A PROJECT FOR THE COOPERATIVE RESEARCH ON HYBRID ELECTRIC PROPULSION

BETWEEN

THE DEPARTMENT OF DEFENSE OF THE UNITED STATES OF AMERICA

AND

THE MINISTRY OF DEFENSE OF JAPAN

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
24 JAN 2011	**Briefing Charts**	**07-09-2010 to 15-01-2011**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
A PROJECT FOR THE COOPERATIVE RESEARCH ON HYBRID ELECTRIC PROPULSION BETWEEN THE DEPARTMENT OF DEFENSE OF THE UNITED STATES OF AMERICA AND THE MINISTRY OF DEFENSE OF JAPAN	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) **Wolfgang Peterman**	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **U.S. Army TARDEC,6501 East Eleven Mile Rd,Warren,Mi,48397-5000**	8. PERFORMING ORGANIZATION REPORT NUMBER **#21483**
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) **U.S. Army TARDEC, 6501 East Eleven Mile Rd, Warren, Mi, 48397-5000**	10. SPONSOR/MONITOR'S ACRONYM(S) **TARDEC**
	11. SPONSOR/MONITOR'S REPORT NUMBER(S) **#21483**

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The objective of this Hybrid Electric Propulsion agreement is to engage in Hybrid Electric Propulsion research under three distinct tasks with the goal of establishing a common hybrid electric propulsion test operating procedure which is suitable for both wheeled and tracked platforms.

15. SUBJECT TERMS
Hybrid Propulsion, Series Hybrid, Parallel Hybrid, TOP, CHEP TOP, HEP TOP, National, Technical infrastructure

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Public Release**	**18**	

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Definitions of Terms and Abbreviations

- The following definitions will apply:

Hybrid Propulsion - Implies the existence of more than one (in general two) power sources (i.e. (a) a prime mover, generally a diesel engine for military vehicles (b) energy storage system, generally a battery pack , and one or more propulsion mechanisms (i.e. mechanical via engine transmission or electrical using engine driven generator and electric motors) which use those previously mentioned power sources to propel the wheels or tracks of the vehicle.

Series Hybrid – Implies the existence of more than one (in general two) power sources (i.e. engine/generator and battery pack which can translate the chemical or electrical energy through power electronics conversion units into mechanical power/energy, either through internal combustion engine (ICE), and one or more electric motors. The mechanical energy of the internal combustion engine (ICE) is used only to drive a generator which can charge the battery pack. The wheels or tracks of the vehicle can be propelled only by the electric motor(s) which is/are driven by the battery and/or generator (acting together or individually).

Parallel Hybrid – Implies the existence of more than one (in general two) power sources (i.e. engine/generator and battery pack) and two drive train paths, a mechanical path through the engine transmission and an electrical path through electric motor(s) and their power electronic controls, with the ability to propel the wheels or tracks of the vehicle by either the ICE engine and transmission , or the electric motor, acting individually or in combination.

TOP – Test Operating Procedure. It implies the development of methodology to evaluate the subject vehicle performance .

CHEP TOP - Common Hybrid Electric Propulsion Test Operating Procedure.

HEP TOP – Hybrid Electric Propulsion Test Operating Procedure.

National – Belonging to a particular country.

Technical infrastructure – Totality of necessary resources in terms of technical expertise, equipments, facilities, supporting human resource (both technical and non-technical), and funding, which collectively can implement and bring a technology to fruition.

Objectives

- The objective of this Hybrid Electric Propulsion agreement is to engage in Hybrid Electric Propulsion research under three distinct tasks with the goal of establishing a common hybrid electric propulsion test operating procedure which is suitable for both wheeled and tracked platforms.

Scope of Work and Sharing of Tasks

- Scope of Work
  - The Parties will conduct cooperative research consisting of the following tasks :
    - Task 1 –Develop national Hybrid Electric Propulsion (HEP) TOPs, exchange national HEP TOPs
    - Task 2 – Observe testing and participate in scoring conferences and reviews of respective national hybrid platforms.
    - Task 3 –Jointly generate a CHEP TOP

Scope of Work and Sharing of Tasks

- Party Tasks:
  - Japan MOD. In Task 1, the following work will be accomplished by the Japan MOD:
    - Develop a national Hybrid Electric Propulsion (HEP) TOP for a Tracked Vehicle.
    - Exchange national HEP TOP for a Tracked Vehicle and analyze the other Party's HEP TOP for a Wheeled Vehicle.

Scope of Work and Sharing of Tasks

- U.S. DoD. In Task 1, the following work will be accomplished by DoD US:
  - Develop a national Hybrid Electric Propulsion (HEP) TOP for a Wheeled Vehicle.
  - TARDEC to provide current Hybrid Test Operating Procedures (TOP) to Japan.
  - Exchange national HEP TOP for a Wheeled Vehicle and analyze the other Party's HEP TOP for a Tracked Vehicle.

Scope of Work and Sharing of Tasks

- Japan MOD. In Task 2, the following work will be accomplished by Japan MOD:
  - Invite U.S. DoD representatives to attend program reviews, technology interchange meetings, system design reviews, and other meetings that the Participants mutually determine are relevant (attendance can be through virtual meetings).
  - Allow GVPM personnel to participate in GSRC hybrid program technical reviews and observe in component and/or platform testing consistent with disclosure authority

Scope of Work and Sharing of Tasks

- U.S. DoD In Task 2, the following work will be accomplished by DOD US:
  - Exchange test data from the DDRE sponsored and already funded FED-B program by allowing TRDI-GSRC to observe FED-B testing using the existing TARDEC Hybrid TOP consistent with disclosure authority.
  - Invite Japan MOD representatives to attend program reviews, technology interchange meetings, system design reviews, and other meetings that the Participants mutually determine are relevant (attendance can be through virtual meetings).

Scope of Work and Sharing of Tasks

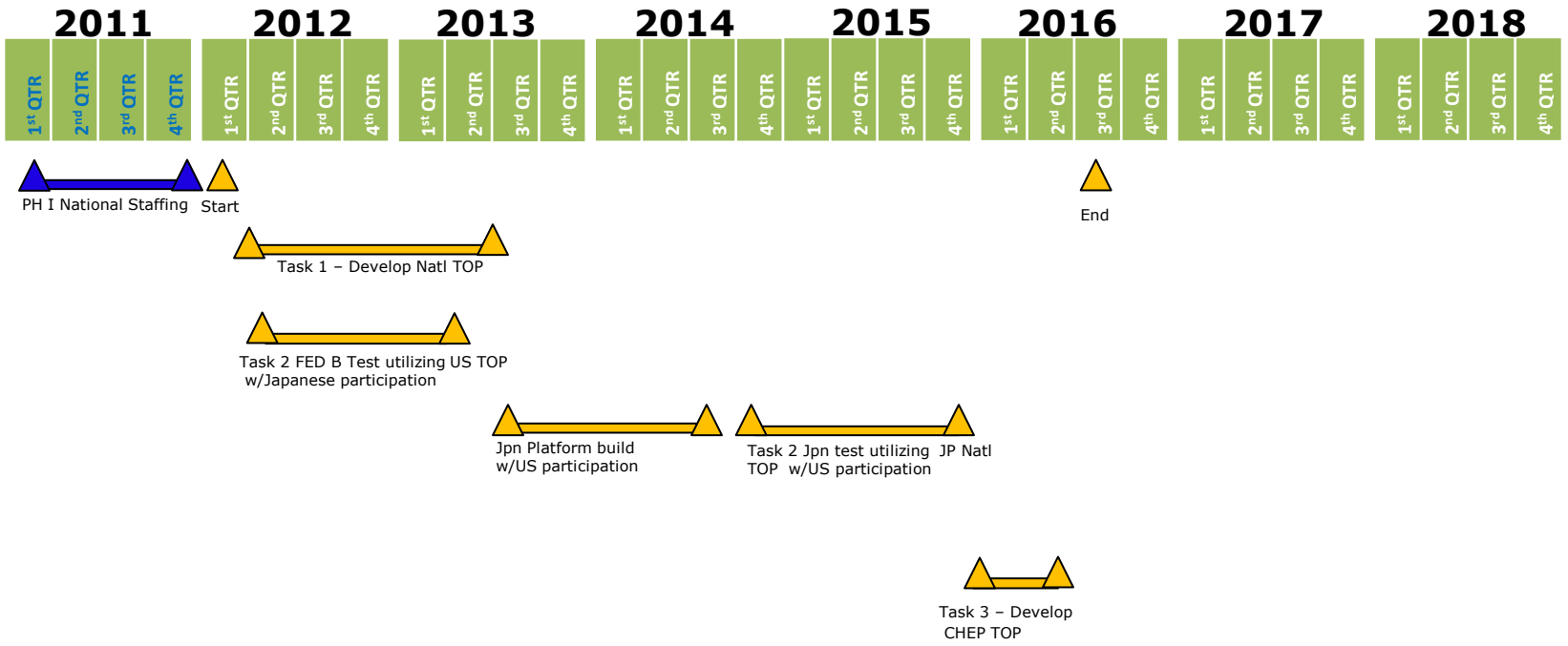
- In Task 3, The following work will be accomplished by both U.S. DoD and Japan MOD:
  - The parties will generate a CHEP TOP for use on both Tracked and Wheeled vehicles
    - The parties will host representatives to attend program reviews, technology interchange meetings, system design reviews, and other meetings that the Participants mutually determine are relevant to accomplish this task (attendance can be through virtual meetings).
  - The parties will review potential options for a possible follow on phase which could entail joint testing of a national HEP demonstrator utilizing the CHEP TOP and established infrastructure to support provided financial resources are available.

Schedule

- This will proceed according to the following phases and schedule. Note that national priorities may pre-empt the agreed-upon schedule:

Start	X
Task #1 Develop a national HEP TOP	X - 20 Months
Task #2 Reciprocal test observation	X - 32 Months
Task # 3 Develop CHEP TOP	32 - 48 Months

Single Step Approach to Hybrid Electric Propulsion Collaboration Utilizing FED B



Management

- The program managers will be from the U.S. Army Tank Automotive Research and Development Engineering Center and from XXXX.
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Management

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Financial Provisions

- The parties estimate that the cost of executing the scope of work is $24.75M then-year U.S. dollars. The parties estimate that $13.25 then year dollars will be spent by the U.S. DoD and that $11.5M then year dollars will be spent by the Japan MOD. The U.S. dollar will be the reference currency for this Project. Cooperative efforts of the Parties over and above the jointly agreed tasks set forth in the Scope of Work and Sharing of Tasks will be subject to amendment.
- The obligations of each participant are subject to the availability of funds for those purposes.

Estimate of Financial Provisions

Funding Source	FY 11	FY 12	FY 13	FY 14	Total
US Financial Cost PE#		.75M	.25		1.0M
US Non-Financial		12.25M			12.25M
Total US Cost		13M	.25M		13.25M
Japan Financial Cost		7.0M	2.2M	2.3M	11.5M
Japan Non-Financial Cost					
Total Japan Cost		7.0M	2.2M	2.3M	11.5M
Total Project Value		20M	2.45M	2.3M	24.75M

Explanation of Financial Contributions

- U.S. DoD
  - Non-Financial
    - Background information
      - 3M - FEB-B Concept and Analysis
      - 8.75M -FED-B Hardware
      - .5M - National HEP TOP
  - Financial
    - Foreground Information
      - 1M - FED-B Test Support
      - CHEP Development
    - Travel
- Japan MoD
  - Non-Financial Background Information
  - Financial

Security

- The highest level of information to be exchanged is Controlled Unclassified Information.