Annex B
To: W8472-165639

TECHNICAL STATEMENT OF REQUIREMENT (TSOR)

Electronic Warfare (EW) Payload System

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REFERENCES

a. MIL-STD-810: Environmental Engineering Considerations and Laboratory Tests
b. Humpback USV-T Payload Integration Interface Control
c. Humpback USV-T Hardpoints Drawings

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LIST OF ACRONYMS

ASM	Anti-Ship Missile
ASMD	Anti-Ship Missile Defence
BW	Bandwidth
CA	Contract Authority
CDRL	Contract Data Requirement List
CEIL	Contract End Item List
dB	decibel
dBW	decibel Watt
DID	Deliverable Item Description
DND	Department of National Defence
DRFM	Digital Radio Frequency Memory
DRI	Detection Recognition Identification
EA	Electronic Attack
EW	Electronic Warfare
ECP	Engineering Change Proposal
EO	Electro-Optical
ERP	Effective Radiated Power
FAT	Factory Acceptance Test
FPR	Final Progress Review
FSR	Field Service Representative
GHz	Gigahertz
GFI	Government Furnished Information
HAT	Harbor Acceptance Trial
HAZMAT	Hazardous Materials
HPoT	Horizontal Pixels on Target
HVU	High Value Unit
IAW	In Accordance With

LRU	Lowest Replaceable Unit
MACA	Months After Contract Award
MOTS	Military-Off-The-Shelf
MTSC	Meggitt Training Systems Canada
MSDS	Material Safety Data Sheets
NEAR-U	Naval Electronic Attack Recapitalization - Unmanned
OEM	Original Equipment Manufacturer
PM	Project Manager
PA	Procurement Authority
PPB	Provisioning Parts Breakdown
PRF	Pulse Repetition Frequency
PRI	Pulse Repetition Interval
PRM	Progress Review Meeting
PSR	Project Status Report
PSPC	Public Services and Procurement Canada
PW	Pulse Width
QAR	Quality Assurance Representative
RCN	Royal Canadian Navy
RGS	Range Gate Steal
RGPO	Range Gate Pull Off
RSPL	Recommended Spare Parts List
Rx	Receive
SAT	Sea Acceptance Trial
SOW	Statement of Work
SPTD	Supplementary Provisioning Technical Documentation
TA	Technical Authority
TBD	To Be Determined
TDP	Technical Data Package
TG	Task Group
TRM	Technical Review Meeting

TSOR	Technical Statement of Requirements
Tx	Transmit
USV	Unmanned Surface Vehicles
VGS	Velocity Gate Steal
VGPO	Velocity Gate Pull Off
VPoT	Vertical Pixels on Target
W	Watt

1 INTRODUCTION

1.1 OBJECTIVE

1.1.1 The objective of this Technical Statement of Requirements (TSOR) is to state the performance and technical requirements for the EW Payload system.

1.2 SYSTEM DESCRIPTION

1.2.1 An EW Payload system is defined as a set of components designed and integrated into a USV to provide jamming capability against Anti-Ship Missile threats, and as well as, radar testing and training capacity. For the purpose of this TSOR, the components of the EW Payload system are categorized into the following two groups:

1.2.1.1 The mast and mast-mounted components: The mast and the components of the EW Payload system that are mounted on the mast of the USV.

1.2.1.2 USV-inboard components: The components of the EW Payload system that are mounted inside the USV.

1.2.2 The purpose of the EW Payload system is two-fold: 1) Anti-Ship Missile Defence (ASMD) in a self-protection and Task Group (TG) setting and 2) Radar testing and Training. The EW Payload system will be integrated in existing RCN USV platforms. The USV and the EW Payload system will be launched, recovered, and remotely controlled from the Controlling Platform. Line-of-Sight control will be maintained with the Controlling Platform.

1.2.3 The USV platform is an existing RCN USV, with pre-defined mounting points and spaces allocated for the integration of the EW Payload system. The details of the pre-defined mounting points and allocated spaces are provided in *"Humpback USV-T Hardpoints Drawings"*.

1.2.4 When stowed on board the ship, the mast and the mast-mounted components will be stored in containers to allow for storage of USVs in their current stacked configuration. The USV-inboard components will remain inside the USV. For launching operations, the mast and the mast-mounted components of the EW Payload system will be installed on the USV, on board the ship before launching. Conversely, the USV with the EW Payload system will be recovered from the sea. Once on board the ship, the mast and mast-mounted components of the EW Payload system will be removed from the USV and prepared for storage.

2 SYSTEM REQUIREMENTS

2.1 GENERAL CAPABILITIES

2.1.1 The jammer module of the EW Payload system must be Military-Off-the-Shelf (MOTS) equipment. The jammer module generates RF jamming signals and provides the EW techniques. It includes, but not limited to, Digital Radio Frequency Memory (DRFM) and up/down converters.

2.1.2 The jammer module of the EW Payload system must be or must have been operational on at least one mobile platform supporting military operations[1].

2.1.3 The EW Payload system must be designed such that the users can program the system with the appropriate jamming response, based on the provided documentation on the theory of operation of the system.

2.1.4 The EW Payload system must be mechanically integratable to the existing RCN USV platform, with pre-defined mounting points and allocated spaces as provided in *"Humpback USV-T Hardpoints Drawings"*.

2.1.5 The EW Payload system must be electrically integratable to the existing RCN USV platform in accordance with "*Humpback USV-T Payload Integration Interface Control"*.

2.1.6 The EW Payload system must be modular such that it can be fitted on the USV, utilizing the mast assembly and the allocated spaces inside the USV. The locations of the mounting points and available spaces inside the USV are provided in *"Humpback USV-T Hardpoints Drawings"*.

2.1.7 The mast and mast-mounted components of the EW Payload system must be able to be manually mounted onto the USV or removed from the USV by a maximum of two (2) trained personnel and within 1 hour.

2.1.8 The mast and mast-mounted components of the EW Payload system must be able to be stored onboard and transported securely in waterproof, stackable, impact-resistant, and durable containers. Each container together with its contents must be less than 1500 mm (L) x 750 mm (W) x 500 mm (D) in dimensions and weight no more than 40 kg.

2.1.9 The EW Payload system must be able to receive and to provide minimum transmit Effective Radiated Power (ERP) throughout the required azimuthal and elevation coverage while the USV is maneuvering. The required azimuthal coverage is 360 degrees. The required elevation coverage is ±15 degrees about the horizon.

2.1.10 The EW Payload system must include modular real-time, trainable, and stabilized video surveillance capability.

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1 Military operation is an activity or a series of activities related to the carrying out of a strategic, operational, tactical, service, training, or administrative military mission.

2.1.10.1 The video surveillance capability must include, at a minimum, a daylight Electro-Optical (EO) camera.

2.1.10.2 The video surveillance capability must have a variable continuous zoom.

2.1.10.3 The video surveillance capability must provide the DRI (Detection Recognition Identification) level for Detection of at least 4 VPoT (Vertical Pixels on Target) and 7 HPoT (Horizontal Pixels on Target) for the target of dimensions 1m x 1.75m, at a range of 2000m, in day condition.

2.1.10.4 The video surveillance capability must provide the DRI level for Recognition of at least 16 VPoT and 28 HPoT for the target of dimensions of 1m x 1.75m, at a range of 1500m, in day condition.

2.2 EW PAYLOAD REQUIREMENTS

2.2.1 The EW Payload system must have built-in test capability to verify the health status of the EW Payload system and confirm the integrity of the RF transmit and receive operations before launch.

2.2.2 The EW Payload system must be capable of recording information about the performance of the EW Payload system. The information to be recorded include, but not limited to, on/off times, EW techniques used, operating frequency, and designated threat information such as ID and frequency.

2.2.3 The EW Payload system must be capable of operating continuously in stand-by mode for no less than 12 hours at a time. Stand-by mode is a mode in which the EW Payload system is powered on and is ready for Radio Frequency (RF) Tx/Rx operations.

2.2.4 The EW Payload system must be designed for and capable of achieving the following physical requirements specified in Table 1 – EW Payload System Physical Requirements.

No.	Characteristics	Requirement	Notes
1	Antenna Height	1.5 m or higher	Height of antenna above the gunnel of the USV.
2	Total Weight of the EW Payload system.	< 125 kg	Total weight of the mass, mass-mounted components, and USV-inboard components. The requirement of Total Weight (2.2.4 Line No. 2) has to be satisfied prior to considering the requirements of Weight of the mast and mast-mounted components (2.2.4 Line No. 3) and Weight of USV-inboard components (2.2.4 Line No. 4).

3	Weight of the mast and mast-mounted components	< 55 kg	Total weight of the mast and all mass-mounted components.
4	Weight of USV-inboard components	< 75 kg	Total weight of all USV-inboard components, including cables and components' mounts.
5	Power Input	< 1000 W	Total power input requirement for all components. (As the largest power drain is the high powered amplifier, the system should be able to operate at lower levels for the majority of the time when the EW Payload system is in standby mode.)

Table 1 – EW Payload System Physical Requirements

2.2.5 The EW Payload system must provide DRFM-based jamming capability and be capable of achieving the following performance requirements specified in Table 2 – EW Payload System Performance Requirements.

No.	Characteristics	Requirement	Notes
1	Tunable Frequency	8 – 18 GHz	
2	Effective Radiated Power (ERP)	> 30 dBW	At either a horizontally or vertically polarized target. 100 % duty cycle.
3	Simultaneous Tx/Rx	Yes	
4	Antenna Isolation	Yes	Must be sufficient to prevent feedback (Ring-Around).
5	Antenna Stabilization	Yes	Must be sufficient to accommodate ± 15 degrees roll about the horizon at rate up to 50 deg/sec while maintaining ERP at the horizon.
6	Instantaneous Bandwidth	≥ 1 GHz	
7	Receiver Dynamic Range	> 60 dB	
8	Receiver Sensitivity	< -90 dBW	The point of Receiver Sensitivity is at the face of the

			receive antenna.
9	Transmit Spurious Signal Level	< -40 dBC	
10	Pulse Repetition Frequency (PRF) Range	200 Hz to 20 KHz	
11	Pulse Width	25 ns to CW	
12	Range Offset	-70 µs to +70 µs	
13	Range Offset Resolution	< 10 ns	
14	Doppler Range	± 25 MHz	Frequency Chirp Range.
15	Doppler Resolution	< 30 Hz	
16	Number of Primary Independent Targets	≥ 4	False target generation.
17	Number of Secondary targets per Primary	≥ 32	
18	Throughput Delay	< 200 ns	Effective throughput delay.

Table 2 – EW Payload System Performance Requirements

2.2.6 The EW Payload system must be designed for and capable of providing the following programmable and callable EW techniques as specified in Table 3 – EW Techniques Requirements.

No.	EW Techniques	Requirement	Notes
1	Jamming Mode	- Both coherent and non-coherent mode	- Coherent Jamming mode is the mode in which the EW Payload system generates and transmits coherent jamming signals by manipulating the amplitude and/or phase of the received signal.
2	Wideband Noise (with programmable bandwidth)	- EW techniques Requirement - Noise BW programmable from 1 MHz to at least 500 MHz, in 1MHz step	- Tuneable frequency is from 8 GHz to 18 GHz.
3	Noise Cover Pulse	- EW techniques	

		Requirement	
4	Range Gate Steal (RGS)	- EW techniques Requirement	
5	Target Generation	- EW techniques Requirement	- Multiple repeat of partial or whole captured pulse with amplitude modulation.
6	Frequency Shift	- EW techniques Requirement	
7	Multiple False Targets	- EW techniques Requirement	- Asynchronous and synchronous.

Table 3 – EW Techniques Requirements

2.3 INTERFACE REQUIREMENTS

2.3.1 The EW Payload system must have an external wireless interface and a shipboard control station that are capable of two-way wireless transmission of control signals and data over a minimum distance of 2000 meters.

2.3.2 The EW Payload system must be capable of operating and conducting all assigned tasks simultaneously with another operating EW Payload system that is controlled from the same Controlling Platform.

2.3.3 The bearing information on the jamming designation that the Controlling Platform provides to the EW Payload system will be true bearing. Other information that can be provided to the EW Payload system includes Threat ID, Threat Frequency, and Technique Number.

2.3.4 The EW Payload system must be able to radiate the jamming signal in the desired direction in less than three (3) seconds after receiving the command and designation information from the Controlling Platform.

2.4 ENVIRONMENTAL REQUIREMENTS

2.4.1 The EW Payload system must be capable of operating and conducting all assigned tasks in the shipboard Electromagnetic Interference (EMI) environment, without interfering with the existing shipboard systems on the Controlling Platform.

2.4.2 The EW Payload system must be capable of operating and conducting all assigned tasks under the operating environment described in Table 4 – Operating Environment.

Operating Environment				
No.	**Environmental Characteristics**	**Max**	**Min**	**Recommended Test Method**
1	Free Air	+37C	-20C	Mil-Std 810

	Temperature			
2	Relative Humidity	95%	0%	Mil-Std 810
3	Rain	0.8 mm per minute		
4	Drip	IAW Procedure III, Method 506.5 of Mil-Std 810		Mil-Std 810
5	Maximum Platform Accelerations	17 g		
6	Sea State	3	0	See Appendix 1 for the definition of sea state in terms of wave height and wind conditions.

Table 4 – Operating Environment

2.4.3 The EW Payload system must be operable without degradation after being exposed to the surviving environment described in Table 5 – Surviving Environment.

Surviving Environment				
No.	***Environmental Characteristics***	***Max***	***Min***	***Recommended Test Method***
1	Free Air Temperature	48C	-20C	Mil-Std 810
2	Relative Humidity	100%	0%	Mil-Std 810
3	Salt Fog	IAW Method 509.5 of Mil-Std 810		Mil-Std 810
4	Sea State	4	0	See Appendix 1 for the definition of sea state in terms of wave height and wind conditions.

Table 5 – Surviving Environment

2.5 INFORMATION SECURITY REQUIREMENTS

2.5.1 The EW Payload system must have services to protect sensitive information. Services or functions such as data encryption, self-destruct, or self-wiping function may be employed.

APPENDIX 1 – DEFINITION OF SEA STATE

Sea State	Significant Wave Height (m)	Modal Wave Period (sec)			
		Open Ocean		Littoral	
		$T_{5\%}$	$T_{95\%}$	$T_{5\%}$	$T_{95\%}$
3	1.25	6.3	14.8	5.1	11.8
4	2.5	6.9	15.2	6.5	12.7
5	4	8.3	15.5	8.2	13.6
6	6	10.3	16.2	9.3	13.6
7	9	13.1	18.5	11	17.1
8	14	16.4	18.6	--	--
9	17.7	20	25.7	--	--

The Bretschneider spectrum shall be used for Open Ocean seaways. The JONSWAP spectrum (gamma=2) shall be used for Littoral seaways.

Steady mean ambient wind speed, acting concurrently with the waves, shall be taken as: 1.823Hs + 3.45 (m/sec) at 19.5 m elevation, where Hs is the significant wave height.

Table 6 – Definition of Sea State

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STATEMENT OF WORK

Electronic Warfare (EW) Payload System

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1 SCOPE

1.1 OBJECTIVE

1.1.1 The Department of National Defence (DND) has a requirement to procure Electronic Warfare (EW) Payload systems that are designed to function in a marine environment with an existing Royal Canadian Navy (RCN) Unmanned Surface Vehicle (USV).

1.2 BACKGROUND

1.2.1 The NEAR-U (Naval Electronic Attack Recapitalization – Unmanned) project is one of the initiatives to revitalize the EA capability. The goal of NEAR-U project is to implement and test a potential solution to improve the naval platform's survivability by incorporating an EW Payload system into an Unmanned Surface Vehicle (USV) platform. DND will procure and integrate EW Payload systems into existing RCN Unmanned Surface Vehicles. The EW Payload system will be tested and evaluated as off-board active decoys or jammers for ship and task group Anti-Ship Missile Defence, as well as EW test set for radar testing and training.

1.3 LIST OF ACRONYMS

ASM	Anti-Ship Missile
ASMD	Anti-Ship Missile Defence
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CDRL	Contract Data Requirement List
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USV	Unmanned Surface Vehicles
VGS	Velocity Gate Steal
VGPO	Velocity Gate Pull Off
VPoT	Vertical Pixels on Target
W	Watt

2 APPLICABLE DOCUMENTS

2.1 APPLICABILITY

2.1.1 The following documents support the SOW and must be considered as supplemental if not specifically identified in the text. In an event of conflicts between the documents referenced below and the content of this SOW, the content of this SOW must take precedence. Where no versions or effective date of any reference is given, the applicable version or effective date at the time of the Contract Award must be used.

2.2 DND PUBLICATIONS

1	C-01-100-100/AG-005, Adoption of Commercial and Foreign Government Publications
2	C-01-100-100/AG-006, Writing, Format, and Production of Technical Publications
3	C-01-000-103/AG-000, Guide to the Canadian Government Cataloguing System
4	C-02-006-009/AG-000, Field and Technical Service Representatives (FSR/TSR) Requirements and Terms of Reference
5	D-01-400-001/SG-000, Engineering Drawing Practices
6	D-01-400-002/SF-000, Drawings, Engineering, and Associated Lists
7	D-01-100-226/SF-001, Specification for Preparation of Test Sheets for Shipboard Systems and Equipment
8	D-01-100-202/SF-000, Preparation of Equipment Descriptions
9	D-01-100-203/SF-000, Preparation of Operation Instructions
10	D-01-100-214/SF-000, Preparation of Provisioning Documentation for Canadian Forces Equipment

2.3 OTHER PUBLICATIONS

1	MIL-STD-810, Environmental Engineering Considerations and Laboratory Tests
2	Humpback USV-T Payload Integration Interface Control
3	Humpback USV-T Hardpoints Drawings

3 REQUIREMENTS

3.1 GENERAL

3.1.1 The Contractor must supply three (3) EW Payload systems that meet the requirements of the Technical Statement of Requirements (TSOR) and are to be delivered in accordance with the Contract End Items List (CEIL).

3.1.2 The Contractor must carry out all of the work required to design, manufacture, deliver, and test EW Payload systems which meet the specifications of the TSOR.

3.1.3 The Contractor must provide waterproof, stackable, impact-resistant, and durable containers for onboard storage and transportation of the mast and mast-mounted components of the EW Payload system.

3.1.4 The Contractor must provide Material Safety Data Sheets (MSDS) for all parts, assemblies and components that contain Hazardous Materials (HAZMAT).

3.2 PROGRAM MANAGEMENT (PM)

3.2.1 The Contractor will assign a Project Manager (PM), placing the authority and responsibility for overall project management under a single point of contact. The PM must ensure the timely and efficient allocation of the Contractor's resources to meet the requirements of the SOW. The PM must have full responsibility for the operations of the Contractor and its sub-Contractors in the performance of the Work and must be authorized to accept on behalf of the Contractor any notice, consent, order, direction, decision or other communication that may be given to the Contractor.

3.2.2 The Contractor must provide a preliminary project schedule, as per DID PM-001, indicating the sequence and completion dates of project milestones, deliverables, and project tasks based on Contract Award as "day 0".

3.2.3 Kick-Off Meeting: Within one month of Contract Award, the Contractor must conduct a project Kick-Off Meeting, as per DID PM-002, at the Contractor's facility. The discussions must include but not be limited to:

3.2.3.1 The Project Schedule and Milestones;

3.2.3.2 The Technical Specification;

3.2.3.3 Critical path activities;

3.2.3.4 Plans for the upcoming activities;

3.2.3.5 Risk management concerns and mitigation actions; and

3.2.3.6 Any other contractual or programmatic issues associated with the project as mutually agreed between the Technical Authority (TA), Procurement Authority (PA), Public

Services and Procurement Canada (PSPC) Contracting Authority (CA) and the Contractor.

3.2.4 Progress Review Meetings (PRM): The Contractor must hold, at the minimum, one (1) PRM meeting per year, at the Contractor's facility or at DND location. The locations, dates, and times for meetings will be mutually agreed on by the TA, PA, PSPC CA, and the Contractor. The PRM meeting will address the following:

3.2.4.1 Discussions on progress to date of the work.

3.2.4.2 Variation from planned progress and the corrective actions to be taken during the next reporting period.

3.2.4.3 Discussions of foreseeable problems and proposed solutions, including an assessment of their impact on the Contract in terms of schedule, technical performance and risks.

3.2.5 Technical Review Meetings (TRM): The Contractor must host a TRM meeting no later than 6 months after Contract Award or as mutually agreed on by the TA. TRMs may be held more frequently at the request of the DND TA or the Contractor, should the need arise. Best effort should be made to have the TRM scheduled immediately preceding the PRM.

3.2.6 Minutes - The Contractor must keep Minutes as per DID PM-003, for all meetings. The Minutes will record the content of the meeting including agreements reached and action items. A draft copy of the Minutes will be distributed to the PSPC CA, DND TA, and PA for review within five (5) working days after the meeting. Comments will be provided to the Contractor, within five (5) working days after the receipt of the draft copy, to be incorporated for distribution and signature by the PSPC CA, DND TA, and PA. For the TRMs, only the DND TA signature is required.

3.2.7 Progress Report - The Contractor must monitor the progress of the project and deliver Project Status Reports (PSR's) according to DID PM-004.

3.3 INTEGRATION

3.3.1 The Contractor must design the EW Payload system to be mechanically integratable to the existing RCN's USV platform, with pre-defined mounting points and spaces allocated for the integration of the EW Payload system. The details of the mounting points and allocated spaces are provided in *"Humpback USV-T Hardpoints Drawings"*.

3.3.2 The Contractor must design the EW Payload system to be electrically integratable to the existing RCN's USV platform in accordance with "*Humpback USV-T Payload Integration Interface Control"*.

3.3.3 The Contractor must conduct the system engineering activities to produce a design that integrates the EW Payload system into the USV platform in accordance with the TSOR.

3.4 TEST AND TRIALS

3.4.1 Factory Acceptance Tests (FAT): The Contractor must provide copies of the FAT procedures and the expected test results consistent with DID FAT-001.

3.4.1.1 The FAT must be conducted by the Contractor for each EW Payload system and witnessed by DND TA or DND-authorized representatives.

3.4.1.2 Upon completion of the FAT activities, the Contractor must provide a trial report in accordance with DID TR-001 to report the results of the trial for each system unit to DND prior to its shipment.

3.4.2 Harbour Acceptance Trials (HATs): The Contractor must provide HAT procedures to verify the installation and integration of each EW Payload system into the USV, in accordance with DID HAT-001.

3.4.2.1 The HAT must be conducted by the Contractor for each EW Payload system and witnessed by the DND TA or DND-authorized representatives. The location of HAT will be on either East coast or West coast and will be determined by DND TA.

3.4.2.2 Upon completion of the HAT activities, the Contractor must provide a trial report in accordance with DID TR-001 to report the results of the trials.

3.5 TRAINING AND TRAINING MATERIALS

3.5.1 Operator's and Maintainer's Course: The Contractor must conduct two operator-maintainer training courses, one on East coast and one on West coast. The course must be offered at DND facilities, within the time period agreed by DND TA and the Contractor.

3.5.1.1 The course must accommodate a class size up to 10 students.

3.5.1.2 The course must provide theory, operation instructions, and maintenance instructions.

3.5.1.3 The course must include interpretation of fault codes, where applicable, and carrying out repairs using a deliverable spares kit, if applicable.

3.5.1.4 The course must include instructions and precautions to be observed in order to reduce downtime and improve the availability of the system.

3.5.1.5 Training Materials: The Contractor must supply all training materials in accordance with DID TRG-002. The supplied material must be used to conduct operator and shipboard maintenance courses for the ship's personnel by DND instructors.

3.5.1.6 Course Reports: The Contractor must prepare Training Course Activity Reports for the Operator and Maintainer courses in accordance with DID TRG-001.

3.6 INTEGRATED LOGISTIC SUPPORT

3.6.1 The Contractor must provide Provisioning Documentation, including the Provisioning Parts Breakdown (PPB), Recommended Spare Parts List (RSPL), and Supplementary Provisioning Technical Documentation (SPTD) in accordance with DID PD-001.

3.6.2 The Contractor must supply operation and maintenance manuals, modified to reflect the delivered EW Payload system configuration, in accordance with DID PUB-001.

3.6.3 The Contractor must prepare and deliver the Technical Data Package (TDP) in accordance with DID TDP-001.

3.7 TECHNICAL SUPPORT

3.7.1 The Contractor may be tasked to provide field engineering support and technical advice throughout the project. The conditions requiring technical support may include, but not limited to:

3.7.1.1 Engineering support;

3.7.1.2 Technical investigations;

3.7.2 In the condition of equipment malfunctions or damage, the Contractor may be tasked to investigate any malfunction. The TA must be notified within five (5) working days from the time the Contractor determines the root cause of the damage. A copy of the Contractor's internal investigation must be sent to the TA.

3.7.3 The Contractor must submit an Activity Report after the completion of the work, in accordance with DID FSR-001.