ATK Integrated Systems Division

Aircraft Survivability Equipment (ASE)

AN/AAR-47A(V)2
AN/AAR-47B(V)2
Missile and Laser Warning Systems

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AN/AAR-47A(V)2/B(V)2 Missile and Laser Warning System

An advanced weapon and space systems company

The AN/AAR-47A(V)2 / AN/AAR-47B(V)2 Missile and Laser Warning Systems are fully integrated airborne threat detection systems. Total deployment is greater than 3,000 aircraft worldwide. The systems feature a low False Alarm Rate and a very high Probability of Timely Warning for missile threats coupled with the detection, warning, classification and angular location of laser-guided / laser-aided threats. All past and present AN/AAR-47 systems as well as enhanced systems currently under development use a common A-kit. No wiring changes or aircraft modifications are needed to upgrade from one version to another.

Mission

- Detect attacking IR guided missiles & battlefield lasers, while minimizing false alarms
- Automatically send a flare-eject signal to the Countermeasure Dispensing System (CMDS) for IR guided missile threats
- Provide audio and visual warnings to aircrew
- Future - Provide Hostile Fire Detection and Indication to aircrew

History

Fielded Systems

- AN/AAR-47 – Legacy 1987 - 2002
  - UV MWS
- AN/AAR-47(V)2 - 2003
  - Laser Warning (LW) Added
  - Improved Missile Detection
  - Reduced False Alarms
- AN/AAR-47A(V)2 - 2006
  - New Adjunct UV Detector for Improved Dynamic Blanking

Future Systems

- AN/AAR-47B(V)2 – Introduction Late 2008
  - Improved Performance in all operational environments
- AN/AAR-47 w/HFI – Introduction mid-2009
  - OFP change only for the detection of HFI threats with temporal persistence
  - Compatible with all AAR-47(V)2 variants, no A-kit or structural change to the aircraft
- AN/AAR-47B(V)2 w/HFI – JCTD Contract for Development 2008
  - Hostile Fire Notification of Small Arms, Tracer Rounds, AAA, and RPGs
  - Potential Angle Of Arrival for MWS

AAR-47 System Roadmap

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Covering the threat spectrum

Current USN / USMC USA / USAF Inventory

AAR-47(V)2
2001 IOC

- Adds Laser Warning
- Improved Missile Detection performance
- Reduced False Alarms
- **No A-Kit Change**

AAR-47A(V)2
2006 IOC

All (V)2 Functions plus:
- Adds Adjunct UV Detector for Improved Dynamic Blanking
- **No A-Kit Change**

Approved ECP

AAR-47B(V)2
2008 IOC

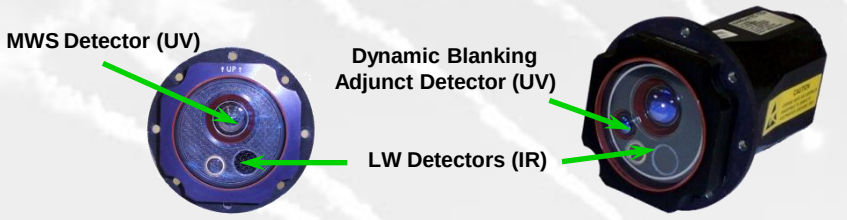
All A(V)2 Functions plus:
- Improved MWS performance in all operational environments
- Enhanced OFP for improved missile warning detection
- Clutter level indication
- Smart dispense capability
- Hostile Fire Indication (HFI) of threats using tracers and RPGs
- **No A-Kit Change**

Approved GFY08 JCTD

AAR-47B(V)2-HFI
Multi Function Threat Detector JCTD

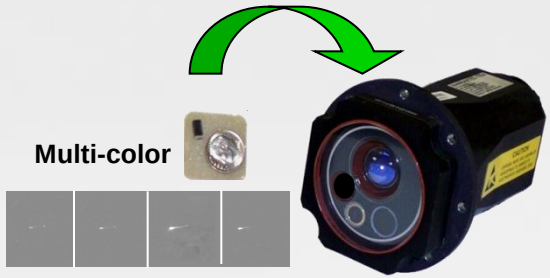
All B(V)2 Functions plus:
- Multi-Color Short Wave IR Camera
- Hostile Fire Indication of Small Arms, Tracer Rounds, AAA, and RPGs

(Meets USMC UNS Requirement)
- Threat Angle Of Arrival for countermeasure cueing
- **No A-Kit Change**



(V)2 A(V)2

B(V)2



B(V)2 HFI

Over 2800 systems delivered.

Sensor MTBF over 16,000 hrs, Computer MTBF over 60,000 hours

U.S. - User Platforms

U.S. Navy & Marine Corps

AH-1

UH-1

CH-46

CH-53

HH/SH-60

P-3

MV-22

KC-130

U.S. - User Platforms (continued)

U.S. Air Force / National Guard

C-5

A-10

C-17

RC-26

MH-53

C-130 / HC-130

U.S. Army

MH-47

MH-60

ARH-70

RC-7

C-27

Other Users

Bell 214

C-12

Bell 412

Cessna Caravan

HB-350

BT-67

AN/AAR-47(V)2 Key Performance Capabilities

Probability of Detection / False Alarms (Pd / FAR)

- Provide uniform, increased sensitivity
- Eliminate class of false alarms optically (shifted pass band)
- Improve Threat Processing algorithms
- Obtain fast saturation recovery for multiple target response

Laser Warning functionality

- Detects and classifies rangefinders, designators and beam riders

Reliability

- Increased temperature tolerance - allows installation near exhaust
- Improved materials and processes
- Improved design of critical components

Communications

- CI: controls/displays both missile and laser warning info
- Updated APR-39A(V)2 interface
- Updated MIL-STD-1553 interface

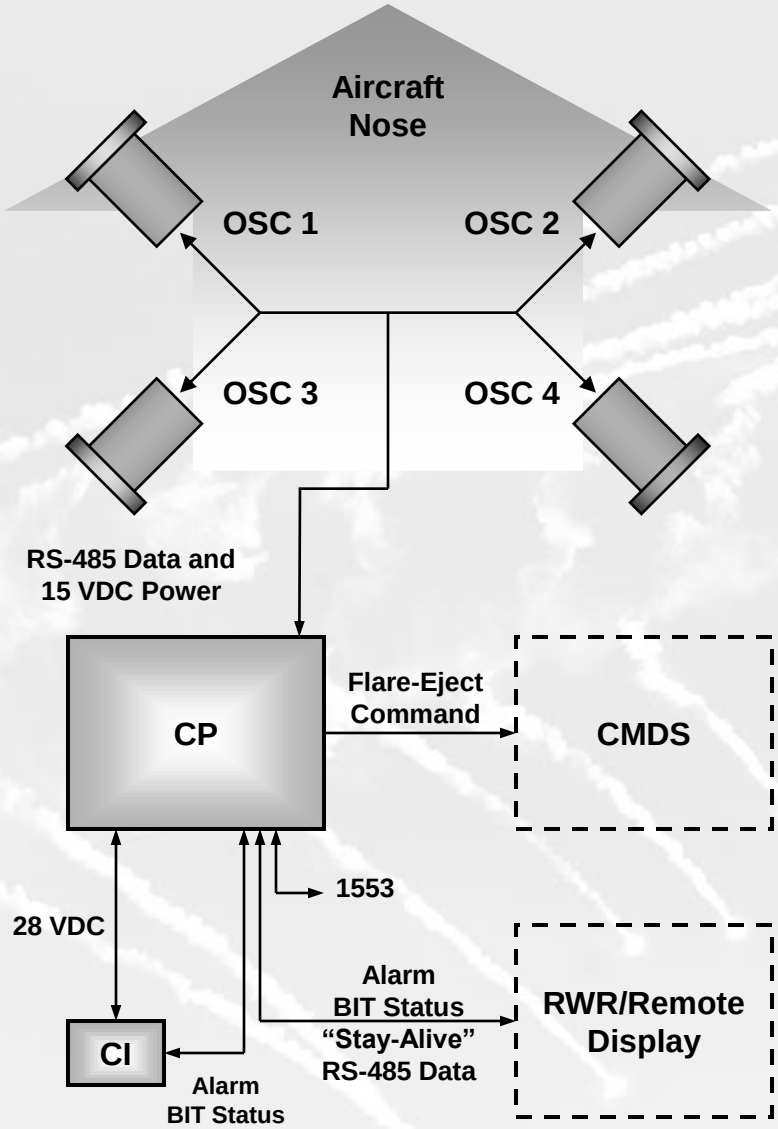
AN/AAR-47B(V)2 Key Performance Capabilities

Added more sophisticated processing to improve performance across all operational environments

- Sensor modified to add sophisticated preprocessing capability based upon Uniformly Most Powerful (UMP) algorithm
- Data fusion algorithms added to combine preprocessed data and standard threat warning processing to improve Pd across all operational environments while maintaining false alarm rate

AN/AAR-47A(V)2 / AN/AAR-47B(V)2 Block Diagram

Comprises 5 or 6 Weapon Replaceable Assemblies



(LW Process)

- 4 Optical Sensor Converters (OSCs), 1 Computer Processor (CP) and 1 Control Indicator (CI)
- OSC - Each OSC covers a quadrant. Detects UV - sends missile photon data to CP. ***Detects and distinguishes between photons from lasers and those from broadband sources. OSC preprocesses laser threats and creates LW threat files. Sends LW threat files to CP***.
- CP – SW algorithms look for temporal energy pattern which distinguishes attacking IR missile from all other UV energy sources. ***Consolidates and classifies LW threats (range finder, designator, or Beamrider), prioritizes each threat, and reports to CI or RWR/Remote Display.***
- When missile threat is declared, CP sends flare-eject command to CMDS and alarm to CI, RWR/Remote Display, and/or over 1553 interface
- CI, RWR/Remote Display - displays missile threat quadrant and sounds audio warning. ***Displays laser threat angle of arrival and threat classification and sounds audio alarm***

AN/AAR-47 / ASE System Overview

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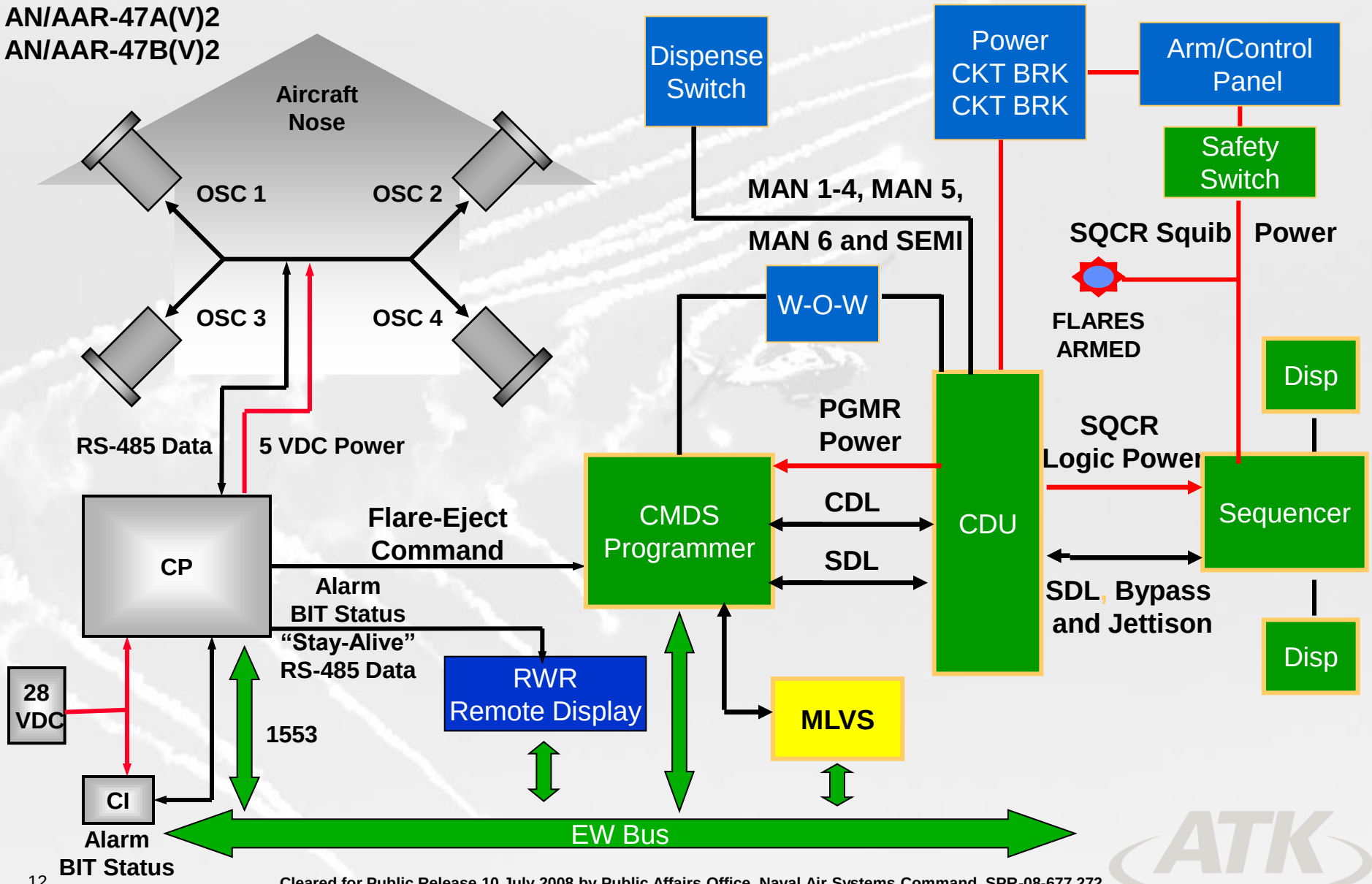
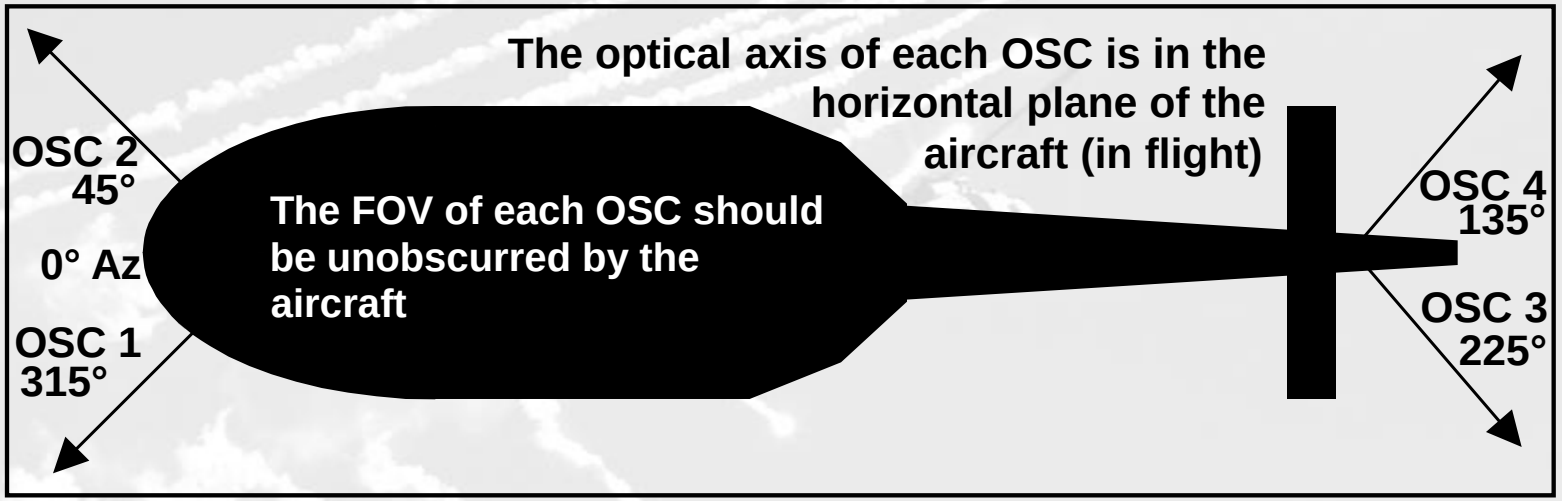


Typical Aircraft Installation



Computer Processor

Provides AN/AAR-47 System Central Processing

- Routes power to the OSCs
- Commands OSC sensor mode
- Collects OSC MW and LW data
- Analyses OSC data for threat detection
- Communicates with the CI for display information and mode selection
- Provides discrete outputs for Counter Measures Systems

28 volt DC to multi-voltage power supply

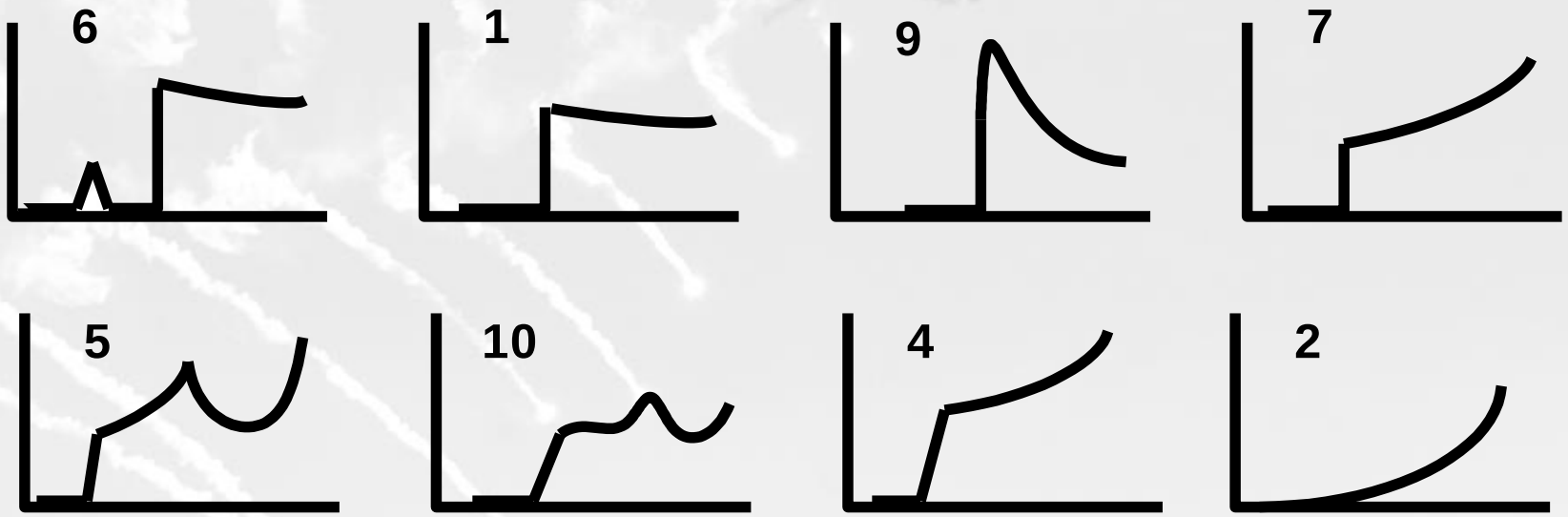
Discrete RS-485 and MIL-STD-1553 I/O

Missile Warning Algorithms

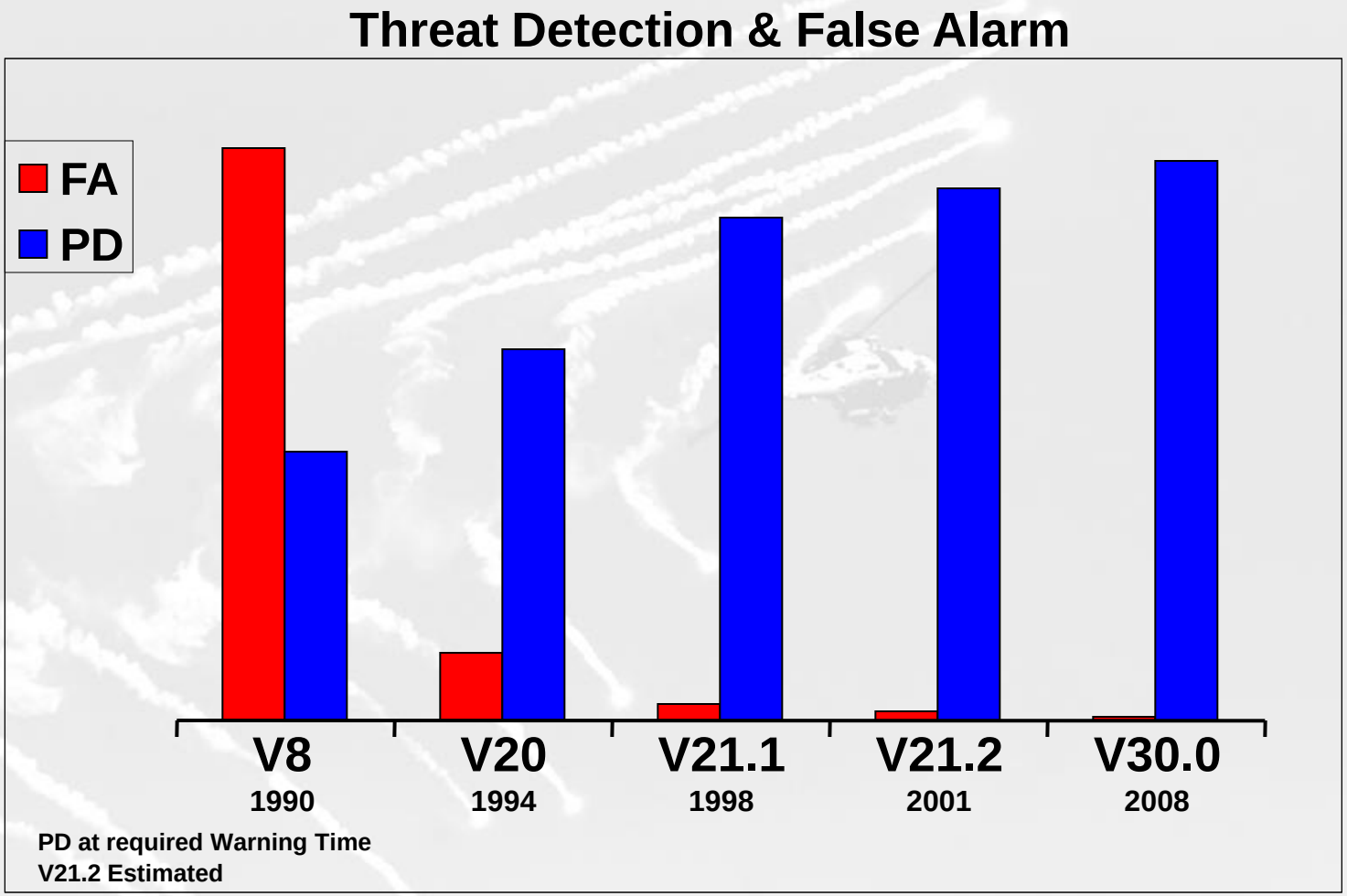
Discriminants

- Temporal - source signal level as a function of time (Intensity versus Time)
- Spectral Bandpass - source signal level within restricted bandpass most sensitive to threats and insensitive to false alarms
- Algorithms looking for an “event” and “confirmation”

Missile Templates



Overall Performance Improvement



OSC Description

The Optical Sensor Converter (OSC)

- Detects optical emissions for a specific band of light energy
- Provides information to the AN/AAR-47 system for evaluation

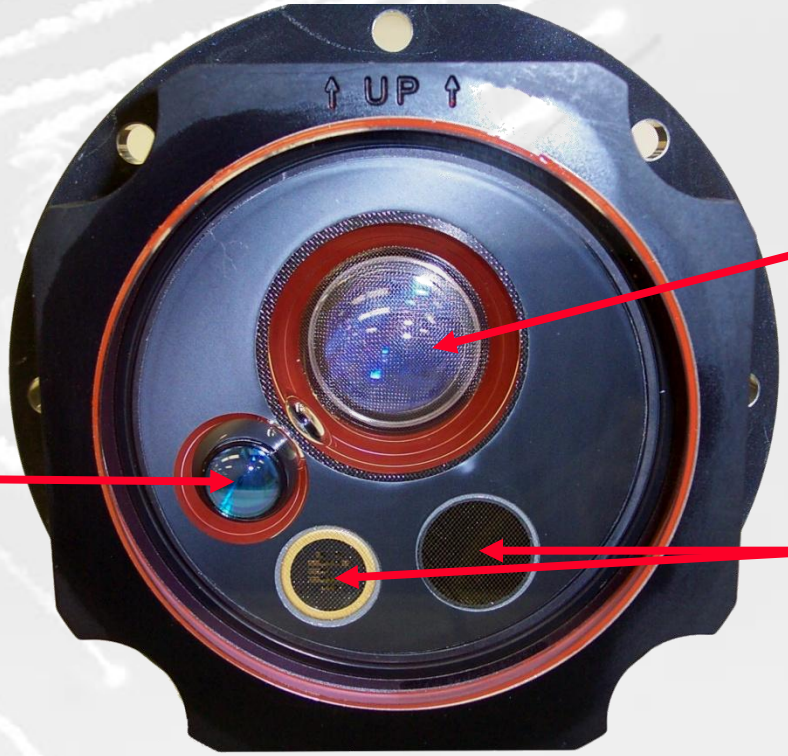
OSC Upgrade Capabilities

- Increases detection sensitivity
- Laser Warning Detection
- Initiates BIT and reports results
- Extends high temperature operating limits to +85C
- Extends operational life to 15 years
- AN/AAR-47A(V)2 adds adjunct detector
- AN/AAR-47B(V)2 adds preprocessing in the sensor to improve signal to noise performance
- AN/AAR-47B(V)2 with HFI implementation of multispectral camera technology to improve HFI performance and potential MW capability

15 Volt DC power supplied by CP

AN/AAR-47A(V)2 - Dynamic Blanking Sensor

The new dynamic blanking sensor for the AN/AAR-47A(V)2 system incorporates an Adjunct Detector to provide quick recovery whenever the sensor is exposed to high levels of in-band irradiance energy.



AN/AAR-47B(V)2 Preprocessing Sensor

The new AN/AAR-47B(V)2 sensor retains the same functional sensor components but adds internal circuitry and algorithms to preprocess data for the purpose of improving performance of the system across all operational environments.

Missile Warning Aperture

Dynamic Blanking Adjunct Detector

Laser Warning Apertures

Control Indicator Description

The Control Indicator provides an optional user interface

- Controls power application to AN/AAR-47 System
- Provides threat display (Missile and Laser Warning) to the operator
- Provides system status and BIT information
- Commands External Annunciator
- Generates tones and commands External Audio

All LED (lamps & displays)

Night Vision (NVIS) Compatible

Control Indicator

Alphanumeric Display
Operating mode
Threat AOA & BIT Status
Software / WRA IDs

Missile Warning
Quadrant Indicators

Laser Warning
Graphical AOA &
Threat Class

Power / Test Switch
Off, On, Test (momentary)

Volume &
Brightness Controls

Sensor Physical Description

Size (Approximate):

- Computer Processor - 8 x 8 x 10 inches
- Optical Sensor Converter - 5 x 8 inches
- Control Indicator - 2 x 5 x 6 inches

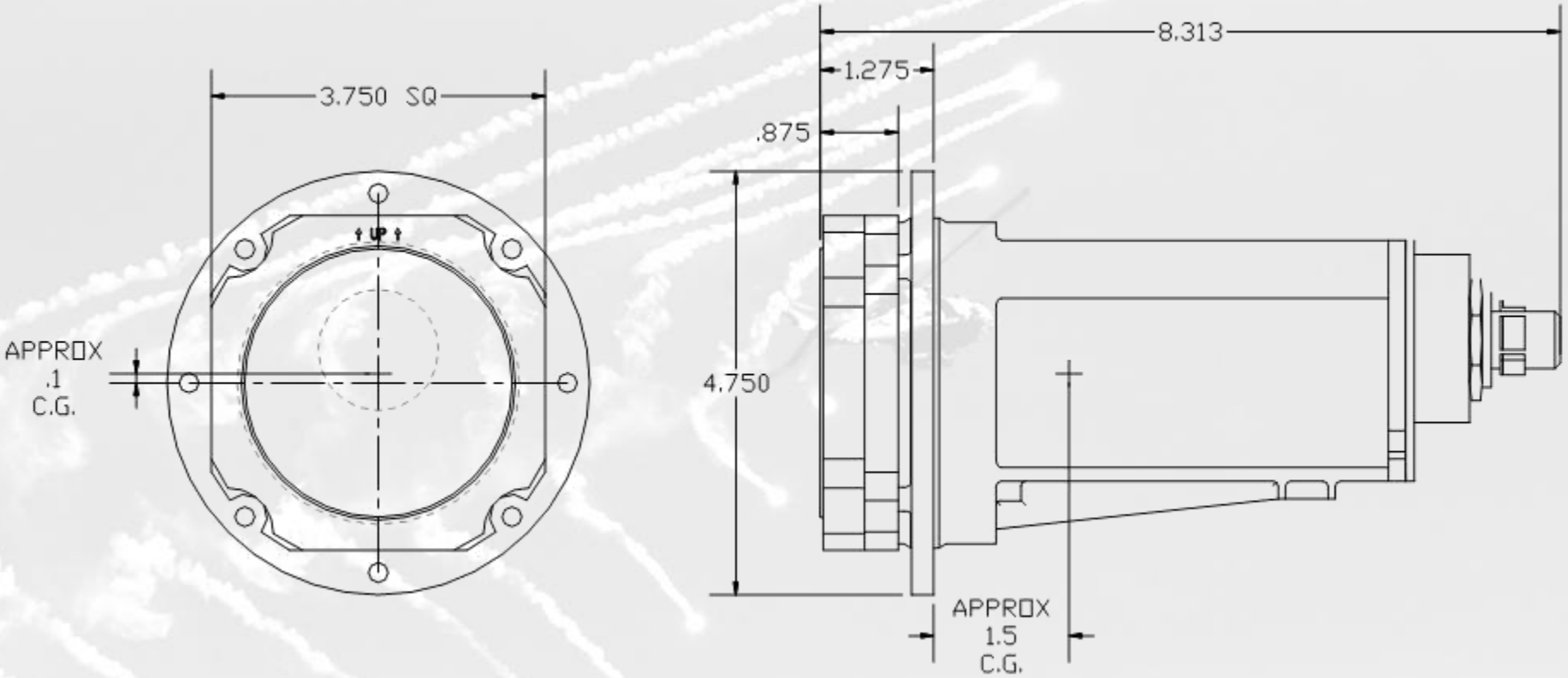
Weight (Approximate):

- Computer Processor - 16 Lb.
- Optical Sensor Converter - 3.5 Lb.
- Control Indicator - 2 Lb.

Power (Approximate):

- Computer Processor and Sensors - 50 – 60 Watts
- Control Indicator - 13 Watts

OSC Physical Envelope



The AN/AAR-47A(V)2 and AN/AAR-47B(V)2 have the same form factor and interface as previous AN/AAR-47 sensors.

Improved Reliability

System reliability was a high priority in the AN/AAR-47A(V)2 / AN/AAR-47B(V)2 design

- Selection / screening of critical components
  - Spectral Filter
  - Photomultiplier
  - Power Supply
- Process Improvements
- Material Selection

MTBF Predictions

- Computer Processor MTBF 11,529
- Control Indicator MTBF 50,201
- Optical Sensor Converter MTBF 11,273

Results

- MTBF greater than 4x over legacy system
  - System is exceeding predictions in heavy operational use.
- Sensor expected life >15 years

Environmental Performance / Qualification

AAR-47 has been qualified for the following environments:

- High / Low Temperature (per MIL-T-28800)
- Humidity (95% RH - Operating)
- Solar Radiation (MIL-STD-810)
- Vibration (per MIL-T-28800)
- Shock (Mil-S-901 Navy High Impact Shock, Transit Drop & Loose Cargo)
- Explosive Atmosphere (per MIL-STD-810)
- Sand and Dust (per MIL-T-28800)
- Watertight and Splashproof (per MIL-T-28800)
- EMI / EMC (MIL-STD-461 & above deck Radiated Shipboard Testing)
- Acoustical Noise (per MIL-T-28800)

AN/AAR-47A(V)2 / AN/AAR-47B(V)2 Advantages

System Capability:

- Significantly improved MWS sensitivity, probability of detection and lower false alarms
- Combines missile and laser warning sensors into one system.
- Uses Adjunct detector for self protection in high irradiance environments
- AN/AAR-47B(V)2 improves performance in difficult operational environments

System Cost:

- System costs are significantly lower than equivalent standalone Missile and Laser Warning Systems.

System Reliability:

- AN/AAR-47A(V)2 is demonstrating very high reliability in the demanding GWOT environment.

System Weight:

- AN/AAR-47A(V)2 and AAR-47B(V)2 each have a total weight of less than 33 lbs.

System Availability:

- Production rates >600 shipsets / year.

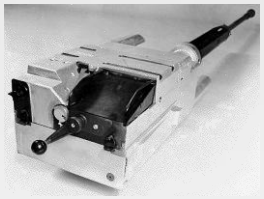
AN/AAR-47
Future Upgrades

The HFI Problem

5.56 mm LSW

7.62 mm AK-47(M)

14.5 mm KPV (КПВ)



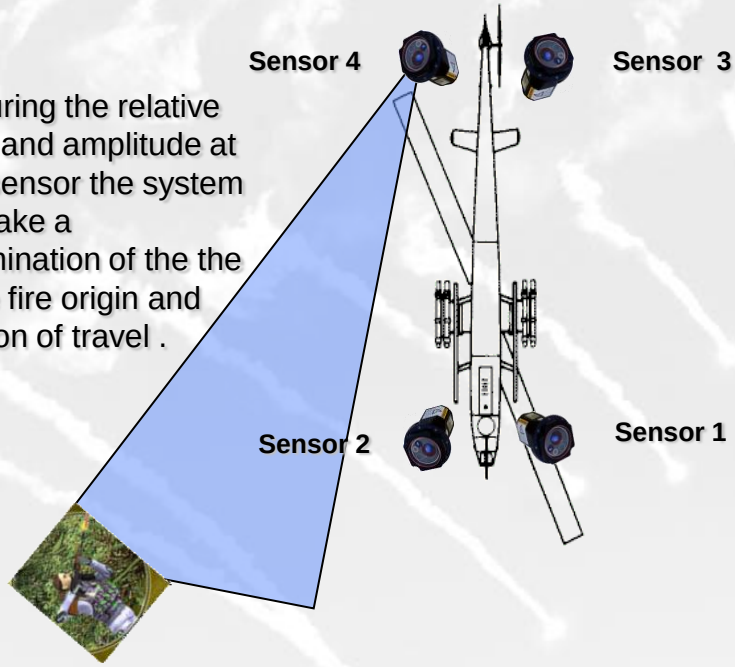
30 mm Rarden Cannon

RPG-7

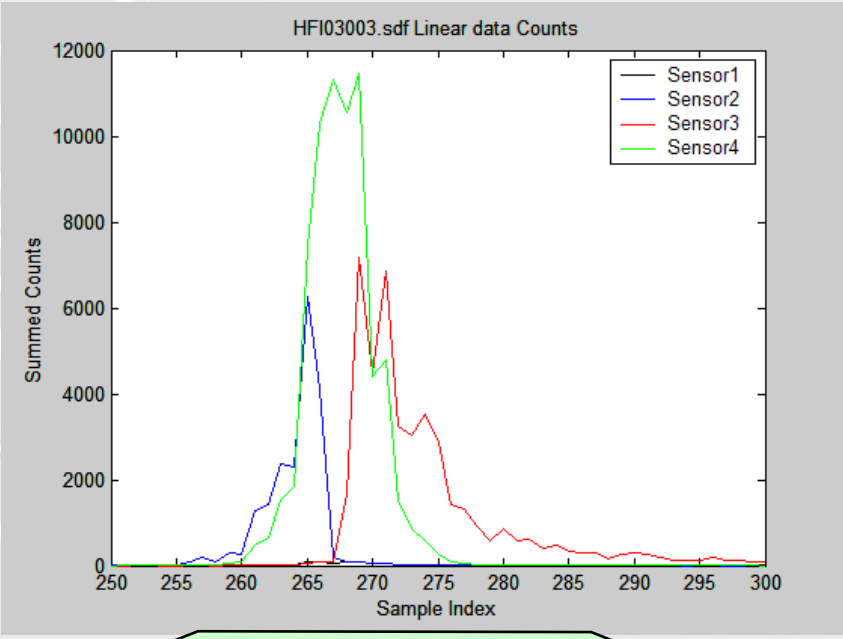
AAR-47 Operational Flight Program (OFP) will introduce HFI

- **The AAR-47 will have an Operational Flight Program (OFP) that will provide Hostile Fire Indication (HFI)**
- **A joint UK/PMA-272/ATK HFI study shows the AAR-47 detects a high percentage of HF events for the ammunition tested.**
- **The system will be capable of detecting ammunition with tracers passing within 100 meters of the aircraft.**
- **The system will also provide classification of single shot or rapid fire engagements.**
- **Full HFI study report delivered to PMA-272 in April 08**

Measuring the relative timing and amplitude at each sensor the system can make a determination of the the hostile fire origin and direction of travel .



Sensor 1 – 4 detection of HF



Why HFI works

- Sharp peaks with short duration = detection & discrimination
- Time-phased response through the 4 sensors = origin + direction of travel
- Amplitude and crossing timeline = estimate of angle to point of closest approach

Hostile Fire Detection

ATK is developing a hostile fire detection capability for the AN/AAR-47A(V)2 system by upgrading the system software (OFP).

- The OFP will add this new threat class without degrading MW/LW performance

ATK has demonstrated that the AN/AAR-47 can detect hostile fire for ammunition employing tracers with a miss distances less than 100 m.

- High Pd demonstrated, greater than 90% against a Gov't provided data set.
- Angle of Approach is available for operator awareness
- Event classification can be provided

AN/AAR-47
Support Equipment

AAR-47 Logistical Support

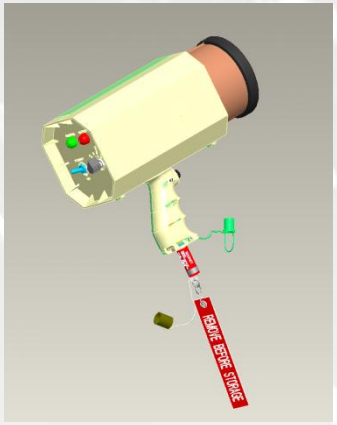
- **FSRs on call to support AAR-47 B(V)2 fielding of CONUS and OCONUS based forces.**
- **Fielding new O-level support equipment with additional modes end-to-end operational test**

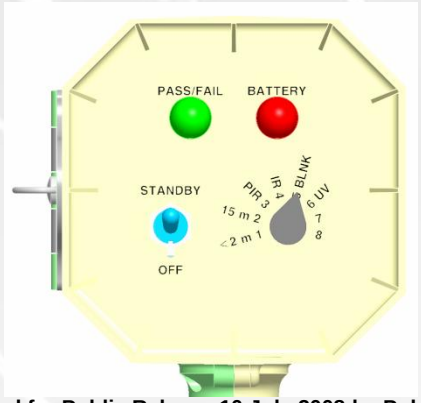
Maintenance Modes:

- **Mode 1** — **UV Test Pattern From 0.15 Meters (6 Inches) To 2 Meters**
- **Mode 2** — **UV Test Pattern From 2 To 15 Meters**
- **Mode 3** — **A Constant UV Light Level for Measuring PIR**
- **Mode 4** — **A Pulsed IR Light Level for Determining IR Sensitivity**
- **Mode 5** — **High Intensity UV Light Level (Blanking Mode)**

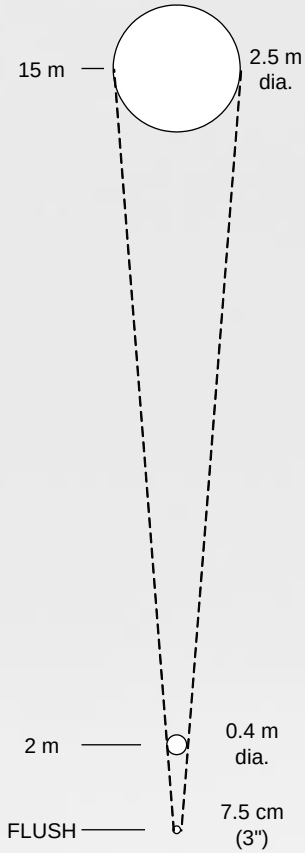
Operational Mode:

- **Mode 6** — **UV Waveform simulates UV Missile Threat. On aircraft end-to-end test.**





Mode 1, Flush to 2 m
Mode 2, 2 m to 15 m
Mode 3, UV PIR (OLST)
Mode 4, IR Flush
Mode 5, Blanking Flush
Mode 6, Operate Flush



Data Acquisition System

- The Data Acquisition System supports all configurations of the AAR-47; legacy AAR-47(V) through AAR-47B(V)2.
- System can be installed without impacting Aircraft Survivability Equipment performance or flight safety.
  - Qualified for operational use in all flight environments
  - Operates upon power up of the AAR-47
  - Data stored on removable, non-volatile memory cards
  - Quickly installed without impact to the aircraft a-kits
  - Failure modes will not degrade AAR-47 performance
- Data Acquisition System capabilities include:
  - Automatic collection of data for up to 8 hours:
    - Missile and Laser data from each sensor
    - GPS time and location data
    - Threat declaration data
    - Flare dispense signals from the CP
  - Manually initiated data collection to support live fire test events
  - All software and data stored in non-volatile memory to prevent data loss at power interruptions
  - Operates on aircraft AAR-47 28 Vdc power (15 watts)
  - Data utilities to convert data to ASCII tables and/or Government approved data formats

Data file allows user to plot flight and threat information using standard GPS track and way points on commercial mapping tools such as Google Earth