REPORT DOCUMENTATION PAGE

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1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED	
		START DATE	END DATE
20220927	Technical Report	20211001	20220927

4. TITLE AND SUBTITLE

Thermal Management Fluids (TMF) Market Survey Report

5a. CONTRACT NUMBER	5b. GRANT NUMBER	5c. PROGRAM ELEMENT NUMBER
N/A	N/A	N/A
5d. PROJECT NUMBER	**5e. TASK NUMBER**	**5f. WORK UNIT NUMBER**
N/A	N/A	N/A

6. AUTHOR(S)
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8. PERFORMING ORGANIZATION REPORT NUMBER
N/A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)	11. SPONSOR/MONITOR'S REPORT NUMBER(S)
N/A	N/A	N/A

12. DISTRIBUTION/AVAILABILITY STATEMENT
DISTRIBUTION STATEMENT A. Approved for public release; distribution unlimited. OPSEC#6932

13. SUPPLEMENTARY NOTES
N/A

14. ABSTRACT
This report is in support of the TMF task of the DEVCOM GVSC Ground Systems Fluids and Fuels (GSFF) research program. The objective was to identify commercial sources of supply for thermal management fluids for use in hybrid/electric vehicle applications for use in Army ground vehicles.

15. SUBJECT TERMS
Coolant, OAT, Thermal Management,
Hybrid, Electric Vehicles, Conductivity

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES
a. REPORT	b. ABSTRACT	C. THIS PAGE		
U	U	U	SAR	12

19a. NAME OF RESPONSIBLE PERSON	19b. PHONE NUMBER *(Include area code)*
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U.S. Army DEVCOM – Ground Vehicle Systems Center

Warren, Michigan 48397-5000

Commercial Thermal Management Fluids for Military Ground Vehicle Usage – Market Survey Responses

Zackery Schroeder

Force Projection Technology – Fuels and Lubricants Branch

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Acknowledgements

The authors would like to thank the following for their help in completing the market survey:

- Fuels and Lubricants Branch (F&L) and Force Projection Technology's Senior Technical Expert for helping to review this report and formulate questions regarding coolant in Army ground vehicles.

1. Introduction

The U.S. Army DEVCOM Ground Vehicle Systems Center (GVSC) conducted a market survey to identify commercial thermal management fluids (hereafter TMF) used in either direct or indirect cooling systems in electric vehicles. It is critical to identify the availability of these new fluids in order to support the future of Army's fleet of ground vehicles and ground support equipment. The intent of the market survey is to identify sources of supply and general information about the thermal management fluids. These sources were required to be commercially available or under development. This was not intended to identify traditional coolants used in internal combustion engines (e.g. Ethylene glycol).

2. Project Background

This market survey report is in support of a development effort starting in FY22 funded by the US Army DEVCOM Ground Vehicle Systems Center (GVSC) titled "Thermal Management Fluids" (TMF). The objective of this development effort is to evaluate commercially available TMFs and define military-specific requirements for Army hybrid and battery-electric ground vehicles. The goal of the market survey was to identify current commercially available TMFs. A secondary goal was to gather knowledge of commercially available TMFs, specifically in the following areas:

- Base chemistry and additive technology
- Use of fluid as an immersive coolant
- Commercial availability
- Documented compatibility testing
- Product color
- Service life and interval testing

This information then aided in the identification of which TMFs may meet the military-specific requirements and selection of possible TMF candidates to be used in this effort.

3. Approach

In order to reach the entire market, GVSC developed a market survey which was posted for 30 days: 16 MAR 22 through 15 APR 22. The market survey was posted on beta.sam.gov. A second round of the survey was sent out to additional OEMs from 20 JUL 22 to 19 AUG 22.

The posted market survey consisted of two parts. Part I consisted of questions relating to operating information on the business entity. Part II consisted of questions relating directly to the TMF

products offered by the business. GVSC's desire was to target commercial products that could be utilized in direct cooling applications, as well as any products currently in the research and development phase. In an effort to gain additional responses to the posted market survey, GVSC contacted the following twenty-seven companies to encourage them to respond to the posted market survey:

- CCI Manufacturing IL Corp, Inc.
- Dober Chemical
- CAT
- Vantage Oleochemicals
- BASF
- Cummins Filtration
- World Oil Recycling Corporation
- Nuset Industries, Inc
- Kost USA Inc
- GlobalTech Fluids
- Huntsman Corporation Australia Pty Limited
- Chem-Group
- Shell
- Safety-Kleen Systems, Inc
- Lubrication Technologies, Inc
- Center For Quality Assurance
- Reliance Fluid Technologies, LLC
- Kukdong USA Inc
- BG Products Inc
- Northland Products Co
- Samato Kft
- John Deere
- The Valvoline Co
- Chevron Lubricants
- Prestone Products

Ultimately, GVSC received eight responses to the survey from seven different companies. The posted market survey can be found in Appendix A. The responses from the companies who replied have been removed from the public release version of this document as they contain proprietary information from commercial suppliers.

The market survey was used for data collection only and will feed into a second report where final candidate selection will be documented.

4. **Discussion & Conclusion**

Market Survey Results:

The following seven companies responded to the market survey:

- CCI Manufacturing IL Corp, Inc.
- BASF
- Chevron Lubricants
- Cummins Filtration
- Kost USA, Inc
- Prestone Products

See Appendix B for a consolidation of the market survey non-proprietary results. Most information captured in this survey is proprietary and cannot be shared publicly, but the types of products offered and their technologies are listed in Table 1 of Appendix B.

Additive technologies of the TMFs ranged between organic acid technologies (OAT) and azoles. The base chemistries of the TMFs were predominantly ethylene glycol, with one company also offering propylene glycol.

One interesting detail learned from the market survey is that some commercial OEMs state their fluid life could be as long as 10 years or 300,000 miles, while others state it could outlast the life of the battery used in a hybrid/electric application. No data were provided to back up these claims, but it was interesting to note that these fluids may last beyond the life of the battery.

In terms of compatibility, many companies stated that compatibility testing was performed on their products with other commercial products.

Lastly of note is that several companies stated that they did not have immersive fluids available for purchase yet but were in the process of developing them for the market; only one company had a product available that could be used in immersive applications. The general consensus is that this technology is still very new, and products available now are often times adapted for this application from other applications e.g., electric transformer cooling.

In addition to a successful response rate, GVSC made many new industry contacts, both in the sales sector and technical sector of thermal management fluids. These contacts have already been helpful to GVSC and will continue to be key players in helping the Army develop and transition to TMF in hybrid/electric vehicle applications.

Conclusion:

The market survey was successful for information gathering and received more responses than GVSC expected. Products identified span a range of cooling technologies and provide a good cross section of products available on the market that could be ideal solutions for Army ground hybrid/electric vehicle application.

The data collected in this market survey was used as a starting point for the selection of fluid candidates for the TMF developmental effort.

5. Appendix A – Posted Market Survey

Request for Information/Market Survey

Thermal Management Fluids in Electric Vehicles

DESCRIPTION OF INTENT:
THIS IS A REQUEST FOR INFORMATION (RFI), A MARKET SURVEY REQUEST IN SUPPORT OF THE FOLLOWING STUDY. No contract will be awarded from this announcement. This is not a Request for Proposal (RFP) or an announcement of a forthcoming solicitation, nor is it a request seeking Offerors to be placed on a solicitation mailing list. Response to this survey is voluntary and no reimbursement will be made for any costs associated with providing information in response to this market survey and any follow-up information requests. No solicitation document exists at this time, and calls requesting a solicitation will not be answered.

STUDY:
The U.S. Army Combat Capabilities Development Command (CCDC) Ground Vehicle Systems Center (GVSC) is conducting a market survey to identify commercial thermal management fluids (hereafter TMF) used in either direct or indirect cooling systems in electric vehicles. It is critical to identify the availability of these new fluids in order to support the future of Army's fleet of ground vehicles and ground support equipment. The intent of the market survey is to identify sources of supply and general information about the thermal management fluids. These sources may be commercially available or under development. Please note that this is not intended to identify traditional coolants used in internal combustion engines (e.g. Ethylene glycol).

MARKET SURVEY QUESTIONS:
Part I. Business Information:

1. Company Name:
2. Type and Size of Business:
3. Manufacturer:
4. CAGE Code:
5. Company Point of Contact:
    a. Name:
    b. Title:
    c. Telephone:
    d. Email address:
6. Business Address:
7. Web page URL:
8. Approved site certifications (e.g. ISO 14001):

Part II. Thermal Management Fluids (TMF) Survey Questions:

Section a. Basic Technical Information

1. TMF Product Name(s):
2. Can this product be used in direct immersion cooling systems (ie. When the fluid contacts the battery)?
3. What is the base chemistry of the product(s) (ie. Hydrocarbon based)?
4. What is the electrical conductivity of the product(s)?
5. What are the operational temperatures of the product(s)?
6. What type of additives are used in the product(s)?
7. Are any of the components of the product(s) hazardous/toxic? If so, please provide explanation and toxicity information.
8. What color is the product(s)?
9. Is the product fill for life?
10. What are the recommended service intervals (if not fill for life) for the product(s)?
11. What sort of testing is conducted to determine when the product(s) should be changed out?
12. Has any compatibility testing been done on the product(s) with other similar products? What sort of testing?
13. Has any hardware compatibility testing been done on the product (e.g. corrosion testing?)
14. What is the shelf-life of the product(s)?
15. Has any standard performance specification testing been completed on the product(s) (e.g. OEM-specific, SAE, ASTM, DOT)? If standard performance specification testing has been completed, please list the specification(s).

Section b. Marketing Information

16. Who are the typical users of your product(s)?
17. How long has your product(s) been commercially available?
18. What is the unit cost of your product(s)?
19. How is the product(s) packaged (e.g. what type of containers and in what sizes)?
20. Is the product(s) readily available in the commercial market? If so, where is it manufactured?
21. If the product(s) is manufactured outside of the United States, can it be shipped to the United States for testing?
22. If the product(s) is manufactured in the United States, can it be shipped overseas?
23. Please provide Safety Data Sheet (SDS) and Technical Documents pertaining to the product(s).

RESPONSES DUE:
Responses to this market survey are DUE BY 19AUG22. Please submit all completed questionnaires and any questions you may have via email to: Zackery.j.schroeder.civ@army.mil

Please format the subject line of the response email as follows: "[Organization Name] response to Request for Information – Thermal Management Fluids for Military Ground Vehicle Application" Provide the email responses in PDF or Word format. Only electronic responses will be accepted. All interested parties and organizations are encouraged to respond to this request for information. All material submitted in response to this RFI must be unclassified and properly marked. No manufacturer/distributor shall be given a copy of another manufacture's/distributor's product information collected in this survey. GVSC will use the information gathered for studying and investigating the current available TMFs to potentially introduce to the Army's fleet of vehicles and equipment.

6. Appendix B – Consolidation of Market Survey Responses

Table 1: Market Survey Response List

Manufacturer	TMF Products Name(s)	Immersive?
CCI Manufacturing IL	L433 - ELC LD for H/EVs L451 - ELC HD for H/EVs L290 - ELC low phosphate LD for H/EVs EV1/EV2 - ELC LD/HD for H/EVs (low conductivty)	No
KOST USA	Reco SLCF Super Low Conductivity Fluid	Yes
Cummins Filtration	Not available; still in development	Not Applicable
Prestone Products	Prestone GM DEX-COOL YA956B YA992 YA991	No
Chevron Lubricants	Not available; still in development	Not Applicable
BASF	Not available; still in development	Not Applicable