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# Advanced Vetronics Architecture for a Net-Enabled Combat Environment (ADVANCE) Technology Demonstration Human Factors Engineering (HFE) Definition Project

*Experimental Plan*

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Contract Scientific Authority:
R.H. Chesney
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Contract Report
DRDC Suffield CR 2006-222
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Contract Number: W7714-030816

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## Defence R&D Canada – Suffield

Contract Report

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# ADVANCED VETRONICS ARCHITECTURE FOR A NET-ENABLED COMBAT ENVIRONMENT (ADVANCE)

## Technology Demonstration

## Human Factors Engineering (HFE) Definition Project

# Experimental Plan

**Completed by:**

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A CAE Company

**For:**

**Alain Goudreau**

**DAVPM 8-4-4**

**12 May 2006**

# Executive Summary

Greenley & Associates was contracted to conduct Human Factors Engineering (HFE) definition activities for the ADVANCE Technology Demonstration project, including creation of an Experimental Plan to outline a desired set of experimental Activities. The two key technology areas being explored by ADVANCE are Active Suspension (AS) and Vetronics, including the operator interface with the vehicle.

A key ADVANCE definition document is the Stakeholder Control Document (SCD) (Reference 2), which lists a number of questions from key Stakeholders in the armoured vehicle (and related equipment and personnel) acquisition community. These questions would be expected to form the basis for experimentation requirements as part of ADVANCE. The SCD was rationalized in a separate document under the ADVANCE HFE Definition Project; this rationalization proposed different methods of experimentation.

The Experimental Plan outlines the recommended experimentation according to different Activities and Trials which would be required to answer the Stakeholder questions, including an overview of the tasks required to conduct each Activity. As part of their definition of the ADVANCE project, DND must determine which of the Activities in the Experimental Plan shall be conducted within the scope of ADVANCE. For each Activity, then, Experimental Test Descriptions will be created and detailed planning done to organized and conduct the Activities. This work will be the subject of a follow-on contract within the ADVANCE TD program.

# Table of Contents

# 1 Introduction

## 1.1 Background

Greenley & Associates was contracted to conduct the Human Factors Engineering Definition Project as part of definition activities for the **Advanced Vetronics Architecture for a Net-Enabled Combat Environment (**ADVANCE) Technology Demonstration project. The two key technology areas being explored by ADVANCE are Active Suspension (AS) and Vetronics, including the operator interface with the vehicle. The DND Project Management Office (PMO) compiled a list of key questions from various Stakeholders in the armoured vehicle and related acquisition communities, termed the Stakeholder Control Document (SCD).

Previous HFE Definition Project work rationalized the Stakeholder questions into a more concise and complete SCD, and created a "Knowledge Approach" which outlined the necessary methods of experimentation required to answer the questions (Reference 2).

From the various methods of experimentation, it is necessary to create a set of distinct Activities that can be suitably conducted to answer the questions. This overall approach is shown in Figure 1.

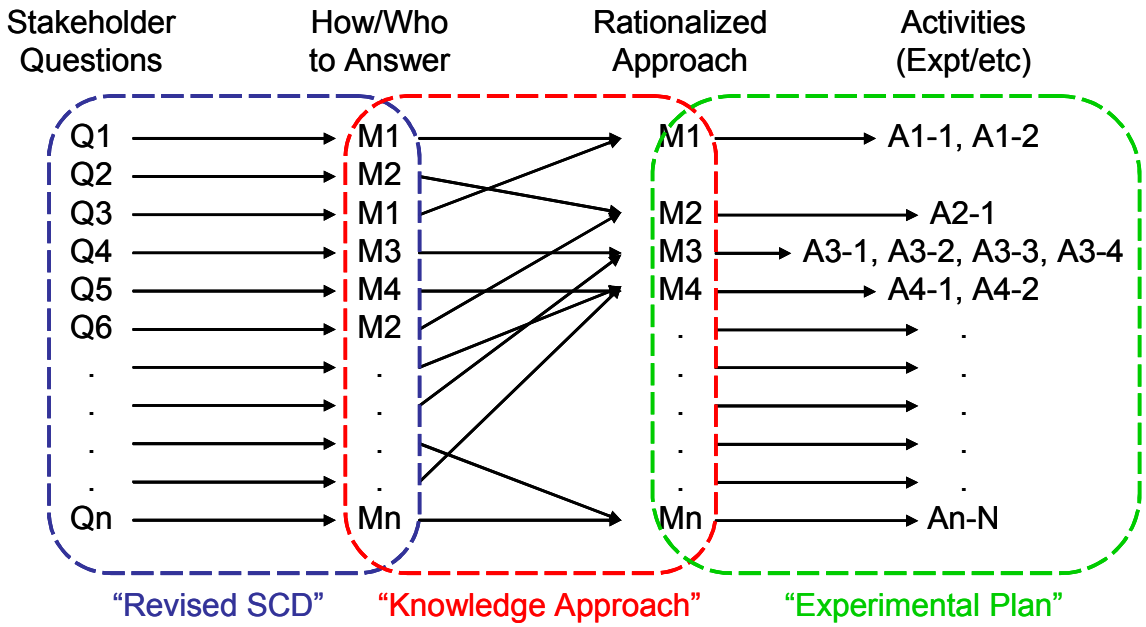



**Figure 1 - Approach to Stakeholder Question Rationalization**

## 1.2 Objective

The objective of this document is to outline an experimental plan for answering the questions raised by Armoured Fighting Vehicle (AFV) Stakeholders in the SCD. The plan outlines the Activities and Trials required and high-level tasks; further development will be required in order to completely plan and conduct the desired experimentation.

## 1.3 This Document

This document is the ADVANCE Experimental Plan, containing an outline of the Activities, Trials, and high-level tasks required to carry out suggested experimentation required to answer questions posed in the Stakeholder Control Document. It will be included as part of the final report in the HFE Definition Project.

## 1.4 References

The following documents are relevant to the Experimental Plan:

1 Armoured Personnel Carrier Replacement Statement of Requirement, 29 February 2000.

2 Stakeholder Control Document Rationalization, Mark Espenant, Greenley & Associates Inc, March 2006.

# 2 Method

## 2.1 General

This Experimental Plan is intended to provide a categorization of the experimental Activities and Trials, and a high-level overview of the tasks that will be required to accomplish them. It outlines methodologies and resource requirements, and relates the Activities to the questions originally posed in the Stakeholder Control Document. The Experimental Plan provides suitable Activities to answer all of the Stakeholder questions; depending on the priorities of the ADVANCE TD, some of the recommended Activities may not proceed. The Experimental Plan is not intended to detail the test procedures, resource requirements, or other parameters of the test descriptions, which will be the subject of future planning.

ADVANCE experimentation concerns demonstration vehicles and technologies. As such, the results of this experimentation will not be directly used for design of future vehicles, as would be the case in the evaluation of prototype vehicles or system integration test beds. Consequently, a lesser standard of rigour may be imposed on validation of the results, and on their statistical significance. On the other hand, however, the results of the ADVANCE TD will have significant influence on future acquisition decisions. The results of this experimentation must satisfy the general expectations of the Technology Demonstration program and, more importantly, the experimentation must be rigorous enough to show the influence of the major demonstration technologies on the characteristics and performance of the vehicle and crew.

To ensure that the results can be reliably used for acquisition decisions, statistical analysis should be used as required to ensure that sufficient repetitions of each Trial are conducted under valid conditions to claim statistical significance. The Experimental Plan includes notes to indicate where statistical analysis may be required.

There is a large previous body of work on evaluation of Armoured Fighting Vehicles. This includes previous Technology Demonstration projects which evaluated advanced vehicle systems in real and virtual (simulated) environments, testing of prototype and production vehicles by the manufacturer, vehicle and soldier evaluations at Test & Evaluation units, and the like. Where possible, the experimentation for ADVANCE should consider these earlier results. There are, however, limitations to the comparison of new and previous experimentation; for such comparison to be valid, all the experimental conditions must be close to identical, and the experimental methodology must be consistent. Therefore, it may not be feasible to correlate the old and new experimental goals, procedure, or conditions. For this reason, most of the Activities in this Experimental Plan require a control vehicle, ie, a standard version which can be evaluated and directly compared to the ADVANCE vehicle.

Where applicable, all testing will conform to ISO, SAE, and/or Mil Std test procedures. Some testing may not have applicable standards, and in other cases the standard may not be appropriate.

## 2.2 Test Vehicles

The ADVANCE project will create three demonstration vehicles, as shown in Figures 2, 3 and 4:

1. LAVIII with Active Suspension, with some elements of the Vetronics system including a power management capability and driver crew station;
2. LAVII (Coyote) with a Vetronics system including a new gunner and commander crew station, Ethernet and Can Bus networks, Operational Data Base with link via radio, and power management; and

3. Heavy Logistics Vehicle Wheeled (HLVW) with a Vetronics logistics system, including vehicle system monitoring, vehicle tracking and attitude measurement, and cargo management system.

The three ADVANCE vehicles are surrogates for a significant number of current and potential future Canadian Forces vehicles – this includes the LAVIII, Coyote and Coyote Life Extension, Mobile Gun System, LAV Tow Under Armour, and Multi-Mission Effects Vehicle. As a result, in each Trial the Experimental Plan must consider the potential characteristics and tactical employment of each of these vehicles. In addition, since there are three different vehicles, the plan must include the provision of the appropriate control vehicle for comparison.

Although the ADVANCE project intends to create the HLVW vehicle with Vetronics, none of the stakeholder questions concerned such a vehicle, and the capabilities and functionality of the Vetronics system are unknown at this point. Annex A shows the HLVW against trials that may be relevant; however, the real requirements for experimentation have not been analyzed in this document. This would need to be the subject of further analysis based on stakeholder knowledge requirement to be determined.

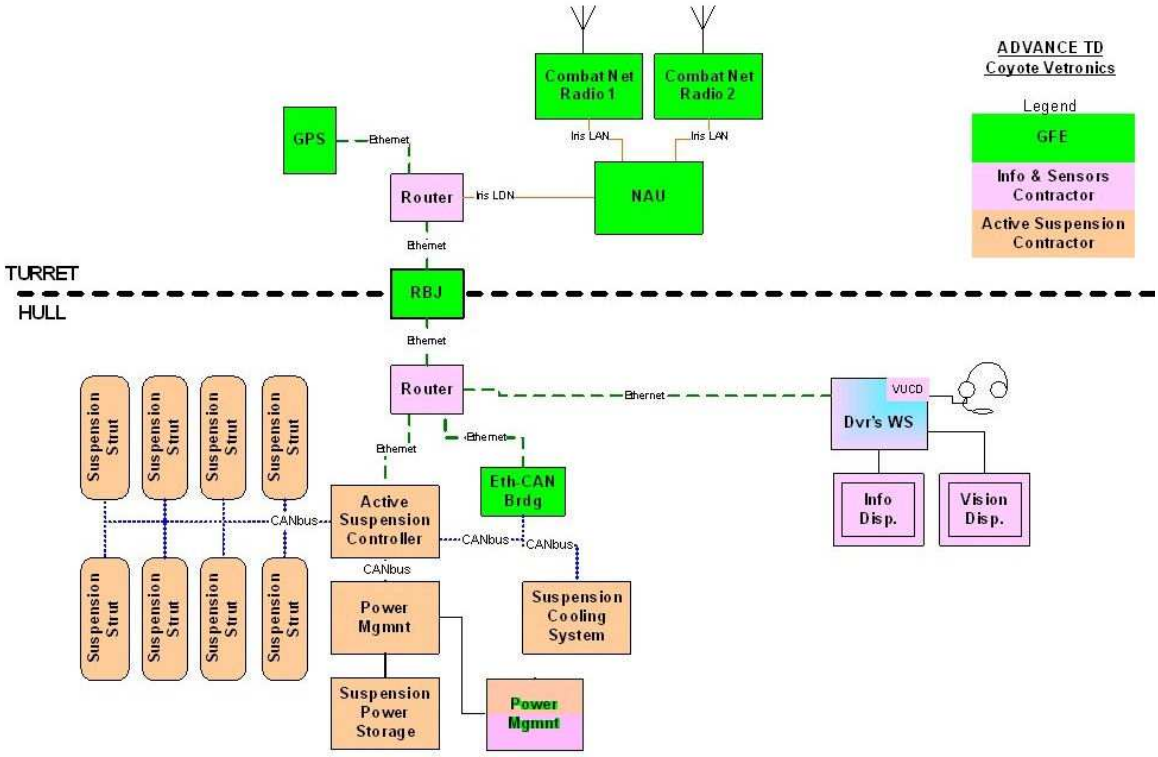



**Figure 2 - LAV III Active Suspension Architecture**

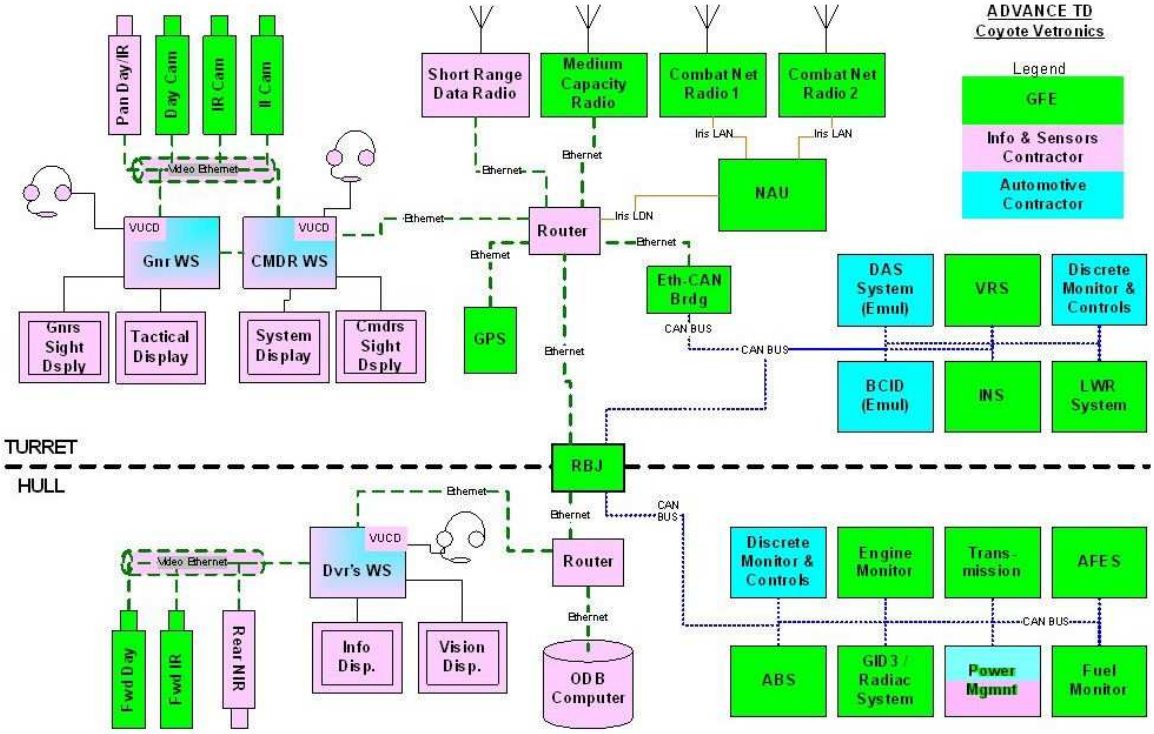



**Figure 3 - LAV II (Coyote) Vetronics Architecture**

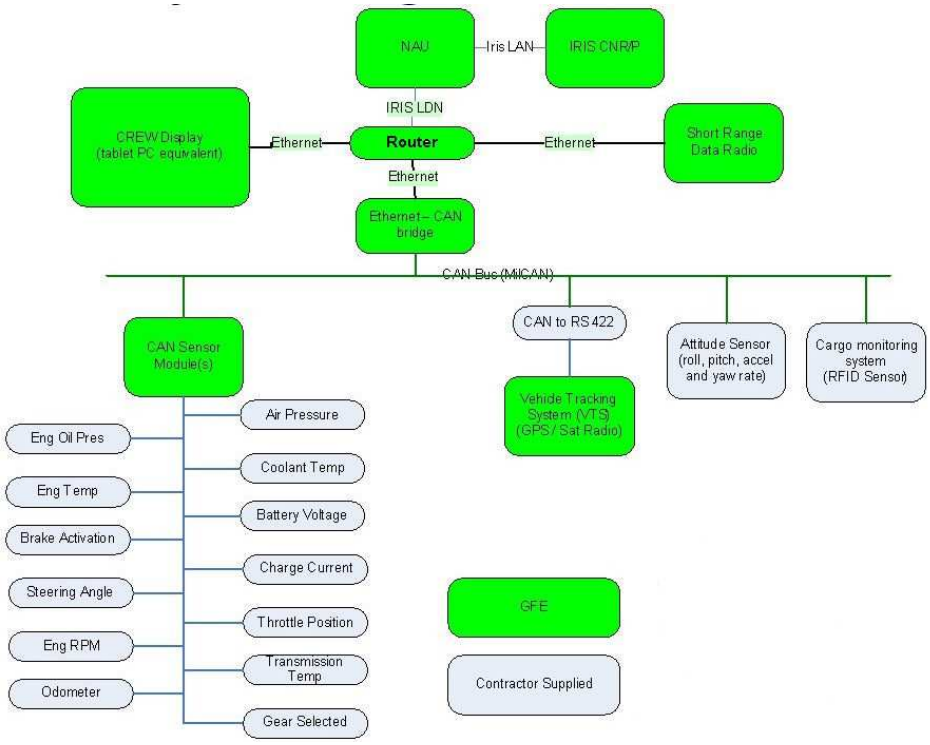



**Figure 4 - HLVW Vetronics Architecture**

## 2.3 Experimental Activities

The Knowledge Approach document previously mentioned (part of Reference 2) listed the following methods of answering the Stakeholder questions ("Mn" in Figure 1). More information about each Method can be found in the SCD Rationalization report:

- **TM** – Technical Measurement. Measurement of vehicle or system parameters or performance, without the requirement to consider operator performance;
- **Analysis** – Using known information from the vehicle to analyze a predicted response to a question;
- **DQ** – Design Question posed to technical contractors, not supported by experimentation or testing;
- **MFTA** – Mission Function Task Analysis, involving decomposition of vehicle missions into individual tasks, and suggesting an allocation of the tasks among the vehicle systems or human crew;
- **HE** – Human Experimentation. Conducting experiments involving the interaction of crews with the vehicle systems, or considering their role in the performance of the system;
- **FT** – Field Trial. Experimentation that must include a "field" component of the evaluation in semi-realistic combat operations;
- **CS** – Constructive Simulation/Modelling, using computer models of the vehicle, systems, or components to predict performance;
- **TD** – Other TD project. Many of the questions in the SCD relate directly to work that has been done in previous TD projects, such as the Future Armoured Vehicle Systems (FAVS), Advanced Land Fire Control System (ALFCS), and Advanced Linked Enhanced Reconnaissance and Targeting (ALERT) projects.

For the Experimental Plan, it was necessary to create sets of Activities and included Trials to perform the necessary evaluations. The Experimental Plan is directly applicable to the methods of Technical Measurement, Human Experimentation, and Field Trial, while it also provides information that would answer some of the questions under Direct Question, MFTA, and Constructive Modelling.

There is an additional method of experimentation included in this plan: Virtual Simulation. It is recognized that the ADVANCE project is limited by funding in the amount of development that it can do, and that the inclusion of both Active Suspension and Vetronics in the project makes it extremely ambitious; for this reason, it is understood that virtual experimentation is very unlikely. However, there are very good reasons for conducting experimentation in a virtual environment, as follows, so Virtual Simulation is included as a potential experimental Activity for completeness:

- Technologies that may not have been included in the ADVANCE real vehicles for lack of funding or time, or because the technology may not be sufficiently mature for inclusion, may be simulated and evaluated. This includes the ability to optimize the operator interface and resulting functionalities;
- Trials in a virtual environment can occur on any kind of terrain or in any weather with absolute ability to be consistent and to replicate the trial conditions; and

- It is easier to emphasize and concentrate on crew performance evaluation, without the requirement for management of field trials, technical issues with demonstration-quality technologies, etc.

The highest level Activities were segregated by type of Activity and by the type of terrain or course required to do the Activity. The following paragraphs briefly outline the rationale for each Activity, the type of Trials to be conducted, and the requirement for terrain or resources.

### 2.3.1 Static Technical Characteristics

2.3.1.1 Evaluation Requirements: Measure vehicle technical characteristics which do not require either vehicle movement or involvement of the crew. This includes such things as vehicle physical characteristics, capabilities of the suspension, and technical characteristics of vehicle systems (including the operator-machine interface).

2.3.1.2 Vehicles: A combination of the LAVIII and LAVII and suitable control vehicles will be required.

2.3.1.3 Terrain: This Activity can be conducted on any flat hard-standing area.

2.3.1.4 Equipment/Devices: Will require measurement equipment and specialized measuring devices, including a tilt-table.

2.3.1.5 Personnel: No crew are required except to move the vehicle to the Activity and between locations.

2.3.1.6 Human Factors (HF): Will require a user group to determine operational parameters for some of the systems.

### 2.3.2 Short Course

2.3.2.1 Evaluation Requirements: Answer questions concerning vehicle systems performance under motion, where limited duration and very repeatable Trials are required. Trials are included for measuring vehicle speed, acceleration, and braking, measurement of the effect of Active Suspension on stabilization and absorbed power, and vehicle signature measurement.

2.3.2.2 Vehicles: Since all questions concern the effect of Active Suspension on vehicle performance, only the LAVIII (and suitable control vehicle) will be required.

2.3.2.3 Terrain: Three courses are required: pavement and two cross-country courses, with "extreme" and "moderate" roughness. The courses will be a straight line over at least 1 km.

2.3.2.4 Equipment/Devices: Will require measurement equipment and specialized measuring devices, and video equipment to record through-sight imagery.

2.3.2.5 Personnel: Crews will be required to drive the vehicle on the course accurately exactly as instructed by the test conductor to maximize repeatability between Trials and vehicles. Some of the Trials require a gunner to measure the effect of Active Suspension on tracking performance.

2.3.2.6 Human Factors: Crew questionnaires will be conducted to evaluate comfort and ease of task performance.

### 2.3.3 Slope Course

2.3.3.1 Evaluation Requirements: Measure the ability of Active Suspension to improve the vehicle's ability on side and forward slopes. Trials are included for static and moving

slope capability considering Active Suspension levelling, including determination of a "best" mode of operation for the Active Suspension.

2.3.3.2 Vehicles: Since all questions concern the effect of Active Suspension on vehicle performance, only the LAVIII (and suitable control vehicle) will be required.

2.3.3.3 Terrain: Slopes of different steepness are required, which can be used in side and forward modes; large areas of constant slope would be preferred to allow repetition of tests given soil destruction by the vehicle.

2.3.3.4 Equipment/Devices: Will require equipment to measure slope. Ideally, the vehicle would be tested on a tilt table first to establish roll-over slope; however, in any case, safety equipment will be required to ensure no roll-over during the Trial.

2.3.3.5 Personnel: Crews will be required to drive the vehicle on the course accurately and smoothly as instructed by the test conductor to maximize repeatability between Trials and vehicles, and to maximize safety of the Trial.

2.3.3.6 Human Factors: Crew questionnaires or interviews will be conducted to gather subjective opinion of the vehicle characteristics during the Trial.

### 2.3.4 Manoeuvring Course

2.3.4.1 Evaluation Requirements: Measure vehicle automotive performance in non-linear motion, ie, manoeuvring; including Trials to measure steady-state and transitory turning, and to establish the most optimum mode of Active Suspension for manoeuvring.

2.3.4.2 Vehicles: Since all questions concern the effect of Active Suspension on vehicle performance, only the LAVIII (and suitable control vehicle) will be required.

2.3.4.3 Terrain: For the steady state Trials, a large hard-surfaced "skid pad" area is required. For the slalom Trials, a cross-country terrain equivalent to the "moderate" level of the short course will be required as well.

2.3.4.4 Equipment/Devices: Will require measurement equipment and specialized measuring devices.

2.3.4.5 Personnel: Crews will be required to drive the vehicle on the course accurately exactly as instructed by the test conductor to maximize repeatability between Trials and vehicles.

2.3.4.6 Human Factors: Crew questionnaires or interviews will be conducted to gather subjective opinion of vehicle characteristics during the Trial.

### 2.3.5 Obstacle Course

2.3.5.1 Evaluation Requirements: Determine the limits of vehicle capabilities on individual obstacles, including gaps and steps, and test the ability of the Active Suspension to enable novel mobility capabilities.

2.3.5.2 Vehicles: Since all questions concern the effect of Active Suspension on vehicle performance, only the LAVIII (and suitable control vehicle) will be required.

2.3.5.3 Terrain: All Trials may be done on a small terrain area; however, individual obstacles must be constructed or available that can be varied until the limits of performance are reached, and must be strong enough to handle the weight of the vehicle. Obstacles constructed for the purpose at a test facility would be preferable.

2.3.5.4 Equipment/Devices: Will require only a measuring tape and recording equipment.

2.3.5.5 Personnel: Crews will be required to drive the vehicle on the course accurately exactly as instructed by the test conductor. They will be required to contribute to suggesting ways to increase the capability of the vehicle by use of the Active Suspension system.

2.3.5.6 Human Factors: Discussions will be conducted with the crews to elicit suggestions on improving the vehicle performance with Active Suspension.

**2.3.6 Duty Cycle**

2.3.6.1 Evaluation Requirements: Measure and evaluate vehicle and crew performance parameters which require realistic vehicle motion, semi-realistic tactical scenarios, and a realistic representation of vehicle duty over a longer-distance course. Trials will include confirmation of vehicle vibration improvement, fuel and power consumption, crew and system performance evaluation, and determination of optimum Active Suspension modes for various tactical tasks.

2.3.6.2 Vehicles: Depending on the exact parameters to be included in the Trials, both the LAVII and LAVIII vehicles will likely be required. In some of the Trials a control vehicle will be required.

2.3.6.3 Terrain: The duty cycle from the LAV SOR is shown in Figure 5. A user group will be held to modify this duty cycle as desired for the Trials.

2.3.6.4 Equipment/Devices: Will require measurement equipment and specialized measuring devices.

2.3.6.5 Personnel: In some of the Trials, crews will be required to drive the vehicle on the course accurately exactly as told by the test conductor to maximize repeatability between Trials and vehicles. In other Trials, the crews themselves will be the subjects of the experiment, measuring their performance in using the vehicle systems and equipment.

2.3.6.6 Human Factors: Extensive HF involvement in this series of Trials, including conduct of user groups, measurement of crew performance and comparison to standard vehicle or methodologies, control of tactical scenarios, and administration of questionnaires and interviews. A user group will be conducted to identify and refine human tasks and consider optimum Active Suspension modes, and questionnaires and/or interviews will be conducted on system usefulness and usability and subjective impressions.

| Distance (km) | Conditions | Speed (kph) |
|---|---|---|
| 100 | Primary or secondary roads | Average 80 |
| 60 | Primary or secondary roads | Average 50 |
| 90 | Trails or unimproved roads | Average 50 |
| 60 | Medium (or gently rolling) cross-country | Average 50 |
| 4 | Medium (or gently rolling) cross-country in reverse | Average 10 |
| 10 | Medium (or gently rolling) cross-country, best possible speed | Minimum 50 |
| 2 | Medium (or gently rolling) cross-country | Maximum 5 |
| 10 | Marginal (severe) cross-country | Best possible |
| | Shallow ford three times | |
| | Ascend and descend 60% grade for 20 m five times | |
| | Stop, shut down for 30 min, start on 60% grade | |
| | Operation of vision devices and stabilization system for entire cycle | |
| | Engine operation for 20 hours/day | |

**Figure 5 - Duty Cycle from LAVIII SOR**

### 2.3.7 Virtual Simulation

2.3.7.1 Evaluation Requirements: Virtual experimentation will allow the evaluation of technologies that are not included in the real ADVANCE vehicle, or of capabilities that are not fully fleshed out. It will also allow the inclusion of trial conditions that may not be possible in the real environments, as well as completely replicable trials.

2.3.7.2 Vehicles: Real vehicles will not be required; however, the planning of the virtual experimentation must include trials comparable to those using real vehicles in order to validate the virtual environment results.

2.3.7.3 Terrain: Any terrain can be created, and should match as much as possible the real terrain, so as to make the results comparable to and able to be validated against the real vehicle experimentation.

2.3.7.4 Equipment/Devices: The primary requirement is for a suitable virtual environment. Given the limitations of the ADVANCE project, this will be an already-created simulation environment that must be modified as required to represent the vehicle characteristic and equipment and OMI desired for ADVANCE.

2.3.7.5 Personnel: Crews will be required to conduct all activities

2.3.7.6 Human Factors: Crew questionnaires will be conducted to evaluate comfort and task performance ease.

### 2.3.8 Constructive Simulation

2.3.8.1 Evaluation Requirements: Constructive simulation is effective at expanding the influence of technology performance on vehicle capabilities to higher organizational levels; the real or virtual experimentation at the vehicle level may show an increase in performance, and constructive simulation allows evaluation of the effects of this

performance increase on a complete unit equipped with such vehicles. Constructive simulation is also used to conduct parametric analysis of system parameters at the vehicle level. There are different types of constructive simulation, including operational research wargames, in which large numbers of entities with specified capabilities interact with each other and simulated other forces, and task network modelling, in which models of all aspects of the vehicle and its systems are created, with the ability to rapidly conduct "what if" analysis of the effects of performance parameter changes.

2.3.8.2 Vehicles: Simulated vehicles with similar performance characteristics to the real (and virtual) vehicle Trials will be required.

2.3.8.3 Terrain: Any terrain can be included, primarily for its effect on the mobility of the simulated vehicles.

2.3.8.4 Equipment/Devices: Suitable constructive simulation environments will be required. It is anticipated that both a large-scale wargame and a task network model simulation will be required to evaluate the impact of all aspects of the ADVANCE technologies.

2.3.8.5 Personnel: Crews will not be required. There may be the requirement for information from a user group; however, this information would most likely be amassed from other user groups listed above and from the results of the real vehicle Trials.

2.3.8.6 Human Factors: Creating a task network model would be an HF activity, and HF input will be required to ensure that the scenarios and task requirements for the constructive models are consistent with the real and virtual work.

## 2.4 Experimental Trials

Annex A lists the experimental Activities defined above, and defines Trials that must be conducted to completely answer the Stakeholder questions. The Annex is arranged in the following columns:

### 2.4.1 Serial, Activity, Description, and Trial

Each Trial is given a serial number for future reference. The Activity and Description columns are self-explanatory, and the Trial column lists the overall parameter to be evaluated in each Trial.

### 2.4.2 Experimental Parameters

This column lists the detailed experimental parameters which must be evaluated during the Trial. The remainder of the Experimental Plan must outline how to define the parameters for experimentation, the methodology for measuring or evaluating the parameter, and the overall resource and other requirements.

There is some overlap between the Activities; for example, absorbed power is measured in both the Short Course and Duty Cycle Activities. In the Short Course, the power will be quantitatively compared between different types of terrain and between versions of the vehicle. In the Duty Cycle Activity, the emphasis is on the effect of the vibration level (ie measured absorbed power) on crew and system performance, and the results of the Short Course evaluation will be combined with those of the Duty Cycle to give a comparison matrix of terrain vs speed vs absorbed power vs performance.

### 2.4.3 Statistical Analysis Requirements

To ensure that the results of this experimentation are valid to be used for making decisions concerning future acquisition programs, statistical analysis should be used as required. This column indicates the requirements to ensure valid results.

### 2.4.4 Resource Requirements

Each Trial will require different resources in terms of personnel, equipment, and measuring devices. An overview of the resource requirements is shown in Section 2.3; this column in the table lists resource requirements in greater detail. This part of the Experimental Plan will require the most additional detail in future planning, ie, in creation of the Test Descriptions as outlined in Section 3.3.

### 2.4.5 Vehicles Required

This column lists the real vehicle requirements to conduct the relevant Trial.

### 2.4.6 References

Each Trial fulfils the requirement to answer one or more of the questions raised in the Stakeholder Control document. Annex B of the SCD listed the methods of answering these questions; this column refers back to the SCD such that each Trial in the Experimental Plan can be traced back to the original Stakeholder question. This column also contains references on experimental technique or standards that should be considered.

# 3 Way Ahead

## 3.1 Next Steps

The Experimental Plan is intended to outline the experimentation required to answer the Stakeholder questions, but not provide sufficient detailed information for its execution. The PMO is in the process of defining what will and what will not be in the scope of ADVANCE; this consideration includes many operator interface and vehicle capabilities systems that would significantly influence experimental requirements. The Experimental Plan lists all suggested experimentation; clearly, depending on the outcome of this scope discussion, some of the experimentation may be deemed to not be required. The PMO must soon present to the Senior Review Board a plan for all development and evaluation in the ADVANCE project – this will include the scope of the experimentation, which will allow further experimental planning to take place.

## 3.2 Schedule

Annex B contains a draft overview schedule for the preparation and conduct of experimentation. There are many unanswered questions (see Section 3.3) which must be finalized before this schedule can be formalized into a complete set of detailed tasks and resource requirements to conduct the necessary Activities and Trials. The durations shown for the tasks in the schedule are meant only as place-holders, pending more precise definition; however, the tasks and their sequence form a good first review of the likely events. As part of the Human Systems Integration Program Plan to be prepared later in this project, the experimentation schedule will be integrated with the project implementation schedule to the extent possible given the aforementioned lack of information.

## 3.3 Key Questions

The following questions must be answered to completely plan experimentation for the ADVANCE project:

- What systems will be included in the ADVANCE vehicles, including new or improved capabilities and operator interface? This directly affects the experimental parameters that must be considered.
- What are the most important criteria for evaluation? Is the project most concerned with crew performance, technical performance, vehicle mobility, weapon performance, etc?
- What is the overall budget for experimentation? This will affect the length of time that contractors can be employed to plan and conduct experiments, that facilities or equipment can be rented, etc.
- Who will conduct the experimentation, and how will the team be organized? This is further addressed in Section 3.4.
- When are experimental results required? This will affect both the degree of experimentation that can be conducted, and the sequencing thereof, particularly if considering virtual or constructive Trials.
- What support can the team expect from military crews? This will directly affect the ability to do some of the Trials.

## 3.4 Experimentation Team

The Experimental Plan was completed under a contract to provide "HFE Definition", including an overall HFE/HSI Plan under separate cover. The experimentation requirements that

result from the Stakeholder questions as outlined in this plan include experiments that involve crew performance, those that involve the crew conducting vehicle performance measurements, and others that involve technical measurements of vehicle systems. When determining how to conduct the experimentation, and the requirement for a team and overall experimental leader, it should be considered that the needs of the crews must be foremost, and that all measurements of vehicle technical or system performance have at their root the needs of the crew. Accordingly, it is recommended that a suitably-qualified Human Factors Engineering company with experience in armoured vehicle tactical, technological, and Human Factors experimentation be engaged to plan and conduct the entirety of the experimental program for ADVANCE.

## 3.5 Test Descriptions

The most important follow-on document for planning the eventual ADVANCE experimentation will be a set of Test Descriptions, covering each of the Trials outlined in the Experimental Plan. The test descriptions will contain the following information:

- Prerequisite Conditions. What conditions of the crews, vehicle, test sites, etc must be satisfied prior to conducting the test, eg, configuration of the vehicle, preparation of the test course, training of the crews, etc. This part of the test descriptions may be further subdivided as required;
- Test Inputs. Describes knowledge or specific resources that must be in place to conduct the test.
- Assumptions and Constraints. Places bounds on the conduct of the test and on the requirements for results to ensure good data.
- Test Procedures. Step-by-step procedures for conducting the test.
- Measures, Expected Results, and Evaluation Criteria. The set of criteria by which the results will be judged, and the specific measurements that must be taken.

## 3.6 HLVW Experimentation

Part of the ADVANCE TD will be a Heavy Logistics Vehicle Wheeled (HLVW) that incorporates a Vetronics system specifically oriented to logistics management. Non of the stakeholder questions relate to this vehicle, and since the specific capabilities and systems of its Vetronics system are unknown at this point, this document does not include any experimentation requirements. This will need to be addressed in later work.

# 4 Summary

This document is an interim deliverable to the ADVANCE HFE Definition Project. It considers the list of Stakeholder questions and the proposed methods of evaluation, and creates a high-level plan for the conduct of the necessary experimentation to answer all Stakeholder questions. This document will be included in the final report for the HFE Definition Project.

**Annex A to**

**ADVANCE Experimental Plan**

**12 May 2006**

| Serial | Activity | Description | Trial | Experimental Parameters | Statistical Analysis Requirements | Resource Requirements (Terrain/Crew/Eqpt/Time) | Vehicle(s) Required | SCD Reference |
|---|---|---|---|---|---|---|---|---|
| **1-1** | **Static Technical Characteristics** | Measurement of technical parameters of vehicle or installed equipment relevant to the ADVANCE TD | Weight | • Weight of vehicle<br>• Height and longitudinal location of CG<br>• Variation of CG location with different loading conditions and vehicle configurations | • Nil | • Conduct user group to confirm number of crew in vehicle, select loading for experiment. Include possible variations in vehicle configuration and vehicle type<br>• Acquire equipment including personal, weapons, ammo, (simulated where necessary) etc.<br>• Require scales to accept 8 wheel stations, crane or hoist to hang vehicle to measure vertical CG location.<br>• Personnel required for loading, no crew.<br>• Testing time for experiment = 2 days | • LAV IIIAS | • TM-8<br>• HE-10<br>• DQ-3<br>• LAVIII manual |
| **1-2** | | | Interior Space | • Internal volume change<br>• Usability of available volume | • Nil | • Determine methodology for internal volume measurement – ultrasonic, manual, CAD, etc.<br>• Measure or calculate actual available volume, compare with standard vehicle.<br>• Assess if any of the internal volume is practically unusable, including anthropometric | • LAV IIIAS<br>• Coyote Vetronics<br>• Control vehicles | • TM-9 |

| Serial | Activity | Description | Trial | Experimental Parameters | Statistical Analysis Requirements | Resource Requirements (Terrain/Crew/Eqpt/Time) | Vehicle(s) Required | SCD Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | | | assessment.<br>• No crew required.<br>• Testing time = 1/2 day | | |
| **1-3** | | | Suspension characteristics | • Min/max suspension height<br>• Time to change height up/down<br>• Range of auto-level angles laterally and longitudinally<br>• Time to auto-level – max Left to max Right<br>• Compensation for unbalanced loading<br>• Confirm that individual wheel stations can be raised.<br>• Duration that suspension settings are maintained without power (Dependant on height or weight?)<br>• Power draw of the suspension system<br>• Entry/departure angles | • Nil | • Can conduct leveling trials largely on flat ground, then confirm "auto-level" on sloped terrain. Ideally, all trials could be done on a tilt-table.<br>• Require ballast, human or otherwise, for unbalanced loading<br>• Maintenance of setting may not require experimentation if suspension "locks" in location without power draw.<br>• Measure peak and instantaneous power consumption while carrying out tests.<br>• Directly measure entry/departure at different suspension heights.<br>• No crew required.<br>• Testing time = 1 day | • LAV III AS | • TM-10<br>• TM-11<br>• TM-5 |
| **1-4** | | | Power requirements | • Silent watch time with various systems operating, including AS on/off, power management system on/off, etc. | • Nil | • Conduct user group to determine appropriate operating systems for different conditions, and duty cycle for equipment (turret traverse, etc) that is operated sporadically, including emergency conditions. | • LAV IIIAS<br>• Coyote Vetronics<br>• HLVW<br>• Control vehicles | • TM-11<br>• MFTA-4<br>• DQ-4 |

| Serial | Activity | Description | Trial | Experimental Parameters | Statistical Analysis Requirements | Resource Requirements (Terrain/Crew/Eqpt/Time) | Vehicle(s) Required | SCD Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | | | • Determine technical limitations of power storage (batteries) – level to which to draw to for experiment.<br>• Measure current draw and battery voltage over time until limit reached.<br>• No crew required.<br>• Testing time = depends on length of capability (3 days?). | | |
| **1-5** | | | System performance | • Time to boot systems - shortcuts to improve?<br>• Accuracy<br>• Speed<br>• Reliability<br>• Latency<br>• Throughput/bandwidth | • Possible requirement to determine minimum repetitions | • Also see 6-8 for testing on moving vehicle.<br>• Determine list of equipment and systems to be installed in ADVANCE vehicle.<br>• For each system/item, determine desired performance characteristics, and determine method to evaluate.<br>• Measure boot time of all installed systems.<br>• No crew required.<br>• Testing time = depends on installed systems and test parameters | • LAVIIIAS<br>• Coyote Vetronics<br>• HLVW | • TM-12<br>• TM-13<br>• TM-15 thru TM-18<br>• DQ-5 |
| **1-6** | | | OMI Technical Performance | • Objective evaluation of technical characteristics of new devices (volume, noise reduction, etc – as opposed to | • Nil | • Identify new devices that will be on ADVANCE vehicle.<br>• For each device, determine important technical characteristics | • Coyote Vetronics<br>• HLVW | • TM-17<br>• HE-8 |

| Serial | Activity | Description | Trial | Experimental Parameters | Statistical Analysis Requirements | Resource Requirements (Terrain/Crew/Eqpt/Time) | Vehicle(s) Required | SCD Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | human-based evaluation). Specific parameters to be defined. | | for human performance.<br>• No crew required.<br>• Testing time = depends on range of devices and parameters for test. | | |
| **2-1** | **Short Course** | Set courses on pavement and two levels of cross country to evaluate effect of AS and determine the optimum AS modes. | Speed | • Max speed based on limiting factor(s):<br>o Crew ride and driver control (subjective)<br>o Absorbed power or SAE acceleration limits | • Crew rotation<br>• Minimum repetitions | • Instrument vehicle to measure 6 DoF acceleration.<br>• Determine applicable SAE limits.<br>• Do runs with increasing speed, measure accelerations, calculate absorbed power. Stop when crew limit reached.<br>• Use crew questionnaires for comfort and task completion ratings and task performance measurement<br>• Compare SAE limits to observed ratings vs absorbed power.<br>• Full crew required.<br>• Testing time = 4 days | • LAVIIIAS<br>• Control vehicle | • TM-3 |
| **2-2** | | | Absorbed Power | • Peak/integrated over specific duration at same speed | • Nil | | • LAVIII<br>• Control Vehicle | • TM-4 |
| **2-3** | | | Acceleration | • Straight-line acceleration over fixed distance | • Nil | • Measure elapsed time over fixed distance.<br>• Use accelerometers to measure time/distance curve.<br>• Driver/CC required.<br>• Testing time = 1 day | • LAVIII<br>• Control Vehicle | • TM-3 |
| **2-4** | | | Weapon/sight stabilization | • Ability to maintain sight on target (subjective)<br>• Objective stability | • Crew rotation<br>• Minimum repetitions | • Using available sighting system set tracking task on target parallel to course. | • LAVIII<br>• Control Vehicle | • TM-4 |

| Serial | Activity | Description | Trial | Experimental Parameters | Statistical Analysis Requirements | Resource Requirements (Terrain/Crew/Eqpt/Time) | Vehicle(s) Required | SCD Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | | | • Do at increasing speeds.<br>• Either instrument sight head with 6 DoF accelerometers or mathematically extend from hull.<br>• Do video capture of sight imagery for post-hoc analysis.<br>• Use crew questionnaires to capture subjective ease of tracking.<br>• Full crew required.<br>• Testing time = 3 days | | |
| **2-5** | | | Braking | • Stopping distance<br>• Optimum AS mode<br>• Degree of dive – effect on crew<br>• Oscillations or other negative effects | • Nil | • Measure stopping distance from increasing speeds.<br>• If different AS modes, vary – anti-dive, etc. Anti-lock on/off?<br>• Driver/CC required.<br>• Testing time = 1 day | • LAVIII<br>• Control Vehicle | • TM-6 |
| **2-6** | | | Signatures | • Acoustic signature<br>• IR signature during and after movement<br>• EMI | • Nil | • Select and obtain sensors – IR camera, sound pressure level, others depending on requirements.<br>• Determine operating conditions for test – different speeds, silent watch, cross-country vs roads.<br>• Determine suitable background.<br>• Assess subjective differences in IR signature – ability to recognize.<br>• Driver/CC required.<br>• Testing time = 2 days | • LAVIII<br>• Control Vehicle | • TM-7<br>• DQ-4 |

| Serial | Activity | Description | Trial | Experimental Parameters | Statistical Analysis Requirements | Resource Requirements (Terrain/Crew/Eqpt/Time) | Vehicle(s) Required | SCD Reference |
|---|---|---|---|---|---|---|---|---|
| **3-1** | **Slope Course** | Measure automotive performance on slopes of different terrain, to evaluate effect of AS and determine the optimum AS modes. | Side-slope | • Max static slope<br>• Performance on side slope<br>• Effect of AS leveling | • Minimum repetitions | • If available (see 1-3 as well), use tilt table to establish maximum static slope.<br>• Locate suitable slope at approximately 75% of max slope<br>• Determine evaluation parameters (degree of understeer, side/rotational slippage, speed?), assess AS on/off/modes.<br>• Test ability of vehicle to traverse straight, sideways, 45 degree lines up/down.<br>• Driver/CC required.<br>• Testing time = 3 days (requirement for significant safety measures) | • LAVIII<br>• Control Vehicle | • TM-2<br>• FT-1 |
| **3-2** | | | Forward slope | • Max slope for start<br>• Optimum AS mode on steep hills<br>• Best sustained speed on long grade | • Minimum repetitions | • Require series of steep hills (LETE?), and/or quite steep dirt hill, plus longish constant grade (public roads).<br>• Measure max speed in various modes on long hill.<br>• Test starting ability on hills of increasing steepness if available – if not, measure degree of wheel slip.<br>• Driver/CC required.<br>• Testing time included in 3-1 | • LAVIII<br>• Control Vehicle | • TM-2<br>• FT-1 |
| **4-1** | **Maneuvering** | Measure | Turn radius | • Minimum-speed turning radius | • Nil | • Require large “skid pad” area of | • LAVIII | • TM-5 |

| Serial | Activity | Description | Trial | Experimental Parameters | Statistical Analysis Requirements | Resource Requirements (Terrain/Crew/Eqpt/Time) | Vehicle(s) Required | SCD Reference |
|---|---|---|---|---|---|---|---|---|
| | **Course** | automotive and obstacle performance on | and acceleration | • Lateral acceleration<br>• Effect of "leaning" vehicle in turn | | asphalt/cement, with circle painted of appropriate diameter.<br>• Drive vehicle around circle as fast as possible in dry and wet, with AS setting several angles of vehicle roll.<br>• Record subjective impressions from vehicle drivers/CC.<br>• Record minimum turning radius at very slow speed.<br>• Driver/CC required.<br>• Testing time = 1 day | • Control Vehicle | |
| **4-2** | | | Slalom course | • Speed of maneuvering through course<br>• Effect of suspension height/leveling<br>• Degree of body roll<br>• Operator comfort and confidence ratings<br>• Optimum AS modes | • Crew rotation<br>• Minimum repetitions | • Prepare slalom course using cones on different terrain types.<br>• Measure time to complete course, using different AS modes (anti-lean, lean into turn, ?)<br>• Measure roll, etc using accelerometers.<br>• Use questionnaire to assess subjective impressions of security, handling, comfort and confidence.<br>• Driver/CC required.<br>• Testing time = 1 day | • LAVIII<br>• Control Vehicle | • TM-6 |
| **5-1** | **Obstacle Course** | | Gap crossing | • Max gap | • Nil | • Would best be done at a facility created for this purpose such as the old LETE; the ability to vary the step height and gap would otherwise be difficult considering | • LAVIII<br>• Control Vehicle | • TM-5 |
| **5-2** | | | Step climb | • Max height of step | • Nil | | • LAVIII<br>• Control | • TM-5 |

| Serial | Activity | Description | Trial | Experimental Parameters | Statistical Analysis Requirements | Resource Requirements (Terrain/Crew/Eqpt/Time) | Vehicle(s) Required | SCD Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | | | the vehicle weight.<br>• Determine measured max capabilities in previous vehicle testing and start with that<br>• Use “commanding” of suspension at different stations<br>• Driver/CC required.<br>• Testing time = 1 day | Vehicle | |
| **5-4** | | | Tip-toeing | • Ability to avoid specific spot on the terrain | • Nil | • Mark location on the ground; try to run vehicle over the spot without touching a wheel.<br>• Assess manually or (if available) automatically.<br>• Driver/CC required.<br>• Testing time = 2 hours | • LAVIII<br>• Control Vehicle | • TM-5 |
| **6-1** | **Duty Cycle** | Vehicle runs multiple laps of a duty cycle typical of real operation, to evaluate effect of AS. | Fuel Economy | • Mileage on different terrain/integrated over duty cycle<br>• Power draw of suspension system | • Nil based on extended duty cycle | • Define duty cycle and test terrain.<br>• Define required runs for statistical significance.<br>• Run vehicle through duty cycle with and without AS.<br>• Use measured amount of fuel or amount to fill tank.<br>• Measure peak/instantaneous power draw during runs.<br>• Driver/CC required.<br>• Testing time = 1 week (including all other “duty cycle” tests. | • LAVIII<br>• Control Vehicle | • TM-1<br>• DQ-4 |
| **6-2** | | | Vibration | • Absorbed power - peak/integrated over duty cycle | • Crew rotation<br>• Minimum | • See 2-2, use same procedure.<br>• Correlate human tasks on | • LAVIII<br>• Control | • TM-4<br>• HE-9 |

| Serial | Activity | Description | Trial | Experimental Parameters | Statistical Analysis Requirements | Resource Requirements (Terrain/Crew/Eqpt/Time) | Vehicle(s) Required | SCD Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | • Subjective effects of vibration on crew at different absorbed power levels and in different terrain types and speeds (ie, does “absorbed power” correlate to crew comfort.<br>• Crew task performance measures | repetitions | installed equipment (will depend on equipment, see 1-5) with runs at different speeds/absorbed power.<br>• Relate to SAE standards.<br>• Full crew required.<br>• Testing time included in 6-1. | Vehicle | |
| **6-3** | | | Navigation system performance | • Reported vehicle location from navigation system<br>• Refresh rate<br>• Requirement for crew information | • Nil | • Compare navigation system accuracy to hand-held GPS.<br>• Measure refresh rate, determine<br>• Use questionnaire to assess refresh rate suitability, measure.<br>• Driver/CC required.<br>• Testing time included in 6-1 | • Coyote Vetronics | • TM-14<br>• MFTA-3 |
| **6-4** | | | Crew performance | • Effectiveness of new devices (LSAS, crew viewing, warning devices, sensors, Vetronics integration, etc) | • Crew rotation<br>• Minimum repetitions | • Identify new devices that will be on ADVANCE vehicle.<br>• Conduct user group to identify specific tasks and human performance parameters relevant to new devices or capabilities.<br>• Conduct testing as required. Include subjective assessment of usability (readability, ease of use, usefulness, etc, as well as objective (task based) human/system performance tests.<br>• Compare to current method, with and without AS | • LAVIIIAS<br>• Coyote Vetronics<br>• HLVW<br>• Control Vehicles | • HE-1 thru HE-7<br>• MFTA-2 |

| Serial | Activity | Description | Trial | Experimental Parameters | Statistical Analysis Requirements | Resource Requirements (Terrain/Crew/Eqpt/Time) | Vehicle(s) Required | SCD Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | | | • Full crew required<br>• Testing time = 1 wk (in addition to 6-1) | | |
| **6-5** | | | On-the-move surveillance | • Ability to observe targets on the move without being detected<br>• Effectiveness improvement from being able to do surveillance on move | • Crew rotation<br>• Minimum repetitions | • Ability to track targets tested in 2-4.<br>• Establish surveillance scenario, including move between surveillance locations, stealth, surveillance tasks<br>• Conduct scenario, determine ability of vehicle to do on-move surveillance, and assess improvement in overall crew and system performance from being able to do on the move.<br>• Compare with/without AS<br>• Full crew required.<br>• Testing time included in 6-1/6-4. | • LAVIIIAS | • HE-1 |
| **6-6** | | | Optimum AS modes | • Modes of the AS that are most useful for different tactical tasks | • Nil | • Conduct user group to define desired tasks, discuss potential AS modes.<br>• Review results of previous testing.<br>• Determine requirements for testing to establish most useful mode.<br>• Full crew required.<br>• Testing time = depends on requirements. | • LAVIIIAS | • MFTA-1 |

| Serial | Activity | Description | Trial | Experimental Parameters | Statistical Analysis Requirements | Resource Requirements (Terrain/Crew/Eqpt/Time) | Vehicle(s) Required | SCD Reference |
|---|---|---|---|---|---|---|---|---|
| **6-7** | | | System performance | • Accuracy<br>• Speed<br>• Reliability<br>• Latency<br>• Throughput/bandwidth | • Nil | • Also see 1-5 for static testing.<br>• Determine list of equipment and systems to be installed in ADVANCE vehicle.<br>• For each system/item, determine desired performance characteristics, and determine method to evaluate.<br>• Crew requirements depending on systems and testing.<br>• Testing time = depends on installed systems and test parameters, likely included in 6-1/6-4. | • LAVIIIAS<br>• Coyote Vetronics<br>• HLVW | • TM-12<br>• TM-13<br>• TM-15 thru TM-18<br>• DQ-5 |
| **7-1** | **Virtual Simulation** | | Crew performance | • Effectiveness of new devices in motion environment – including:<br>○ more complete or sophisticated representations of current devices<br>○ Other postulated devices not implemented in the ADVANCE vehicle.<br>○ Capabilities under more challenging or more replicable conditions | • VV&A of simulation and models<br>• Crew rotation<br>• Minimum repetitions<br>• Depending on evaluation | • Determine devices and capabilities to be represented, and level of fidelity and integration into simulation and OMI.<br>• Create models and capabilities, including AS model.<br>• Expand scenarios and tasks from 6-4 and 6-5 for use in the virtual environment.<br>• Create test plan including comparisons (design studies), measurements of human/system performance, etc.<br>• Full crew required.<br>• Testing time = depends on | • Nil | • HE-1 thru HE-7 |

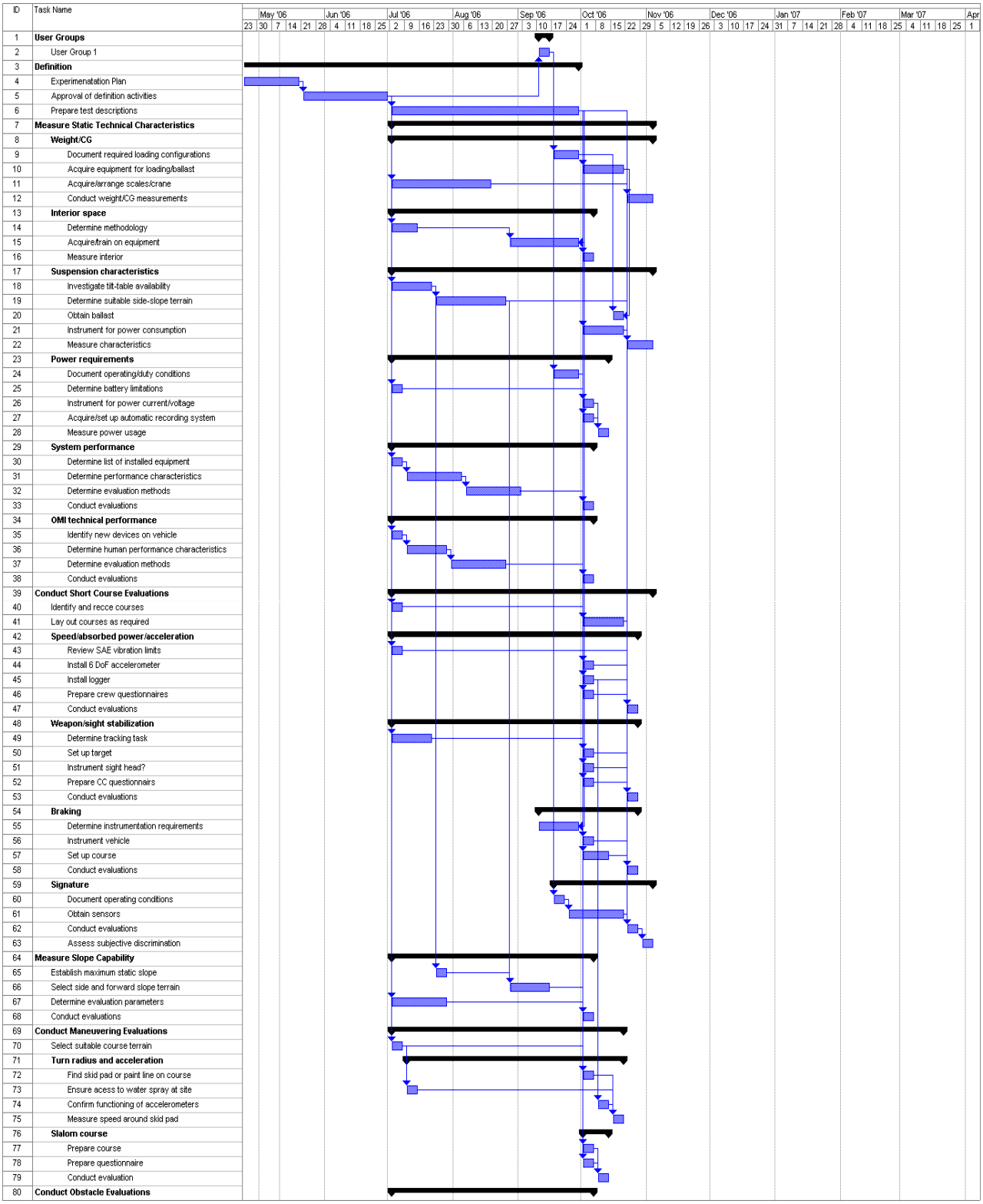
| Serial | Activity | Description | Trial | Experimental Parameters | Statistical Analysis Requirements | Resource Requirements (Terrain/Crew/Eqpt/Time) | Vehicle(s) Required | SCD Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | | | capabilities and testing required, perhaps 2 weeks. | | |
| **7-2** | | | Optimum AS modes | • Modes of the AS that are most useful for different tactical tasks | | • Include in definition of model capabilities (for AS) in 7-1.<br>• Incorporate in test plan.<br>• Full crew required.<br>• Testing time = included in 7-1. | | • MFTA-1 |
| **7-3** | | | Vibration | • Level of crew comfort and performance at different absorbed power inputs, with wider range of vibration levels and suspension characteristics. | | • Replicate testing from the field, concentrate on areas considered to be problematic for human performance or comfort.<br>• Full crew required.<br>• Testing time = possibly included in 7-1. | | • TM-4<br>• HE-9 |
| | | | Sight Stabilization | • Objective evaluation of crew's ability to maintain sight-line at different vibration levels.<br>• Engagement and gunnery performance; ability to fire on the move under varying conditions | | • Replicate vibration results from 2-1/2-4.<br>• Crew assigned pointing task, measure peak, RMS variation in deviation from desired pointing direction.<br>• Full crew required.<br>• Testing time = included in 7-1. | | • TM-4 |
| **8-1** | **Constructive Simulation (OR and TNM)** | | Logistics planning | • Impact of maintenance, manning, and logistics requirements on availability and battlefield effectiveness of the force | • VV&A of model<br>• Minimum repetitions | • Create OR model of larger force equipped with vehicles with ADVANCE capabilities.<br>• Use presumed RAMD data from OEM or from testing, and logistics requirements from OEM.<br>• No crew requirement. | • Nil | • Nil |

| Serial | Activity | Description | Trial | Experimental Parameters | Statistical Analysis Requirements | Resource Requirements (Terrain/Crew/Eqpt/Time) | Vehicle(s) Required | SCD Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | | | • Testing time = 2 weeks? | | |
| **8-2** | | | Battlefield Effectiveness | • Effectiveness of force equipped with vehicles with ADVANCE capabilities | | • Use OR model from 8-1, including combat function capabilities.<br>• Assess LER or other parameter with different vehicle capabilities.<br>• No crew requirement.<br>• Testing time = included in 8-1? | | • Nil |
| **8-3** | | | AS Performance | • Capabilities of AS system | | • AS contractor creates model of the AS system.<br>• Conduct analysis of the performance of individual capabilities and compare to the results from other trials.<br>• No crew requirement. | | • CS-2 |
| **8-4** | | | OMI Assessment | • Effectiveness of OMI | | • Model vehicle systems and crew interfaces using Task Network Model.<br>• Assess variations in performance parameters, differences in system capabilities or availability, etc.<br>• No crew requirement. | | • All |

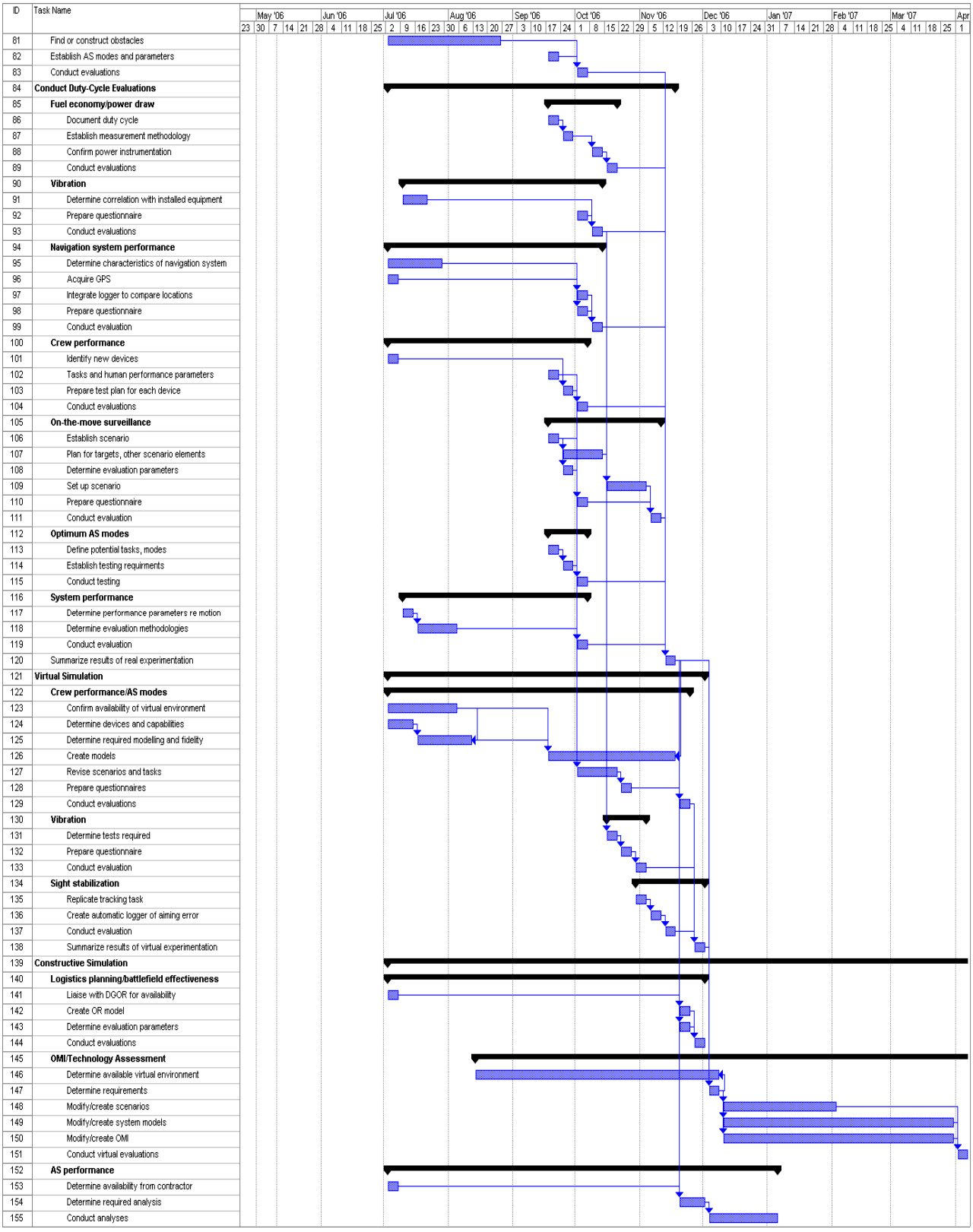
## Annex B to

## ADVANCE Experimental Plan

## 12 May 2006



| ID | Task Name |
|---|---|
| 1 | **User Groups** |
| 2 | User Group 1 |
| 3 | **Definition** |
| 4 | Experimenatation Plan |
| 5 | Approval of definition activities |
| 6 | Prepare test descriptions |
| 7 | **Measure Static Technical Characteristics** |
| 8 | **Weight/CG** |
| 9 | Document required loading configurations |
| 10 | Acquire equipment for loading/ballast |
| 11 | Acquire/arrange scales/crane |
| 12 | Conduct weight/CG measurements |
| 13 | **Interior space** |
| 14 | Determine methodology |
| 15 | Acquire/train on equipment |
| 16 | Measure interior |
| 17 | **Suspension characteristics** |
| 18 | Investigate tilt-table availability |
| 19 | Determine suitable side-slope terrain |
| 20 | Obtain ballast |
| 21 | Instrument for power consumption |
| 22 | Measure characteristics |
| 23 | **Power requirements** |
| 24 | Document operating/duty conditions |
| 25 | Determine battery limitations |
| 26 | Instrument for power current/voltage |
| 27 | Acquire/set up automatic recording system |
| 28 | Measure power usage |
| 29 | **System performance** |
| 30 | Determine list of installed equipment |
| 31 | Determine performance characteristics |
| 32 | Determine evaluation methods |
| 33 | Conduct evaluations |
| 34 | **OMI technical performance** |
| 35 | Identify new devices on vehicle |
| 36 | Determine human performance characteristics |
| 37 | Determine evaluation methods |
| 38 | Conduct evaluations |
| 39 | **Conduct Short Course Evaluations** |
| 40 | Identify and recce courses |
| 41 | Lay out courses as required |
| 42 | **Speed/absorbed power/acceleration** |
| 43 | Review SAE vibration limits |
| 44 | Install 6 DoF accelerometer |
| 45 | Install logger |
| 46 | Prepare crew questionnaires |
| 47 | Conduct evaluations |
| 48 | **Weapon/sight stabilization** |
| 49 | Determine tracking task |
| 50 | Set up target |
| 51 | Instrument sight head? |
| 52 | Prepare CC questionnairs |
| 53 | Conduct evaluations |
| 54 | **Braking** |
| 55 | Determine instrumentation requirements |
| 56 | Instrument vehicle |
| 57 | Set up course |
| 58 | Conduct evaluations |
| 59 | **Signature** |
| 60 | Document operating conditions |
| 61 | Obtain sensors |
| 62 | Conduct evaluations |
| 63 | Assess subjective discrimination |
| 64 | **Measure Slope Capability** |
| 65 | Establish maximum static slope |
| 66 | Select side and forward slope terrain |
| 67 | Determine evaluation parameters |
| 68 | Conduct evaluations |
| 69 | **Conduct Maneuvering Evaluations** |
| 70 | Select suitable course terrain |
| 71 | **Turn radius and acceleration** |
| 72 | Find skid pad or paint line on course |
| 73 | Ensure acess to water spray at site |
| 74 | Confirm functioning of accelerometers |
| 75 | Measure speed around skid pad |
| 76 | **Slalom course** |
| 77 | Prepare course |
| 78 | Prepare questionnaire |
| 79 | Conduct evaluation |
| 80 | **Conduct Obstacle Evaluations** |



| ID | Task Name |
|---|---|
| 81 | Find or construct obstacles |
| 82 | Establish AS modes and parameters |
| 83 | Conduct evaluations |
| 84 | **Conduct Duty-Cycle Evaluations** |
| 85 | **Fuel economy/power draw** |
| 86 | Document duty cycle |
| 87 | Establish measurement methodology |
| 88 | Confirm power instrumentation |
| 89 | Conduct evaluations |
| 90 | **Vibration** |
| 91 | Determine correlation with installed equipment |
| 92 | Prepare questionnaire |
| 93 | Conduct evaluations |
| 94 | **Navigation system performance** |
| 95 | Determine characteristics of navigation system |
| 96 | Acquire GPS |
| 97 | Integrate logger to compare locations |
| 98 | Prepare questionnaire |
| 99 | Conduct evaluation |
| 100 | **Crew performance** |
| 101 | Identify new devices |
| 102 | Tasks and human performance parameters |
| 103 | Prepare test plan for each device |
| 104 | Conduct evaluations |
| 105 | **On-the-move surveillance** |
| 106 | Establish scenario |
| 107 | Plan for targets, other scenario elements |
| 108 | Determine evaluation parameters |
| 109 | Set up scenario |
| 110 | Prepare questionnaire |
| 111 | Conduct evaluation |
| 112 | **Optimum AS modes** |
| 113 | Define potential tasks, modes |
| 114 | Establish testing requirments |
| 115 | Conduct testing |
| 116 | **System performance** |
| 117 | Determine performance parameters re motion |
| 118 | Determine evaluation methodologies |
| 119 | Conduct evaluation |
| 120 | Summarize results of real experimentation |
| 121 | **Virtual Simulation** |
| 122 | **Crew performance/AS modes** |
| 123 | Confirm availability of virtual environment |
| 124 | Determine devices and capabilities |
| 125 | Determine required modelling and fidelity |
| 126 | Create models |
| 127 | Revise scenarios and tasks |
| 128 | Prepare questionnaires |
| 129 | Conduct evaluations |
| 130 | **Vibration** |
| 131 | Determine tests required |
| 132 | Prepare questionnaire |
| 133 | Conduct evaluation |
| 134 | **Sight stabilization** |
| 135 | Replicate tracking task |
| 136 | Create automatic logger of aiming error |
| 137 | Conduct evaluation |
| 138 | Summarize results of virtual experimentation |
| 139 | **Constructive Simulation** |
| 140 | **Logistics planning/battlefield effectiveness** |
| 141 | Liaise with DGOR for availability |
| 142 | Create OR model |
| 143 | Determine evaluation parameters |
| 144 | Conduct evaluations |
| 145 | **OMI/Technology Assessment** |
| 146 | Determine available virtual environment |
| 147 | Determine requirements |
| 148 | Modify/create scenarios |
| 149 | Modify/create system models |
| 150 | Modify/create OMI |
| 151 | Conduct virtual evaluations |
| 152 | **AS performance** |
| 153 | Determine availability from contractor |
| 154 | Determine required analysis |
| 155 | Conduct analyses |

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(U) Greenley & Associates was contracted to conduct the Human Factors Engineering Definition Project as part of definition activities for the Advanced Vetronics Architecture for a Net-Enabled Combat Environment (ADVANCE) Technology Demonstration project. The two key technology areas being explored by ADVANCE and Active Suspension (AS) and Vetronics, including the operator interface with the vehicle. The DND Project Management Office (PMO) compiled a list of key questions from various Stakeholders in the armoured vehicle and related acquisition communities, termed the Stakeholder Control Document (SCD). Previous HFE Definition Project work rationalized the Stakeholder questions into a more concise and complete SCD, and created a “Knowledge Approach” which outlined the necessary methods of experimentation required to answer the questions. The objective of this document is to outline an experimental plan for answering the questions raised by Armoured Fighting Vehicle (AFV) Stakeholders in the SCD. The plan outlines the Activities and Trials required and high-level tasks; further development will be required in order to completely plan and conduct the desired experimentation.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifies, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus-identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

Vetronics, Technology Demonstrator, ADVANCE, Crew Workstation, SMI, Human Factors, Net-Enabled