STANDARDS RELATED DOCUMENT

AECP-02.1

OPERATIONAL SHIPBOARD ELECTROMAGNETIC ENVIRONMENTAL EFFECTS (E3) AWARENESS PROCEDURES AND LESSONS LEARNED

Edition A Version 1
November 2019

NORTH ATLANTIC TREATY ORGANIZATION

ALLIED ENVIRONMENTAL CONDITIONS PUBLICATION

Published by the
NATO STANDARDIZATION OFFICE (NSO)

INTENTIONALLY BLANK

NORTH ATLANTIC TREATY ORGANIZATION (NATO)

NATO STANDARDIZATION OFFICE (NSO)

NATO LETTER OF PROMULGATION

27 November 2019

1. The enclosed Standards Related Document, AECP-02.1, Edition A, Version 1, OPERATIONAL SHIPBOARD ELECTROMAGNETIC EFFECTS (E3) AWARENESS PROCEDURES AND LESSONS LEARNED, which has been approved in conjunction with AECP-02 by the nations in the MILITARY COMMITTEE MARITIME STANDARDIZATION BOARD (MCMSB), is promulgated herewith.

2. AECP-02.1, Edition A, Version 1 is effective upon receipt.

3.

4. This publication shall be handled in accordance with C-M(2002)60.

Zoltán GULYÁS
Brigadier General, HUNAF
Director, NATO Standardization Office

INTENTIONALLY BLANK

RESERVED FOR NATIONAL LETTER OF PROMULGATION

INTENTIONALLY BLANK

TABLE OF CONTENTS

INTENTIONALLY BLANK

CHAPTER 1 INTRODUCTION

1.1. PURPOSE

Military ships are subject to extreme levels of electromagnetic environmental effects (E3). These environments can have an adverse effect on personnel, munitions, fuels, and electronics systems. Further, from an electronics perspective, ships are designed to be hardened against the electromagnetic environment (EME). However, over time, the ship, its systems, and subsystems can become susceptible to the EME. The susceptibility is due to material corrosion, modifications like addition of new equipment or replacement of existing equipment that may affect the ship’s electromagnetic compatibility (EMC), poor repairs, and less than adequate maintenance. Also the tendency to use Commercial Off The Shelf (COTS) or Military Off The Shelf (MOTS) equipment that has been certified to civil EMC requirements which are less stringent than military requirements can have an effect on the overall EMC performance of a military ship.

The aforementioned can affect mission performance and safety. A ship can minimize the effects of E3 to munitions, personnel, fuels, and electronics systems throughout the operational life cycle as long as the personnel assigned to the ship are aware of the practices and procedures necessary to minimize the impact.

1.2. SCOPE

This document has been developed in response to:

a. The need to address Hazards of Electromagnetic Radiation to Personnel, Ordnance, and Fuels (HERP, HERO and HERF) in concert with the above mentioned systems; and

b. The need to specify operational electromagnetic compatibility (EMC) awareness instructions, procedures, and guidelines for senior military managers, commanding officers, sailors, maintenance and electronic personnel, in support of all aspects of the ship’s mission.

It also provides a description of operational EMC awareness practices for maintaining a hardened ship.

Furthermore, it provides a method for identifying, recording and tracking HERP, HERO, and HERF incidents and Electromagnetic Interference (EMI) problems for specific shipboard equipment, systems, and ship classes.

The basis for this repository of information is to use the data to provide “how-to” or “lessons learned” information for future NATO operations and Partner Nations, regarding specific equipment, system, or ship classes such that HERP, HERO, HERF, and EMI incidents and problems can be avoided.

The information contained in this publication is based on principles that have been practiced and proven successful. Since all national entities may have unique or similar organizational structures, the practices contained herein can be adjusted or modified depending on the responsible command within each national authority.

1.3. RELATED DOCUMENTS

A. **STANAG 1380/AECP-02** NATO Naval eElectromagnetic Radiation Hazards Manual

B. **STANAG 2345** Military Workplaces - Force Health Protection Regarding Personnel Exposure To Electric, Magnetic and Electromagnetic Fields, 0 Hz TO 300 GHz

C. **STANAG 4370/AECTP-501** Equipment and Subsystem Testing

D. **STANAG 4370/AECTP-504** Introduction to Platform and System Verification and Testing

E. **STANAG 4370/AECTP-506** Sea Platforms and Systems Electromagnetic Environmental Effects Test and Verification

F. **STANAG 4370/AECTP-250** Leaflet 258 Radio Frequency Electromagnetic Environments

G. **STANREC 3731/AAEP-03** Bibliography on Electromagnetic Compatibility (EMC)

H. **STANREC 4567/AEP-41** NATO Implementation of Unified Protection Against Electromagnetic Environmental Effects (UE3)

I. **MIL-STD-1605** Procedures for Conducting a Shipboard Electromagnetic Interference (EMI) Survey (Surface Ships)

J. **NAVSEA OP 3565/NAVAIR 16-1-529 VOLUME 1** ELECTROMAGNETIC RADIATION HAZARDS (HAZARDS TO PERSONNEL, FUEL AND OTHER FLAMMABLE MATERIAL)

K. **NAVSEA OP 3565 VOLUME 2** ELECTROMAGNETIC RADIATION HAZARDS (HAZARDS TO ORDNANCE)

L. **EU-directive 2013/35/EU** On the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields)

M. **BRd 2924** Radio Hazards in Naval Service Volume 2

N. **NORMDEF 0301-02 Edition 1 September 2019** “General safety requirements on weapon systems and munitions embodying EID against the effects of non-ionizing electromagnetic radiations throughout their entire life cycle”

O. **DIN EN 50413 VDE 0848-1:2009-08** Basic standard on measurement and calculation procedures for human exposure to electric, magnetic and electromagnetic fields (0 Hz – 300 GHz)

P. **DIN VDE 0848-5:2001-01** Safety in electric, magnetic and electromagnetic fields - Part 5: Protection against explosion

1.4. UPDATES

Inputs regarding the content, accuracy, and completeness of this document are essential if document is to be maintained current. Recommended changes with supporting justification are encouraged and should be forwarded to the custodian of this document.

CHAPTER 2 RADHAZ AWARENESS

2.1. BACKGROUND

RADHAZ is an acronym for Electromagnetic Radiation Hazards and is defined as: The risk of adverse health effects to personnel or inadvertent initiation of electro-explosive devices and flammables, resulting from exposure to an electromagnetic radiation environment in the frequency range 0 Hz - 300 GHz.

Note: RADHAZ refers to 3 specific hazards; Hazards of Electromagnetic Radiation to Personnel (HERP), Hazards of Electromagnetic Radiation to Ordnance (HERO), and Hazards of Electromagnetic Radiation to Fuels (HERF). A derived hazard is the risk of malfunctioning of Safety Critical Electronic Systems (SCES) as a result of exposure to electromagnetic fields. To mitigate hazards related to personnel, ordnance and fuel, mitigation programs must be in force. For the derived risk on SCES the risk can be mitigated by design or mitigation measures.

RADHAZ is the result of exposure to an electromagnetic field/power density of sufficient intensity to induce currents and/or voltages of magnitudes large enough to:

- Cause harm or injuries to humans.
- Trigger electrically initiated devices (EIDs) or other sensitive explosive components of weapon systems, ordnance, or explosive devices.
- Create sparks having sufficient magnitude to ignite flammable mixtures.

The potential for electromagnetic radiation (EMR) hazards to personnel is present in the 0 to 300 GHz frequency range. The risk of overexposure and the related hazard is referred to as HERP.

Below 3 kHz, certain magnetic and electric fields can result in adverse non-thermal effects. The effects resulting from exposure to EMR below 3 kHz can include painful stimulation of sensory or motor nerves, inadvertent muscle excitation resulting from potentially hazardous activity, alteration of synaptic activity within the brain, cardiac excitation, and adverse effects associated with blood flow. Above 3 kHz, exposure to EMR can results in adverse thermal effects. The effects resulting from exposure to EMR above 3 kHz can include modified behavior, tissue burns, and in extreme cases, death. Depending on the frequency and strength of the EMR, these effects may not produce a noticeable sensation of pain or discomfort to give warning that an injury may be occurring. In addition, electromagnetic energy can result in high levels of induced and contact currents through the body when exposed to electromagnetic fields below 3 kHz, and when in close proximity to high-power Radio Frequency (RF) transmitting antennas operating below 10 MHz.

Technological advances have resulted in the proliferation of military equipment that is able to radiate high levels of EM energy. These advances, coupled with the increased trend to use sensitive, low-power electronic circuits in the design of ordnance systems, perpetuate a long-standing hazard. The hazards that result from adverse interactions between the electromagnetic environment (EME) and the electrical initiators or initiating systems contained within ordnance systems are referred to as HERO. The need for HERO control arises from a fundamental incompatibility between the EIDs or EID firing circuits contained within the ordnance and the external radiated EME that the ordnance encounters during its progression through the ordnance lifecycle.

The possibility of accidental ignition of fuel vapors, by RF induced arcs, during fuel handling operations in proximity to high-power transmitting antennas and radars can exist under certain conditions. The probability of an ignition varies widely with many factors, the most significant being the type of fuel, the manner and locations in which the fuel is handled, and the size of the vehicle being refueled. The hazard of these effects is referred to as HERF.

In order to avoid RADHAZ issues aboard ship, precautions must be taken during the conduct of operations and exercise to minimize exposure to the Electromagnetic Environment (EME). In order to manage these precautions aboard ship, one must understand the Maximum Permissible Exposure Limit (Personnel limit), Maximum Allowable Environment (Ordnance Susceptibility) or Fuel Ignition level (Fuel limit), as well as, the specific environments that exists aboard ship at all applicable topside locations. Generally, to perform the latter, RADHAZ surveys are conducted to characterize the EME.

2.2. RADHAZ PROGRAM REQUIREMENTS

STANAG 1380 which is a cover letter for AECP-02/MECP-02, provides information regarding procedures to be taken to avoid the hazards that can arise when the followings are exposed to electromagnetic radiation (EMR) in radio and radar frequency environments during NATO Naval operations:

- Personnel;
- Munitions and weapon systems embodying electrically initiated devices (EIDs);
- Fuels and flammable materiel;
- Safety critical electronic systems (SCES),

Methods by which these hazards can be avoided are described, or referenced, for individuals with responsibilities for directing such operations.

STANAG 4370 provides the requirements for HERO testing to characterize the susceptibility of ordnance and to conduct RADHAZ surveys aboard ships.

Also refer to other NATO or National requirements, as STANAG1380/AECP-02 is mainly focused on interoperability.

Furthermore, nations can have their own national procedures or measures to prevent personnel from overexposure to electromagnetic fields, whereas the limits of overexposure can differ from each nation due to national labor protection laws.

2.3. RADHAZ REDUCTION METHODS

It is recommended that Shipboard RADHAZ assessments and surveys be conducted to characterize the Electromagnetic Environment (EME). Using the measured and/or calculated RF environment from fixed (or permanently located) emitter systems, RADHAZ can be managed either through control procedures (i.e., frequency and/or power management or sectoring) or through calculated safe separation distances. The latter option of calculating EMEs and providing safe separation distances is purely analytical and is generally a more conservative approach for managing RADHAZ (particularly in a shipboard environment) and the result is generally more restrictive and provides less operational flexibility.

The impact on operational flexibility can be minimized by performing RADHAZ surveys. This means that, by measuring the actual EME from the ship at personnel, ordnance, and fueling locations a more exact means for managing RADHAZ for specific situations can be provided.

HERP surveys characterize the EME in and around antennas in manned areas of the ship. Of concern are the electric and magnetic field strengths, induced and contact currents, and the potential for RF burn. For HERP, it must be recognized that National requirements for these may vary, although STANAG 2345 provides requirements that can be used for NATO operations. Mitigation techniques for HERP may include RADHAZ warning signs to exclude personnel from specific areas and warning signs with procedures for frequency and power management, Permissible Exposure Lines painted on the deck of the ships, colored warning bands painted on safety rails, and personnel barriers can be employed to restrict access to these areas. STANAG 1379/AECP-03 presents some of the NATO Nation's RADHAZ Warning Signs that are used.

For HERO, where the EME at specific ordnance locations is characterized, management techniques may include HERO Emission Control (EMCON) Bills that includes administrative procedures and work-around at precise locations for specific classifications of ordnance (e.g., HERO SAFE, HERO SUSCEPTIBLE, and HERO UNSAFE). STANAG 1380/AECP-2 provides an alternate approach whereby Susceptibility RADHAZ Designator (SRAD) and Transmitter RADHAZ Designator (TRAD) codes are assigned to ordnance and emitters, respectively, that defines a level of susceptibility (for ordnance) and a level of radiated emissions (for emitters). Once assigned, the two are compared to identify HERO concerns and establish safe separation distances.

2.4. IN-PORT INSPECTION AND PREPARATION

Prior to deploying, it should be ensured that ships have up-to-date RADHAZ information; including operational requirements and procedures to mitigate RADHAZ during operations and exercises. This would include the following:

- Understanding of the upcoming mission and operational requirements to include the use of ordnance, radars, communication systems, and other RF transmitters such as jammers,
- Up-to-date National ship specific guidance to mitigate RADHAZ,
- Proper placement of RADHAZ signs,
- Proper RADHAZ training and awareness for ship's crew, and
- For ship's participating in NATO or Partner cross-deck operations with aircraft, information relevant to the platforms involved, including associated SRAD and TRAD codes.

2.5. RADHAZ INCIDENT DOCUMENTATION REQUIREMENTS

A Lessons Learned Database used for ships, systems, and equipment has been developed and established to document RADHAZ incidents. The database should address as a minimum, the information contained in Chapter 5. Chapter 5 provides examples of the specific information that should be included in the Lessons Learned Database reporting. The database can be tailored to meet the individual requirements of each nation. The information should be used to provide historical data to track equipment, systems, and ship RADHAZ incidents over time. The database should serve as a cautionary tool to provide proactive corrective action to mitigate future incidents. The information contained in the Lessons Learned Database should be exchanged with other NATO member nations and Partner Nations. Furthermore, the information stored in the Lessons Learned Database must be shared with MARCOM for the Lessons Learned Portal.

2.6. INFORMATION EXCHANGE

Prior to the conduct of NATO and Partner operations, participating Nations should be prepared for the exchange of RADHAZ information. This involves identifying all platform SRAD and TRAD codes prior to the conduct of the exercise or operations.

CHAPTER 3 EMC AWARENESS

3.1. BACKGROUND

Modern combat ships employ more powerful radar and transmitters that increase the electromagnetic energy in an operational environment. In addition, electrical and electronic equipment operate at lower electrical power levels. The resulting effect is increased risk of EMI within operating ships and shipboard systems. Combat ships, in order to engage and destroy an adversary, are supported by other ships and systems of enormous capabilities. A combat ship can be rendered ineffective if EMI is not controlled by initial design followed by verification and testing of its equipment and systems, or if EMI is caused by faulty maintenance, component failure, or improper operation. The presence of EMI in a sensor system or weapon system can deny target acquisition or tracking. EMI induced in shipboard ordnance may be hazardous to the crew launching it, as well as affecting accuracy. This publication aims to provide information towards establishing an EMC awareness program for operational personnel. The EMC awareness program is used to provide and implement instructions, procedures, and guidelines for operational personnel, in order to identify and correct EMI occurring in shipborne and aviation assets as well as to ensure restoration to full combat capability.

Ship survivability and safety depends on the severity of the electromagnetic environment, mission scenarios, evasive actions, operating procedures, and ship's maintenance; as well as retention of electromagnetic hardening measures designed into the ship. Maintenance personnel at the organizational, intermediate, and shore station levels also require instruction, procedures, and guidelines to address EMC/EMI issues.

An important aspect of retaining electromagnetic hardness is to ensure that all operational personnel understand and are aware of the characteristic elements of EMC and EMI. Given this knowledge, they can then be available to recognize, identify, define, and recommend corrective action to resolve EMI problems. This approach can help to ensure that the EMI hardness of the ship is maintained during deployment.

A detailed discussion on EMC is beyond the scope of this document, but useful technical resources can be found in STANREC 3731/AAEP-03 *Bibliography on Electromagnetic Compatibility (EMC)*, which lists many applicable national and international references. Very detailed discussion of E3 hardening methods are provided in STANREC 4567/AEP 41 *NATO Implementation of Unified Protection Against Electromagnetic Environmental Effects (UE3).*

An operational EMC awareness program should contain sufficient information and material to permit operational personnel to recognize, define, address, and correct/mitigate EMI problems. The syllabus for the awareness program should be clear, concise, and easily understood. Information should be provided by the use of various training media including: videos; formal class instruction; hands-on demonstrations; training manuals and guides; individual briefings; and computer based training. The content of this allied publication is an initial step in addressing these needs.

3.2. EMC AWARENESS PROGRAM REQUIREMENTS

In order to develop, establish, and maintain an EMC awareness program, specific areas of technical interest should be addressed. These areas are the minimum requirements to develop, implement, and maintain the program. Operational personnel should be provided the necessary instructions, procedures, guidelines, and on-the-job training in order to ensure a functional and useful EMC awareness program. The program should address as a minimum, the following topics:

- Electromagnetic terminology definitions;
- Basic Electromagnetic Environmental Effects concepts and theory:
- EMI sources;
- EMI victims;
- Causes of EMI;
- Specific EMI problems that degrade and affect operational performance, mission objectives, and personnel safety;
- EMI reduction methods;
- In-port Inspection;
- Underway EMI awareness;
- Documentation requirements to implement EMI preventive and/or corrective maintenance, operational procedures, and electromagnetic spectrum management and coordination;
- The need for information exchange in order to enhance interoperability; and
- Methods for promoting and sustaining an operational EMC awareness program.

CHAPTER 4 OPERATIONAL EMC AWARENESS PROGRAM

4.1. DEFINITIONS OF TERMS

EMC terminology plays an important part in developing, establishing, and maintaining an EMC awareness program. All NATO approved terms and definitions are listed on the publically accessible NATO Terminology Database "NATOTerm" official website at https://nso.nato.int/natoterm.

Those wishing to add to the terminology are encouraged to do so. If approval is obtained, any new terminology in addition to being added to this document could be considered for addition to NATOTerm.

4.2. EMI SOURCES

Sources of EMI should be included in an awareness program. A detailed explanation of natural and man-made sources of EMI should be addressed. Sources of EMI should be defined as those electromagnetic environments (EME) emanating from external sources and those emanating from sources internal to the ship.

Natural EMI Sources – Comprehensive information should be provided on natural EME sources, including Lightning, Precipitation Static (P-Static), Solar, Cosmic, and Galactic noise. The information should describe how natural EME sources impact the EMC of a ship, its systems and equipment.

Other EMI Sources – Comprehensive information should be provided on EME sources that emanate internally from the ship or externally to the ship. Radar systems especially can be an external or internal source of EMI. Other sources are transmitters/radio systems, navigation systems, electronic countermeasure (ECM) systems, and fire control systems and switches, electrical motors, AC transformers, power cables, wires and communication devices are additional subjects that should be addressed. Depending on the ship, there may be other sources of EMI within the ship, system, or equipment complement. The training should address these areas in detail since these are areas that operational personnel must be intimately familiar with, in order to recognize specific anomalies in their systems.

4.3. EMI VICTIMS

The EMC awareness program should include an explanation of possible indications that equipment or systems may be experiencing EMI. These should include a description of possible EMI effects on victims such as:

- bridge/equipment lights flashing for no apparent reason;
- spinning or fluctuating instruments or gauges;
- incorrect electronic indications of arresting/hoisting gear status indicators; and
- audio noise heard on radio receivers or video noise observed on electronic displays.

The awareness program should also address weapon systems including inadvertent ordnance firings, and non-commanded jettison of ordnance. Other areas should include the EMI to communication, navigation, and radar systems that cause loss of signal, computer reboot or memory loss, loss of alignment, false targeting, incorrect identification, and loss of receiver sensitivity. The awareness program is not meant as a test method, it delivers guidance to be able to understand EMC related phenomena.

4.4. EMI CAUSES

The EMC awareness program should include detailed information on the causes of EMI. Some of the causes are:

- coupling interference of cabling:
  - antenna to cable;
  - antenna to box;
  - box to antenna;
  - cable to antenna;
- power supply and ground coupling interference paths.

Other areas to address are the lack of suitable grounding, and deterioration of electrical bonds. Poor material selection, corrosion, deterioration of cable and wire shields and deterioration of filtering devices should also be addressed as causes of EMI. Lack of proper circuit design within the equipment or on the circuit board, improper wire and cable design; cable separation and installation; stuffing tube corrosion; co-channel and in-band interference from other operating ships; and the optimum use of transient protection devices, should be shown as adding to the causes of EMI.

4.5. EXAMPLES OF POTENTIAL EMI ISSUES

The EMC awareness program should include specific examples of actual EMI issues that have had a previous effect on operational performance, mission objectives, and flight safety on aircraft carriers or helicopter landing platform equipped ship. Each nation should identify issues for the Lessons Learned Database that is related to their ship, systems, or equipment. Where feasible, nations should identify a specific ship, system, or equipment. Member nations should agree to exchange the information of Lessons Learned Database, in accordance with the requirements of paragraph 2.5 of this document. Issue examples should address those areas that involve mission critical equipment or safety of mission critical systems. During actual operational EMC awareness instructions, discussions should be tailored to specific ships, systems, or equipment.

4.6. EMI REDUCTION METHODS

The EMC awareness program should include specific methods for reducing EMI issues. As a minimum, these methods should include information on grounding, filtering, bonding, shielding, blanking, material selection, frequency selection plan, cable separation, corrosion control, and maintenance control. EMI preventive maintenance practices should be addressed at the organizational level and the depot level. The awareness program should be tailored for each ship, system, or equipment depending on the ship class and the level of maintenance performed. Each participating nation should agree to develop and maintain their own EMI problem database in order to use the information to identify where design modifications must be implemented; or where maintenance procedures need to be upgraded/improved for future acquisitions or modifications.

4.7. IN-PORT INSPECTIONS

The EMC awareness program should include specific practices and inspections for sailors, maintenance and installation personnel. Practices and inspections should include information on specific problem areas. The problem areas to be addressed are:

- bare wires;
- cracked or missing gaskets;
- broken, corroded or missing grounding straps;
- stuffing tube bonds;
- loose or missing panels;

- missing or broken screens;
- paint or corrosion on EMI door seals;
- broken EMI springs or stock fingers; and
- any corrosion at mating surface areas.

4.8. UNDERWAY EMI AWARENESS

The EMC awareness program should include officer and sailor awareness procedures to identify and report suspected EMI anomalies in mission performance. The EMI anomalies should be related to the frequency selection plan. If an anomaly occurs, the crew should attempt, if feasible, to replicate the suspected EMI anomaly and document the results for corrective action by maintenance personnel. The procedures should also include the preparation of a report of the suspected EMI issue.

4.9. DOCUMENTATION REQUIREMENTS

Documentation should be prepared to implement procedures relating to EMI preventive maintenance, EMC operational, and electromagnetic spectrum management and coordination into the EMC awareness program. A Lessons Learned Database for ships, systems, and equipment has been developed and established. The database should address, as a minimum, the information contained in Chapter 5. Chapter 5 provides examples of the specific information that should be included in the Lessons Learned Database reporting. The database can be tailored to meet the individual requirements of each nation. The information should be used to provide historical data to track equipment, systems, and ship EMC degradation over time. The database should serve as a cautionary tool to provide proactive corrective action to prevent catastrophic failures. The information contained in the Lessons Learned Database should be exchanged with other NATO member nations.

4.10. INFORMATION EXCHANGE

An integral part towards the implementation of this effort is to ensure that member nations participate in a free exchange of information regarding shipboard systems EMC/EMI issues. In order to enhance interoperability during joint operations, member nations should provide information on EMC/EMI for specific ship class on a periodic basis. Each nation should determine its support of this information exchange determined by its logistical ability to present information and its own security restrictions. Member nations should make a concerted effort to support the information exchange to the extent of their best capabilities.

4.11. ASPECTS OF EMC AWARENESS

Operational EMC awareness should be a continuous and sustaining activity. It must include a commitment by higher authority (i.e., senior military managers who have the authority to commit funds) to maintain such a program. Each member nation will have to determine the extent and depth of its commitment to an operational EMC awareness program. The scope of the program is encompassed within the preceding paragraphs.

CHAPTER 5 LESSONS LEARNED DATABASE

5.1. BACKGROUND

The E3 RADHAZ WG has developed a means for identifying, recording and tracking HERO, HERP, and HERF incidents and EMI issues for specific shipboard equipment, systems, and ship classes. The basis for this repository of information is to use the data to provide “how-to” or “lessons learned” information for future NATO operations and Partner Nations, regarding specific equipment, system, or ship classes such that HERO, HERP, HERF, and EMI incidents and potential issues in which can be avoided.

5.2. REPORTING

Reporting of incidents is essential to avoid future incidents and to increase the awareness of personnel with respect to RADHAZ and EMI. Natural EMI sources, like for example P-Static or Lightning are not to be included in the report.

Incident reports are fed into the MARCOM LL website for all NATO nations and partner nations to be able to access.

The E3 and RADHAZ LESSONS LEARNED DATABASE should be coordinated with the MARCOM (MARITIME COMMAND) Lessons Learned Portal according to the following documents:

A. NSA (NAVAL) 0927 (2011) MCMSB – Working together on Lessons Learned dated 1st October 2011

B. Bi Strategic Command directive. 080-006 – Lessons Learned - dated 10th July 2013.

Reporting is an automated process, from which the lessons learned database reports can be produced. The process is depicted in Figure 1.

An example of an incident report can be found in ANNEX A.

These reports will be discussed during meetings held within NATO amongst the E3 RADHAZ WG. The outcome of these discussions can be used to modify operational procedures.

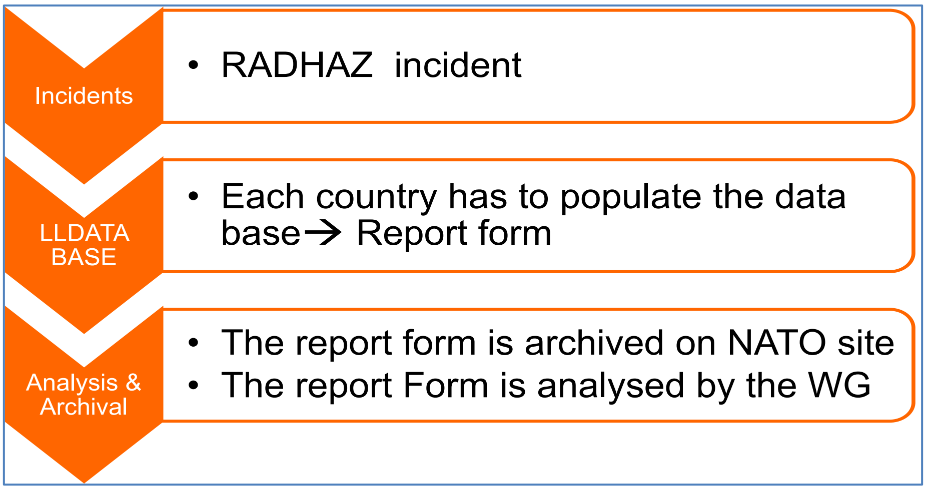

Figure 1: Process Overview

5.3. DATABASE INTRODUCTION

The incidents are collected with a software tool titled: E3 and RADHAZ LESSONS LEARNED DATABASE. This tool was provided to nations and the latest version of the software can be obtained from the custodian Nation of the lessons learned database.

The following nations have validated the tool:

Canada	**Germany**	**Norway**	**The United Kingdom**
France	**Greece**	**The Netherlands**	**United States of America**

5.4. HOW TO USE THE DATABASE

The Incident Report Form must be completed and provided to the custodian Nation. The process and the steps to be taken by using the database tool is explained in the following paragraphs. All steps needed to complete an incident report are described and clarified by screenshots of the software tool.

The opening page of the tool is given in figure 2. In this page the user can choose either issuing a new report, or loading an existing report.

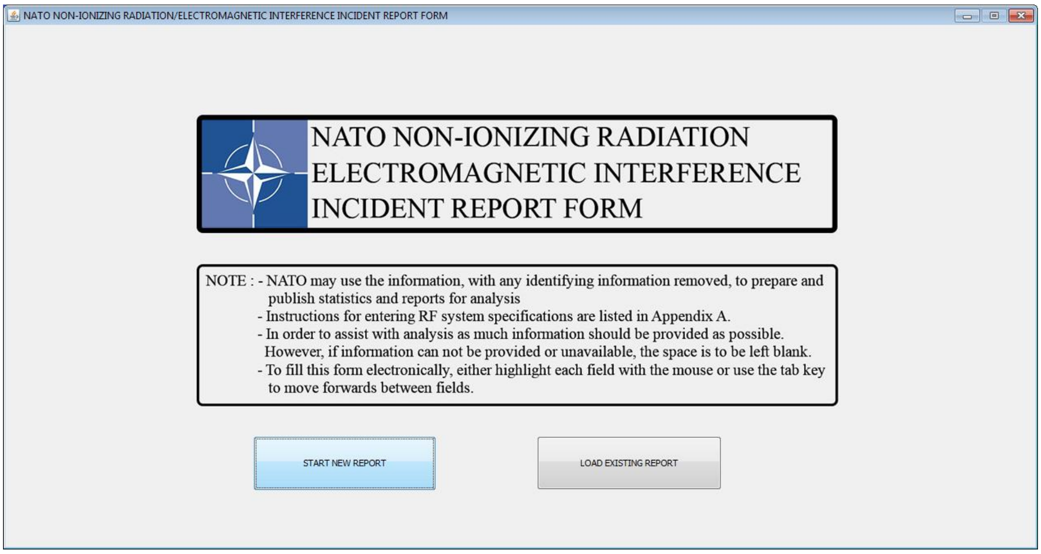

Figure 2: Opening page Incident Report Form

PART 1: DETAILS OF ORGANIZATION SUBMITTING REPORT

The first step is to complete the form template that contains the details of the organization or unit that submits the report. The figure below displays the applicable form.

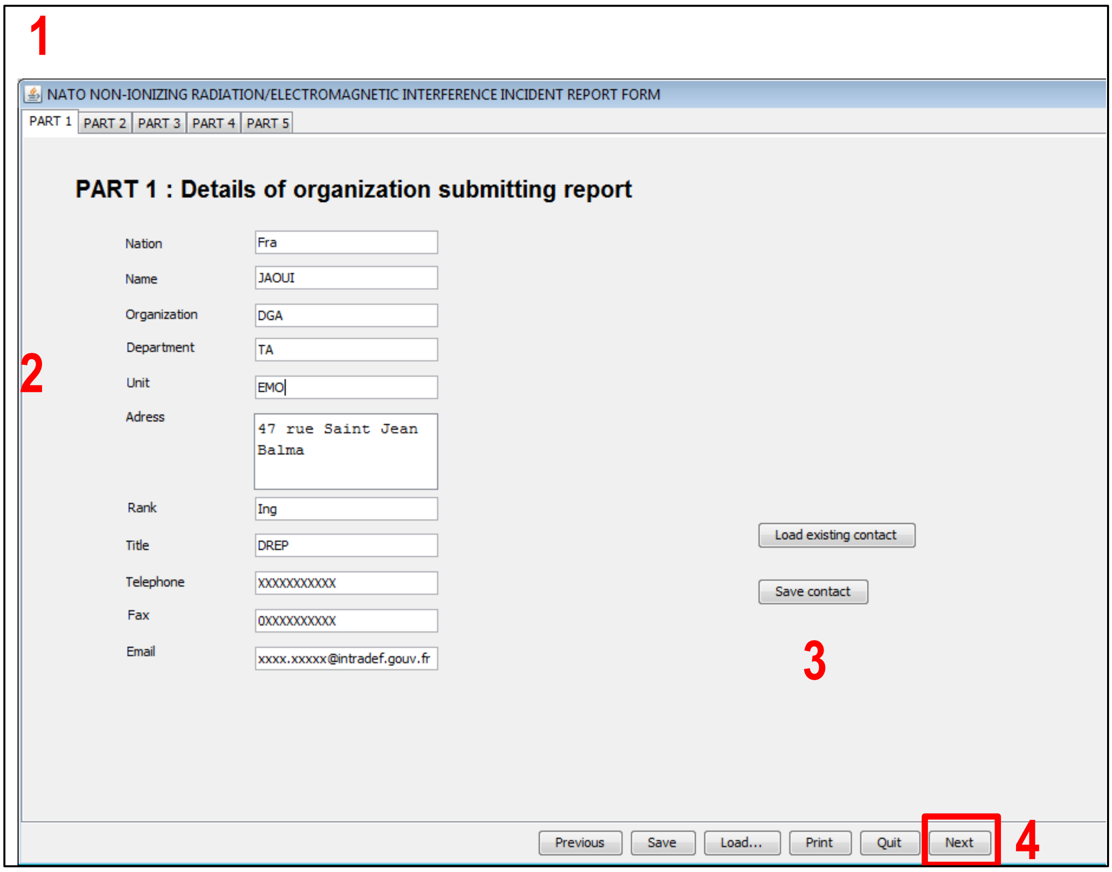

Figure 3: Step 1

1: Click Part 1
2: Fill in the details
3: Save the contact
4: Click Next

<u>PART 2:</u> GENERAL INFORMATION ABOUT THE INCIDENT

The figure below depicts the general information that is required to be submitted for the incident to be reported. The form contains self-explanatory fields which contains information such as location, equipment name and platform.

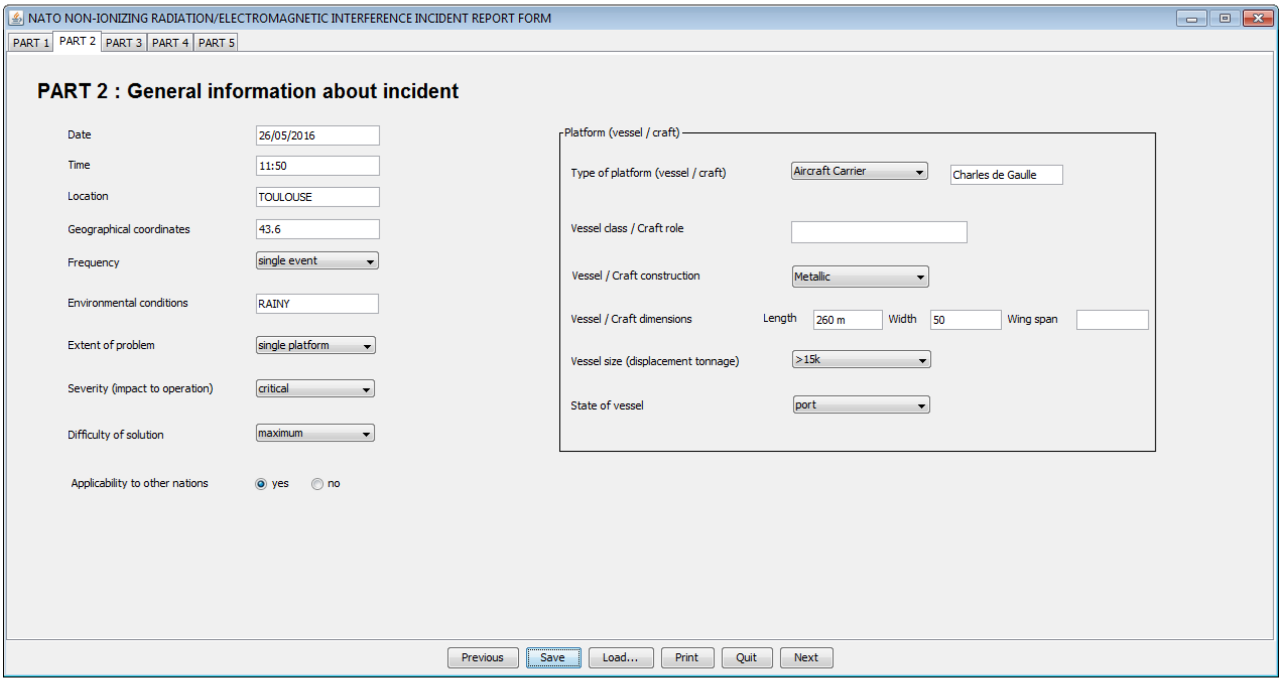

Figure 4: General Information

PART 3: EMITTER SPECIFICATIONS (TRANSMITTER/RECEIVER/ANTENNA)

The “emitter specifications” compromises three forms to be completed. The first form is about the transmitter, the second about the receiver, and the third about the antenna of the equipment that is involved in the incident.

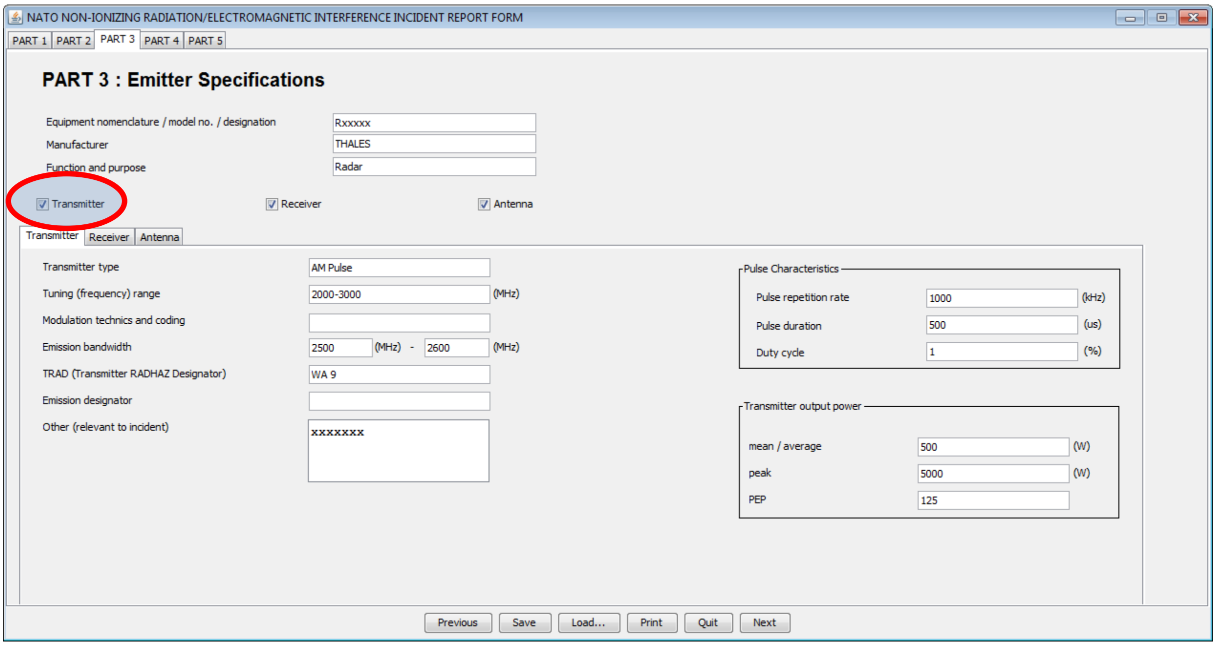

Figure 5: Emitter Specifications and Transmitter data

Equipment nomenclature / model no. / designation:

Enter the official assigned military equipment designation. If not available, enter the manufacture's model number (e.g. Rxxxx), and indicate manufacture's name. If this too is not available, enter a short descriptive title (e.g. ATS-6 Telemetry Transmitter).

Manufacturer:

Enter the manufacture's name, if available.

Function and purpose:

Enter a short description of the function of the system, e.g. radio comm, SATCOM system, microwave link, digital link, fire/weapon control system, navigation system etc…

<u>Transmitter:</u>

Transmitter Type:

Enter the generic name of the transmitter (e.g. Frequency Scan, Scan While Track Radar, Monopulse Tracker, AM or PM Communications). In addition, for radar enter the radar type (e.g. Non-FM Pulse, FM Pulse, Frequency Hopping, CW or FM-CW).

Tuning (Frequency) Range:

Enter the method of tuning (e.g. crystal, synthesizer or cavity). Enter the frequency range through which the transmitter is capable of being tuned (e.g. 225 to 400 MHz). For equipment designed to operate only at a single frequency, enter that frequency. Include units (MHz).

Modulation techniques and coding:

Describe, in detail, the modulation and coding techniques employed. For complex modulation schemes, such as direct sequence spread spectrum, frequency hopping or frequency agile, provide information relating to the hop rate, processing gain, clock rate, pre-defined hop sets and frequencies, minimum required number of frequencies per hop set, notching capability, etc.

Pulse Characteristics (where applicable):

Enter the average number of pulses per second emitted by a transmitter for Pulse Repetition Rate (PRR) expressed in Hz or kHz or, alternatively, average time between leading edges of two consecutive pulses for Pulse Repetition Period (PRP). Enter time between the 6 dB points (50% voltage points) of the radar pulse for Pulse Duration (i.e. Pulse Width). Include units (MHz). Enter Pulse Width / Pulse Repetition Period for Duty Cycle (Duty Factor).

Emission Bandwidth:

Enter the emission bandwidths for which the transmitter is designed at the -3, -20 and -60 dB levels and the Occupied Bandwidth. For pulse radar transmitters the bandwidth at -40 dB shall also be entered. The emission bandwidth is defined as the bandwidth appearing at the antenna terminals and includes any significant attenuation contributed by filtering in the output circuit or transmission lines. Values of emission bandwidth specified should be indicated as calculated or measured. Indicate units used (MHz). Note that the Occupied Bandwidth is defined as the width of the frequency band such that, below its lower and above its upper limit, the mean power radiated is each equal to 0.5% of the total mean power radiated (this is known as 99% Occupied Bandwidth). Alternatively, Occupied Bandwidth defined by -20 dB lower and upper limit points can be entered.

Emission Designator:

Enter emission designators, including the necessary bandwidth, for each designator (e.g. 16K0F3E). For systems with a frequency hopping mode as well as a non-hopping mode, enter the emission designators for each mode. Identify each mode as hopping or non-hopping.

Output Power:

Enter the mean power delivered to the antenna terminals for all AM and FM emissions, or the peak envelope power (PEP) for all other classes of emissions. If there are any unique situations, such as interrupted CW, provide details in Remarks. Indicate the units (e.g. W).

Receiver:

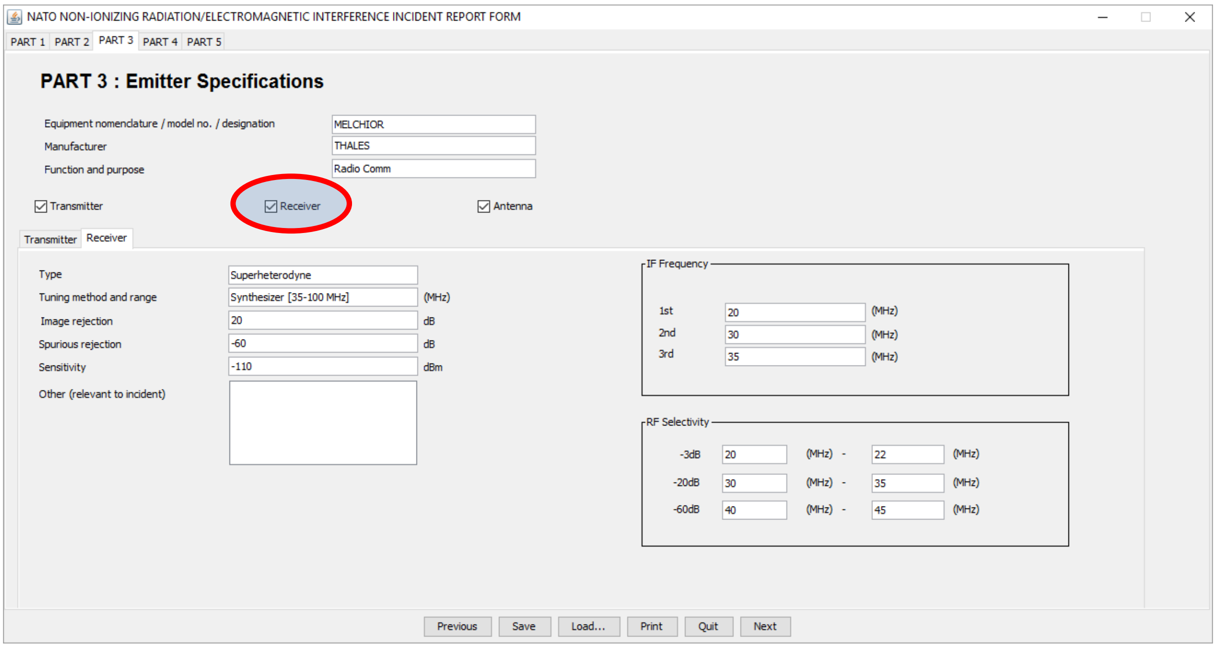

Figure 6: Emitter Specifications and Receiver data

Receiver Type:

Enter the generic class (e.g. dual conversion super-heterodyne or homodyne).

Receiver Tuning Method and Range:

Enter the method of tuning (e.g. crystal, synthesizer or cavity). Enter the frequency range through which the receiver is capable of being tuned (e.g. 35 to 100 MHz). For equipment designed to operate only at a single frequency, enter that frequency.

Image Rejection:

Enter the image rejection in dB. Image rejection is the ratio of the image frequency signal level required to produce a specified output to the desired signal level required to produce the same output.

Spurious Frequency Rejection:

Enter the spurious frequency rejection in dB. Enter the single level of spurious frequency rejection that the receiver meets or exceeds at all frequencies outside the -60 dB IF bandwidth. Spurious frequency rejection is the ratio of a particular out-of-band frequency level required to produce a specified output, to the desired signal level required to produce the same output.

Receiver Sensitivity:

Complete as follows:

(a) Enter the sensitivity, in dBm;
(b) Specify criteria used (e.g. 12 dB SINAD, where SINAD is (signal + noise + distortion) / (noise + distortion[22]);
(c) If the receiver is used with terrestrial systems, enter the receiver noise figure in dB; and
(d) If the receiver is used with space or satellite earth stations, enter the receiver noise figure in Kelvin.

IF Frequency:

Enter the tuned frequency of the first, second and third IF stages.

RF Selectivity:

Enter the bandwidth at the -3, -20 and -60 dB levels. The RF bandwidth includes any significant attenuation contributed by filtering in the input circuit of transmission line. Values of RF bandwidth specified should be indicated as calculated or measured by checking the appropriate box.

<u>Antenna:</u>

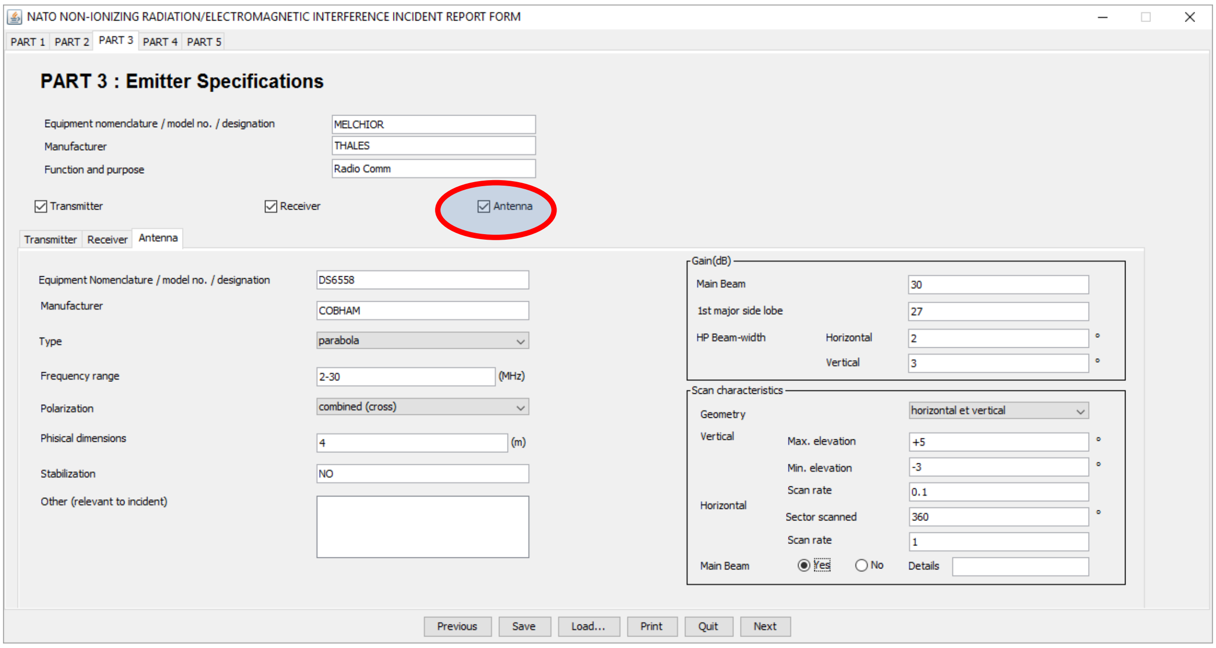

Figure 7: Emitter Specifications and Antenna details

Antenna nomenclature / model no. / designation:

Enter the official assigned alphanumeric equipment designation. If not available, enter the manufacturer's model number (e.g. DS6558) and indicate manufacturer's name. If this too is not available, enter a short descriptive title (e.g. ATS-6 Telemetry Antenna).

Manufacturer:

Enter the manufacturer's name, if available.

Antenna Type:

Enter the generic name or describe the general technical features (e.g. horizontal, log periodic, Cassegrain with polarization twisting, whip, phased array or conformal array).

Antenna Frequency Range:

Enter frequency range for which the antenna is intended for.

Polarization:

Enter the polarization. If circular, indicate whether it is left or right handed.

Physical Dimensions:

Enter dimensions of the physical structure of the antenna (e.g. length for linear structures or wire antennas such as monopoles, dipoles, stacked dipoles, yagi- or log-periodic antennas, etc. or width / height / diameter for aperture antennas such as parabolic dishes, horns, radar antennas, etc.). Where applicable, enter height of the antenna above the ground / deck level. Indicate units (metric).

Stabilization:

Indicate if antenna is equipped with a mechanical stabilization system. If “Yes” enter the range of angular position error correction/compensation in degrees.

Antenna Gain (dBi):

Indicate gain of antenna relative to an isotropic radiator (expressed in dBi).

(a) Enter the maximum gain, in dBi; and

(b Enter the nominal gain of the first major side lobe, in dBi, and the angular displacement from the main beam, in degrees.

Alternatively, gain relative to a dipole can be entered, which should be indicated in the entry with dBd unit.

Half-Power (HP) Beam-width:

Enter the 3 dB beam-width (expressed in degrees) in both, horizontal and vertical plane.

Scan Characteristics:

Complete as follows:

(a) If the antenna scans, enter the type of scanning (e.g. vertical, horizontal, vertical and horizontal);

(b) Vertical scan:

 (1) Enter the maximum elevation angle, in degrees (positive or negative, referenced to the horizontal plane), that the antenna can scan;

 (2) Enter the minimum elevation angle, in degrees (positive or negative, referenced to the horizontal plane), that the antenna can scan; and

 (3) Enter the vertical scanning rate, in scans per minute.

(c) Horizontal scan:

 (1) Enter the angular scanning range, in degrees, of the horizontal sector scanned; and

 (2) Enter the horizontal scan rate, in scans per minute.

(d) Indicate if antenna is capable of being sector blanked. If "Yes", enter details.

<u>PART 4:</u> TYPE OF INCIDENT (HERP/HERF/HERO/OTHER EM ENVIRONMENTAL EFFECT

This part describes the incident. The software tool allows you to choose between one or more such incidents (HERP, HERO, HERF, EMI and Environmental effects -- other EM effects). The picture depicted below shows an example of HERP incident.

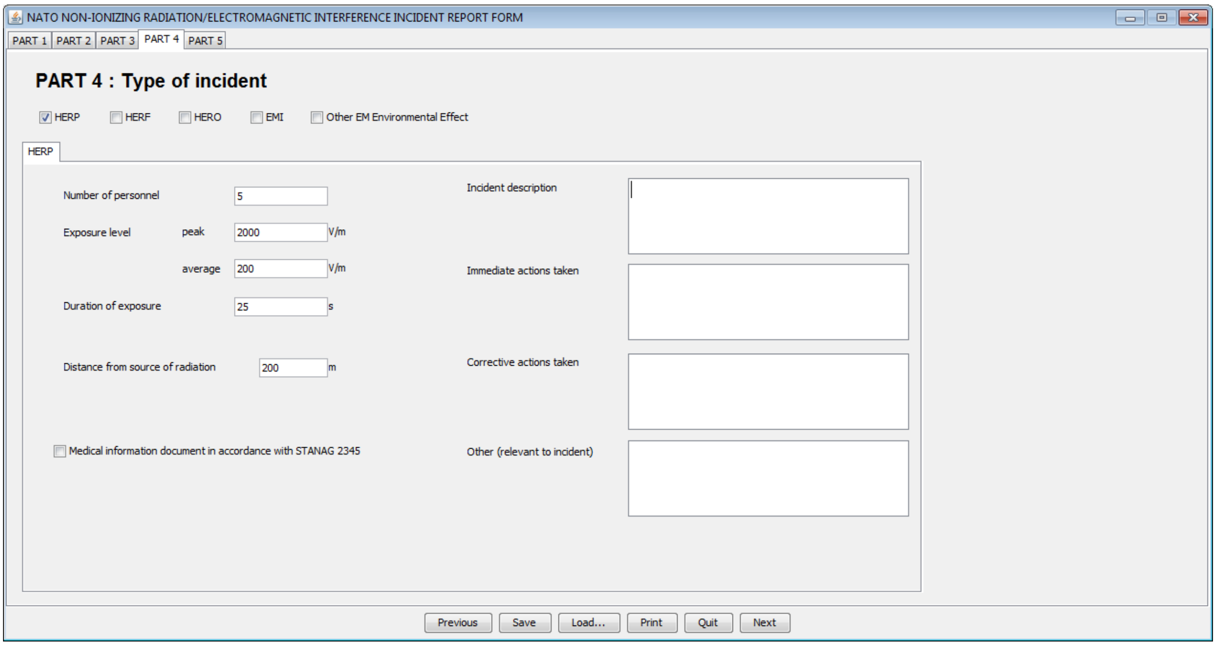

Figure 8: Type of Incident

PART 5: POST INCIDENT FOLLOW UP

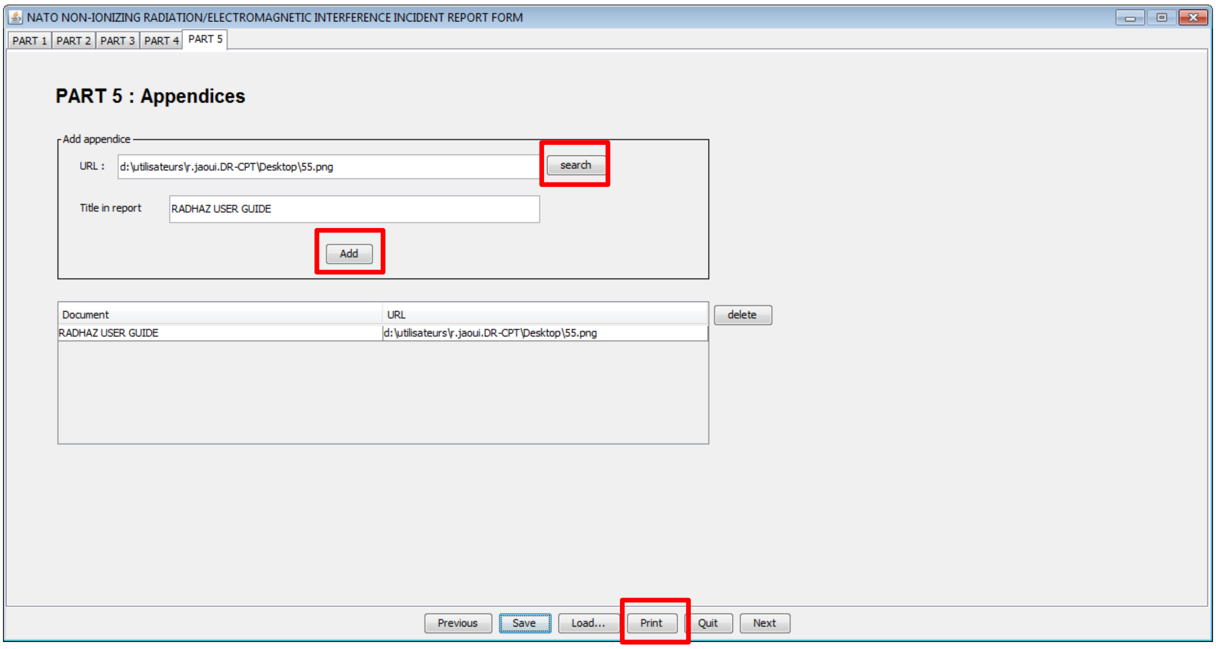

Figure 9: Appendices to the report

Images can be added to illustrate the reporting form.

Nomenclature (filename) of the report is automatically generated by the application. This is based on the contents of the report and consists of country abbreviation, year, type and number of incident (Example: FRA_2015_HERP_004). If more than one incident type is selected (e.g. HERP and HERO), the name will be FRA_2015_**E3**_004).

Once the reporting form is generated, in pdf, it will be saved in the folder named REPORT (this folder and the report tool must be located in the same location on the computer).

PART 6: OPEN AN EXISTING REPORT

An existing report form can be opened with the software. The report form can be chosen by Country, Year and Type. An example of a generated report can be found in ANNEX A.

To open an existing report the following steps (1, 2 and 3) have to be taken.

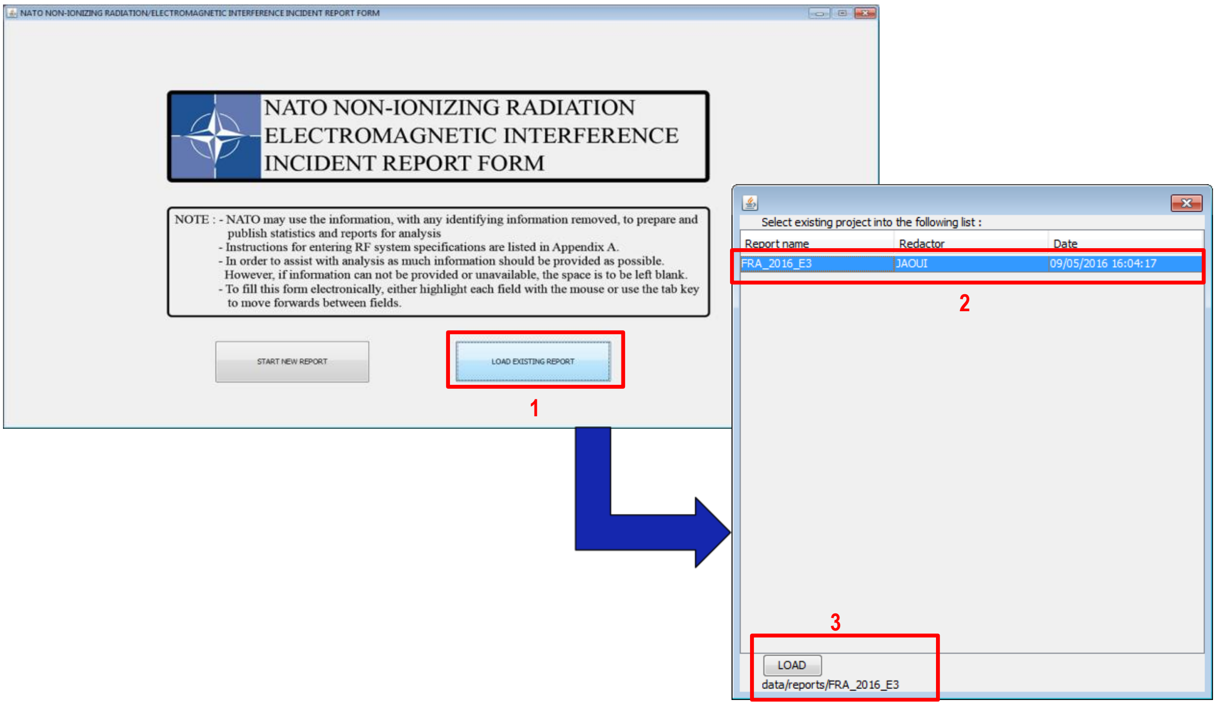

Figure 10: How to load an existing report

ANNEX A NATO NON-IONIZING RADIATION/ELECTROMAGNETIC INTERFERENCE INCIDENT REPORT FORM

<u>For Administration Use Only:</u>

Date Received:

Incident No.

NOTE:

- NATO may use the information, with any identifying information removed, to prepare and publish statistics and reports for analysis.
- Instructions for entering RF system specifications are listed in Appendix A.
- In order to assist with analysis as much information should be provided as possible.
- However, if information cannot be provided or unavailable, the space is to be left blank.
- To fill this form electronically, either highlight each field with the mouse or use the "tab" key to move forwards between fields.

PART 1: DETAILS OF ORGANIZATION SUBMITTING REPORT:

1. Nation:		
2. Organization:		
3. Department:		
4. Unit:		
5. Adress:		
6. Contact:	Name:	
	Rank:	
	Title:	
	Telephone:	
	Fax:	
	E-Mail:	

PART 2: GENERAL INFORMATION ABOUT INCIDENT:

7. Date:	test		
8. Time:	test		
9. Location	test	Geographical	
10.	Single Event ☐ Occasional – Intermittent ☐ Frequent ☐ Regular ☐		

11. Environmental conditions:	
12. Extent of Problem:	Single Platform ☐ Group of Vessels – Crafts ☐ Class
13. Severity (impact to	Catastrophic ☐ Critical ☐ Major ☐ Minor ☐ None ☐
14. Difficulty of Solution:	Maximum ☐ Medium ☐ Minimum ☐
15. Applicability to Other Nations:	

Platform (vessel / craft)

16. Type of platform (vessel / craft)*:	AC ☐ LC ☐ CC ☐ DD ☐ FF ☐ PB ☐ MCM ☐ AUX ☐ SUB ☐ Aircraft ☐ Helicopter ☐ Hovercraft ☐ Other ☐
17. Vessel Class / Craft Role:	test
18. Vessel / Craft Construction*:	Metallic ☐ GRP ☐ Composite ☐ Various ☐
19. Vessel / Craft Dimensions:	Length Width Wing Span
20. Vessel Size (displacement tonnage)*:	< 1.5 k ☐ 1.5 - 5 k ☐ 5 - 10 k ☐ 10 - 15 k ☐ > 15 k ☐
21. State of Vessel:	Sea ☐ Port ☐ Passage ☐ Trials ☐ Exercise ☐

***Construction of the vessel:** GRP - Glass Reinforced Plastic,
***Type of platform:** AC = Aircraft Carrier, LC = Large Cruiser, CC = Corvette, DD = Destroyer, FF = Frigate, PB = Patrol Boat, MCM = Mine Countermeasure, AUX = Auxiliary, SUB = Submarine
***Size of vessel (ktons):** ships displacement

PART 3: TYPE OF INCIDENT:

HERF

31. Type of Fuel / Combustible:	
32. Flashing Point:	°C
33. RF Radiation Levels at Fuel	Peak: Peak Average / RMS: Peak Pulse Duration: Peak Pulse Repetition Rate: Peak
34. Distance Between Source of RF Radiation and Fuel Handling Point:	meters
35. Incident Description:	
36. Immediate Actions Taken:	
37. Corrective Actions Taken:	
38. Other (relevant to incident):	

PART 4: EMITTER SPECIFICATIONS:

58. Equipment nomenclature / model no. / designation:	
59. Manufacturer :	
60. Function and Purpose :	

PART 5: POST INCIDENT FOLLOW UP:

90. Details of any investigation undertaken in respect of the described incident:	
91. Lessons learned that may be helpful to other nations:	

PART 6: APPENDICES:

AECP-02.1(A) (1)