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# Electrical Wiring Interconnect System RAM Data Scoring and Work Unit Code



# References



- **SAE AS50881** – Wiring, Aerospace Vehicle
- **MIL-STD-1798D** – Mechanical Equipment and Subsystems Integrity Program
- **MIL-HDBK-522D** – Guidelines for Inspection of Aircraft Electrical Wiring and Interconnect Systems
- **MIL-HDBK-525\_Ch1** – Electrical Wiring Interconnect System (EWIS) Integrity Program
- **TM 1-1500-323-24-1** – Aircraft Electric and Electronic Wiring
  - NAVAIR 01-1A-505-1
  - T.O 1-1A-14



# Overview



- RAM Engineering
- Aviation System Assessment Program (ASAP)
- Scoring Process
- EWIS WUC History
- EWIS Scoring
- Initial Findings
- Continuing Challenges
- Potential Improvements



# RAM Engineering & System Assessment Division: What we do

## Aviation Systems

- Supports All PEO Aviation PMOs
- Aviation RAM Support
  - Analyses / Assessments
  - Models
  - Design for Reliability & Maintainability (R&M)
- Aviation System Assessment Program (ASAP) Analyses / Assessments
- Reliability Centered Maintenance (RCM)
- Reliability Improvement Projects (RIP)
- Fault Tree Analysis
- Foreign Military Sales (FMS) RAM Analyses

## Missile Systems

- All PEO M&S PMOs and MDA
- Materiel Release RAM Certification
- Missile and Ground Support Equipment RAM Support
- Stockpile Reliability Programs (Army & FMS)
- Sustainability Support for Missile Operations
- Missile Health Monitoring
- Supportability Analysis
- Logistics Assessments

## RAM Technology

- Reliability, Availability, Maintainability Analysis
- Failure Reporting and Corrective Action System (FRACAS)
- Science & Technology (S&T) Development & Support
- Data Driven AI and Machine Learning Analytics using ASAP data
- Policies and Procedures
- Failure Modes, Effects and Criticality Analysis (FMECA)



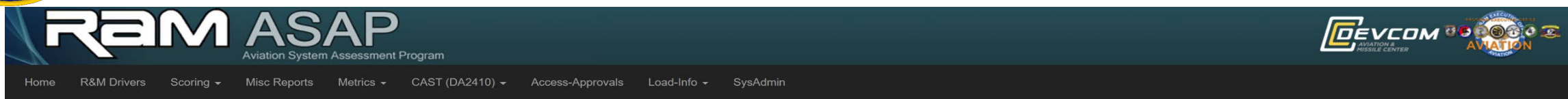
**Improved Reliability, Availability, and Maintainability**



**Ensuring System Readiness**



# RAM Engineering & System Assessment Division: Aviation System Assessment Program



## Aviation System Assessment Program (ASAP)

*The preeminent data source providing the foundation for all RAM engineering across Army Aviation*

- Transforms maintenance records into operational RAM information/metrics to support and enhance fleet management activities
  - Mirrors DT/OT RAM data scoring and evaluation procedures
  - Primary metrics output matches ORD/CDD/CPD requirements
  - Always looking for additional techniques to utilize existing log/maintenance data.
- Trusted engineering data source for U.S. Army air worthiness acceptance authorities
- Secure, Online, & Centralized location for U.S. Army Aviation Reliability Data
- Customize RAM Metrics within ASAP to PM or FMS requirements
- Begun in 2000 and contains over 7 million total records scored across all aviation platforms
- Provides a guide for Program/Fleet Managers to identify system/subsystem maintenance burdens centered on reliability and maintainability of platform systems and components

**ASAP serves as THE TRUSTED engineering data source for assessing fielded RAM system performance and recommending system improvements.**



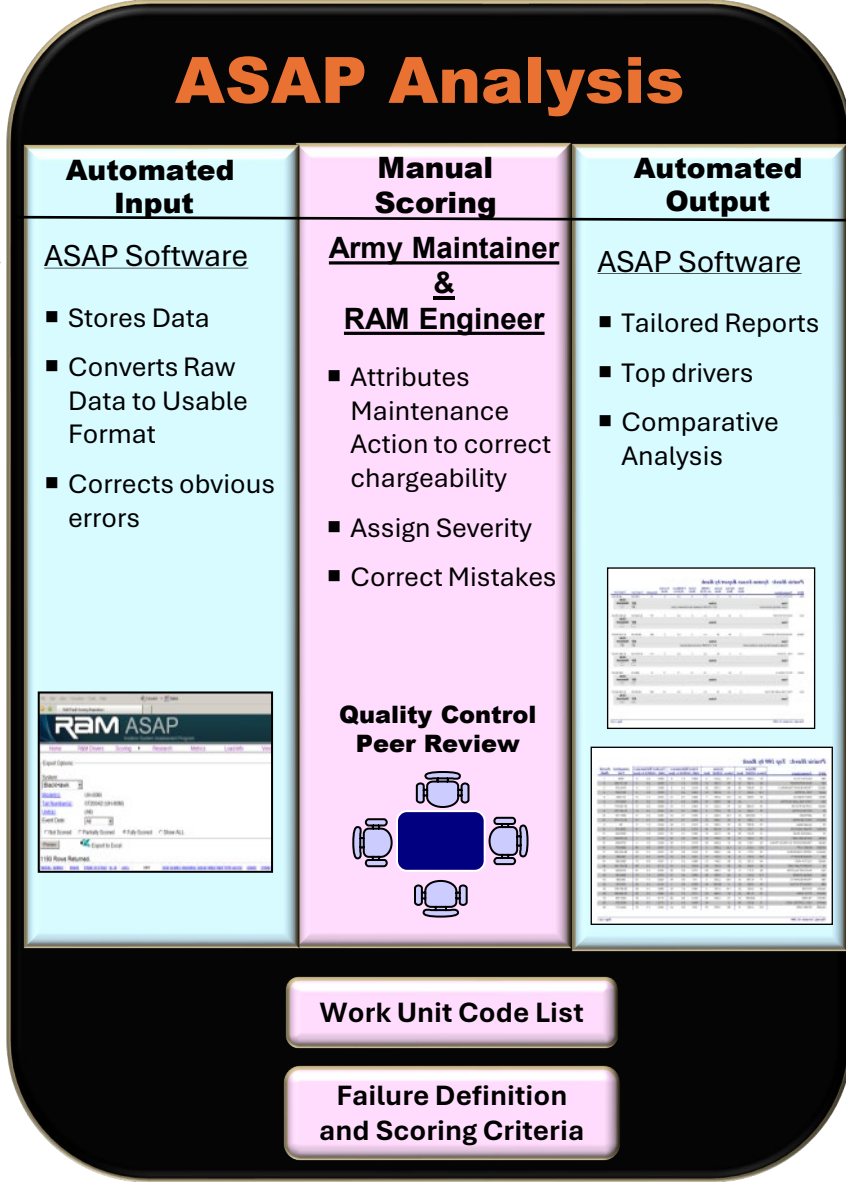


# RAM Engineering & System Assessment Aviation System Assessment Program (ASAP)



- ASAP CUSTOMERS**
- Attack Helicopter – Apache
  - Cargo Helicopter – Chinook
  - Fixed Wing
  - Foreign Military Sales (FMS)
  - Future Vertical Lift
  - Uncrewed Aircraft Systems
  - Utility Helicopter – Black Hawk

- Aircraft Data**
- Maintenance event data
  - Corrective Actions
  - Life limited Items



- Part / Component RAM Metrics**
- Mission Abort Rate
  - Mission Affecting Failures
  - Maintenance Man hours
  - Maintenance Time
  - System Failures

- Fleet Drivers**
- Operational Tempo
  - Environmental Factors
  - Age Related Failures
  - Trending
  - Potential Failures

- Fact Based Decision Making**
- Component Upgrades
  - Maintenance Changes
  - Resource Allocation
  - Business Case Analysis



# EWIS MECSIP and RAM Eng & SA Div



- MIL-HDBK-525 ELECTRICAL WIRING INTERCONNECT SYSTEM (EWIS) INTEGRITY PROGRAM
  - To establish Mechanical Equipment and Subsystems Integrity Program (MECSIP) tasks for an aircraft Electrical Wiring Interconnect System.
  - FAA developed programs to address EWIS integrity concerns in the late 1990's.
  - These programs culminated in FAA EWIS Advisory Circulars and programs to address service life of aircraft wiring in transport aircraft.
  - MIL-HDBK-525 leverages FAA EWIS AC's and applies them in a tailored form to military aircraft electrical systems. (*Ref 1.2 pg1*)
- Section 4 identifies tailorable “Core Process Tasks” that can be used to assess EWIS condition, support service life extensions, and establish or sustain airworthiness.
  - Task 1 – Overall EWIS Documentation
  - **Task 2 – Data Analysis**
  - Task 3 – Physical Aircraft Inspection
  - Task 4 – Component Assessment
  - Task 5 – Risk Assessment
  - Task 6 – Action Plan



# History of WUC 59 EWIS



## IMPORTANCE OF EWIS WUC FOR RAM DATA SCORING

- RAM ASAP sorts scored data by Work Unit Code (WUC).
  - With no EWIS WUC, EWIS faults scored to parent component or system.
  - Artificially inflates component system failures.
  - Hides EWIS failures in other aircraft systems.
- Dedicated EWIS WUC allows for EWIS failures to be identified on their own merit.
  - Allows for accurate and timely EWIS failure analysis.

## WUC 59 Electrical Wiring Interconnect System

- WUC 59 was selected by AMCOM as the EWIS WUC.
- In January 2024 WUC 59 builds were implemented for all Army model aircraft.
  - This includes all MDS of CH-47, H-60, AH-64, UAS, and fixed wing aircraft.
- WUC 59 structure is the same for all Army aircraft at the three-digit level.



# WUC 59 EWIS Structure



<b>59 ELECTRICAL WIRING INTERCONNECT SYSTEM (EWIS)</b>	
<b>59A</b>	WIRES, HARNESSSES AND CABLES
<b>59B</b>	TERMINATION POINTS ON ELECTRICAL WIRES
<b>59C</b>	CIRCUIT PROTECTION DEVICES
<b>59D</b>	CONNECTORS
<b>59E</b>	SHIELD TERMINATION DEVICES
<b>59F</b>	ELECTRICAL GROUNDING AND BONDING DEVICES
<b>59G</b>	ELECTRICAL SPLICES AND TERMINATION DEVICES
<b>59H</b>	WIRE PROTECTION DEVICES
<b>59J</b>	SHIELDS AND BRAIDS
<b>59K</b>	CLAMPS AND ROUTING SUPPORT DEVICES
<b>59L</b>	SECONDARY WIRE RESTRAINT DEVICES
<b>59M</b>	LABELS AND IDENTIFICATION MARKERS
<b>59N</b>	ENVIRONMENTAL SEPARATION PRESSURE SEALS
<b>59P</b>	EWIS COMPONENTS FOR RACKS, PANELS AND SHELVES



# EWIS Aircraft Data Scoring



- WUC 59 Scoring implemented Spring 2024
- All scored maintenance faults from 1/1/2024 onward scored with WUC 59 for EWIS faults
- Initially scored at the three-digit WUC level for all platforms
- Consideration given to ensure EWIS system is ultimately the bad actor
  - Especially important for faults that present with compounding aircraft system problems requiring in-depth troubleshooting or have multiple recurring entries resulting in multiple component replacements prior to resolution
- ***Faults are not scored until the bad actor is identified***



# Initial Scored Data



- Across CH-47 and H-60;
  - Scored data for calendar year 2024
  - Over 70,000 aircraft flight hours of scored data
  - Over 3,000 unique maintenance entries scored to WUC 59





# WUC 59 Top 3 Scored Data CH-47



CH-47		
EWIS WUC	Nomenclature	Percentage of Faults Scored in 2024
'59D	<i>Connectors</i>	52.90%
'59F	<i>Electrical Grounding and Bonding Devices</i>	10.79%
'59A	<i>Wires, Harnesses, and Cables</i>	7.99%



# Fault Examples CH-47



- 59D Connectors
  - High 'touch point' connector failures often removed/reinstalled because of scheduled maintenance.
  - Connectors repeatedly repaired or replaced due to lack of strain relief in wiring.
- 59F Electrical Grounding and Bonding Devices
  - Areas where panels are opened and closed as part of scheduled maintenance see the highest rate of failure to continual movement.
  - Hardware not properly secured or vibrating loose.
- 59A Wires, Harnesses, and Cables
  - Repair/Replace Wire/Cable most common repair due to multiple issues.



# WUC 59 Top 3 Scored Data H-60



H-60		
EWIS WUC	Nomenclature	Percentage of Faults Scored in 2024
'59D	<i>Connectors</i>	35.25%
'59A	<i>Wires, Harnesses, and Cables</i>	18.34%
'59G	<i>Electrical Splices and Termination Devices</i>	12.94%



# Fault Examples UH-60



- 59D Connectors
  - High 'touch point' connector failures often removed/reinstalled because of scheduled maintenance.
  - Faults corrected or unable to be duplicated after connectors disconnected/reconnected.
- 59A Wires, Harnesses, and Cables
  - Blade de-ice wiring harness coating failure/cracking due to exposure to elements.
  - Exposed wiring harnesses replaced due to failing coatings.
- 59G Electrical Splices and Termination Devices
  - Exposed wires or wires outside of wiring bundles requiring repair.



# Shared EWIS Bad Actors



- Connectors
  - Bent pins, failed pin crimping
  - Broken/loose/failed back shells
  - Broken wiring in connector
  - Loose/not fully installed connectors
- Wiring harnesses
  - UV damage to exposed wiring harnesses
  - Damage to wiring harnesses that have no repair ability
- Connectors disconnect/reconnect clearing EWIS faults
  - 'Could not duplicate' faults not returning after system hardware manipulated



# Continuing Challenges of Data Scoring



- Fidelity of data
  - Repairs are not specifically called out on DA Form 2408-13-1
    - E.g. 'Repaired' vs 'P1186 cannon plug pin replaced'
  - ***Better data allows for more accurate EWIS 'Bad Actor' identification***
- EWIS faults often affect multiple systems and take multiple maintenance entries to resolve.
  - Initial entries '*fixed*' with using the '*parts shotgun*' to replace multiple components during one maintenance fault
  - Faults often continue throughout several operational checks, operational cycles and maintenance test flights
- Continual training of machine learning scoring assistance tools



# Potential Areas for Improvement



- Training
  - Increased focus on troubleshooting
  - Importance of accuracy on maintenance forms and records
- Scheduled wiring inspections and maintenance
  - Aircraft system wire testing
  - Focus on wiring health at major maintenance inspections
- Additions to WUC 59 at the 5-digit level to further identify 'bad actors' within EWIS systems.



# Questions?

