose from the flush tee and place cap on the tee and tighten.
18. Attach the suction hose (wand) to the CCCPS inlet hose.
19. Turn the Process/Pump//Bypass/Pump switch to "**Process/Pump**" and, using the suction hose (wand), remove all the coolant from the overflow bottle and place it in the same container with the coolant removed from the system in Step #16.

(Continued)

20. Add the required amount of BG Cool'r Clean'r Ethylene Glycol (BG Part #556), antifreeze, or water to the cooling system.
21. Add the proper amount of both parts of BG Cool'r Clean'r Complet'r Kit (BG Part #5502A and #5502B) to the cooling system. Add one ounce of "A" per quart of coolant, and one ounce of "B" per quart of coolant. **DO NOT** premix the "A & B" parts; they **MUST** be added one at a time. TIP: If antifreeze is added, use one ounce less of "A & B" per quart of antifreeze added. (**NOTE:** When servicing heavy duty engines, especially diesels with wet sleeve cylinder liners, use BG Part #5702A and #5702B which yields a low-silicate, heavy-duty coolant precharged with supplemental coolant additives.)
22. Top off the radiator and overflow bottle, as necessary, with the coolant removed in Step 16.
23. Replace vehicle radiator cap.
24. Restart engine and allow it to run at least five minutes with the thermostat open to allow complete mixing.
25. Carefully remove the radiator cap and recheck freeze protection.
26. Check the color of the coolant. If it is not green, one or both of the BG Cool'r Clean'r Complet'r Kit Parts A & B were not added in Step #21.
27. If coolant does not meet desired freeze protection, repeat Steps 15 through 20.
28. Disconnect CCCPS from vehicle and replace radiator cap.
29. Place both hoses in the container of fluid removed from the cooling system. Turn the Process/Pump//Bypass/Pump switch to "**Process/Pump.**" Continue processing until the fluid level in the container stays constant. The CCCPS now has all air pockets purged and is ready for the next processing.

antifreeze recycling by . . .

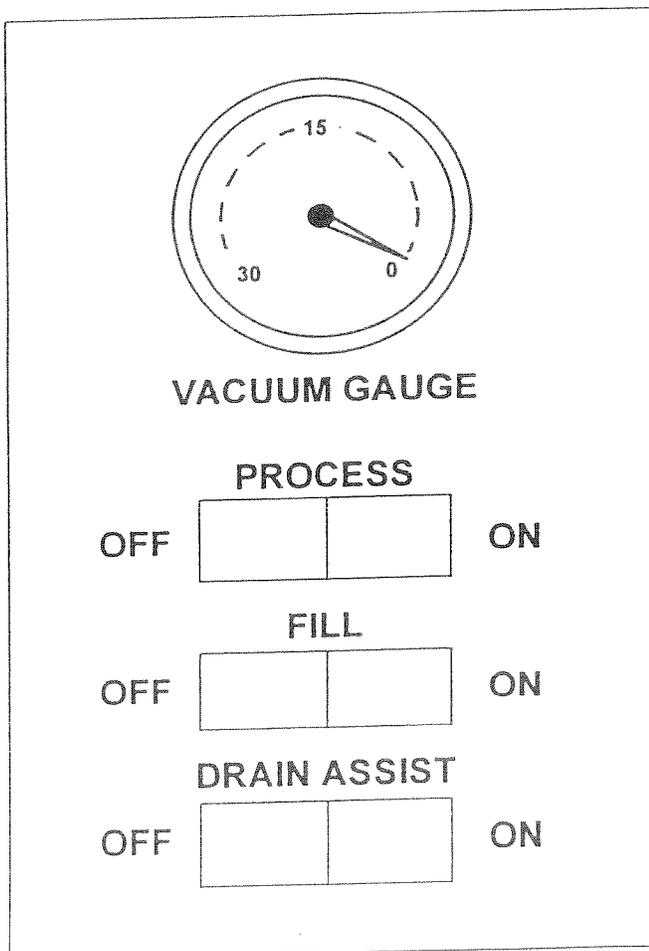


~ Operating the BE-55C ~

▲ CAUTION:

ALWAYS WEAR SAFETY GOGGLES, PROTECTIVE CLOTHING, AND GLOVES WHEN OPERATING THIS UNIT.

1. Position your two collection drums to the right of the BE-55C and insert the unit's hoses into the drums. Take care to not allow the level of the processed liquid to cover these hoses to prevent over-pressure or liquid from being drawn back into the process tank.
2. Insert the clear, braided Fill Hose into your waste coolant drum.
3. Close both the Fill Valve and the Drain Valve.



4. Depress the Fill Switch. The vacuum will begin to register on the Vacuum Gage. When the vacuum reaches -10" to -15" Hg., open the Fill Valve to allow the waste coolant to be drawn into the process tank. The Fill Switch will automatically disengage when approximately 55 gallons is drawn into the tank. Close the Fill Valve. If less than 55 gallons is to be processed, manually disengage the Fill Switch when the waste coolant drum is empty and close the Fill Valve.

NOTE: Do not over-fill the process tank. Fill only from a 55-gallon drum. Processing batches less than 55 gallons can result in inconsistent yields.

NOTE: The BE-55C is not designed to process motor oils. Every attempt must be made to prevent oil and debris from entering the Process Tank. Failure to do so will result in poor quality product and could damage the BE-55C.

5. Depress the Process Switch to the ON position. The switch's light will illuminate, the cycle begins, and will now function automatically. When the process is complete (usually less than 20 hours), the Process Switch will move to the OFF position, and the light will go out.

NOTE: If the Fill Switch illuminates during the process while the Fill Switch is in the OFF position, the distillate overtemp switch has activated. This indicates that the unit is in a cool-down mode. The process will resume when the distillate temperature cools.

6. The Processed Water and Processed Glycol are now ready for mixing and reinhibiting (refer to the Adding Reinhibitors/Freeze Point Check instructions at the end of the manual). The Processed Glycol normally contains about 10-20% water.

7. Allow the BE-55C to cool for at least two to three hours.

NOTE: Warm residues flow easier than cold residues.

8. Use the Drain Assist to remove the residues from the process tank to a waste container.

CAUTION:

LIQUID DRAINED FROM THE PROCESS TANK CAN REMAIN VERY HOT FOR MANY HOURS. USE EXTREME CARE WHEN DRAINING.

8. Place the Black Drain Hose into a metal waste container. Depress the Drain Assist Switch and carefully open the Drain Valve. Air will begin to push the residues into your waste container. When residue no longer is flowing, and only air is coming out of the hose, close the Drain Valve and push the Drain Assist Switch to the "off" position. Open the manual drain valve and allow any remaining liquid to flow into a catch pan, then close the valve.

NOTE: Use only the special high temperature Black Drain Hose on the air assisted residue drain. Other hose types may burst due to high temperature.

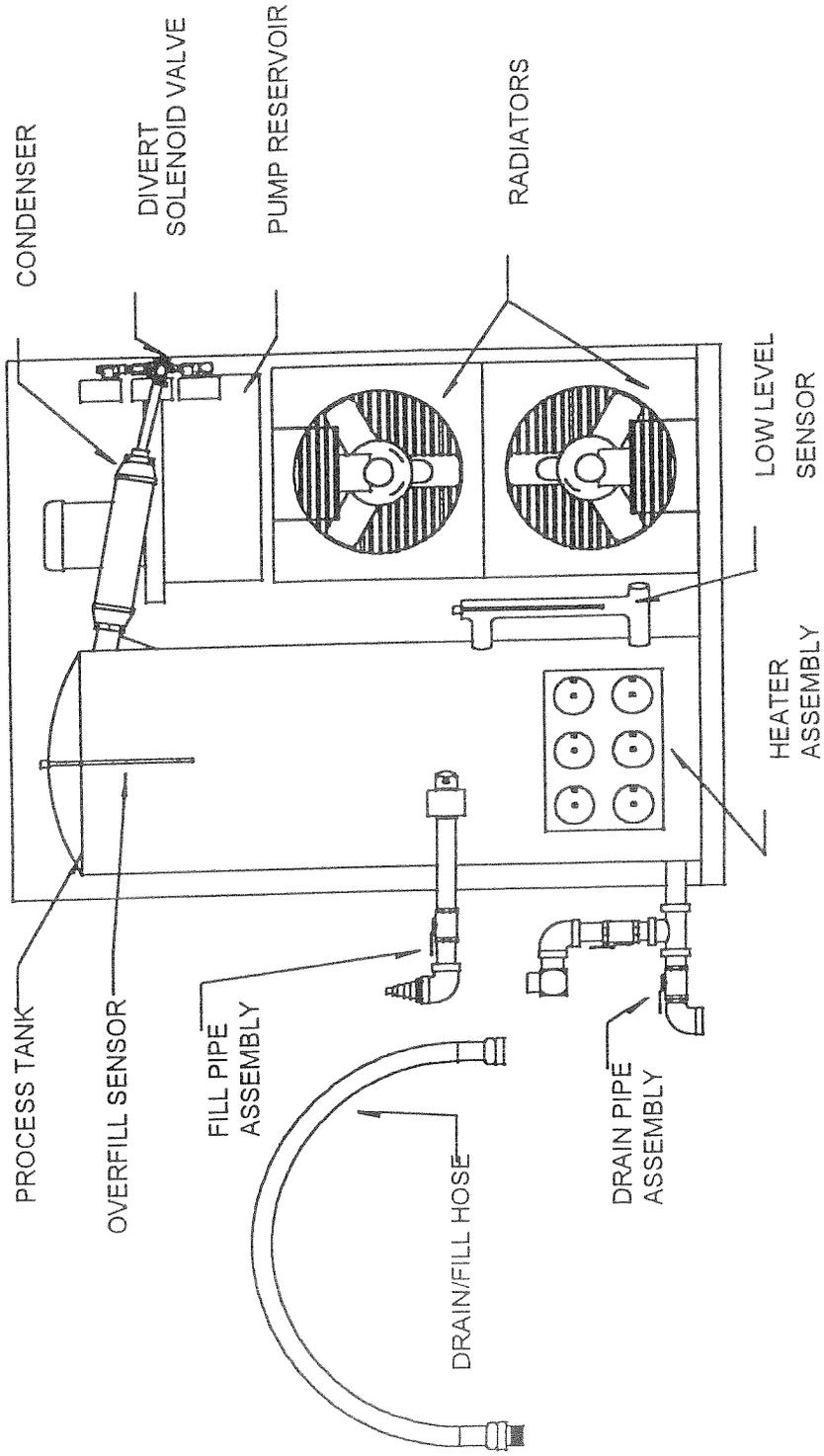
9. Dispose of residue properly in accordance with Federal, State and Local regulations.

10. Perform maintenance as outlined in the "Maintenance Schedule" section of this manual.

NOTE: Residues must be drained after every run. Failure to do so will result in poor quality product and will damage the BE-55C.

NOTE: If less than 5 gallons of residue is drained, or the material is the consistency of tar, a cleaning cycle must be performed before attempting another waste coolant cycle (refer to the "Maintenance Schedule" section of this manual).

NOTE: Never re-run residues or mix residues with waste coolant to re-run. Doing so will result in poor quality product and will damage the BE-55C.



BE-55C PARTS LOCATION DIAGRAM

ATTACHMENT B

**"DETAILS/DIAGRAM of FINISH
THOMPSON INC SYSTEM"**

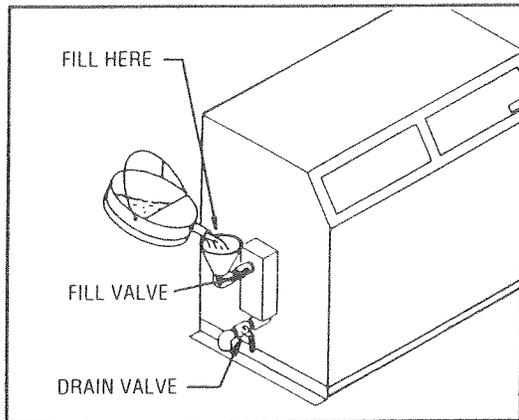
OPERATING INSTRUCTIONS

Please refer to Engine Coolant Treatment Containers for proper mixing instructions and ratios.



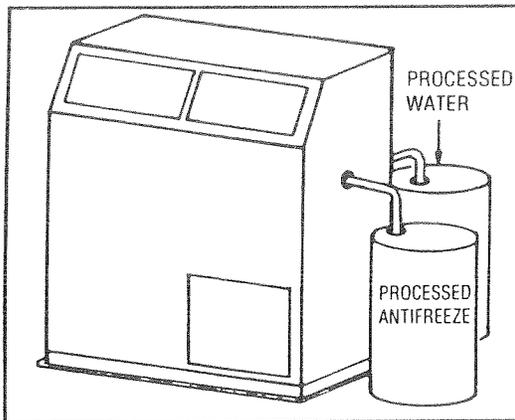
CAUTION:

ALWAYS WEAR SAFETY GOGGLES, PROTECTIVE CLOTHING AND GLOVES WHEN WORKING WITH THIS UNIT. NEVER SERVICE THE UNIT WHILE IT IS HOT

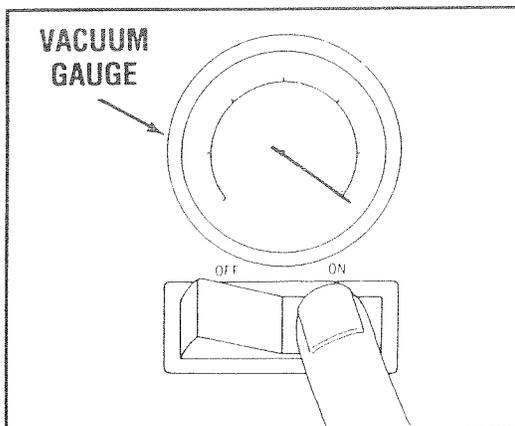


1. (Close Drain Valve before filling). Open Fill Valve. Pour used engine coolant into empty unit until funnel is full. **CLOSE FILL VALVE BEFORE STARTING UNIT.**

NOTE: Liquid will remain in funnel during entire operation.



2. Insert Processed Antifreeze hose and Processed Water hose into drums. Processed Water hose may go to an open drain.



3. Push "ON" switch on front of unit to start operation.

The recovery process typically takes 12 to 15 hours. The unit will shut down automatically when the process is complete. (The "ON" light will go off and the switch will return to the "OFF" position).

After the unit has shut off, check the amount of liquid in the collection drums. **DO NOT ALLOW COLLECTION DRUMS TO OVERFLOW.**

NOTE: Vacuum gauge will register 0 while water is being processed. Vacuum gauge will register 26 to 28 in Hg. while ethylene glycol is being processed. Refer to the troubleshooting section if the vacuum is less than 26 in. Hg.

Each process run will produce about 5 gallons of processed antifreeze (based upon 50/50 spent coolant being processed).

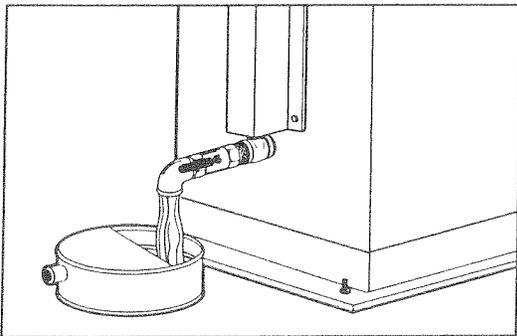
NOTE: 1. Spent coolant with a high ratio of water will take longer to process.
2. Voltage less than 240V will result in longer process times.

REGULAR OPERATION



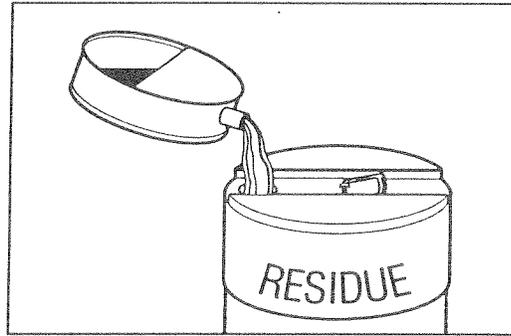
CAUTION:

DO NOT OPEN EITHER FILL VALVE OR DRAIN VALVE DURING OPERATION OR WHILE HOT. ALLOW A MINIMUM OF TWO HOURS TO COOL.



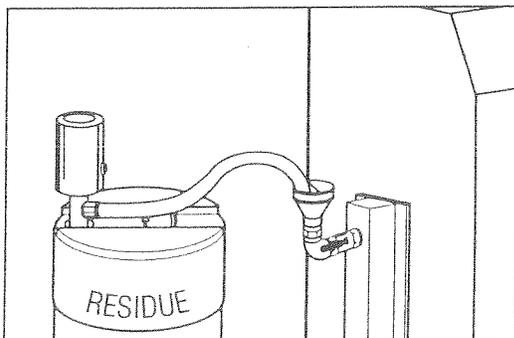
IMPORTANT

1. Drain after each batch run!

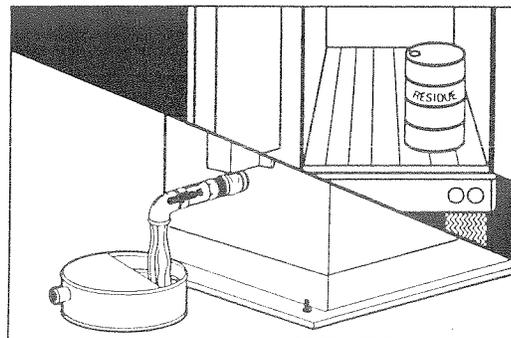


2. Collect residue in a 15 gallon container.

RESIDUE PROCESS



3. When residue container is full, pump into empty reclaimer, and process.



4. Drain after residue run and properly dispose.

ATTACHMENT C

"TESTING PROTOCOL and EVALUATION METHODOLOGY"

TESTING PROTOCOL AND EVALUATION METHODOLOGY FOR COMMERCIAL ON-SITE ANTIFREEZE RECYCLING SYSTEMS

1. Objective. The following testing program is provided for manufacturers of used antifreeze recycling systems interested in Department of Defense (DOD) business. This program is applicable to on-site recycling units, and requires the interested manufacturer to incur all expenses for testing. When a recycling technology demonstrates its capability for effectively recycling used military specification antifreeze, MIL-A-46153 (Antifreeze, Ethylene Glycol, Inhibited, Heavy Duty, Single Package), it will be included as an acceptable system in the Army's Antifreeze Recycling Users Guide.

2. Background. This Center has evaluated four methods of antifreeze recycling which are commercially available. The methods evaluated included vacuum distillation, chemical pre-treatment/filtration, ultra-filtration, and ion exchange technologies. This testing protocol provides a means to have other commercially available systems evaluated. The protocol focuses primarily on (1) assessing the degree of contaminant removal, (2) verifying the performance and quality of the recycled antifreeze, and (3) determining the compatibility of each system's inhibitor package system with MIL-A-46153 antifreeze.

2.1. The importance of thoroughly testing recycling systems with MIL-A-46153, instead of assuming MIL-A-46153 to be similar to commercial antifreezes, was revealed in the previously conducted study. The results indicated that the most effective recycling methods for used MIL-A-46153 are those which consistently remove essentially all contaminants including dirt, metals, oxidation products, and depleted corrosion and other inhibitors. Complete removal of contaminants and inhibitors provides a clean starting material to which a balanced inhibitor package can be added without chemical interferences. The consequence of not removing depleted and/or residual inhibitors was made evident by incompatibilities observed when treating the recycled antifreeze generated from three of four systems evaluated in this program. These incompatibilities included precipitate formations, low pH, low buffering capacities (i.e., low reserve alkalinities), and turbid solutions, all of which or individually will cause increased maintenance to engine cooling systems or possibly premature failure of components such as water pumps, heater cores, etc due to inadequate corrosion protection and blockage of critical passage ways.

3. Used Antifreeze Reference. Purchase new Military Specification antifreeze concentrate, MIL-A-46153 (NSN 6850-00-181-7940) from current suppliers. To obtain a list of current suppliers contact the Defense General Supply Center, Freedom of Information Office, 8000 Jefferson Davis Highway, Richmond, Virginia 23297-5000, Phone: 804-279-3861.

3.1. Prepare a 50/50 antifreeze solution using the new MIL-A-46153 and ASTM corrosive water¹². Prepare a sufficient amount of the 50/50 used antifreeze reference solution to complete all the tests in ASTM D4985 a total of two times.

3.2. To the 50/50 MIL-A-46153 solution, add the contaminants listed in table I so the final synthetic used solution will have the concentrations shown in table I. Five to ten minutes after adding the contaminants, a yellow-white, flocculent precipitate will form. The formation of the precipitate is normal. The reference solution should be thoroughly agitated prior to all testing to insure that a representative sample is employed.

3.3. Check the pH and reserve alkalinity (RA) values of the synthetic used solution. The values should range approximately between 7 to 8 and 6mL to 7mL, respectively. The freeze point of the used reference solution should range approximately between -18°F to -30°F when tested as specified in ASTM D3321.

4. Performance Tests. Subject the used reference solution to all the tests found in ASTM D4985. The reference antifreeze should fail one or more of the performance test before continuing the protocol. After obtaining failure(s), process the used reference solution through the system to be evaluated.

4.1. Depending on the recycled product returned, subject the resultant recycled antifreeze to all the tests in ASTM D4985 or ASTM D5345 and the tests given in paragraphs 5, 6, and 7 of this document.

5. Compatibility Test. Combine one part recycled antifreeze and one part new MIL-A-46153 antifreeze and two parts ASTM corrosive water in a suitable beaker or graduated cylinder. Thoroughly mix the solution, then allow to stand at room temperature undisturbed for 24 hours. After 24 hours, observe the solution for any precipitate, phase separation, or cloudiness. For an additional 24 hours, place solution in an oven at 60°C. After 24 hours, remove from oven and again observe the solution for any precipitate, phase separation, or cloudiness. Report observations. The observation of any precipitate, phase separation, or cloudiness any time during this test constitutes failure of this test.

¹ASTM corrosive water is prepared by dissolving the anhydrous salts of sodium sulfate (148mg), sodium chloride (165mg) and sodium bicarbonate (138mg) in one (1) liter of distilled water.

²ASTM methods can be found in the Annual Book of ASTM Standards, Vol 15.05. A copy of this book can be obtained from ASTM Headquarters, 1916 Race Street, Philadelphia, PA 19103.

6. Metal and Organic Contaminate Tests. Determine metal content of used reference solution and recycled antifreeze using atomic absorption, atomic emission, or other quantitative technique that can be shown to have similar accuracy. Determine the glycolic acid and formic acid content using liquid chromatography or other quantitative technique that can be shown to have similar accuracy. Report concentrations to the nearest 1 ppm. Concentrations above those in table II constitutes failure of this test.

7. General Appearance Test. Observe the sample. Report observations. The recycled antifreeze shall be translucent in appearance, but free of any insoluble suspensions, such as dirt, undissolved, or foreign matter. The presence of any of the aforementioned constitutes failure of this test.

8. Test Results. The test results will only be accepted from a certified, independent laboratory. The test results should be forwarded from the testing laboratory to the Mobility Technology Center-Belvoir for review and evaluation, at the address shown in paragraph 9. Once all results are received, a comparison of tables I and II and the actual results will made to determine the system's acceptance. Systems meeting all requirements will be included in the Antifreeze Recycling User's Guide. Those systems not meeting all the requirements may be retested again at the manufacturer's expense.

9. Point-of-Contact. Any comments, questions, etc to relative to this testing protocol and its contents, the following individual should be contacted:

Ms Maria Goetz

Any comments, recommendations, etc to improve the overall utility of this User Guide should be sent to the following address:

AMSTA-TR-R/210 (JOHN DOE)
U S ARMY TANK AUTOMOTIVE AND ARMAMENT COMMAND
WARREN MI 48397-5000

TABLE. I
Contaminants

<u>Contaminant</u> ³	<u>Concentration</u>
Glycolic Acid	2000 ± 100ppm
Formic Acid	900 ± 20ppm
Iron (Fe)	60 ± 5ppm
Aluminum (Al)	30 ± 5ppm
Lead (Pb)	30 ± 5ppm
Copper (Cu)	30 ± 5ppm

TABLE II.
Metal and Organic Contaminate Limits

Contaminate	Value	Test Method
Glycolate, ppm	900 max	IC
Formate, ppm	300 max	IC
Chloride, ppm	25 max	IC
Iron (Fe), ppm	10 max	ICP/AA
Lead (Pb), ppm	5 max	ICP/AA
Copper (Cu), ppm	5 max	ICP/AA
Aluminum (Al), ppm	5 max	ICP/AA

³Use technical grade glycolic acid and formic acid; for all four elements, use atomic absorption (AA) reference standards.

TESTING PROTOCOL AND EVALUATION METHODOLOGY FOR COMMERCIAL OFF-SITE ANTIFREEZE RECYCLING SERVICES

1. Objective. The following testing program is provided for companies offering used antifreeze off-site recycling service, interested in Department of Defense (DOD) business. This program requires the interested company to incur all expenses for testing. When a recycling service company demonstrates its capability for effectively recycling used military specification antifreeze, MIL-A-46153 (Antifreeze, Ethylene Glycol, Inhibited, Heavy Duty, Single Package), it will be included as an acceptable service in the Army's Antifreeze Recycling Users Guide.

2. Background. This Center has examined several antifreeze recycling technologies which are commercially marketed. The technologies include distillation, chemical pre-treatment/filtration, ultra-filtration, and ion exchange. This testing protocol provides a means to evaluate companies who offer antifreeze recycling as part of a service. The protocol focuses on (1) assessing the degree of contaminant removal, (2) verifying the performance and quality of the recycled antifreeze, and (3) determining the compatibility of each system's inhibitor package system with MIL-A-46153 antifreeze.

The importance of thoroughly testing a recycling method with MIL-A-46153 is extremely important. From past examinations, it was revealed that used MIL-A-46153's residual inhibitors will greatly decrease the effectiveness of a reinhibition package and cause incompatibilities if not removed in significant amounts. These incompatibilities included precipitate formations, low pH, low buffering capacities (i.e., low reserve alkalinities), and turbid solutions. The result of these incompatibilities can cause increased maintenance to engine cooling systems or possibly premature failure of components such as radiators, water pumps, heater cores, and thermostat housings, due to inadequate corrosion protection and blockage of critical passage ways. The results of past studies indicate that the most effective recycling methods for used MIL-A-46153 are those which significantly reduce the level of contaminants such as dirt, metals, oxidation products, and depleted or residual corrosion inhibitors.

3. Requirements.

3.1. Facility. An off-site antifreeze recycler shall be capable of batch processing a minimum of 1000 gallons of used antifreeze. The off-site recycler must employ either ion exchange or distillation as the method of recycling. As indicated, a letter from the recycling service company seeking acceptance addressed to the contracting officer is needed which states the recycling service company's ability to meet the facility requirements.

Failure to provide letter constitutes failure of the facility requirement.

3.2. Performance. The recycled antifreeze shall be meet all the requirements specified in ASTM D4985. This will be determined by a certified laboratory independent from the recycling service company seeking acceptance. Failure to meet any requirements in D4985 constitutes failure of the performance requirement.

3.3. Storage and Compatibility. The recycled antifreeze shall pass the storage test as specified herein. The recycled antifreeze shall pass the compatibility test specified herein when tested with new MIL-A-46153.

3.3.1. Storage Test. Place unopened, original 1-gallon container of a recycled antifreeze in oven at 50°C for a period of two (2) weeks. At the end of two weeks remove container from oven with minimal agitation and carefully pour contents in a 4-liter glass beaker. Drain container completely as possible and allow the antifreeze to stand undisturbed. After five (5) minutes, note the appearance of phase separations, precipitates, sludges, or gels in the antifreeze and remaining in the original container. The appearance of precipitates, sludge, gels, or phase separations constitutes failure of this test.

3.3.2. Compatibility Test. Combine one part recycled antifreeze concentrate, one part new MIL-A-46153 concentrate, and two parts water in a 100-mL graduated cylinder. Thoroughly mix the solution, then allow to stand at room temperature undisturbed for 24 hours. After 24 hours, observe the solution for any precipitate, phase separation, or cloudiness. For an additional 24 hours, place solution in an oven at 60°C. After 24 hours, remove from oven and again observe the solution for precipitates or phase separations. The appearance of precipitates or phase separations during any part of this test constitutes failure of this test.

3.4. Cleanliness Test. Determine metal content of the recycled antifreeze using atomic absorption or other quantitative technique that can be shown to have similar or better accuracy. Determine the glycolic acid and formic acid content using liquid chromatography or other quantitative technique that can be shown to have similar accuracy. Report concentrations to the nearest 1 ppm. Concentrations above those in table I constitutes failure of this test.

3.5. Appearance Test. Combine one part recycled antifreeze and one part ASTM corrosive water described in D1384 in a suitable container. Thoroughly mix, allow to stand 1 minute, and observe the resultant solution. The solution shall be translucent in appearance, but free of any insoluble suspensions, such as dirt, undissolved, or foreign matter. The presence of any of the aforementioned constitutes failure of this test.

4. Those recycling service companies not meeting all the requirements may be retested.

5. Point-of-Contact. Should questions arise relative to this testing protocol and its contents, the following individual should be contacted:

Ms Maria Goetz

Any comments, questions, or suggestions to relative this testing protocol should be sent to the following address:

AMSTA-TR-R/210 (JOHN DOE)
U S ARMY TANK AUTOMOTIVE AND ARMAMENT COMMAND
WARREN MI 48397-5000

TABLE I.
Contaminant Level Limits for Recycled Antifreeze

Contaminant	Value	Test Method
Glycolate, ppm	900 max	IC
Formate, ppm	300 max	IC
Chloride, ppm	25 max	IC
Iron (Fe), ppm	10 max	ICP/AA
Lead (Pb), ppm	<5	ICP/AA
Copper (Cu), ppm	10 max	ICP/AA
Aluminum (Al), ppm	10 max	ICP/AA

ATTACHMENT D

"SUMMARY CHART of COMMERCIAL SYSTEMS EVALUATED"

**SUMMARY OF COMMERCIAL ANTIFREEZE
RECYCLING SYSTEM/SERVICE COMPANY EVALUATIONS FOR DOD APPLICATION**

SYSTEM/SERVICE	Cool'r Clean'r	BE Series	Glyclean
MANUFACTURER	BG Products Inc	Finish-Thompson Inc	FPPF Chemical Co
PROCESS TYPE	Ion Exchange	Vacuum Distillation	Chemical Pretreatment and Filtration
PROCESS RATE (gal/hr)	180	1-3-2	150
FEEDSTOCK LIMITATIONS	Oil Contamination	Oil Contamination	Oil Contamination
REPLACEMENT FILTER(S) REQUIRED	Yes (1 & 5 micron filters)	None	Yes(1 & 5 micron filters)
FILTER REPLACEMENT INTERVAL	@ Every 200-250 gallons	NA	@ Every 100-300 gallons
SUPPLEMENTAL ADDITIVES REQUIRED	Yes	Yes	Yes
EASE OF OPERATION	Moderate Difficulty	Moderate Difficulty	Moderate Difficulty
PERSONNEL REQUIRED	1	1	1
HAZARDOUS WASTE REMAINING	Spent Filters	Distillation Residue	Spent filters
RECOMMENDED CHANGE INTERVAL FOR RECYCLED ANTIFREEZE	Check regularly; Change when necessary	Check regularly; Change when necessary	Check regularly; Change when necessary
RESULTS OF EVALUATION: Quality of Reclamation	Satisfactory	Satisfactory	Marginal
Compatible with MIL-A-46153 ¹	Yes	Yes	No
RECOMMENDED FOR DOD USE	Yes	Yes	No

May 1996

¹MIL-A-46153 - Antifreeze, Ethylene Glycol, Inhibited, Heavy Duty, Single Package

**SUMMARY OF COMMERCIAL ANTIFREEZE
RECYCLING SYSTEM/SERVICE COMPANY EVALUATIONS FOR DOD APPLICATION cont.**

SYSTEM/SERVICE	Kleer-Flo	Service
MANUFACTURER	Kleer-Flo Co	Central Texas Diesel Injection Service
PROCESS TYPE	Ultra-Filtration	Reverse Osmosis
PROCESS RATE (gal/hr)	6	90-100
FEEDSTOCK LIMITATIONS	Oil Contamination	Oil Contamination
REPLACEMENT FILTER(S) REQUIRED	Yes (.0025 & 5 micron filters)	NA
FILTER REPLACEMENT INTERVAL	@ Every 100 gallons	NA
SUPPLEMENTAL ADDITIVES REQUIRED	Yes	Yes
EASE OF OPERATION	Low Difficulty	NA
PERSONNEL REQUIRED	1	NA
HAZARDOUS WASTE REMAINING	Spent Filters	None
RECOMMENDED CHANGE INTERVAL FOR RECYCLED ANTIFREEZE	Check regularly; Change when necessary	Check regularly; Change when necessary
RESULTS OF EVALUATION: Quality of Reclamation	Unsatisfactory	Unsatisfactory
Compatible with MIL-A-46153	No	No
RECOMMENDED FOR DOD USE	No	No

May 1996

ATTACHMENT E

"DRAFT COMMERCIAL ITEM DESCRIPTION for ANTIFREEZE RECYCLERS"

Note: This draft, dated _____, 1996, prepared by the US Tank-Automotive and Armaments Command, ATTN: AMSTA-TR-E/Blue, Warren, MI 48397-5000 has not been approved and is subject to modification. DO NOT USE FOR ACQUISITION PURPOSES. (Project Number 6850-XXXX)

NOT
MEASUREMENT
SENSITIVE

A-A-XXXXX
PROPOSED

COMMERCIAL ITEM DESCRIPTION

RECYCLING SYSTEM, ANTIFREEZE

The General Services Administration has authorized the use of this commercial item description (CID), for all federal agencies.

1. **SCOPE.** This CID covers the requirements for used antifreeze recycling systems suitable for reprocessing used automotive, ethylene glycol base antifreeze, employed in light-duty and heavy-duty vehicles and equipment.

2. SALIENT CHARACTERISTICS.

2.1 Material. The antifreeze recycling system shall meet all the requirements specified herein.

Beneficial comments, recommendations, additions, deletions, clarifications, etc. and any other data which improve this document should be sent by a letter to: US Tank-Automotive and Armaments Command, ATTN: AMSTA-TR-E/Blue, Warren, MI 48397-5000

FSC 6850

AMSC N/A

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited

2.2 Requirements.

2.2.1 Performance requirements. The antifreeze recycling system shall be capable of producing a recycled prediluted antifreeze that fully conforms to the requirements of either **ASTM D 4656 Prediluted Aqueous Ethylene Glycol Base Engine Coolant (50 Percent Volume Minimum) for Automobiles and Light-Duty Service** or **ASTM D 5345 Prediluted Aqueous Ethylene Glycol Base Low Silicate Engine Coolant (50 Volume Percent Minimum) for Heavy-Duty Engines Requiring an Initial Charge of Supplemental Coolant Additive (SCA)** or The Maintenance Council (TMC) Recommended Practice **TMC RP 329 Fleet Purchasing Specification for Nitrite-Containing Ethylene Glycol Base Coolant**, from a prepared reference used antifreeze containing contaminants specified herein for control purposes. In addition, the recycled prediluted antifreeze shall pass specified compatibility and appearance tests.

2.2.2 Reference used antifreeze. Prepare the reference contaminated used antifreeze by combining ASTM Reference Fluid for Coolant Tests, D 3585 with ASTM corrosive water in a 50:50 ratio. ASTM corrosive water is prepared by dissolving the anhydrous salts of sodium sulfate (148mg), sodium chloride (165mg) and sodium bicarbonate (138mg) in one (1) liter of distilled water. To this prediluted reference antifreeze, add the contaminants in table I so the final solution will have the concentrations listed. The use of technical grade glycolic and formic acids and atomic absorption (AA) reference standards is recommended. Prepare a sufficient amount of the reference used antifreeze for recycling, subsequent testing against TMC RP 329, and to complete the battery of tests specified herein at least two (2) times.

TABLE I.
Contaminants

<u>Contaminant</u>	<u>Concentration</u>
Glycolic Acid	2000 ± 100ppm
Formic Acid	900 ± 20ppm
Iron (Fe)	60 ± 5ppm
Aluminum (Al)	30 ± 5ppm
Lead (Pb)	30 ± 5ppm
Copper (Cu)	30 ± 5pp

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2.2.3 Compatibility. Combine one part of recycled prediluted antifreeze and one part 50/50 aqueous solution of ASTM Reference Coolant D 3585 in a suitable beaker or graduated cylinder. Thoroughly mix the solution, then allow to stand at room temperature undisturbed for 24 hours. After 24 hours, observe the solution for any precipitate, phase separation, turbidity, or cloudiness. Place this same solution in an oven at 60°C. After 24 hours, remove from oven and again observe the solution for any precipitate, phase separation, turbidity, or cloudiness. Report observations. The observation of any precipitate, phase separation, turbidity, or cloudiness any time during this test constitutes failure of this test.

2.2.4 General appearance. In a 250-mL graduated cylinder, place 180-mL sample of fresh recycled prediluted antifreeze. Sample should be at ambient temperature prior to test. Shake sample for approximately ten (10) seconds. After shaking allow the sample to stand undisturbed for twenty (20) minutes. After 20 minutes observe sample. Report observations. The recycled prediluted antifreeze shall be translucent in appearance, but free of any insoluble suspensions, such as dirt, undissolved, or foreign matter. The presence of any of the aforementioned constitutes failure of this test.

3. QUALITY ASSURANCE PROVISIONS.

3.1 Contractor certification. The contractor shall certify and maintain substantiating evidence that the product offered meets the salient characteristics of this Commercial item Description, and that the product conforms to the producer's own drawings, specifications, standards, and quality assurance practices, and is the same product offered for sale in the commercial marketplace. The government reserves the right to require proof of such conformance prior to first delivery and thereafter as may be otherwise provided for under the provisions of the contract.

4. PACKAGING. Packaging, labeling, packing, and marking shall be as specified in the contract or order.

5. NOTES.

5.1 Source of documents.

5.1.1 ASTM standards are available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

5.1.2 TMC recommended practices are available from The Maintenance Council, American Trucking Associations, Inc, 2200 Mill Road, Alexandria, VA 23314.

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5.2 Acquisition data. Acquisition documents must specify the following:

- a. Title, number, and date of this CID.
- b. Issue of DODISS to be cited in the solicitation.
- c. Name of antifreeze recycling system and manufacturer preferred.
- d. Selection of desired ASTM or TMC standard (i.e., D 4656, D 5345 or TMC RP 329).
- e. Selection of applicable packaging requirements.

MILITARY INTERESTS

CIVIL AGENCY COORDINATION ACTIVITIES
GSA/FSS

Custodian:

Army - AT

Reviewing Activities:

Army - EA

DLA - GS

Air Force - 68

Navy - SH

Users Interest:

Army - CE

Marine - MC

Air Force - 68

Preparing Activity

Army - AT

Project No. 6850-XXXX