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Further integration of the free-fall cone penetrometer with moving vessel profiler

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Contractor's Document Number: TR 06008-0-04-01
PWGSC Contract Number: W7707-053202/001/HAL
CSA: Dr. John Osler, Defense Scientist, 902-426-3100 x119

Defence R&D Canada

Contract Report

DRDC Atlantic CR 2007-028

February 2007

Canada

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IMPORTANT INFORMATIVE STATEMENTS

The scientific or technical validity of this Contract Report is entirely the responsibility of the Contractor and the contents do not necessarily have the approval or endorsement of the Department of National Defence of Canada.

Abstract

In the fall of 2005, experimental trials to integrate the Free-Fall Cone Penetrometer (FFCPT), an *in situ* sediment profiling tool, with a Moving Vessel Profiler (MVP), an automated profiling winch, from a vessel underway were completed in conjunction with DRDC Atlantic aboard the *CFAV Quest* as part of scientific cruise Q290. This experimental work revealed several areas in which further R&D was required. This Contract Report details the work completed by Brooke Ocean Technology Ltd. (BOT), developer and manufacturer of both the MVP and FFCPT, to further integrate the two products. The primary development efforts were to improve methods for data handling, to permit the viewing of FFCPT data in real-time, to investigate the performance of the FFCPT sensor suite, and to upgrade the MVP to further its operational capability and to improve the interface with the FFCPT. These developments are consistent with the primary goal of the work: to develop the system as an effective tool for Rapid Environmental Assessment (REA) of *in situ* seabed properties. This effort culminated in a successful demonstration of the system's REA capability aboard the Maritime Coastal Defence Vessel (MCDV) *HMCS Summerside* in October 2006.

Résumé

À l'automne 2005, des essais expérimentaux visant à intégrer la sonde pénétrométrique à cône à chute libre (SPCCL), un outil d'établissement de profils sédimentaires *in situ*, à un Moving Vessel Profiler (MVP), un treuil profileur automatisé, à partir d'un navire en mouvement ont été effectués en liaison avec RDDC Atlantique à bord du *NAFC Quest* dans le cadre de la croisière scientifique Q290. Cette expérience a révélé plusieurs questions nécessitant davantage de recherche et développement. La présente déclaration de contrat décrit en détail les travaux effectués par Brooke Ocean Technology Ltd. (BOT), concepteur et fabricant du MVP et de la SPCCL, pour intégrer davantage les deux produits. Les principaux efforts de développement ont porté sur l'amélioration des méthodes de manipulation des données, sur les façons de rendre possible la visualisation des données de la SPCCL en temps réel, sur l'étude de la performance de l'ensemble de capteurs de la SPCCL ainsi que sur l'amélioration de la capacité opérationnelle du MVP et de l'interface avec la SPCCL. Les progrès réalisés cadrent avec l'objectif principal du projet qui est le suivant : faire du système un outil efficace pour effectuer des évaluations environnementales rapides de propriétés *in situ* du fond marin. Le projet a abouti à la démonstration réussie de la capacité du système pour effectuer des évaluations environnementales rapides à partir du navire de défense côtière (NDC) *NCSM Summerside* en octobre 2006.

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Executive summary

Further integration of the free-fall cone penetrometer with moving vessel profiler:

Daniel Cunningham; Shane McDonald; DRDC Atlantic CR 2007-028; Defence Research and Development Canada – Atlantic; February 2007.

Introduction or background: In the fall of 2005, during DRDC Atlantic scientific cruise Q290, experimental trials to integrate the Free-Fall Cone Penetrometer (FFCPT), an *in situ* sediment profiling tool, with a Moving Vessel Profiler (MVP), an automated profiling winch, were conducted. This experimental work revealed several areas in which further R&D was required. Brooke Ocean Technology Ltd. (BOT), the developer and manufacturer of both the MVP and FFCPT, was contracted by DRDC Atlantic to further integrate the two products. The primary goal of this work was to develop the overall system capability as an effective tool for the Rapid Environmental Assessment (REA) of *in situ* seabed properties. With this goal in mind, the development effort was aimed specifically at improving the data handling capability of the FFCPT/MVP system, with the desire to obtain the data in or near real-time.

Results: This R&D effort culminated with a successful demonstration of the REA capability of the MVP/FFCPT from the Maritime Coastal Defence Vessel (MCDV) *HMCS Summerside*. The key achievements of this work were: continuous real-time telemetry of the 25 Hz (low speed) FFCPT and sound velocity data; intermittent telemetry of the 2000 Hz (high speed) geotechnical data; significant improvements to the post-processing software and its interaction with the instrument; improvements to certain sensors and their mounts; and a developmental demonstration of fully automated FFCPT deployment.

Significance: The FFCPT/MVP system has proven to be an effective tool for the REA of *in situ* sediment properties from a naval vessel. The system can provide a wealth of geotechnical and water column sound velocity data that may be useful for military applications, in particular Military Oceanography, MCM, and ASW.

Future plans: BOT plans on continuing to further develop and market the FFCPT/MVP system as a tool for the REA of seabed properties. Consistent with this effort is the desire to implement new capabilities such as surface powering and fully automated deployment to reduce the need to recover the instrument to change batteries and to increase the volume of data collected; in essence, to permit the collection of more data in less time.

Sommaire

Further integration of the free-fall cone penetrometer with moving vessel profiler:

Daniel Cunningham; Shane McDonald; DRDC Atlantic CR 2007-028 ; Recherche et développement pour la défense Canada – Atlantique; février 2007.

Introduction ou contexte : À l'automne 2005, des essais expérimentaux visant à intégrer la sonde pénétrométrique à cône à chute libre (SPCCL), un outil d'établissement de profils sédimentaires *in situ*, à un Moving Vessel Profiler (MVP), un treuil profileur automatisé, ont été effectués durant la croisière scientifique Q290 menée par RDDC Atlantique. Cette expérience a révélé plusieurs questions nécessitant davantage de recherche et développement. RDDC Atlantique a retenu les services de Brooke Ocean Technology Ltd. (BOT), le concepteur et le fabricant du MVP et de la SPCCL, pour intégrer davantage les deux produits. L'objectif principal du projet était d'améliorer la capacité générale du système afin que celui-ci constitue un outil efficace pour effectuer des évaluations environnementales rapides de propriétés *in situ* du fond marin. Compte tenu de cet objectif, les travaux de développement ont été axé particulièrement sur l'amélioration de la capacité de manipulation des données du système SPCCL-MVP dans le but d'obtenir les données en temps réel ou presque.

Résultats : Ce projet de recherche et développement a abouti à la démonstration réussie de la capacité du système MVP-SPCCL pour effectuer des évaluations environnementales rapides à partir du navire de défense côtière (NDC) *NCSM Summerside*. Les principales réalisations du projet sont les suivantes : la télémétrie continue en temps réel des données de la SPCCL et des données sur la vitesse du son obtenues à 25 Hz (faible vitesse); la télémétrie intermittente des données géotechniques obtenues à 2 000 Hz (haute vitesse); des améliorations importantes apportées au logiciel de post-traitement et à son interaction avec l'instrument; des améliorations apportées à certains capteurs et à leur support; la démonstration du déploiement entièrement automatisé de la SPCCL.

Importance : Le système SPCCL-MVP s'est révélé être un outil efficace pour effectuer des évaluations environnementales rapides des propriétés *in situ* des sédiments à partir d'un navire militaire. Le système peut fournir une grande quantité de données géotechniques et de données sur la vitesse du son dans la colonne d'eau qui peuvent être utiles pour des applications militaires, en particulier l'océanographie militaire, la LCM et la GASM.

Perspectives : BOT prévoit poursuivre le développement et la commercialisation du système SPCCL-MVP comme un outil pour effectuer des évaluations environnementales rapides des propriétés du fond marin. Dans la lignée de ces travaux, il y a le désir de mettre en œuvre de nouvelles capacités, comme l'alimentation en surface et le déploiement entièrement automatisé, pour éviter d'avoir à récupérer l'instrument chaque fois qu'il est nécessaire de changer les piles ou d'augmenter le nombre de données recueillies. Essentiellement, le but du projet est de permettre la collecte de davantage de données en moins de temps.

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Acknowledgements

The authors would like to acknowledge Dr. John Osler for his enthusiastic support over the years in developing the Free-Fall Cone Penetrometer (FFCPT) and would like to specifically thank him for his most recent support in further integrating the FFCPT with the MVP, culminating in a successful demonstration aboard the *HMCS Summerside* in October of 2006.

The authors would also like to gratefully acknowledge the work of Daniel Graham, Jeff Scrutton, Roger Arsenault, Sean O'Grady, Martin O'Connor and Paul Shouldice of DRDC Atlantic; the Officer's and Crew of the CFAV Quest; and the Officer's and Crew of the HMCS Summerside, under the command of LCdr Koch.

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1. Overview

This report details all of the work completed by Brooke Ocean Technology Limited (BOT) as part of Contract Number W7707-053202/001/HAL. The contract was to provide technical support, engineering, and hardware to continue the integration of the Free Fall Cone Penetrometer (FFCPT) with the Moving Vessel Profiler (MVP). The work conducted was follow-on development to initial testing completed during DRDC Atlantic Scientific Cruise Q290 in October 2005, which revealed several areas in which further research and development was required. The primary goal of this work was to develop the overall system capability as an effective tool for the Rapid Environmental Assessment (REA) of *in situ* seabed properties [2]. With this goal in mind, the development effort was aimed specifically at improving the data handling capability of the FFCPT/MVP system, with the desire to obtain the data in or near real-time.

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2. Background

The FFCPT is an instrument designed for the rapid geotechnical profiling of sub-aqueous sediments. The instrument is designed to free fall through the water column, eventually impacting the seabed and recording penetration data at a high sample rate (2 kHz). This permits high resolution characterization of the sediment layering and material properties such as grain size and undrained shear strength. Penetration depth below the seabed is governed by the impact velocity and the seafloor sediment characteristics. Penetration depths of 2 – 3 m in soft clay are typical.

The Moving Vessel Profiler (MVP) is a computer controlled winching system that can deploy and recover a sensor from a ship underway. The system is controlled by a computer that accepts input from the operator, input from the vessel for vessel speed, position and fish depth to execute a safe mid-water deployment. After achieving the desired depth the computer automatically applies the brake on the winch system and recovers the fish back to the towed position behind the ship.

The FFCPT has been integrated with the MVP to create an efficient platform for the collection of geotechnical data from a vessel that is either on-station or underway [1].

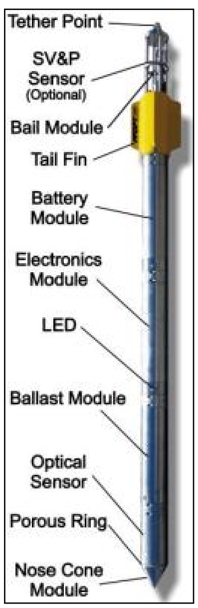

Figure 1. FFCPT and MVP

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3. Summary of Work Completed and Results

A detailed summary of all of the work completed as part of this contract is provided below.

3.1 Improvements to Data Offload Capability

An automated offload capability for the FFCPT when it is cabled directly to the post-processing computer has been developed. This automated offload capability has been created through development of the instrument firmware (TT8 code) and integration of an FFCPT Downloader into the existing post-processing software, FfcptView. The FFCPT Downloader is essentially a terminal emulator window with additional buttons to automate some of the procedures. This functionality allows scanning of probe data and selection of files to be downloaded. It also compares previously downloaded data with probe data and recommends for download only those files which have not already been downloaded. It also allows the user to automatically delete multiple drop files without having to format the entire flash card (when connected on-deck in RS-232 mode only). These functions include:

Scan button to scan and display probe data and the ability to select drops for download (will automatically download all files associated with selected drops).

Communication and data download at 9,600, 38,400 and 115,200 baud.

Button for automatic entry of computer date/time string in correct probe format.

Button for formatting of probe flash card (automatically downloads FFCPT.cfg to computer).

Ability to send and receive single files between computer and probe (for example, to load the FFCPT.cfg file).

Button for quick display of flash card DIR.

The existing control circuit board was upgraded. The primary developments in the new control circuit board were the implementation of a real-time clock, modifications to the powering scheme, and changes to the control of the RS485 driver to permit bi-directional interaction with the instrument in RS485. Development throughout the course of the contract also introduced two instrument modes of operation, stand-alone mode and real-time mode. Stand-alone mode is selected for use of the instrument without an MVP while real-time mode is selected for use of the instrument with an MVP. These improvements have provided the ability to configure, monitor, and download data from the FFCPT through the MVP electro-mechanical cable with the instrument either on-deck or in the water when transiting between drop sites.

To permit communication with the FFCPT through the MVP, an interface box was also developed and provided to DRDC. For FFCPT work, this interface box essentially replaces the tow cable input on the MVP controller interface box, permitting two-way communications with the FFCPT through the tow cable.

3.2 Performance of the Pore Pressure Transducer

During field tests in 2005, some anomalous behaviour of the pore pressure sensor was noted. This was evident in several drops in which the sensor spiked to 0m depth when the water depth was approximately 40 – 50m. On completion of the field trial, the pressure sensor was shop tested and found to be faulty. A shift in the sensor calibration was noted (the scale factor had changed). As a result, the anomalous pressure response was concluded to most likely be a result of the faulty pressure sensor.

The faulty 500psi pore pressure sensor was replaced by the same model sensor with an increased pressure range (up to 1,000psi) in order to be consistent with both MVP200 operational depth limits (660m) and all new FFCPT builds. The 500psi tail pressure sensor in the FFCPT has also been replaced with a new 1,000psi sensor.

3.3 Performance of the Acceleration Transducers

During field tests in 2005, some anomalous behaviour of the accelerometers was noted. In particular, for impacts on harder layers, resonance of the accelerometer channels tended to occur, appearing as a "ringing/hash" in the accelerometer data (see **Figure 2.**). BOT investigated the performance of the accelerometers to determine if the resonance was a fundamental behaviour of the instrument itself (i.e. the accelerometers were measuring correctly) or if the response was due to either faulty accelerometers or resonance of the accelerometer on its mount. The primary goals of the investigation were to determine if this resonance was corrupting the geotechnical analysis and to evaluate the suitability of the accelerometers that were installed at that time.

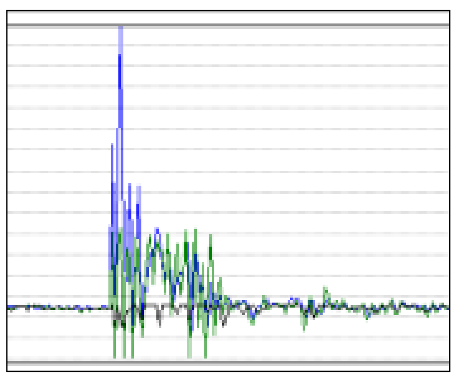

Figure 2. Accelerometer Ringing

The analytical approach used was to audit the quality of the accelerometer data using data from the tail pressure sensor located in the bail. This was done first by computing speed and displacement curves for the instrument during free-fall in the water-column from the pressure sensor data. These curves were then compared to speed and displacement curves computed by integrating water-column accelerometer data. On-station drops were used for the comparison because the instrument was near-vertical at the start of the drop (as opposed to when it is being towed) providing better boundary conditions for integration of accelerometer data (accelerometer at 1g).

The curves generated from both data sets compared very well. This gave confidence in the computed velocities because they were derived through two independent data sets. It also provided reassurance that the accelerometers were providing quality data and served as a good first check because the test conditions in the water-column are much more controlled than the randomness associated with the bottom conditions.

The next step was to compare the computed impact velocity for each drop (from the water-column pressure and accelerometer data) with the impact velocity computed from accelerometer data collected during the penetration events. This was completed for the same drops discussed above, which were conducted in a wide range of bottom conditions. It was concluded that the impact velocity integrated from post-impact accelerometer data compared very well with that predicted from the water-column data sets.

Based on this work, it was concluded that the accelerometer resonance, which is prevalent in drops with high-g impacts has no effect on integrated velocity and depth values for the impact event. This is likely a result of the oscillatory nature of the response. However, because other post-processing outputs are obtained using a point-by-point analysis of the accelerometer response, this resonance does have an effect on the interpretation of the seabed properties.

To minimize the effect that this resonance has on the interpretation of seabed properties, filtering (smoothing) of data has been incorporated into the vehicle dynamics section of the post-processing software (FfcptView) for use when necessary. Appropriate filtering can be done without altering integrated velocity and depth values (i.e. it does not remove real or useful data). It will, however, remove probe resonances associated with high-g impacts that negatively affect the calculation of probe resistance from accelerometer data. Figure 3 below illustrates the effect of data filtering. It is important to note that the data shown below includes data from an accelerometer that was mounted for test purposes (the blue trace below). It was not rigidly mounted and therefore demonstrates an excessive amount of ringing. It nonetheless serves as a good illustration of filtering. The pink trace to the left is the mud-line response.

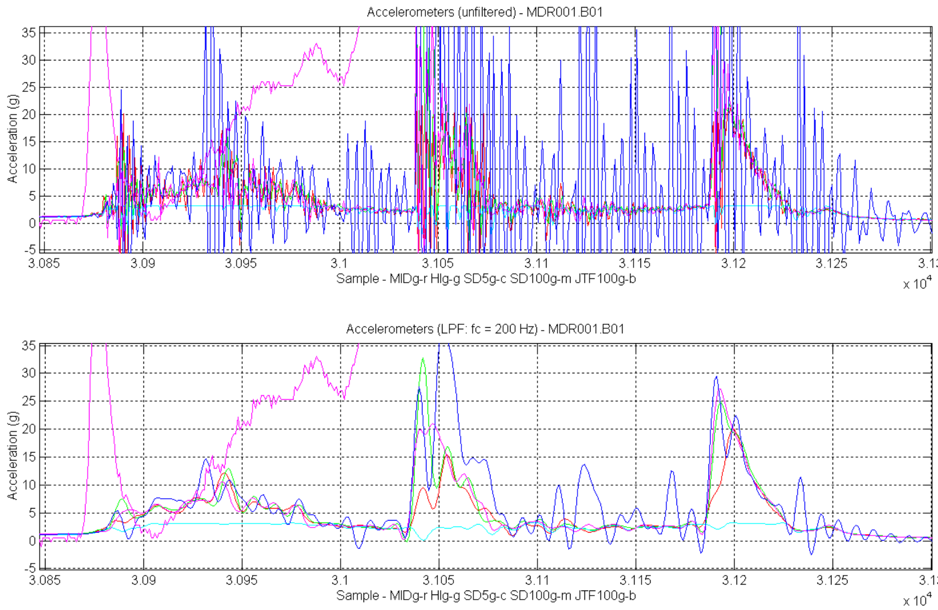

Figure 3. Effect of Filtering

A secondary goal of this investigation was to evaluate replacement accelerometers for the existing sensors, because they were becoming obsolete. In October 2005 during Q290, new accelerometers were added to the existing DRDC FFCPT as a test. They were mounted in conjunction with the existing accelerometers. The new accelerometers also showed the suspect resonance, indicating that the ringing was not particular to the style of accelerometer used in the instrument. It was determined, that while the existing accelerometers recorded data of a suitable nature, the new accelerometers are of higher quality. These new accelerometers were installed in the new FFCPT (S/N 10414) that was delivered as part of this contract, while the original accelerometers remained in the existing DRDC FFCPT (S/N 10119). This was done to allow further testing of the new accelerometers, while maintaining the existing capability of the original DRDC FFCPT (S/N 10119) in case issues with the new sensors and mount were identified during Q298. A full upgrade to the new accelerometers and mount was made following the trial aboard *HMCS Summerside*.

It is suspected that the measured resonances are associated with either a “ringing” in the instrument that occurs during high-g impacts, or a resonance of the accelerometer mount structure. As part of the upgrade to the new accelerometers, the mounting of the accelerometers has been changed. The accelerometers are now mounted directly to a machined surface in the nose cone, providing a much stiffer mount and minimizing the potential for mount resonance

3.4 Modifications to the Post-Processing Software

The post-processing software (FfcptView) has been improved as per recommendations from the Scientific Authority. The ability to evaluate the FFCPT vehicle dynamics has been added, including the ability to filter the accelerometer data as discussed on Section 3.3. The vehicle dynamics page is intended to provide a detailed picture of the instruments behaviour during free-fall in the water-column. Information on the tilt, position, velocity and acceleration of the instrument is provided, in addition to the ability to align the mud-line time series with the acceleration time series, based on its physical separation from the nose cone tip of the instrument. The position of the instrument during free-fall is provided as three output traces; one is based on the raw pressure signal, the second is based on a smoothed pressure signal, and the third is based on a curve fitted pressure signal. The velocity is provided from integration of raw acceleration, from the derivative of a fitted pressure signal, and from the derivative of a smoothed pressure signal. Acceleration is provided as raw acceleration, smoothed acceleration and curve fitted acceleration. The ability to customize the level of smoothing and the order of the polynomial curve fits is provided.

Figure 4 below shows the vehicle dynamics page. Of particular interest is the velocity strip chart (third chart down). It is plotting the velocity of the FFCPT from the start of impact to the end of impact (user defined). The green curve is velocity from smoothed pressure which is not very accurate as a result of noise on the pressure signal, the blue curve shows velocity from a curve fitted pressure signal, and the red curve is velocity from a smoothed accelerometer signal.

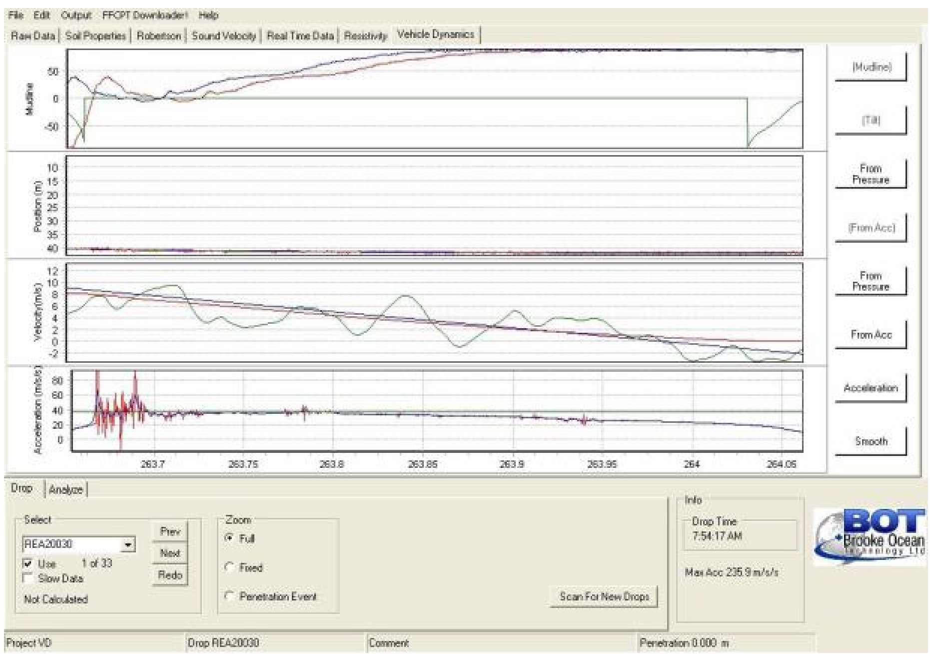

Figure 4. Vehicle Dynamics Page

An improved method of estimating impact velocity from pressure response has also been added to the main page, which incorporates a polynomial curve fit. Enhancements have been made to the data and image export capabilities in addition to extensive modification to the graphical user interface and re-organization of menus and features to provide a more user-friendly layout.

3.5 Delivery of an Additional FFCPT

A complete FFCPT rated to a working depth of 660m was delivered as part of the contract. The FFCPT included a communications cable, user manual, AML Smart Sound Velocity and Pressure Sensor (SVP) integrated into the bail, two (2) shipping cases, two (2) asymmetric tail fins, and spare TT8 controller with a CompactFlash Card.

3.6 Delivery of a Spares Kit for the MVP

The following MVP spares were provided as part of the contract: two (2) pump solenoid valve coils, four (4) brake selector valve coils, one (1) brake cylinder assembly, two (2) sheave limit switches, one (1) male tow cable pigtail, one (1) female tow cable pigtail, one (1) E/M tow cable, one (1) sensor extension cable, one (1) tow cable re-termination kit (w/ pigtail), one (1) cable counter, and one (1) oil filter.

3.7 Real-Time Telemetry

The capability to communicate bi-directionally with the FFCPT in RS485 through the winch connection was introduced during the improvements to the data offload capability discussed in section 3.1. To build on this capability and to add true real-time data collection, the FFCPT was further integrated with the MVP. For operational instructions on how to configure the FFCPT and MVP for telemetry, please refer to section 4.3.

To permit the viewing of FFCPT data in real-time, updates were made to both the FFCPT firmware and the MVP control software (please refer to section 4.2 for details on appropriate manuals). The FFCPT was added as a payload option in the MVP configuration screen. All of the key instrument data can now be viewed in digital output boxes on the MVP main screen in engineering units. This includes: depth (from tail and nose pressure in m), acceleration (from the low, mid and high range sensors in g's), mud-line (in volts), and battery voltage. This data is also plotted in three strip charts: a depth chart which plots depth from tail pressure; a chart which plots the three accelerometer channels and the mud-line channel; and a tension chart which plots load cell tension. The tension chart also records the peak tension (in kg) and displays it in a digital output box, while the depth chart records the maximum profile depth. The data that is displayed on the MVP main screen is the 25Hz data (from the low speed buffer) as opposed to the 2,000Hz data that is logged to the flash card during the impact event.

Sound velocity data from the instrument can be logged manually using this feature of the MVP control software and plotted to view the sound velocity profile. Alternatively, if it is not desired to view the FFCPT engineering data, the instrument can be configured as a sound velocity instrument only. This is similar to using the standard free-fall fish and the sound velocity profiles will be displayed continuously as the instrument is deployed. The only exception is that the stream is interrupted when data is being written to the flash card.

The ability to configure the FFCPT using the MVP control software has also been added. The instrument can be configured using the Fish Debug screen. The FFCPT drop data that is logged to the instrument flash card can be downloaded in between drops using an auxiliary laptop that is connected to the MVP controller.

As a result of this work, it is now possible to activate Freewheel + Line-puller from the MVP controller. This will deploy the FFCPT in a fully-automated manner. Previously, it was only possible to do this from the winch control box or operators pendant. Though the FFCPT can technically be deployed and recovered from the lab, this was implemented for a developmental evaluation and BOT does not recommend that this be conducted without our involvement.

3.8 Q298 Equipment Preparation

BOT inspected and tested both of the DRDC FFCPTs and the MVP prior to DRDC scientific cruise Q298. The accelerometers and pressure sensors in both FFCPTs were calibrated and shop test drops were conducted to ensure that everything was functioning properly. Pressure testing of both instruments was also conducted because of upgrade work to the mud-line and LED lenses. A pre-cruise check was conducted on the MVP after installation on the CFAV Quest. The MVP line puller was also configured.

During Q298, communication difficulty and subsequent failure of both FFCPTs occurred. BOT conducted a service visit to the Quest while it was on a scheduled port call in Woods Hole. The communications difficulties were traced to a partial short in the E/M cable extension that is used to connect the 4 pin MVP tow cable to the 8 pin communications bulkhead on the FFCPT. The subsequent failure of the FFCPTs occurred because the partially shorted cable caused the MOSFET circuit to heat up and fail. Both circuits were repaired during the trial and a new E/M cable extension was provided.

Please refer to Appendix A for a summary of the FFCPT calibrations for Q290, Q298 and the REA trial and Appendix B for the appropriate FFCPT.cfg files.

3.9 Q298 Post-Trial Inspection

The DRDC FFCPTs and the MVP were thoroughly inspected following Q298. Generally, the equipment was found to be in good working order following the sea-trial. The following minor repairs and/or upgrade work were completed by BOT:

Inspection of the electro-mechanical tow cable to locate and repair an intermittent short on the tow cable's wet end.

Minor repair of the winch brake drum.

The DRDC2 SVP sensor was found to be faulty as result of being flooded prior to Q298. This repair was completed under warranty.

The remote pendant was replaced under warranty as a result of water ingress into the pendant body.

Increased the haul-in speed when using the remote pendant.

Re-configuration of FW+ Line Puller to permit actuation of the line puller using the pendant, the winch control box switch, and from the MVP controller computer.

A quotation for further work was provided to the Scientific Authority.

3.10 Modifications to the MVP Winch Control Software

To permit the monitoring of FFCPT depth and tow cable tension as a function of time, modifications were made to the MVP control software. Digital readout boxes below the depth and tension strip charts were added to record and display the maximum profile depth and peak pull-out load for each drop. The display can be reset to zero by right-clicking on the readout box.

To prevent damage to the winch hydraulic system during previous underway FFCPT trial work, the winch control firmware was modified. The changes were made to prevent system damage in the event that the FFCPT was not extracted from seabed, causing the brake to slip and the tow cable to be pulled off-of-the drum. At the time, the changes implemented were developmental. Further to that developmental work, BOT has implemented a cable snag alarm. This will disengage the winch motor if 5m of cable is pulled off-of-the drum when the brake is applied or the motor is hauling-in. This will prevent damage to the hydraulic system from occurring.

3.11 Post-Q298 MVP Repairs and Upgrades

The hydraulic system in DRDC's MVP was upgraded with a new hydraulic manifold. The manifold, which is located in a watertight enclosure, locates all of the operations valves in a single place. A lever valve is also located adjacent to the enclosure to permit easy actuation of the selected functions. This upgrade reduces the level of routine maintenance required and permits easier manual actuation of winch functions during an emergency. Please refer to TD-0010-2-04-030 for operational instructions pertaining to this new upgrade.

A hydraulic oil cooler was added to the system. The cooler requires a salt (or fresh) water input and will help to maintain the hydraulic oil temperature at safe level during operation in warm ambient temperatures.

During Q298, the conductivity-temperature-depth sensor in the standard MVP free-fall fish was damaged. The damage occurred as a result of an excess voltage that was applied during diagnostic testing when DRDC staff bypassed the tow cable, which is relied upon to reduce voltage into the fish through cable resistance (for which DRDC staff were not aware). The sensor was tested by BOT and repair was arranged with the instrument manufacturer. The sensor was re-installed and tested in the free-fall fish.

3.12 Support for a Developmental Evaluation aboard an MCDV

BOT provided engineering and field support for a Maritime Evaluation aboard the Maritime Coastal Defence Vessel (MCDV) *HMCS Summerside*. The trial was conducted from October 17 to 20, 2006 in Operation Areas *Delta 2* and *Bravo*. The primary purpose of the evaluation was to demonstrate the rapid environmental assessment capability (REA) of the MVP/FFCPT system. This support included: two BOT field support staff for the duration of the trial; manufacture and installation of a two-part deck/communications cable; assembly and installation of a 100 foot power cable (the cable and plug were supplied by DRDC); and the provision of FFCPT consumables.

Key achievements of the trial were as follows:

Demonstrated the REA capability of the system on an MCDV, in particular to observers from MetOc and the Route Survey Office.

Collected more data underway at speeds between 4 and 8 knots, and in deeper water, from known sites to further validate equipment performance.

Collected data for use in DRDC research initiatives.

Continuous real-time telemetry of 25 Hz (low speed) FFCPT Data and sound velocity data.

Telemetry of impact (sediment) data after drop – as the instrument is recovered and prior to the next drop.

Demonstrated fully automated deployment and recovery of the FFCPT (developmental only)

While the developments discussed throughout this report culminated in a successful demonstration aboard the *HMCS Summerside*, a few issues which will require further investigation were identified. In particular, on a couple of occasions the FFCPT entered an unknown mode. In this mode, all communications to the instrument were lost and it appeared to be off. The instrument did not return to normal operation until it was disassembled and the battery disconnected and re-connected.

Initial suspicions were a fault in the tow cable. This was investigated and while no direct fault could be found, the tow cable was replaced with a new one. It is also believed that the nature of the FFCPT powering and communications circuitry and its interaction with the tow cable and RS485 communications protocol contributed to the problem.

After replacement of the tow cable, the instrument behaved normally for the remainder of the trial; however, further investigation is required to determine the source of the problem so that development can be conducted to prevent future failures from occurring.

As discussed above, fully automated deployment of the FFCPT from the MVP was trialed as a development step. It was achieved by making use of existing coded MVP operational schemes and was intended purely as means to identify the preferred logic to be used in later developments. This demonstration provided valuable insight into the variables associated with this kind of operation. This will allow further development to be carried out in this area, hopefully leading to a refined, fully automated solution.

Figure 5. FFCPT/MVP on HMCS Summerside. Photos courtesy of DRDC Atlantic.

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4. Operational Instructions

Changes in operation have resulted throughout the course of this development work. The majority of these changes to the operational procedure are a result of new software. The current versions of software containing these developments are identified below, as well as new instructions for operational procedures that have changed.

4.1 Software Versions

The software versions identified below are those currently installed on the DRDC MVP and FFCPT.

FFCPT Firmware (TT8 Code): V2.62

FfcptView: V4.0 Build 37

MVP Controller Software: V2.33

MVP Winch Firmware: V1.24

4.2 Software Manuals

For further details on using the MVP controller software and FfcptView, please refer to the following documents:

MVP Controller Software: OM-010-0-03-233

FfcptView: OM-06000-0-03-01

4.3 Configuration of FFCPT/MVP for Telemetry

To configure the FFCPT, enable the real-time operation mode by selecting main menu option "M" (see Figure 6, below.). Save the configuration and initiate data logging. The RS485 channel is enabled to output data at 115,200 baud.

```
 FFCPT Main Menu (ver 2.62)
----------------------------

 Date/Time: 01/08/2007, 10:08:25
 VBat: 12.537 (V)

 0. Start Logging Data
 1. Save Config

 2. System Time
 3. File Name
 4. Log Buffer
 5. Triggering
 6. Auto Start
 7. R-module
 8. SV-module
 9. Display
 M. Switch to RT OpMode (RS485 On)

 U. Utilities
 R. Save Cfg and Reboot
 D[ir]. Directory
 PS filename
 Baud 1|2|3  for 9600, 38400 or 115200
 Q. Quit Program

[*] ? |
```

Figure 6. FFCPT Main Menu

Now that the instrument has been configured for real-time operation it is a relatively simple process to view the data as it transmitted.

Next, open the MVP Controller Software and open the System Configuration by clicking the Edit menu located at the top of the main view screen.

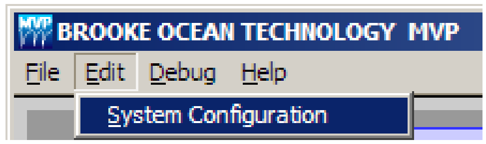

Figure 7. MVP Software Edit Menu

Once the System Configuration window pops up, the FISH Interface parameters will have to be modified as indicated below ("Port" setting should not have to be changed).

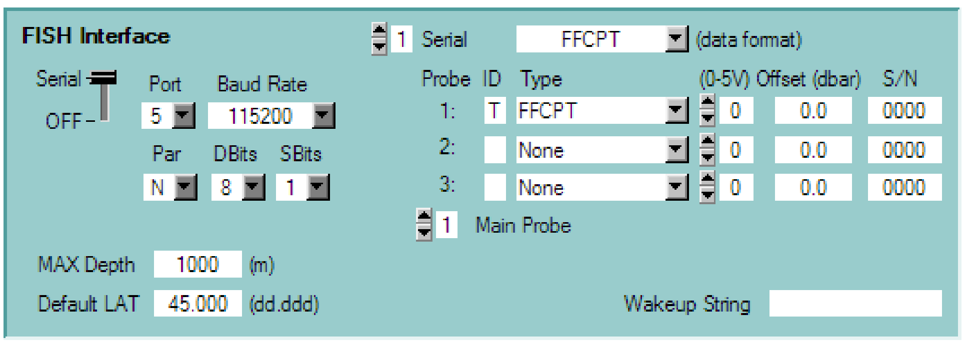

Figure 8. MVP Fish-Interface Configuration Screen

Exit System Configuration and save when prompted.

Assuming the FFCPT has been configured properly and is running; confirm that the data is being received by opening the Fish Interface terminal window in the Debug menu.

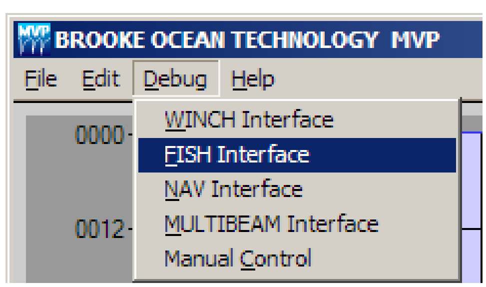

Figure 9. MVP Software Debug Menu

In order for the incoming slow data to be plotted in the correct engineering units on the corresponding strip charts and in the digital readouts, the *FFCPT.cfg* file of the currently connected FFCPT must be copied to the Data Directory specified in the MVP System Configuration window.

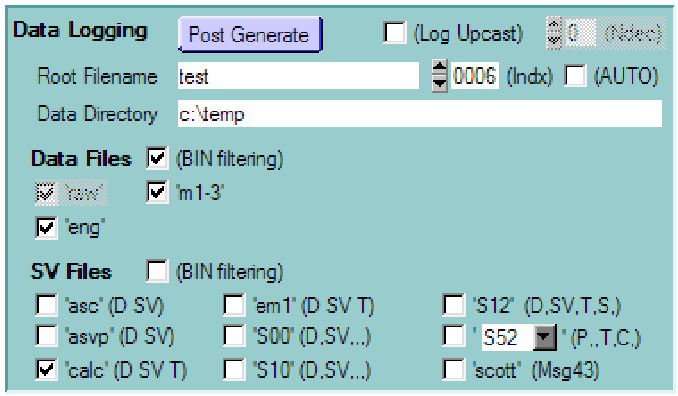

Figure 10. MVP Configuration Screen

Data should now be displayed in the Deployment data section of the main view screen as well as being plotted on the strip charts. Tail and Nose pressure are displayed in the Depth (m) 1 and 2 digital readout boxes. LOg, MIDg, and HIg accelerometers are displayed in Accel (g) 1, 2, 3 boxes. Mud-line is displayed in Mud (V) 1 box. VBat is displayed in Vbat (V) 1 box. Left clicking on the strip charts cycles through the Depth -> SV -> Tension displays. Only the tail pressure is plotted in the Depth strip chart. To scale the plots, right-click on the plot window or adjust the scale in the configuration screen. The Profile Depth (m) is plotted on the bottom of the Depth strip chart. The maximum profile depth is displayed here – it is automatically reset at the start of a new cast or when RESET is pressed. The 3 accelerometers and the mud-line response are plotted in the SV strip chart. Peak tension is displayed at the bottom of the Tension strip chart. To reset the peak tension to zero, right-click in the readout box.

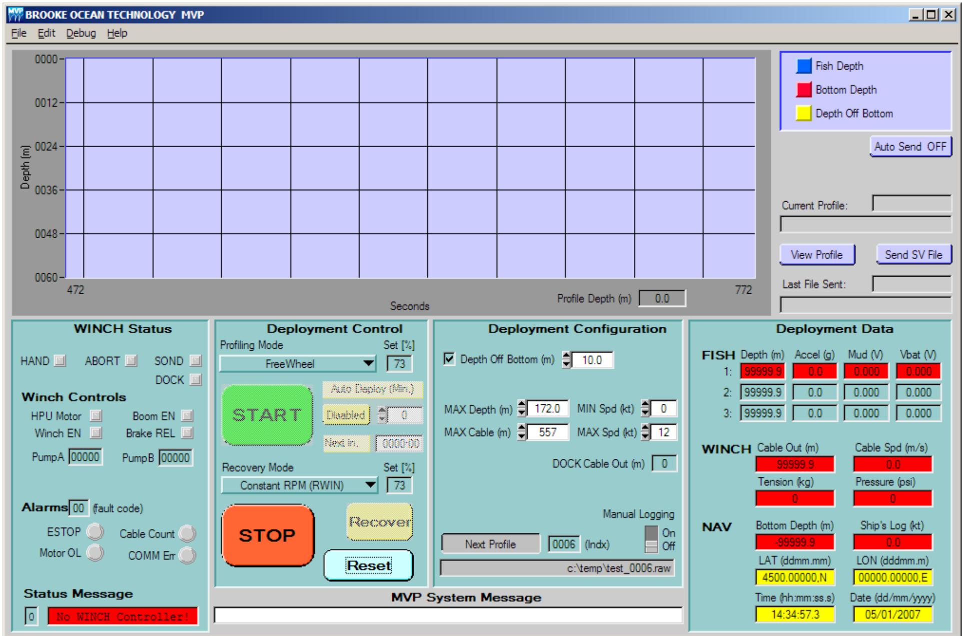

Figure 11. MVP Software Main Screen

5. Conclusions

The further integration of the FFCPT with the MVP has significantly enhanced the capability of the system as an effective tool for the REA of *in situ* seafloor properties [2]. As a result of the implementation of the capability to continuously receive in real-time the 25 Hz FFCPT data and the sound velocity data, in addition to intermittent telemetry of the FFCPT 2,000 Hz geotechnical data, the MVP/FFCPT can efficiently collect a wealth of data that may be of use for Naval applications such as Military Oceanography, MCM, and ASW.

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6. Plans for Future Work

BOT, in conjunction with input from DRDC, has identified several areas of further development. These include:

> Implementation of surface powering. As a direct result of the number of drops being completed in the underway deployment mode, and the fact that the instrument no longer needs to be recovered to download the data, it is desired to implement surface powering of the FFCPT. This will eliminate the requirement to rely on battery power when using the instrument in conjunction with an MVP, allowing more data to be collected in less time because it does not need to be recovered to change batteries.

Re-design of the FFCPT powering and communications circuitry to prevent failures as identified in section 3.12 and in conjunction with the implementation of surface powering as discussed above.

Further streamlining of the interaction between the MVP controller software and the FFCPT.

Development of the fully automated deployment logic, leading to an acceptable solution for the deployment of the FFCPT, underway, and in a fully automated manner.

Improvement to the manner in which the tow cable is electrically connected to the FFCPT. In particular, to create a more robust connection.

Improvement to the re-configuration requirement when switching between the FFCPT and other MVP payloads.

Tow cable evolution (stronger tow cable for FFCPT operations).

Further development of the post-processing software, FfcptView. This would include improvements to the communications, use of filtered pressure data in the analysis, and improvements to the charting functions.

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7. References

[1] Osler, J., et al., The Integration of the Free Fall Cone Penetrometer (FFCPT) with the Moving Vessel Profiler (MVP) for the rapid assessment of seabed characteristics, International Hydrographic Review, Vol. 7 No. 3 (New Series), 19 – 27, October 2006.

[2] Furlong, A., Osler, J., Christian, H., Cunningham, D.,Pecknold, S., The Moving Vessel Profiler – a Rapid Environmental Assessment Tool for the collection of water column profiles and sediment classification, as presented at UDT Pacific, December 2006. [available at http://www.brooke-ocean.com/ffcpt-01.html]

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Appendix A – Calibration Coefficients

The table on the next page summarizes the sensor calibration coefficients for both DRDC FFCPTs that were used during Q290, Q298 and the REA trial. For further detail on the instrument configurations, please refer to Appendix B.

SUMMARY OF SENSOR CALIBRATION COEFFICIENTS

	Trial	Date	Firmware	Lo-g[B]		Mid-g[B]		Hi-g[B]		Nose P.		Tail P.	
				Offset	Scale	Offset	Scale	Offset	Scale	Offset	Scale	Offset	Scale
S/N 10119	Q290	10/19/05	2.54	1606	1149.327	1269	129.967	1254	26.823	580[A]	11.664[A]	594[A]	11.708[A]
	Q298	08/01/06	2.60	1644	818.269	823	162.964	413	40.854	245	5.032	214	5.043
	REA	10/18/06	2.62	1637	817.445	823	163.430	413	40.911	241	5.025	207	5.042
	PRESENT[C]	01/08/07	2.62	1513	807.875	880	160.807	273	40.123	241	5.025	207	5.042
S/N 10414	Q298	07/22/06	2.60	1522	807.293	912	160.63	266	40.174	227	5.054	319	5.073
	REA	10/17/06	2.62	1513	804.863	908	159.853	264	39.712	226	5.063	217	5.051

NOTES:	
A	The pressure sensors installed during Q290 had a pressure range of 0 - 500 psi. These sensors were replaced with new sensors of the same style, having a range of 0 - 1,000 psi following the trial.
B	FFCPT 10119 had the original style of accelerometers for Q290, Q298 and REA, while FFCPT 10414 had the new accelerometers for both Q298 and the REA trial.
C	FFCPT 10119 was upgraded to the new accelerometers following the REA trial.

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Appendix B – Configuration Files

Q290 DRDC 1 (SN10119)

```
*** General ***
    Software Ver: 2.54
001 Instrument: SN10119
002 Date (mm/dd/yyyy): 10/19/2005
003 Time (hh mm ss): 16:25:44

*** Main Communications ***
010 Port: 0
011 Baud Rate (9600/57600/115200): 9600

*** AtoD - sampling parameters ***
    System Clock (MHz): 16.000000
    HiSpd Sampling Period (us): 499.938
    LoSpd Sampling Period (us): 39995.000
103 LoSpd SubSampL Factor (100): 80
    Number of Channels (1-8): 8
105 Reference Channel (0-7):  7

*** Datalogging ***
110 Root Filename (6 char Max or AUTO): DROP
111 File Index (00-99): 00
112 HiSpd Log Interval (0s=max): 20.000
    NBufr1 Samples: 40005
    Max Log Interval (s): 21.277
115 LoSpd Log Interval (300s): 299.923
    NBufr0 Samples: 7499

*** Trigger Parameters ***
200 Trigger Channel (0-7): 4
201 Trigger Level (m): 50.0
202 Pre Trigger (0%-90%): 40.0
    Trigger Count: 1163

*** Trigger filter coefficients ***
210 Filter Coeff0: 1.000
211 Filter Coeff1: 1.000
212 Filter Coeff2: 1.000
213 Filter Coeff3: 1.000

*** AutoStart (multi drops) ***
300 Enable (0/1): 1
301 Delay (1s-30s): 5
302 Re-Arm Channel (0-7): 1
303 Re-Arm Level (m): 10.0
    Re-Arm Count: 0711
```

```
*** Channel Calb Factors ***
500 A0 Label (15 chars max): LO-g
501 A0  Offset (counts): 1606
502 A0  Scale (Counts/EU): 1149.327
503 A0  Eng. Unit (15 chars max): g
    A0  Range Minimum: -1.397 g
    A0  Range Maximum: 2.166 g
510 A1 Label (15 chars max): Tail_Press
511 A1  Offset (counts): 0594
512 A1  Scale (Counts/EU): 11.708
513 A1  Eng. Unit (15 chars max): m
    A1  Range Minimum: -50.735 m
    A1  Range Maximum: 299.026 m
520 A2 Label (15 chars max): HI-g
521 A2  Offset (counts): 1254
522 A2  Scale (Counts/EU): 26.823
523 A2  Eng. Unit (15 chars max): g
    A2  Range Minimum: -46.751 g
    A2  Range Maximum: 105.917 g
530 A3 Label (15 chars max): Mid-g
531 A3  Offset (counts): 1269
532 A3  Scale (Counts/EU): 129.967
533 A3  Eng. Unit (15 chars max): g
    A3  Range Minimum: -9.764 g
    A3  Range Maximum: 21.744 g
540 A4 Label (15 chars max): Nose_Press
541 A4  Offset (counts): 0580
542 A4  Scale (Counts/EU): 11.664
543 A4  Eng. Unit (15 chars max): m
    A4  Range Minimum: -49.726 m
    A4  Range Maximum: 301.355 m
550 A5 Label (15 chars max): Not_Used
551 A5  Offset (counts): 0000
552 A5  Scale (Counts/EU): 1.000
553 A5  Eng. Unit (15 chars max): mV
    A5  Range Minimum: 0.000 mV
    A5  Range Maximum: 4095.000 mV
560 A6 Label (15 chars max): Mud-line
561 A6  Offset (counts): 0000
562 A6  Scale (Counts/EU): 1.000
563 A6  Eng. Unit (15 chars max): mV
    A6  Range Minimum: 0.000 mV
    A6  Range Maximum: 4095.000 mV
570 A7 Label (15 chars max): Battery
571 A7  Offset (counts): 0000
572 A7  Scale (Counts/EU): 273.107
573 A7  Eng. Unit (15 chars max): VDC
    A7  Range Minimum: 0.000 VDC
    A7  Range Maximum: 14.994 VDC

*** RModule ***
600 Enable (0/1): 0
601 Cmd Char (a-auto, 0-5): a
602 No. Readings (1-25): 25
```

```
603 No. Electrodes (1-2): 2

*** SVModule ***
700 SVPEnable (0/1): 1

*** Display ***
800 Display Rate (0.5Hz-25 Hz): 25.0
801 Display NAve (1-25 samples): 25

*** End Config ***

NumChans = 8;
T1SampL = 499.938; %(us)
T0SampL = 39995.000; %(us)

Bufr0NScansLogD = 7499;
Bufr0SampLOffset = 65;

Bufr1NScansLogD = 40005;
Bufr1NPreTLogD = 16002;
Bufr1NPosTLogD = 24003;
```

Q298 DRDC1 (SN10119)

```
*** General ***
    Software Ver: 2.60
001 Instrument: 10119
002 Date (mm/dd/yyyy): 08/01/2006
003 Time (hh mm ss): 21:37:08

*** Main Communications ***
010 Port: 0
011 Baud Rate (9600/57600/115200): 9600

*** AtoD - sampling parameters ***
    System Clock (MHz): 16.000000
    HiSpd Sampling Period (us): 499.938
    LoSpd Sampling Period (us): 39995.000
103 LoSpd SubSampL Factor (100): 80
    Number of Channels (1-8): 8
105 Reference Channel (0-7):  7

*** Datalogging ***
110 Root Filename (6 char Max or AUTO): DROP
111 File Index (00-99): 00
112 HiSpd Log Interval (0s=max): 20.000
    NBufr1 Samples: 40005
    Max Log Interval (s): 21.213
115 LoSpd Log Interval (300s): 299.923
    NBufr0 Samples: 7499
```

```
*** Trigger Parameters ***
200 Trigger Channel (0-7): 1
201 Trigger Level (m): 60.0
202 Pre Trigger (0%-90%): 10.0
    Trigger Count: 0516

*** Trigger filter coefficients ***
210 Filter Coeff0: 1.000
211 Filter Coeff1: 1.000
212 Filter Coeff2: 1.000
213 Filter Coeff3: 1.000

*** AutoStart (multi drops) ***
300 Enable (0/1): 1
301 Delay (1s-30s): 5
302 Re-Arm Channel (0-7): 1
303 Re-Arm Level (m): 10.0
    Re-Arm Count: 0264

*** Channel Calb Factors ***
500 A0 Label (15 chars max): LO-g
501 A0  Offset (counts): 1644
502 A0  Scale (Counts/EU): 818.269
503 A0  Eng. Unit (15 chars max): g
    A0  Range Minimum: -2.009 g
    A0  Range Maximum: 2.995 g
510 A1 Label (15 chars max): Tail_Press
511 A1  Offset (counts): 0214
512 A1  Scale (Counts/EU): 5.043
513 A1  Eng. Unit (15 chars max): m
    A1  Range Minimum: -42.435 m
    A1  Range Maximum: 769.582 m
520 A2 Label (15 chars max): HI-g
521 A2  Offset (counts): 0413
522 A2  Scale (Counts/EU): 40.854
523 A2  Eng. Unit (15 chars max): g
    A2  Range Minimum: -10.109 g
    A2  Range Maximum: 90.126 g
530 A3 Label (15 chars max): Mid-g
531 A3  Offset (counts): 0823
532 A3  Scale (Counts/EU): 162.964
533 A3  Eng. Unit (15 chars max): g
    A3  Range Minimum: -5.050 g
    A3  Range Maximum: 20.078 g
540 A4 Label (15 chars max): Nose_Press
541 A4  Offset (counts): 0245
542 A4  Scale (Counts/EU): 5.032
543 A4  Eng. Unit (15 chars max): m
    A4  Range Minimum: -48.688 m
    A4  Range Maximum: 765.103 m
550 A5 Label (15 chars max): Not_Used
551 A5  Offset (counts): 0000
552 A5  Scale (Counts/EU): 1.000
```

```
553 A5  Eng. Unit (15 chars max): mV
    A5  Range Minimum: 0.000 mV
    A5  Range Maximum: 4095.000 mV
560 A6 Label (15 chars max): Mud-line
561 A6  Offset (counts): 0000
562 A6  Scale (Counts/EU): 1.000
563 A6  Eng. Unit (15 chars max): mV
    A6  Range Minimum: 0.000 mV
    A6  Range Maximum: 4095.000 mV
570 A7 Label (15 chars max): Battery
571 A7  Offset (counts): 0011
572 A7  Scale (Counts/EU): 263.310
573 A7  Eng. Unit (15 chars max): V
    A7  Range Minimum: -0.042 V
    A7  Range Maximum: 15.510 V

*** RModule ***
600 Enable (0/1): 0
601 Cmd Char (a-auto, 0-5): 2
602 No. Readings (1-25): 25
603 No. Electrodes (1-2): 2

*** SVModule ***
700 SVPEnable (0/1): 1

*** Display ***
800 Display Rate (0.5Hz-25 Hz): 25.0
801 Display NAve (1-25 samples): 25


*** End Config ***

NumChans = 8;
T1SampL = 499.938; %(us)
T0SampL = 39995.000; %(us)

Bufr0NScansLogD = 6337;
Bufr0SampLOffset = 38;

Bufr1NScansLogD = 13999;
Bufr1NPreTLogD = 1399;
Bufr1NPosTLogD = 12600;
```

Q298 DRDC2 (SN10414)

```
*** General ***
    Software Ver: 2.60
001 Instrument: 10414
002 Date (mm/dd/yyyy): 07/22/2006
003 Time (hh mm ss): 16:29:46

*** Main Communications ***
010 Port: 0
011 Baud Rate (9600/57600/115200): 9600

*** AtoD - sampling parameters ***
    System Clock (MHz): 16.000000
    HiSpd Sampling Period (us): 499.938
    LoSpd Sampling Period (us): 39995.000
103 LoSpd SubSampL Factor (100): 80
    Number of Channels (1-8): 8
105 Reference Channel (0-7):  7

*** Datalogging ***
110 Root Filename (6 char Max or AUTO): DROP
111 File Index (00-99): 00
112 HiSpd Log Interval (0s=max): 20.000
    NBufr1 Samples: 40005
    Max Log Interval (s): 21.213
115 LoSpd Log Interval (300s): 299.923
    NBufr0 Samples: 7499

*** Trigger Parameters ***
200 Trigger Channel (0-7): 3
201 Trigger Level (g): 5.0
202 Pre Trigger (0%-90%): 30.0
    Trigger Count: 1715

*** Trigger filter coefficients ***
210 Filter Coeff0: 1.000
211 Filter Coeff1: 1.000
212 Filter Coeff2: 1.000
213 Filter Coeff3: 1.000

*** AutoStart (multi drops) ***
300 Enable (0/1): 1
301 Delay (1s-30s): 5
302 Re-Arm Channel (0-7): 1
303 Re-Arm Level (m): 10.0
    Re-Arm Count: 0369

*** Channel Calb Factors ***
500 A0 Label (15 chars max): LO-g
501 A0  Offset (counts): 1522
502 A0  Scale (Counts/EU): 807.293
```

```
503 A0  Eng. Unit (15 chars max): g
    A0  Range Minimum: -1.885 g
    A0  Range Maximum: 3.187 g
510 A1 Label (15 chars max): Tail_Press
511 A1  Offset (counts): 0319
512 A1  Scale (Counts/EU): 5.073
513 A1  Eng. Unit (15 chars max): m
    A1  Range Minimum: -62.882 m
    A1  Range Maximum: 744.333 m
520 A2 Label (15 chars max): HI-g
521 A2  Offset (counts): 0266
522 A2  Scale (Counts/EU): 40.174
523 A2  Eng. Unit (15 chars max): g
    A2  Range Minimum: -6.621 g
    A2  Range Maximum: 95.310 g
530 A3 Label (15 chars max): Mid-g
531 A3  Offset (counts): 0912
532 A3  Scale (Counts/EU): 160.630
533 A3  Eng. Unit (15 chars max): g
    A3  Range Minimum: -5.678 g
    A3  Range Maximum: 19.816 g
540 A4 Label (15 chars max): Nose_Press
541 A4  Offset (counts): 0227
542 A4  Scale (Counts/EU): 5.054
543 A4  Eng. Unit (15 chars max): m
    A4  Range Minimum: -44.915 m
    A4  Range Maximum: 765.334 m
550 A5 Label (15 chars max): Not_Used
551 A5  Offset (counts): 0000
552 A5  Scale (Counts/EU): 1.000
553 A5  Eng. Unit (15 chars max): mV
    A5  Range Minimum: 0.000 mV
    A5  Range Maximum: 4095.000 mV
560 A6 Label (15 chars max): Mud-line
561 A6  Offset (counts): 0000
562 A6  Scale (Counts/EU): 1.000
563 A6  Eng. Unit (15 chars max): mV
    A6  Range Minimum: 0.000 mV
    A6  Range Maximum: 4095.000 mV
570 A7 Label (15 chars max): Battery
571 A7  Offset (counts): 0011
572 A7  Scale (Counts/EU): 263.310
573 A7  Eng. Unit (15 chars max): V
    A7  Range Minimum: -0.042 V
    A7  Range Maximum: 15.510 V

*** RModule ***
600 Enable (0/1): 0
601 Cmd Char (a-auto, 0-5): 2
602 No. Readings (1-25): 25
603 No. Electrodes (1-2): 2

*** SVModule ***
700 SVPEnable (0/1): 1
```

```
*** Display ***
800 Display Rate (0.5Hz-25 Hz): 25.0
801 Display NAve (1-25 samples): 25


*** End Config ***

NumChans = 8;
T1SampL = 499.938; %(us)
T0SampL = 39995.000; %(us)

Bufr0NScansLogD = 2020;
Bufr0SampLOffset = 71;

Bufr1NScansLogD = 40005;
Bufr1NPreTLogD = 12001;
Bufr1NPosTLogD = 28004;
```

REA DRDC1 (SN10119)

```
*** General ***
000 Software Ver: 2.62
001 Instrument: SN10119
002 Date (mm/dd/yyyy): 10/18/2006
003 Time (hh mm ss): 15:55:44

*** Main Communications ***
010 Port: 0
011 Baud Rate (9600/57600/115200): 9600
012 OpMode (0-StandAlone, 1-Real-Time): 1

*** AtoD - sampling parameters ***
    System Clock (MHz): 16.000000
    HiSpd Sampling Period (us): 499.938
    LoSpd Sampling Period (us): 39995.000
103 LoSpd SubSampL Factor (100): 80
    Number of Channels (1-8): 8
105 Reference Channel (0-7):  7

*** Datalogging ***
110 Root Filename (4 char Max or AUTO): DROP
111 File Index (0-9999): 0000
112 HiSpd Log Interval (0s=max): 20.000
    NBufr1 Samples: 40005
114 Pre Trigger (0%-90%): 50.0
    Max Log Interval (s): 21.405
115 LoSpd Log Interval (300s): 299.923
    NBufr0 Samples: 7499
```

```
*** Trigger Parameters ***
200 Trig0 Channel (0-7): 1
201 Trig0 Level (m): 50.0
    Trig0 Count: 0459
203 Trig1 Channel (0-7): 3
204 Trig1 Level (g): 2.0
    Trig1 Count: 1149

*** Trigger filter coefficients ***
210 Filter Coeff0: 1.000
211 Filter Coeff1: 1.000
212 Filter Coeff2: 1.000
213 Filter Coeff3: 1.000

*** AutoStart (multi drops) ***
300 Enable (0/1): 1
301 Delay (1s-30s): 1
302 Re-Arm Channel (0-7): 1
303 Re-Arm Level (m): 19.6
304 Re-Arm Count: 0306

*** Channel Calb Factors ***
500 A0 Label (15 chars max): LO-g
501 A0  Offset (counts): 1637
502 A0  Scale (Counts/EU): 817.445
503 A0  Eng. Unit (15 chars max): g
    A0  Range Minimum: -2.003 g
    A0  Range Maximum: 3.007 g
510 A1 Label (15 chars max): Tail_Press
511 A1  Offset (counts): 0207
512 A1  Scale (Counts/EU): 5.042
513 A1  Eng. Unit (15 chars max): m
    A1  Range Minimum: -41.055 m
    A1  Range Maximum: 771.123 m
520 A2 Label (15 chars max): HI-g
521 A2  Offset (counts): 0413
522 A2  Scale (Counts/EU): 40.911
523 A2  Eng. Unit (15 chars max): g
    A2  Range Minimum: -10.095 g
    A2  Range Maximum: 90.000 g
530 A3 Label (15 chars max): Mid-g
531 A3  Offset (counts): 0823
532 A3  Scale (Counts/EU): 163.430
533 A3  Eng. Unit (15 chars max): g
    A3  Range Minimum: -5.036 g
    A3  Range Maximum: 20.021 g
540 A4 Label (15 chars max): Nose_Press
541 A4  Offset (counts): 0241
542 A4  Scale (Counts/EU): 5.025
543 A4  Eng. Unit (15 chars max): m
    A4  Range Minimum: -47.960 m
    A4  Range Maximum: 766.965 m
550 A5 Label (15 chars max): Not_Used
551 A5  Offset (counts): 0000
```

```
552 A5  Scale (Counts/EU): 1.000
553 A5  Eng. Unit (15 chars max): mV
    A5  Range Minimum: 0.000 mV
    A5  Range Maximum: 4095.000 mV
560 A6 Label (15 chars max): Mud-line
561 A6  Offset (counts): 0000
562 A6  Scale (Counts/EU): 1.000
563 A6  Eng. Unit (15 chars max): mV
    A6  Range Minimum: 0.000 mV
    A6  Range Maximum: 4095.000 mV
570 A7 Label (15 chars max): Battery
571 A7  Offset (counts): 0011
572 A7  Scale (Counts/EU): 263.310
573 A7  Eng. Unit (15 chars max): V
    A7  Range Minimum: -0.042 V
    A7  Range Maximum: 15.510 V

*** RModule ***
600 Enable (0/1): 0
601 Cmd Char (a-auto, 0-5): 2
602 No. Readings (1-25): 25
603 No. Electrodes (1-2): 2

*** SVModule ***
700 SVPEnable (0/1): 1

*** Display ***
800 Display Rate (0.5Hz-25 Hz): 25.0
801 Display NAve (1-25 samples): 25


*** End Config ***

NumChans = 8;
T1SampL = 499.938; %(us)
T0SampL = 39995.000; %(us)

Bufr0NScansLogD = 3013;
Bufr0SampLOffset = 7;

Bufr1NScansLogD = 20002;
Bufr1NPreTLogD = 10001;
Bufr1NPosTLogD = 10001;
```

REA DRDC2 (SN10414)

```
*** General ***
000 Software Ver: 2.62
001 Instrument: SN10414
002 Date (mm/dd/yyyy): 10/17/2006
003 Time (hh mm ss): 22:11:23

*** Main Communications ***
010 Port: 0
011 Baud Rate (9600/57600/115200): 9600
012 OpMode (0-StandAlone, 1-Real-Time): 1

*** AtoD - sampling parameters ***
    System Clock (MHz): 16.000000
    HiSpd Sampling Period (us): 499.938
    LoSpd Sampling Period (us): 39995.000
103 LoSpd SubSampL Factor (100): 80
    Number of Channels (1-8): 8
105 Reference Channel (0-7):  7

*** Datalogging ***
110 Root Filename (4 char Max or AUTO): DROP
111 File Index (0-9999): 0000
112 HiSpd Log Interval (0s=max): 20.000
    NBufr1 Samples: 40005
114 Pre Trigger (0%-90%): 50.0
    Max Log Interval (s): 21.405
115 LoSpd Log Interval (300s): 299.923
    NBufr0 Samples: 7499

*** Trigger Parameters ***
200 Trig0 Channel (0-7): 1
201 Trig0 Level (m): 49.9
    Trig0 Count: 0469
203 Trig1 Channel (0-7): 3
204 Trig1 Level (g): 2.0
    Trig1 Count: 1227

*** Trigger filter coefficients ***
210 Filter Coeff0: 1.000
211 Filter Coeff1: 1.000
212 Filter Coeff2: 1.000
213 Filter Coeff3: 1.000

*** AutoStart (multi drops) ***
300 Enable (0/1): 1
301 Delay (1s-30s): 1
302 Re-Arm Channel (0-7): 1
303 Re-Arm Level (m): 20.0
304 Re-Arm Count: 0318
```

```
*** Channel Calb Factors ***
500 A0 Label (15 chars max): LO-g
501 A0  Offset (counts): 1513
502 A0  Scale (Counts/EU): 804.863
503 A0  Eng. Unit (15 chars max): g
    A0  Range Minimum: -1.880 g
    A0  Range Maximum: 3.208 g
510 A1 Label (15 chars max): Tail_Press
511 A1  Offset (counts): 0217
512 A1  Scale (Counts/EU): 5.051
513 A1  Eng. Unit (15 chars max): m
    A1  Range Minimum: -42.962 m
    A1  Range Maximum: 767.769 m
520 A2 Label (15 chars max): HI-g
521 A2  Offset (counts): 0264
522 A2  Scale (Counts/EU): 39.712
523 A2  Eng. Unit (15 chars max): g
    A2  Range Minimum: -6.648 g
    A2  Range Maximum: 96.470 g
530 A3 Label (15 chars max): Mid-g
531 A3  Offset (counts): 0908
532 A3  Scale (Counts/EU): 159.853
533 A3  Eng. Unit (15 chars max): g
    A3  Range Minimum: -5.680 g
    A3  Range Maximum: 19.937 g
540 A4 Label (15 chars max): Nose_Press
541 A4  Offset (counts): 0226
542 A4  Scale (Counts/EU): 5.063
543 A4  Eng. Unit (15 chars max): m
    A4  Range Minimum: -44.638 m
    A4  Range Maximum: 764.171 m
550 A5 Label (15 chars max): Not_Used
551 A5  Offset (counts): 0000
552 A5  Scale (Counts/EU): 1.000
553 A5  Eng. Unit (15 chars max): mV
    A5  Range Minimum: 0.000 mV
    A5  Range Maximum: 4095.000 mV
560 A6 Label (15 chars max): Mud-line
561 A6  Offset (counts): 0000
562 A6  Scale (Counts/EU): 1.000
563 A6  Eng. Unit (15 chars max): mV
    A6  Range Minimum: 0.000 mV
    A6  Range Maximum: 4095.000 mV
570 A7 Label (15 chars max): Battery
571 A7  Offset (counts): 0011
572 A7  Scale (Counts/EU): 263.310
573 A7  Eng. Unit (15 chars max): V
    A7  Range Minimum: -0.042 V
    A7  Range Maximum: 15.510 V

*** RModule ***
600 Enable (0/1): 0
601 Cmd Char (a-auto, 0-5): 2
602 No. Readings (1-25): 25
```

```
603 No. Electrodes (1-2): 2

*** SVModule ***
700 SVPEnable (0/1): 1

*** Display ***
800 Display Rate (0.5Hz-25 Hz): 25.0
801 Display NAve (1-25 samples): 25


*** End Config ***

NumChans = 8;
T1SampL = 499.938; %(us)
T0SampL = 39995.000; %(us)

Bufr0NScansLogD = 2453;
Bufr0SampLOffset = 8;

Bufr1NScansLogD = 20002;
Bufr1NPreTLogD = 10001;
Bufr1NPosTLogD = 10001;
```

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In the fall of 2005, experimental trials to integrate the Free-Fall Cone Penetrometer (FFCPT), an *in situ* sediment profiling tool, with a Moving Vessel Profiler (MVP), an automated profiling winch, from a vessel underway were completed in conjunction with DRDC Atlantic aboard the *CFAV Quest* as part of scientific cruise Q290. This experimental work revealed several areas in which further R&D was required. This Contract Report details the work completed by Brooke Ocean Technology Ltd. (BOT), developer and manufacturer of both the MVP and FFCPT, to further integrate the two products. The primary development efforts were to improve methods for data handling, to permit the viewing of FFCPT data in real-time, to investigate the performance of the FFCPT sensor suite, and to upgrade the MVP to further its operational capability and to improve the interface with the FFCPT. These developments are consistent with the primary goal of the work: to develop the system as an effective tool for Rapid Environmental Assessment (REA) of *in situ* seabed properties. This effort culminated in a successful demonstration of the system's REA capability aboard the Maritime Coastal Defence Vessel (MCDV) *HMCS Summerside* in October 2006.

À l'automne 2005, des essais expérimentaux visant à intégrer la sonde pénétrométrique à cône à chute libre (SPCCL), un outil d'établissement de profils sédimentaires *in situ*, à un Moving Vessel Profiler (MVP), un treuil profileur automatisé, à partir d'un navire en mouvement ont été effectués en liaison avec RDDC Atlantique à bord du *NAFC Quest* dans le cadre de la croisière scientifique Q290. Cette expérience a révélé plusieurs questions nécessitant davantage de recherche et développement. La présente déclaration de contrat décrit en détail les travaux effectués par Brooke Ocean Technology Ltd. (BOT), concepteur et fabricant du MVP et de la SPCCL, pour intégrer davantage les deux produits. Les principaux efforts de développement ont porté sur l'amélioration des méthodes de manipulation des données, sur les façons de rendre possible la visualisation des données de la SPCCL en temps réel, sur l'étude de la performance de l'ensemble de capteurs de la SPCCL ainsi que sur l'amélioration de la capacité opérationnelle du MVP et de l'interface avec la SPCCL. Les progrès réalisés cadrent avec l'objectif principal du projet qui est le suivant : faire du système un outil efficace pour effectuer des évaluations environnementales rapides de propriétés *in situ* du fond marin. Le projet a abouti à la démonstration réussie de la capacité du système pour effectuer des évaluations environnementales rapides à partir du navire de défense côtière (NDC) *NCSM Summerside* en octobre 2006.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS

Rapid Environmental Assessment; Marine sediments; Cone Penetrometer Test; Seabed classification; Marine geophysics; Oceanographic and geophysical instrumentation

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