**Missile Warning System**

**System Requirement Specification**

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**History**

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**References**

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| **ID** | **Document Name** | **Version** |
| Ref-1 | Therma case.pdf | 1 |
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**Abbriviations**

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| --- | --- |
| UR | User Requirement |
| FR | Functional Requirement |

# Scope

## Identification

This document describes a self protection suite for the F-16 combat aircraft used by the Royal Danish Air Force. The protection suite incorporates a pod for mounting under the left wing and an intelligent cockpit control unit for controlling the system. In the pod is mounted a Missile Warning System (MWS) which gives input to the cockpit control unit. From the cockpit control unit is the dispensing of flares and chaffs from the pod controlled. The solution shall provide warning upon detection of missile threats and be able to automatically dispense payloads in response.

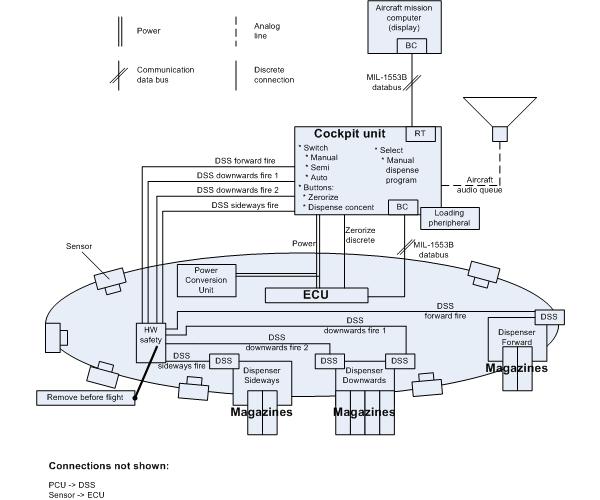
The MWS will be provided as Government Furnished Equipment (GFE) and be physically installed by your company.

If there where more information about the system it should also be placed here, that could be information about which version and type of MWS system that shall be mounted.

## System overview

The system is a self protection suite for a F-16 combat aircraft , it shall protect the aircraft against missile attacks. The system consists of 2 main systems:

* Cockpit Unit, which communicate with the systems in the POD and Aircraft Mission Computer. Has also an interface to the aircraft intercom system and an interface for the user to control the system.
* POD, which holds magazines for flares and chaffs and what is needed for firing them of, plus the MWS system.



Missiles shall be detected by the MWS that are provided as a GFE equipment and mounted by Company F. When missile attacks are detected information is sent to the cockpit control unit, which depending on the mode it is in will react on the information and is able to react according to a number of programs by dispensing flares and chaffs according to the program chosen. By the interface to the aircraft intercom system audio cues and warnings can be provided.

The system has a number of different users depending on what is done and where:

* On ground the system can be maintained by technicians that update SW and control the system
* Ground personnel shall be able to mount it and when ready to takeoff arm it.
* The pilot shall use the system, by choosing an appropriate program and depending on program chosen do further to let it dispense when missile attacks are detected.
* After dispensing has happened maintenance has to be done again to fill up the magazines again with flares and chaffs.

Other relevant documents for this system are:

* Technical description of MWS system. Document number xxx
* Mechanical description of MWS system. Document number xxx
* User handbook of MWS system. Document number xxx

System overview. This paragraph shall briefly state the purpose of the system to which

this document applies. It shall describe the general nature of the system; summarize the history

of system development, operation, and maintenance; identify the project sponsor, acquirer, user,

developer, and support agencies; identify current and planned operating sites; and list other

relevant documents.

## Document overview

This document shall describe all the Systems Requirements for the Self Protection System for the F-16 combat aircraft and the development of the system shall be based on this document, when the system fulfil the requirements in this document the requirement of the Royal Danish Air Force is fulfilled.

This document must only be used in the project group by Company F and project group and other personal at The Royal Danish Air force that are cleared to have access to this project.

Document overview. This paragraph shall summarize the purpose and contents of this

document and shall describe any security or privacy considerations associated with its use.

# Referenced documents

* Terma case.pdf Document received from TERMA at IHA 3/9 2010.
* Terma case comments v1.pdf
* Terma case meeting 17 9 2010 at IHA v1.pdf
* Terma case questions and answers v1.pdf Answers received at consultation meeting at IHA 17/9 2010 room 517.
* MIL standard 1600-2-9 v12.45 – POD design rules.

This section shall list the number, title, revision, and date of all

documents referenced in this specification. This section shall also identify the source for all

documents not available through normal Government stocking activities.

# Requirements

## Functional requirements

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| **REQ ID** | **Requirement** |
| FR-12 | The systems shall comply with all F-16 EW standards for EMC and data bus load as specified by the F-16 EW standard *FE16d*. |

## CCU

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| **REQ ID** | **Requirement** |
| FR-12 | The systems shall comply with all F-16 EW standards for EMC and data bus load as specified by the F-16 EW standard *FE16d*. |
| FR-20 | The ECU shall perform the built in test that is supported by this Government Furnished Equipment (*GFE*). |
| FR-21 | The cockpit unit shall perform an internal built-in test of its internal subsystems and HW, as specified by the F-16 subsystem BIT standard *FBIT12c*. |
| FR-23 | The cockpit unit shall request status information from the ECU every 20ms. |
| FR-24 | The ECU shall report the status information available for this Government Furnished Equipment (*GFE*). |
| FR-26 | The cockpit unit shall play an audio cue on the aircrafts audio system when a threat is detected. |
| FR-27 | The audio cue played in case of a threat shall be an indication of threat type (e.g. “Missile”), location (e.g. “4 o’clock”) and elevation (e.g. “low”), as specified by the audio queue table *ACTv2*. |
| FR-31 | The cockpit unit shall keep all sensitive data in an encrypted format as specified by the DOD sensitive data standard *SDS23v*. |
| FR-32 | The cockpit unit shall erase the decryption key using the DOD data wipe specification *DWS12g*. |

## POD

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| **REQ ID** | **Requirement** |
| FR-1 | The POD shall contain three dispenser magazine mounts.  INFO: These shall henceforth be named first, second and third. |
| FR-2 | The POD’s first dispenser magazine mount shall physically be located before the second and third dispenser magazine mount relative to the nose of the plane. |
| FR-3 | The POD’s first dispenser magazine mount shall support forward dispensing. |
| FR-4 | The POD’s first dispenser magazine mount shall support two magazines. |
| FR-5 | The POD’s second dispenser magazine mount shall physically be located before the third dispenser magazine mount relative to the nose of the plane. |
| FR-6 | The POD’s second dispenser magazine mount shall support leftwards dispensing. |
| FR-7 | The POD’s second dispenser magazine mount shall support four magazines. |
| FR-8 | The POD’s third dispenser magazine mount shall support downwards dispensing. |
| FR-9 | The POD’s third dispenser magazine mount shall support two magazines. |
| FR-11 | The POD shall comply with all F-16 requirements for aerodynamics and radar reflections as specified by the F-16 POD standard *FP42f*. |
| FR-13 | The POD shall be mounted under the left wing. |
| FR-20 | The ECU shall perform the built in test that is supported by this Government Furnished Equipment (*GFE*). |
| FR-24 | The ECU shall report the status information available for this Government Furnished Equipment (*GFE*). |
| FR-28 | The POD shall include a safety pin that prevents the dispenser from firing. |
| FR-29 | The POD safety pin shall be clearly labelled and accessible by aircraft maintenance crew as specified by the aircraft maintenance manual *AMM32f*. |
| FR-35 | The POD shall keep all sensitive data in an encrypted format as specified by the DOD sensitive data standard *SDS23v*. |
| FR-37 | The POD shall erase the decryption key using the DOD data wipe specification *DWS12g*. |
| FR-39 | The POD shall supply the status of the following LRUs:   * The Sensors * The POD as a whole   INFO: The Magazines and DSS are not seen as LRUs and also do not have status reporting capabilities. |
| FR-44 | The status reported by the POD as a whole shall be:   1. POD internal temperature 2. ECU operational status (OK, ERROR) |
| FR-45 | The POD overall status shall be reported in the POD status format specified under interfaces. |

## Performance requirements

## CCU

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| **REQ ID** | **Requirement** |
| FR-16 | The cockpit unit shall forward the threat data received from the MWS within 20ms. |
| FR-19 | The cockpit unit shall request the performance of a built in test by the ECU every 15 minutes. |
| FR-22 | The cockpit unit shall forward the built in test results to the aircraft mission computer with a maximum latency of 1 second from receiving the results. |
| FR-25 | The cockpit unit shall forward the status of the individual subsystems and LRUs; ECU, POD and aircraft unit to the aircraft mission computer with a maximum latency of 100ms from receiving the information.  INFO: The Magazines and DSS are not seen as LRUs and also do not have status reporting capabilities. |
| FR-34 | When the erasing of sensitive data procedure is initiated, the cockpit unit shall erase its sensitive data decryption key within 100ms. |

## POD

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| **REQ ID** | **Requirement** |
| FR-33 | When the erasing of sensitive data procedure is initiated, the POD erase sensitive data discrete shall be set within 10ms. |
| FR-38 | The POD sensitive data decryption key shall be erased within 100ms of receiving the erase signal. |

## Environment requirements

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| **REQ ID** | **Requirement** |
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## External interface requirements

## CCU

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| **REQ ID** | **Requirement** |
| FR-15a | The cockpit unit shall communicate with the aircraft mission computer via the planes main MIL-1553B data bus. |
| FR-15b | The cockpit unit shall forward all threat data received from the MWS to the aircraft mission computer in body frame format. |
| FR-17 | The cockpit unit shall use the NATO dispenser threat format DF14b to forward threat data to the aircraft mission computer. |
| FR-30 | The cockpit unit shall include a button to trigger the erasing of sensitive data procedure. |

## POD

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| **REQ ID** | **Requirement** |
| FR-10 | The POD shall support standard NATO dispenser magazines type *DM30p*. |
| FR-14 | The POD shall be mounted by two T-hooks as specified by the F-16 POD mounting standard *PM11b*. |

## Internal interface requirements (POD and CCU)

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| **REQ ID** | **Requirement** |
| FR-18a | The ECU shall communicate with the cockpit unit via a dedicated *MIL-1553B* data bus. |
| FR-18b | The ECU shall forward threat data to the cockpit unit in NATO dispenser threat format *DF14b*. |
| FR-36 | The POD shall receive a discrete signal to indicate that it should erase its sensitive data, i.e. erase the decryption key. |

**Explanation:**

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| Threat Response Subystem | When the AMC receives information about threats that are detected by the MWS, This subsystem will determine the response with respect to automatic semiautomatic or manual dispensing of chaffs and flares according to a Countermeasure program. |
| Countermeasure program | A preprogrammed sequence of dispensing chaffs and or flares in certain directions with a certain timing |
| Thread pattern | A thread pattern is a certain number of threads attacking the aircraft from certain angles |

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| --- | --- | --- | --- |
| Requirement continued | TestMethod | Trace | Completion |
| 1. Controlling power on/off, for the dispensing system and the MWS shall be done by a secured switch Mil.Grade.xyz inside the cockpit | Observe that the power led in the MWS is turned on and off by controlling the switch in the cockpit | UR-11 | TBR |
| * 1. When turning on power a maximum of 5 seconds will last before the system is fully operational | Using an oscilloscope and checking the delay from turning on the switch to the “operational led” is on | UR-11 indirect | TBR |
| * 1. When turning off power a maximum of 2 seconds will last before the system is fully closed down | Using an oscilloscope and checking the delay from turning off the switch to the “operational led” is off | UR-11  Indirect | TBR |
| 1. When the AMC receives information about threats that are detected by the MWS, the kind of threat and the direction (body frame format) shall be displayed in the cockpit ,( within 20 milliseconds from AMC is receiving threat info) | Test ???? | UR7 | TBR |
| 1. When the AMC receives information about threats that are detected by the MWS the Threat Response Subsystem shall be triggered ( within 20 milliseconds from AMC is receiving threat info) |  |  |  |
| 1. The Threat Response Subsystem shall be in one of three modes : Manual, Semiautomatic, Automatic. The mode shall be chosen by the position of a selector switch | Test that the status LED’s reflect the setting of the appropriate selector switch | UR12 | TBR |
| * 1. When the Threat Response Subsystem is in the manual mode, the threads shall be heard and seen by the pilot but he himself must select and execute a Countermeasure program | Tested by using the Threat simulator mode of the MWS | UR13 | TBR |
| * 1. When the Threat Response Subsystem is in the Semiautomatic mode a countermeasure program shall be chosen by the system and executed but only upon consent from the pilot | Tested by using the Threat simulator mode of the MWS | UR14 | TBR |
| * 1. When the Threat Response Subsystem is in the Automatic mode a countermeasure program shall be chosen by the system and executed | Tested by using the Threat simulator mode of the MWS | UR15 | TBR |
| 1. The Threat Response Subsystem shall be able to store 100 countermeasure programs, each of these are configured as being best suited for a given Threat pattern    1. All data concerning the countermeasure programs shall be handled by the winXYZapplication. This includes programming configuration uploading or downloading to the Threat response system |  | UR21 |  |
| 1. The Threat Response Subsystem shall be able to store 100 Threat patterns    1. All data concerning the Threat patterns shall be handled by the winXYZapplication. This includes programming configuration uploading or downloading to the Threat response system |  | UR21 |  |
| 1. When the Threat Response Subsystem chooses a countermeasure program, it shall be done by matching the stored Thread patterns with the actual threat pattern and finding the best match using the mathematical zyx procedure.    1. All data concerning the mathematical zyx procedure shall be handled by the winXYZapplication. This includes programming configuration uploading or downloading to the Threat response system |  | UR15 |  |

## States and modes

The system shall be able to work in 2 different states:

* Armed: In this state the system is able to react on information from the MWS system and depending on which mode it is set to by the pilot (Manuel, Semi automatic or automatic from UR 12 in TBD) it will react according to the mode. But for security reasons there shall also be a “plane on ground” mode, where firing of chaffs and flares are disabled.
* Disarmed: in this state it shall be impossible to fire flares or chaffs even though the MWS system of any reason gives a warning against missile attack. In this state shall it also be possible to update SW in the MWS and run different tests to make sure every part of the system report normal conditions or some information about things that are not correct.



## Functional requirements

## External interfaces

## Internal nterfaces

## Design constraints

# Requirement traceability

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| **REQ ID** | **Requirement (short)** | **Trace ID** | **Reference** | **Test description** | **Test type** |
| FR-1 |  | UR-2 |  | Inspect that the requested dispenser mounts are located on the POD | Inspection |
| FR-2 |  | UR-2 |  | Inspect that the first dispenser mount is mounted correctly on the POD. | Inspection |
| FR-3 |  | UR-2 |  | Inspect that the first dispenser mount is placed correctly on the POD. | Inspection |
| FR-4 |  | UR-1 |  | Inspect that the first dispenser mount can hold 2 magazines. | Inspection |
| FR-5 |  | UR-2 |  | Inspect that the second dispenser mount is placed correctly on the POD. | Inspection |
| FR-6 |  | UR-2 |  | Inspect that the second dispenser mount is placed correctly on the POD. | Inspection |
| FR-7 |  | UR-1 |  | Inspect that the second dispenser mount can hold 4 magazines. | Inspection |
| FR-8 |  | UR-2 |  | Inspect that the third dispenser mount is placed correctly on the POD. | Inspection |
| FR-9 |  | UR-1 |  | Inspect that the third dispenser mount can hold 2 magazines. | Inspection |
| FR-10 |  | UR-1 |  | Inspect that the dispenser mounts support the correct magazine type. | Inspection |
| FR-11 |  | UR-3 |  | The POD design and implementation must be verified by a certified third party F-16 POD certifying authority. | Inspection and verification |
| FR-12 |  | UR-3 |  | The POD design and implementation must be verified by a certified third party F-16 EW certifying authority. | Inspection and verification |
| FR-13 |  | UR-4 |  | Inspect that the POD is mounted correctly. | Inspection |
| FR-14 |  | UR-4 |  | Inspect that the POD is mounted correctly. | Inspection |
| FR-15 |  | UR-5 |  | Inspect the code and run simulation with a MWS simulator to verify the inertial format to body-frame format conversion. | Code inspection and test |
| FR-16 |  | UR-5 |  | Run simulation with a MWS simulator to verify the delay from cockpit unit reception to availability on aircraft mission bus. A simulator of the aircraft mission bus must be set up to poll the cockpit unit as fast as possible. | Test |
| FR-17 |  | UR-5 |  | Inspect the code and run simulation with a MWS simulator to verify the threat data format. | Code inspection and test |
| FR-18a |  | UR-5 |  | Inspect that the MWS uses a dedicated MIL-1553B data bus. | Inspection |
| FR-18b |  | UR-5 |  | Inspect the code and run simulation with a MWS simulator to verify the threat data format. | Code inspection and test |
| FR-19 |  | UR-6 |  | Run simulation with a MWS simulator to verify the BIT request interval. | Test |
| FR-20 |  | UR-6 |  | Inspect that the supported BIT is requested and run simulation with a MWS simulator to verify the BIT responses. | Code inspection and test |
| FR-21 |  | UR-6 |  | Inspect the internal BIT code and run test with test setup (faulty HW) to verify BIT responses. | Code inspection and test |
| FR-22 |  | UR-6 |  | Run simulation with a MWS simulator to verify the maximum delay. A simulator of the aircraft mission bus must be set up to poll the cockpit unit as fast as possible. | Test |
| FR-23 |  | UR-6 |  | Inspect the status request code time and run test with MWS simulator to verify status request interval. | Code inspection and test |
| FR-24 |  | UR-6 |  | Verify that all available status information is placed on the MWS to cockpit unit data bus. | Test |
| FR-25 |  | UR-6 |  | Run simulation with a MWS simulator to verify the maximum delay. A simulator of the aircraft mission bus must be set up to poll the cockpit unit as fast as possible. | Test |
| FR-26 |  | UR-7 |  | Run simulation with a MWS simulator to verify an audio cue is played. | Test |
| FR-27 |  | UR-7 |  | Run simulation with a MWS simulator to verify the correct audio cues are played. | Test |
| FR-28 |  | UR-8 |  | Verify that a removable pin exists and that firing is disabled when the pin is present in the POD. | Inspection and test |
| FR-29 |  | UR-8 |  | Verify pin design according to standard | Inspection |
| FR-30 |  | UR-9 |  | Verify that zerorize button is present on cockpit unit. | Inspection |
| FR-31 |  | UR-9 |  | Verify the DOD standard is met with respect to sensitive data storage. | Code inspection |
| FR-32 |  | UR-9 |  | Verify the DOD standard is met with respect to decryption key erase. | Code inspection |
| FR-33 |  | UR-9 |  | Verify that the POD erase discrete is set within 10ms of depressing the zerorize button. | Test |
| FR-34 |  | UR-9 |  | Show that it is probable that the key will be wiped within 100ms. | Code inspection |
| FR-35 |  | UR-9 |  | Verify the DOD standard is met with respect to sensitive data storage. | Code inspection |
| FR-36 |  | UR-9 |  | Verify that the POD erases its sensitive data decryption key when the POD erase discrete is set. | Test |
| FR-37 |  | UR-9 |  | Verify the DOD standard is met with respect to decryption key erase. | Code inspection |
| FR-38 |  | UR-9 |  | Show that it is probable that the key will be wiped within 100ms. | Code inspection |
| FR-39 |  | UR-10 |  | Verify with MWS simulator that the required status is available and correct. | Test |
| FR-44 |  | UR-10 |  | Verify with MWS simulator that the required status is available and correct. | Test |
| FR-45 |  | UR-10 |  | Verify with MWS simulator that the required status is available and correct. | Test |
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## Standards

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| **Standard** | **Description** |
| DM30p | NATO dispenser magazine type contains the complete details about the magazines physical constructions and interface, |
| FP42f | F-16 POD standard contains complete specification about requirements for POD manufacturing, including size, weight, material, shape, etc. |
| FE16d | F-16 EW standard contains the requirements and test procedures required to have a new system approved on an F-16. |
| PM11b | F-16 POD mounting standard includes specifications on how a POD shall safely be mounted to an F-16 aircraft. |
| DF14b | NATO dispenser threat format specify the protocol to use when exchanging threat data with the F-16 aircraft mission computer. |
| GFE | The complete specification of the Government Furnished Equipment that is the MWS. |
| FBIT12c | F-16 subsystem BIT standard indicate how a subsystem shall test its internal status to comply with the F-16 operational standard. |
| ACTv2 | Separate document excluded due to the fact that it is not important for the process. |
| AMM32f | Aircraft maintenance manual contains details about how removable parts on aircraft shall be located and labeled. |
| SDS23v | DOD sensitive data standard specify how sensitive data must be stored, and also how the decryption key must be stored. |
| DWS12g | DOD data wipe specification dictates how sensitive data must be wiped from different media. |
| MIL-1553B | Military standard for a redundant communication protocol. The MIL-1553B is pure master-slave(s), and can have 1 Bus Controller (BC) and a number of Remote Terminals (RT). Only the BC can initiate communication, so if two RTs are to communicate it must be programmed into the BC. The MIL-1553B specify polling frequencies of up to 50Hz, meaning that a given package (e.g. status information) can be requested (and thereby sent) with a minimum interval of 20ms. |
|  |  |