

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. Contract ID Code
Cost-Plus-Fixed-Fee

Page 1 Of 11

2. Amendment/Modification No. P00007	3. Effective Date 2013FEB11	4. Requisition/Purchase Req No. SEE SCHEDULE	5. Project No. (If applicable)
---	--------------------------------	---	--------------------------------

6. Issued By U.S. ARMY CONTRACTING COMMAND JENNIFER PRUENTE WARREN, MICHIGAN 48397-5000 HTTP://CONTRACTING.TACOM.ARMY.MIL EMAIL: JENNIFER.PRUENTE@US.ARMY.MIL	Code W56HZV	7. Administered By (If other than Item 6) DCMA DAYTON AREA C, BUILDING 30 1725 VAN PATTON DRIVE WRIGHT-PATTERSON AFB, OH 45433-5302	Code S3605A
--	----------------	---	----------------

8. Name And Address Of Contractor (No., Street, City, County, State and Zip Code) ASHLAND INC. 50 E RIVERCENTER BLVD STE 1600 COVINGTON, KY 41011-1683	<input type="checkbox"/>	9A. Amendment Of Solicitation No.
	<input type="checkbox"/>	9B. Dated (See Item 11)
	<input checked="" type="checkbox"/>	10A. Modification Of Contract/Order No. W56HZV-07-C-0211
	<input type="checkbox"/>	10B. Dated (See Item 13) 2007APR24
Code 4NK87	Facility Code	

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

The above numbered solicitation is amended as set forth in item 14. The hour and date specified for receipt of Offers

is extended, is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended by one of the following methods: (a) By completing items 8 and 15, and returning _____ copies of the amendments; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. **FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER.** If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. Accounting And Appropriation Data (If required)

NO CHANGE TO OBLIGATION DATA

**13. THIS ITEM ONLY APPLIES TO MODIFICATIONS OF CONTRACTS/ORDERS
It Modifies The Contract/Order No. As Described In Item 14.**

<input type="checkbox"/>	A. This Change Order is Issued Pursuant To: The Contract/Order No. In Item 10A.	The Changes Set Forth In Item 14 Are Made In
<input type="checkbox"/>	B. The Above Numbered Contract/Order Is Modified To Reflect The Administrative Changes (such as changes in paying office, appropriation data, etc.) Set Forth In Item 14, Pursuant To The Authority of FAR 43.103(b).	
<input checked="" type="checkbox"/>	C. This Supplemental Agreement Is Entered Into Pursuant To Authority Of:	mutual agreement of parties
<input type="checkbox"/>	D. Other (Specify type of modification and authority)	

E. IMPORTANT: Contractor is not, is required to sign this document and return _____ copies to the Issuing Office.

14. Description Of Amendment/Modification (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

SEE SECOND PAGE FOR DESCRIPTION

Except as provided herein, all terms and conditions of the document referenced in item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. Name And Title Of Signer (Type or print)	16A. Name And Title Of Contracting Officer (Type or print) LYNN M. BYRNE LYNN.M.BYRNE@US.ARMY.MIL (586)282-6553		
15B. Contractor/Offeror (Signature of person authorized to sign)	15C. Date Signed	16B. United States Of America By _____ /SIGNED/ (Signature of Contracting Officer)	16C. Date Signed 2013FEB11

CONTINUATION SHEET	Reference No. of Document Being Continued	Page 2 of 11
	PIIN/SIIN W56HZV-07-C-0211 MOD/AMD P00007	

Name of Offeror or Contractor: ASHLAND INC.

SECTION A - SUPPLEMENTAL INFORMATION

Buyer Name: JENNIFER PRUENTE
 Buyer Office Symbol/Telephone Number: CCTA-ASG-C/(586)282-9608
 Type of Business: Large Business Performing in U.S.
 Surveillance Criticality Designator: C
 Weapon System: No Identified Army Weapons Systems
 Kind of Modification: Supplemental Agreement

*** End of Narrative A0000 ***

W56HZV-07-C-0211, Modification P00007

Previous Contract Amount: \$2,404,441.00
 Amount this Action: \$ 0.00
 Current Contract Amount: \$2,404,441.00

1. This is a bilateral Modification. There is no additional cost to either party as a result of this Modification. No further funds will be obligated as a result of this Modification.
2. The purpose of this bilateral Modification P00007 to contract W56HZV-07-C-0211 is to revise the type of tests being performed IAW FAR Clause 52.243-2, Changes - Cost Reimbursement (Alternate V). The SOW will be modified to remove three (3) tests and replaced with four (4) new tests to facilitate testing a Cummins engine.
3. Due to accounting system inadequacies found in a recent audit, work was stopped on this contract from 30Jul2012 to 28Nov2012. This Modification P00007 is now being executed since work has resumed pursuant to the resolution of the accounting system inadequacies and the Stop Work Lift issued 28Nov2012.
4. The contract will be modified as follows:

<u>SECTION</u>	<u>DESCRIPTION</u>
B	Revise the performance completion date on SubCLIN 0001AC to 06May2014.
C	Revise paragraphs 4.0, 4.1, 6.2.1.1, 6.2.1.1.1, 6.2.1.1.2, 6.2.1.1.3, 6.1.1.4, 6.2.1.2, 6.2.1.2.1, 6.2.1.2.2, 6.2.1.3, 6.2.1.3.1, 6.2.1.3.2, 6.2.1.3.3, 6.2.1.3.4, 6.2.1.4, 6.2.1.5, 6.3.2, 6.3.4, and 6.4.1.
F	Revise paragraph F.1.1 to reflect the new PoP
J	Revise all CDRLs with new delivery date and with new email addresses and names for the Contract Specialist and the COR.

5. As a result of this Modification P00007, the total negotiated value remains unchanged at \$2,404,441.00
6. Except as specifically provided in Modification P00007, all other terms and conditions remain unchanged.

*** END OF NARRATIVE A0007 ***

CONTINUATION SHEET

Reference No. of Document Being Continued
 PIIN/SIIN W56HZV-07-C-0211 MOD/AMD P00007

Name of Offeror or Contractor: ASHLAND INC.

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT									
	SECTION B - SUPPLIES OR SERVICES AND PRICES/COSTS													
0001	4D49 NANOFLUIDS-ASHLAND INC													
0001AC	<p><u>NANOPARTICLES RESEARCH & DEVELOPMENT</u></p> <p>GENERIC NAME DESCRIPTION: 4D49 NANOFLUIDS-ASHLAND INC PRON: R392C051R3 PRON AMD: 03 ACRN: AC AMS CD: 622601T2600</p> <p><u>Inspection and Acceptance</u> INSPECTION: Destination ACCEPTANCE: Destination</p> <p><u>Deliveries or Performance</u></p> <table border="0"> <tr> <td>DLVR SCH</td> <td></td> <td>PERF COMPL</td> </tr> <tr> <td><u>REL CD</u></td> <td><u>QUANTITY</u></td> <td><u>DATE</u></td> </tr> <tr> <td>001</td> <td>1</td> <td>06-MAY-2014</td> </tr> </table> <p style="text-align: right;">\$ 720,447.00</p>	DLVR SCH		PERF COMPL	<u>REL CD</u>	<u>QUANTITY</u>	<u>DATE</u>	001	1	06-MAY-2014	1	LO		\$ 720,447.00
DLVR SCH		PERF COMPL												
<u>REL CD</u>	<u>QUANTITY</u>	<u>DATE</u>												
001	1	06-MAY-2014												

CONTINUATION SHEET	Reference No. of Document Being Continued	Page 4 of 11
	PIIN/SIIN W56HZV-07-C-0211	MOD/AMD P00007
Name of Offeror or Contractor: ASHLAND INC.		

SECTION C - DESCRIPTION/SPECIFICATIONS/WORK STATEMENT

Scope of Work

C.1 SCOPE. This Statement of Work (SOW) defines the research effort required to identify, characterize, synthesize, and evaluate nanoparticles for use in military engine oils. Additionally, this effort will research and evaluate the dispersion method necessary to suspend the nanoparticles in oil.

C.1.1 Background. The nanoparticle program has been initiated in response to a Science and Technology need to improve military Petroleum, Oil, & Lubricants (POL) products. The nanoparticles will be researched to determine if and how nanoparticles can be added to fully-formulated military POL products (i.e. engine oil). The addition of nanoparticles to POL products is anticipated to improve a number of properties; for example increase thermal conductivity and heat transfer properties for better overall heat management and reduced peak operating temperatures, while reducing friction and wear, and enhancing fluid film protection. Fully formulated POL products with nanoparticles could ultimately contribute to make improvements in fuel efficiency, reducing the size of the cooling system (i.e., radiator) thus aiding in vehicle weight reductions and further helping to make vehicles more fuel efficient.

C.2 APPLICABLE DOCUMENTS. The following documents are applicable to this Statement of Work and attached appendices to the extent specified herein.

Department of Defense Specifications.
MIL-PRF-2104 Lubricating Oil, Internal Combustion Engine, Combat/Tactical Service
MIL-PRF-46167 Lubricating Oil, Internal Combustion Engine, Arctic

C.3 REQUIREMENTS.

C.3.1 General. The contractor, acting as an independent contractor and not as an agent of the Government, shall provide the necessary personnel, facilities, materials, and services to complete the effort described herein. The overall project is envisioned to encompass a period of 12 months. The work required by this contract shall be performed in accordance with Statement of Work.

The contractor shall research, select, and characterize specific nanoparticles, select and demonstrate the best method to disperse the nanoparticles in oil, and develop a nanoparticle concentrate to treat an engine oil with nanoparticles to demonstrate whether nanoparticles can improve performance in the areas of reduced friction, thermal stability and fuel consumption. The tasks involved are listed below in 3.2.

C.3.2 Detail Tasks.

C.3.2.1 Design, Engineering, Formulation and Test.

C.3.2.1.1 Selection, Synthesis, and Characterization of Nanoparticles. The contractor shall select and characterize up to three different nanoparticles to achieve increased heat transfer and/or reduce friction and wear.

C.3.2.1.1.1 Contractor shall create an index of all previously evaluated nanoparticles and summary of findings. This index shall be delivered not later than (NLT) 90 days after contract award (see DD 1423 Contract Data Requirements List (CDRL) A002).

C.3.2.1.1.2 Contractor shall identify the nanoparticles selected for this work and why they were chosen. This report shall be delivered NLT 90 days after contract award (see CDRL A002). Final selection of candidate nanoparticles shall be with the concurrence and approval of the Contracting Officers Representative (COR).

C.3.2.1.1.3 Contractor shall characterize the selected nanoparticles for chemical and physical properties before and after it has been blended with the lubricants.

C.3.2.1.2 Dispersant System Development. The contractor shall develop a particle concentrate dispersion system. The concentrates shall be tested for stability as a function of temperature and time, and diluted to evaluate their complete rheology in a reference lubricant selected with TARDEC.

C.3.2.1.2.1 The contractor shall provide an index of dispersion systems developed for the specific nanoparticles chosen in Section C.3.2.1.1. This index shall be delivered NLT 90 days after contract award or as agreed upon with the COR (see CDRL A002).

C.3.2.1.3 Formulation of prototype oils. The contractor shall formulate a prototype nanoparticle system which shall be blended into an agreed upon, or as specified by the COR, engine oil. ** The contractor shall evaluate and document the limitations or problems with adding nanoparticle system(s) (to include proper dispersion method) into existing, fully formulated, military engine oils (MIL-PRF-46167 or MIL-PRF-2104). The evaluation shall include, at a minimum, property characterization, stability, and shelf

CONTINUATION SHEET	Reference No. of Document Being Continued	Page 5 of 11
	PIIN/SIIN W56HZV-07-C-0211	MOD/AMD P00007

Name of Offeror or Contractor: ASHLAND INC.

life. Additionally, the contractor shall develop several potential base formulations for further development to nanofluids.** A 1 gallon sample of the resulting oil and 1 pint of the nanoparticle concentrate shall be provided to TARDEC for evaluation. The contractor shall formulate the resulting oil for high temperature (140\ 'b0F ambient) and high loads.

C.3.2.1.3.1 The contractor shall continue to explore stability of developed nanofluid formulations, on nanoparticles selected from previous work, to include nanoparticle dispersion systems and base fluid formulations. Adjustments to the base oil formulations shall be made, if needed, in order to incorporate the nanoparticle systems.

C.3.2.1.3.2 Contractor shall create a test plan to outline the methods to evaluate the stability of the nanofluid formulations and fully formulated engine oils with nanoparticles. This test plan shall be delivered not later than (NLT) 90 days after the effective date of this Modification (see DD 1423 Contract Data Requirements List (CDRL) A003).

C.3.2.1.4 Engine testing of Arctic-to-Desert Engine Oil Base Formulation. The contractor shall conduct engine performance testing designed and optimized for operation at ambient temperatures in the range between -50\ 'b0C (-60\ 'b0F) and 60\ 'b0C (140\ 'b0F).

C.3.2.1.4.1 The contractor shall provide and discuss with TARDEC parameters and conditions for verifying engine performance at the ambient temperatures listed above.

C.3.2.1.4.2 The contractor shall provide a test plan for the engine testing, to include the model of the engine proposed for the evaluation. This test plan shall be delivered NLT 90 days after the effective date of Modification or as agreed upon with the COR (see CDRL A003).

C.3.2.1.4.3 Engine Test Screening. The contractor shall run three (3) Sequence IIIG oxidation engine tests to determine initial feasibility of the prototype oil. One test will be run on a baseline candidate that does not include nanoparticles, one on the baseline with nanoparticles, and one on the current Arctic oil formulation.

C.3.2.1.5 The contractor shall continue to explore the frictional and heat transfer behavior of the developed baseline formulation and derived nanofluids for comparison and optimization.

C.3.2.1.5.1 The contractor shall evaluate the heat transfer capabilities of nanoparticles in coolants and stability when the nanoparticles are added to fully formulated coolants; ethylene or propylene glycols.

C.3.2.1.5.2 The contractor shall provide a report to identify the developed baseline formulation and derived nanofluids which are to be further studied and the reason the fluids were chosen. Additionally, the report shall document the methods or techniques to be used to continue to explore the frictional and heat transfer behaviors. A heat transfer model of the impact introduced by the nanoparticles shall be developed.

C.3.2.1.5.3 The contractor shall develop and provide results of the heat flow modeling of the impact introduced by the nanoparticles.

C.3.2.1.6 The contractor shall select three of the most promising Arctic-to-Desert Diesel Engine Oil Nanofluid Formulations and conduct engine performance testing in accordance with the test plan developed in C.3.2.1.2. A test plan and proposed engine test matrix shall be prepared

C.3.2.1.6.1 This test plan shall be delivered NLT 90 days after effective date of Modification P00001 (see 3.3.3) or as agreed upon with the COR (see CDRL A003). The contractor shall prepare and submit a test report identifying the three most promising nanofluid formulations and the results of the engine performance testing. The test report shall also include discussion of the tests results, and areas for improvement. The contractor shall also offer suggestions to achieve the desired improvements.

C.3.2.1.6.2. The contractor shall provide the results of the heat-flow modeling.

C.3.2.1.7 Manufacturing. Contractor shall assess capabilities and requirements for full-scale production of a nanoparticle based lubricating oil, which shall include bulk manufacturing of the nanoparticle system. * Based on the previous assessment of capabilities and requirements for full-scale production, the contractor shall identify those areas that need to be developed or enhanced to allow full-scale production. The contractor shall describe what will be needed (process improvements, equipment procurement, manufacturing technique development, etc) in order to achieve full-scale production and a time-table, with appropriate milestones, expected for full-scale production.*

C.3.2.2 Program Planning. The contractor shall provide program management, in accordance with the detail requirements below

C.3.2.2.1 Program Management. The contractor shall establish and maintain management operations that shall include the following areas:

Name of Offeror or Contractor: ASHLAND INC.

- (a) Program Planning and Control,
- (b) Subcontractor Control,
- (c) Financial Management,
- (d) Data Management,
- (e) Management and Accountability for Government Furnished Equipment, and
- (f) Risk Management

The contractor shall develop and implement a Management Program that clearly defines how the nanoparticle program will be conducted and controlled. A task matrix keyed to the Work Breakdown Structure (WBS) shall be developed in sufficient detail to identify Contractor and subcontractor responsibilities. The contractor shall develop a financial management system to document and report funding allocations spent by the contractor and all subcontractors.

C.3.3 Deliverables

C.3.3.1 The contractor shall provide monthly status reports (to include cost schedule) to the government technical POC.

C.3.3.2 The contractor shall provide NLT 90 days after contract award; or a date to be agreed upon with the COR:

C.3.3.2.1 an index of all previously evaluated nanoparticles and summary of findings (CDRL A002),

C.3.3.2.2 a list of the nanoparticles selected for this work and why they were chosen (CDRL A002),

C.3.3.2.3 an index of dispersion systems developed for the specific nanoparticles chosen in Section 3.2.1.1 (CDRL A002).

C.3.3.3 The contractor shall provide NLT 60 days prior to the beginning of testing, or at a time to be mutually agreed upon with the COR, a comprehensive test plan (CDRL A003). The Government shall have 30 days for review and comment. Final test plan shall be delivered NLT 15 days prior to start of testing. Test results shall be reported in a separate test report, due NLT 30 days after completion of testing.

C.3.3.4 The contractor shall provide NLT 90 days after the effective date of this modification P00001; or a date to be agreed upon with the COR:

C.3.3.4.1 a test plan to outline the methods to evaluate the stability of the nanofluid formulations (CDRL A003);

C.3.3.4.2 a test plan for engine performance testing (CDRL A003); and

C.3.3.4.3 a test plan and engine test matrix to evaluate the most promising Arctic-to-Desert Diesel Engine Oil Nanofluid Formulation (CDRL A003).

C.3.3.5 The contractor shall provide a 1-gallon sample of the finished fluid formulated with nanoparticles and 1 pint of the nanoparticle concentrate.

C.3.3.6 The contractor shall provide a final report (CDRL A004) identifying the most promising nanoparticles for reducing thermal conductivity and enhancing friction and wear properties.

C.3.3.7 The contractor shall provide a 1-gallon sample of each of the Arctic-to-Desert Diesel Engine Oil Nanofluid Formulations.

C.3.3.8 The contractor shall provide a report to identify the developed baseline formulation and derived nanofluids which are to be further studied and the reason the fluids were chosen.

C.3.3.9 The contractor shall prepare and submit a test report (CDRL A005) identifying the three most promising nanofluid formulations and the results of the engine performance testing.

C.3.3.9.1 The contractor shall provide an engine test report for the three (3) Sequence IIIG tests (C.3.2.1.4.3) (CDRL A005).

C.3.3.10 The contractor shall develop and provide results of the heat flow modeling.

C.3.3.11 The contractor shall provide a final report (CDRL A004) which shall include identification of the most promising Arctic-to-Desert Diesel Engine Oil Nanofluid Formulations for increasing thermal conductivity and enhancing friction and wear properties

CONTINUATION SHEET**Reference No. of Document Being Continued**

Page 7 of 11

PIIN/SIIN W56HZV-07-C-0211

MOD/AMD P00007

Name of Offeror or Contractor: ASHLAND INC.

and the rationale supporting the choices as well as a summary of all efforts conducted.

C.3.4 Meetings

C.3.4.1. Kick-Off Meeting. The Contractor shall plan and conduct a one (1) day kick-off meeting at TARDEC within thirty (30) days of *initial* Contract award. The Contractor shall coordinate this meeting with the COR. At the meeting, the Contractor shall explain its intended approach for accomplishing the Contract SOW.

C.3.4.2. Semi-Annual Meetings. The Contractor shall plan and conduct status meetings (every 6 months) with the COR for status updates.

C.3.4.3. Final Demonstration. The Contractor shall plan and conduct a one day final report presentation and meeting before contract expiration. At this meeting, the Contractor shall report the results of the prototype development and testing as defined in the Contract SOW at TARDEC or at a location agreed to by the COR.

Nanofluids Continuation Project Added by Modification P00003

C.4.0 SCOPE. This Statement of Work (SOW) defines the research effort required to evaluate *performance of nano-particulate engine oil under large scale engine testing. This work is a continuation of previous contracts in FY 2006 and FY 2007. Additionally, this effort will research and evaluate soft nanoparticles. The work described below in the Statement of Work shall be completed in twelve (12) months and shall be awarded as a modification to the current contract, W56HZV-07-C-0211. *This proposed work will test previously formulated nano-particle engine oil in large scale engines under laboratory test conditions to evaluate for various performance characteristics : namely thermal, tribological, thermo-mechanical and rheological performance. Also, vehicle level mileage accumulation type testing will be performed to estimate fuel economy benefits with use of nano-particulate oil.

C.4.1 Background. The nanoparticle program has been initiated in response to a Science and Technology need to improve military petroleum, oil and lubricants (POL) products. During the first two years of the research, nanoparticles were evaluated to determine if and how nanoparticles could be utilized in oil (POL) products (i.e. engine oil, coolants). *Various different forms of nano-particles with variety of shapes, sizes and various physical and chemical characteristics were researched to arrive at most suitable combination. In addition, it included research on various dispersion and suspension techniques. The resultant physical, chemical and kinematic properties of the fluids developed with nano-particles were evaluated using various lab bench test methodologies. Estimation of some physical parameters like thermal conductivity and heat transfer coefficients for better overall heat management were evaluated using bench tests. This work has been completed satisfactorily. Now, it is needed to validate the chosen nano-particulate formulation using larger scale engine tests. This engine testing will provide more accurate evaluation towards actual performance capability of nano-oil in military vehicle application

C.5.0 APPLICABLE DOCUMENTS. The following documents are applicable to this Statement of Work and attached appendices to the extent specified herein.

Department of Defense Specifications.

MIL-PRF-2104 Lubricating Oil, Internal Combustion Engine, Combat/Tactical Service

MIL-PRF-46167 Lubricating Oil, Internal Combustion Engine, Arctic

C.6.0 REQUIREMENTS.

C.6.1 General. The work required by this contract shall be performed in accordance with Statement of Work. The contractor shall continue work on the nanofluids developed during the first two years of funding. Testing will continue to demonstrate whether nanoparticles can improve performance in the areas of reduced friction, thermal management and fuel consumption, as well as pass standard engine tests. Engine tests are a controlled outlet used to evaluate lubricants in extremely harsh conditions. If the fluids are able to perform in engine tests then they will likely be able to perform in the harsh conditions that are seen Army combat vehicles. The contractor shall provide program management, in accordance with the detail requirements of C.6.2.2.1 below.

C.6.2 Detail Tasks.

C.6.2.1 Design, Engineering, Formulation and Testing.

C.6.2.1.1 *Laboratory Engine Testiing: Laboratory engine testing shall be done on a Cummins - ISB Diesel Engine

C.6.2.1.1.1 *Test Schedule 09-1: Evaluation of Thermo-mechanical Performance Characteristics of Engine Oil in a Compression Ignition,Water Cooled Diesel Engine

The current military arctic oil, non-nano baseline and two variants of the nano particulate oil, one with 2.0% nano-particle concentration and one with 1.5% nano-particle concentration, total of 4 oils shall be tested in a

Name of Offeror or Contractor: ASHLAND INC.

Cummins - ISB Diesel Engine with 3 numbers of repeats per oil.
The testing will be done on Ultra Low Sulfur Diesel ASTM D975
Grade No. 2-D S15 / MV-15 fuel.
This test will be designed to capture following aspects of fluid
performance:

- a) Thermal performance of fluids
- b) Heat balance / heat flow analysis
- c) Energy conversion efficiency estimation
- d) Start-up performance at 20 40 deg C temperature

*C.6.2.1.1.2 *Test Schedule 09-2: Evaluation of Start-up Performance of Engine
Oils in Cold Temperature Conditions
(Cummins ISB Diesel Engine - Pickup Truck:- Cold Temp. Test)
The current military arctic oil, non-nano baseline and two
variants of the nano particulate oil, one with 2.0% nano-particle
concentration and one with 1.5% nano-particle concentration, total of 4 oils with 3 repeats per oil shall be tested in a Cummins ISB
Diesel
Engine Pick-up Truck for Cold temperature performance (below 0\b0 C).
Start-up and warm-up performance of the fluids shall be tested.
The testing will be done on Ultra Low Sulfur Diesel ASTM D975
Grade No. 2-D S15 / MV-15 fuel.

*C.6.2.1.1.3 *Test Schedule 09-3: Evaluation of Thermo-mechanical, Tribological
and Rheological Endurance-performance Characteristics of Diesel
Engine Oils:
Current military arctic oil, non-nano baseline and nano-particulate oil
which shows best results among the two variants tested in test
schedules 09-1 and 09-2, total of 3 oils shall be tested with 1 test per oil
in a Cummins ISB Diesel Engine.
The testing will be done on Ultra Low Sulfur Diesel ASTM D975
Grade No. 2-D S15 / MV-15 fuel.
This test will be designed to capture following aspects of fluid
performance:
a) Tribological performance (Cam/ Liner wear)
b) Thermo-mechanical performance
(Piston deposits, ring sticking, sludge, filter plugging)
c) Soot influence study (soot-related viscosity increase, wear)
d) Rheological Performance (extent / effect of oil ageing)

*C.6.1.1.4 *The contractor shall develop a test plan (CDRL A003) for engine
testing. The contractor shall provide NLT 60 days prior to the beginning
of testing, or at a time to be mutually agreed upon with the COR, a
comprehensive test plan (A003). The Government shall have 30 days
for review and comment. Final test plan shall be delivered NLT 15 days
prior to start of testing. Test results shall be reported in a separate test
report, due NLT 30 days after completion of testing.

C.6.2.1.2 *Vehicle Level Testing

C.6.2.1.2.1 *Test Schedule 09-4 (Fuel Economy Testing): Vehicle Level Testing for
Fuel economy Assessment SAE-J1321 Surface Vehicle Fuel
Consumption Test Procedure (Type II)
A vehicle level testing will be performed to evaluate benefits of
fuel economy improvement by using control + candidate combination for
statistical confidence purpose. Current military arctic oil will be used as
control and non-nano baseline oil and nano-particulate oil which shows
best results among the two variants tested in test schedules 09-1 and
09-2 will be used as candidates, total of 3 oils will be tested: according to
SAE-J1321 test protocol on a Cummins ISB engine based class-6 trucks
to provide a true comparison basis. Two repeats will be performed on
each of the oils in control + candidate combinations. The testing will be done on Ultra Low Sulfur Diesel ASTM D975 Grade No. 2-D S15 /
MV-15 fuel.

*C.6.2.1.2.2 The contractor shall develop a test plan (CDRL A003) for Vehicle
level testing. The contractor shall provide NLT 60 days prior to the

Name of Offeror or Contractor: ASHLAND INC.

beginning of testing, or at a time to be mutually agreed upon with the COR, a comprehensive test plan (A003). The Government shall have 30 days for review and comment. Final test plan shall be delivered NLT 15 days prior to start of testing. Test results shall be reported in a separate test report, due NLT 30 days after completion of testing.

*C.6.2.1.3 The contractor shall blend enough quantity of non-nano baseline oil and nano oil variants as per the quantity requirement for the test plan outlined under 6.2.1.1 and 6.2.1.2.

*C.6.2.1.3.1 Contractor shall perform analytical testing in order to ensure the consistency and uniformity of blended nano oils across multiple blend batches. It shall also verify that the blended products match closely with the previously decided formulations.

*C.6.2.1.3.2 As allowed per section C.3.2.1.5 and C.3.2.1.6, contractor shall make two variants of the nano-oil, one with 2% particle concentration and another with 1.5% particle concentration to find any preferential benefit towards resolving the particle agglomeration issue found according to the previous work and the engine test results of Engine Test schedule 07-1.

*C.6.2.1.3.3 Contractor shall use both the variants of nano-oil as outlined in 6.2.1.3.2 to perform test according to test schedule 09-1 and 09-2 for their thermal performance and evaluate whether the agglomeration issue reduces using CRC-type of rating methodology and conclude the best one among the two mentioned variants.

*C.6.2.1.3.4 Contractor then shall use the best nano-oil among the two mentioned variants to perform further testing mentioned in test schedule 09-3 listed in section 6.2.1.1.3 and test schedule 09-4 listed in section

*C.6.2.1.4 *Continued Testing of Nanofluids. The contractor shall evaluate soft nanoparticles to see if they can achieve increased heat transfer and/or reduce friction and wear. Bench test available in the contractors laboratory will be used for evaluation. These tests include HFRR (high frequency reciprocating rig), MTM (mini traction machine), and the thermal conductivity rig. The contractor will also continue to evaluate any promising new nanotechnologies as they present themselves.

*C.6.2.1.5 Contractor will continue evaluation of any new technologies that may present themselves. Details of new technologies evaluated will be included in bi-monthly reports.

C.6.2.2 Program Planning.

C.6.2.2.1 Program Management. The contractor shall establish and maintain management operations that shall include the following areas:

- (a) Program Planning and Control
- (b) Subcontractor Control
- (c) Financial Management
- (d) Data Management
- (e) Management and Accountability for Government Furnished Equipment
- (f) Risk Management

The contractor shall develop and implement a Management Program that clearly defines how the nanoparticle program will be conducted and controlled. A task matrix shall be developed in sufficient detail to identify Contractor and subcontractor responsibilities. The contractor shall develop a financial management system to document and report funding allocations spent by the contractor and all subcontractors.

C.6.3 Deliverables.

C.6.3.1 The contractor shall provide bi-monthly status reports (to include cost schedule) to the government technical POC (CDRL A001).

C.6.3.2 The contractor shall provide a *laboratory engine test plan *and vehicle level test plan before any *related engine testing begins (CDRL A003).

C.6.3.3 The contractor shall provide an engine test report for any engine test completed (CDRL A005).

CONTINUATION SHEET**Reference No. of Document Being Continued****Page 10 of 11****PIIN/SIIN** W56HZV-07-C-0211**MOD/AMD** P00007

Name of Offeror or Contractor: ASHLAND INC.

C.6.3.4 The contractor shall provide a final report summarizing *all of the test results (CDRL A004). The report will also include a summary of soft nanoparticles, any new technologies evaluated, and a production capability summary.

C.6.4 Meetings

C.6.4.1 The contractor shall plan and conduct a one-day kick-off meeting at TARDEC within *75 days of contract Modification P00007 award. The contractor shall coordinate this meeting with the COR and present the intended approach for accomplishing the Contract SOW.

C.6.4.2 The contractor shall plan and conduct semi-annual status meetings with the COR for status of the contract SOW.

C.6.4.3 The contractor shall plan and conduct a one-day final report presentation and meeting prior to contract expiration to convey nanofluid engine oil development and testing as defined in the SOW. Meeting will be held at TARDEC or a location agreed to by the COR.

* Revised per Modification P00007

*** END OF NARRATIVE C0001 ***

CONTINUATION SHEET

Reference No. of Document Being Continued

Page 11 of 11

PIIN/SIIN W56HZV-07-C-0211

MOD/AMD P00007

Name of Offeror or Contractor: ASHLAND INC.

SECTION J - LIST OF ATTACHMENTS

<u>List of</u> <u>Addenda</u>	<u>Title</u>	<u>Date</u>	<u>Number</u> <u>of Pages</u>	<u>Transmitted By</u>
Exhibit A	CONTRACT DATA REQUIREMENTS LIST (CDRL) DD 1423	04-FEB-2013	003	

CONTRACT DATA REQUIREMENT LIST

Form Approval OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 440 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503. Please DO NOT RETURN your form to either these addresses. Send completed form to the Government Issuing Contracting Officer for the Contract/PR No. listed in Block E.

A. CONTRACT LINE ITEM NO...:
B. EXHIBIT.....: A
C. CATEGORY.....:
D. SYSTEM/ITEM.....: Research & Development - Nanofluids
E. CONTRACT/PR NO.....: W56HZV-07-C-0211
F. CONTRACTOR.....: Valvoline, Inc

1. DATA ITEM NO.: A001
2. TITLE OF DATA ITEM.....: Contractor's Progress Status and Management Report
3. SUBTITLE:
4. AUTHORITY: DI-MGMT-80227(T) (see 16a. below)
5. CONTRACT REFERENCE.....: C.3.3.1, C.6.3.1
6. REQUIRING OFFICE.....: AMSRD-TAR-D / MS 110
7. DD250 REQ: LT
8. APP CODE: N/A
9. DIST. STATEMENT REQUIRED:
10. FREQUENCY.....: Monthly
11. AS OF DATE.....:
12. DATE OF FIRST SUB.....: *120 DAC
13. DATE OF SUBS. SUB.....:
14. DISTRIBUTION ADDRESSEES: SUBMIT REPORTS ELECTRONICALLY TO THE E-MAIL ADDRESSES SHOWN IMMEDIATELY BELOW:
*JILL M. BRAMER, CONTRACTING OFFICER'S REPRESENTATIVE, E-MAIL: jill.m.bramer.civ@mail.mil
Jennifer Prunte, CONTRACT SPECIALIST, E-MAIL: jennifer.s.prunte.civ@mail.mil
ADMINISTRATIVE CONTRACTING OFFICER: DCMA-Dayton, DCMMA-ACOB E-MAIL: TBD
15. TOTAL.....:
16. REMARKS.....: DI-MGMT-80227 is tailored by deleting 10.2, 10.3(j) 10.3(k), and 10.3(l).
17. PRICE GROUP.....:
18. ESTIMATED TOTAL PRICE..:

*Revised by Mod P00007

1. DATA ITEM NO.....: A002
2. TITLE OF DATA ITEM.....: Index and Summary
3. SUBTITLE.....:
4. AUTHORITY.....:
5. CONTRACT REFERENCE.....: C.3.2.1.1.1, 3.2.1.1.2, 3.2.1.2.1, 3.3.2.1, 3.3.2.2, 3.3.2.3
6. REQUIRING OFFICE.....: AMSTA-TR-D/MS 110
7. DD 250 REQ.....: LT
8. APP CODE.....:
9. DIST. STATEMENT REQUIRED:
10. FREQUENCY.....:
11. AS OF DATE.....:
12. DATE OF FIRST SUBMISSION: SEE BLK 16
13. DATE OF SUBS.....: SEE BLK 16
14. DISTRIBUTION/ A. ADDRESSEE B. COPIES DRAFT / FINAL
*JILL M. BRAMER, CONTRACTING OFFICER'S REPRESENTATIVE, E-MAIL: jill.m.bramer.civ@mail.mil 1 / 1
15. TOTAL.....: 1 / 1
16. REMARKS *120 days after contract award provide, in contractor format, an index of all previously evaluated nanoparticles and summary of findings, a list of the nanoparticles selected for this work and why they were chosen, an index of dispersion systems developed for the specific nanoparticles chosen.

1. DATA ITEM NO.....: A003
2. TITLE OF DATA ITEM.....: Test Plan

3. SUBTITLE.....:
4. AUTHORITY.....: DI-NDTI-80566
5. CONTRACT REFERENCE.....: C.3.2.1.3.2, C.3.2.1.4.2, C.3.2.1.6.1, C.3.3.4, C.6.3.2
6. REQUIRING OFFICE.....: AMSTA-TR-D/MS110
7. DD 250 REQ.....: LT
8. APP CODE.....:
9. DIST. STATEMENT REQUIRED:
10. FREQUENCY.....: ASREQ
11. AS OF DATE.....:
12. DATE OF FIRST SUBMISSION: SEE BLK 16
13. DATE OF SUBS.....: SEE BLK 16
14. DISTRIBUTION/ A. ADDRESSEE B. COPIES DRAFT / FINAL
*JILL M. BRAMER, CONTRACTING OFFICER'S REPRESENTATIVE, E-MAIL: jill.m.bramer.civ@mail.mil, 1 / 1
15. TOTAL.....: 1 / 1
16. REMARKS The Test Plan shall be electronically delivered (email or CD) in an editable and printable digital format. Draft Test Plan delivered 60 days prior to Test and Demonstration *or as directed in Section C*; Government to review and provide comments 30 days after receipt of draft. FINAL Test Plan delivered 15 days after receipt of Government comment

*Revised by Mod P00007

-
1. DATA ITEM NO.: A004
 2. TITLE OF DATA ITEM : SCIENTIFIC AND TECHNICAL REPORT
 3. SUBTITLE: DRAFT/FINAL TECHNICAL REPORT
 4. AUTHORITY: DI-MISC-80711A(T) (see 16a. below)
 5. CONTRACT REFERENCE.....: C.3.3.6, C.3.4.3, C.3.3.11, C.6.3.3, C.6.3.4
 6. REQUIRING OFFICE: AMSRD-TAR-D / MS 110
 7. DD250 REQ: DD
 8. APP CODE: A
 9. DIST. STATEMENT REQUIRED:
 10. FREQUENCY.....: SEE ITEM 16
 11. AS OF DATE.....:
 12. DATE OF FIRST SUB.....: SEE ITEM 16
 13. DATE OF SUBS. SUB.....: SEE ITEM 16
 14. DISTRIBUTION ADDRESSEE: SUBMIT REPORTS ELECTRONICALLY TO THE E-MAIL ADDRESSES SHOWN IMMEDIATELY BELOW:
JILL M. BRAMER, CONTRACTING OFFICER'S REPRESENTATIVE, E-MAIL: jill.m.bramer.civ@mail.mil DRAFT/FINAL 1/1
Jennifer Prunte, CONTRACT SPECIALIST, E-MAIL: jennifer.s.prunte.civ@mail.mil DRAFT/FINAL 0/1
ADMINISTRATIVE CONTRACTING OFFICER: DCMA-Dayton, DCMAA-ACOB E-MAIL: TBD 0/1
 15. TOTAL.....: 1/3
 16. REMARKS:
 - a. DI-MISC-80711A is tailored by deleting 10.2.
 - b. The Draft of the Final Technical Report (C.2.2) shall be delivered *15 months after date of contract award. The Government will review and respond within 30 days of receipt. The contractor shall submit the Final Technical Report within 30 days after receipt of draft comments/approval.
 17. PRICE GROUP.....:
 18. ESTIMATED TOTAL PRICE...:

*Revised by Mod P00007

-
1. DATA ITEM NO. A005
 2. TITLE OF DATA ITEM.....: Test Report
 3. SUBTITLE.....:
 4. AUTHORITY.....: MIL-HDBK-831
 5. CONTRACT REFERENCE.....: C.3.2.1.6.2, C.3.2.1.6.3, C.3.3.8, C.3.3.9,C.3.3.9.1, C.3.3.10
 6. REQUIRING OFFICE.....: AMSTA-TR-D/MS110
 7. DD 250 REQ.....: LT
 8. APP CODE.....:
 9. DIST. STATEMENT REQUIRED.:
 10. FREQUENCY.....: ASREQ
 11. AS OF DATE.....:
 12. DATE OF FIRST SUBMISSION: SEE BLK 16
 13. DATE OF SUBS.....: SEE BLK 16
 14. DISTRIBUTION/ A. ADDRESSEE B. COPIES DRAFT / FINAL
*JILL M. BRAMER, CONTRACTING OFFICER'S REPRESENTATIVE, E-MAIL: jill.m.bramer.civ@mail.mil 1 / 1

15. TOTAL.....: 1 / 1

16. REMARKS The Test Report shall be electronically delivered (email or CD) in an editable and printable digital format. Draft Test Report delivered 60 days after Test and Demonstration; Government to review and provide comments 30 days after receipt of draft. FINAL Test Plan delivered 15 days after receipt of Government comments.

* Revised by Mod P00007

\-\-\-

THE FOLLOWING INSTRUCTION APPLIES TO ALL REPORTS DELIVERABLE UNDER THE CONTRACT

Prepare the reports in Contractor format. Submit the reports using any of the following electronic formats:

- (1) Files readable using these Microsoft* Office XP or Microsoft* Office 2002 & lower Products: Word, Excel, PowerPoint, or Access. Spreadsheets must be sent in a file format that includes all formulae, macro and format information. Print or scan images of spreadsheets are not acceptable. Please see security note below for caution regarding use of macros.
- (2) Files in Adobe PDF (Portable Document Format). When scanning documents, scanner should be set to 200 dots per inch.
- (3) Files in HTML (Hypertext Markup Language) Format. HTML documents must not contain active links to Internet websites or web pages for reference information. All linked information must be contained within your electronic report, and be accessible offline.
- (4) Other electronic formats. Before preparing your report in any other electronic format, please e-mail the COR, with an e-mail copy-furnished to amsta-id@tacom.army.mil, to obtain a decision as to the format's acceptability. This e-mail must be received by the COR not later than ten (10) calendar days before the draft report's due date. All alternate methods must be at no cost to the Government.
- (5) Please note that we can no longer accept .zip files due to increasing security concerns.

NOTE. Macros: The virus scanning software used by our e-mail systems cannot always distinguish a macro from a virus. Therefore, sending a macro embedded in an e-mail message or an e-mail attachment may cause the e-mail report to be quarantined.

d. Acceptable media: The Contractor shall submit reports via e-mail. If e-mail is not workable, another acceptable media is a 650 megabyte CD ROM. Identify the software application and version used to create each file submitted.

- (1) E-MAIL. Maximum size of each e-mail message shall be three and one-half (3.5) megabytes. Previously "zipped" files were accepted, but due to security concerns these zipped attachments cannot be received through our mail system. You may use multiple e-mail messages if necessary, however, you must annotate the subject lines in this manner: "Message 1 of 3, 2 of 3, 3 of 3."
- (2) 650 MEGABYTE CD ROM to be delivered via U.S. Mail or other carrier. The Contractor shall label all submitted disks with the Contract number, the Contractor's name and address, and a contact's phone number. Exterior mailing envelopes containing disks must be addressed to the following address:

U.S. Army TACOM Life Cycle Management Command (TACOM LCMC)
Attn: Jill M. Bramer
AMSRD-TAR-D/ MS 110
6501 East 11 Mile Road
Warren, MI 48397-5000

NOTE: Please select only one type of electronic media to transmit each report. For instance, do not submit a report via e-mail and CD-ROM.

* Registered Trademark