

**CONDITION BASED MAINTENANCE PLUS (CBM⁺)
JOINT INTERMITTENCE TESTING (JIT)
WORKING INTEGRATED PRODUCT TEAM (WIPT)
CBM⁺ JIT WIPT Charter**

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I. BACKGROUND

The impact across the Department of Defense (DOD) resulting from the removal and replacement of Line Replaceable Units (LRUs)/Weapon Replaceable Assemblies (WRAs) which subsequently test No Fault Found (NFF) during depot testing and are turned right around back to the field, is \$2 billion annually. Visual inspection is ineffective in detecting the intermittent faults that are primarily responsible for this high NFF rate. Documented military weapon system verification and validation results indicate that three out of four aircraft in a mission ready status contain electrical interconnect issues.

A modern avionics system has thousands of internal and external circuit paths. These systems are subjected to hostile operating environments and will likely fail intermittently long before they fail permanently. Intermittence occurs randomly in time, place, amplitude and duration. Electromechanical devices go into a long and frustrating period of low-level intermittency as their mechanical tolerances change. It only takes one undetected and hence unrepaired intermittent circuit in an electronic box to cause it to randomly malfunction. It is therefore very important that all intermittent circuits that are present in these boxes be detected, isolated and repaired. With the proper test equipment it is now possible to detect and repair these intermittent circuits.

The known projects currently pursuing the intermittent fault / NFF issues include:

- The Automatic Wire Test Set (AWTS) provides support for Ship and Shore Aviation Maintenance. The AWTS provides automatic test functions to detect wire faults and to determine the distance to the faults within wire bundles at Navy I- and D-Level maintenance activities and at Air Force flight line and back shop facilities. It replaces the obsolete Wire Test Set at Navy I-Level Wire Repair facilities and detects wiring shorts and opens within cable assemblies. Recent capability was extended to test inside the FA-18 radar receiver chassis, with a focus on intermittent fault location. Data shows cost avoidance of \$1M/month at the first fielded location, with over 93% of the chassis having wiring faults, of which 26% were intermittent. This effort received the 2011 NAVAIR Innovation Award.
- The Intermittent Fault Detection & Isolation System (IFDIS) targets intermittent faults through the use of a hardware neural network. This functions like multiple latching oscilloscopes on each and every circuit individually, simultaneously and continuously monitoring all circuit paths at the same time ensuring no missed faults, while the units are tested in an environmental chamber and on a shaker table to simulate flight conditions. The IFDIS has the ability to detect faults (micro-breaks) at a greater sensitivity level, faults that previously would go undetected and therefore be coded NFF. The first case study on a F-16 radar Line Replaceable Unit (LRU) resulted in a \$50M ROI, tripled the Mean Time Between Depot Repair, and removed this LRU from the Mission Incapable (MICAP) list after sitting at or near the top of the list for over a decade previous to IFDIS

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testing. IFDIS has also been used on additional F-16 components and has been used to test LRUs and WRAs on the F/A-18, EA-6B, CH-47, RQ-170, Tornado GR4, Typhoon FGR4, Unmanned Aerial Vehicles (UAVs), Boeing 757 and Airbus A320, all with similar results as the first F-16 case study. IFDIS was the winner of the Great Ideas competition at the 2010 DoD Maintenance Symposium, a “Top 5 Finalist” in the 2012 Office of the Secretary of Defense Maintenance Technology Challenge and a 2012 “Top 3 Finalist” in the Aerospace & Defense Category of the American Technology Awards.

II. PURPOSE

This charter establishes the CBM⁺ JIT WIPT to leverage current and emerging commercial industry activity for demonstration, testing, and cost analysis. The following WIPT project goals are to:

- Define and validate joint performance requirements for a Joint Service intermittent fault detection system.
- Collect and analyze implementation and operational data on commercial field intermittent fault detection systems in use currently.
- Define the minimum fault detection threshold requirements for the applicable wiring systems, component types, and system architectures.
- Identify, define and validate test methods for ensuring that specified minimum performance requirements for detecting and isolating intermittence are met.
- Publish a joint performance requirements Military-Performance (Mil-PRF) document.
- Brief and publish findings in a technical report and make a recommendation to Service Components on a path forward.

III. IMPACT

For Intermediate Level: A common, transportable, modular, flexible, fault detection system which employs an intuitive graphical user interface that facilitates familiarity with the system and ease of use.

For Depot Level: A common, highly sensitive, flexible, fault detection system which employs an environmental chamber and a vibration table. The test set should be designed to provide an intuitive easy to use interface that facilitates familiarity with the system and ease of use.

Such a system would provide the following advantages to both maintenance levels:

- Quickly detect, isolate and identify intermittent circuit paths, shorts, opens and incorrect wiring problems in complex LRUs / WRAs
- Provide root cause fault identification

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- Provide advanced prognostic and diagnostic capability
- Increase mission readiness, availability and reliability
- Remediate bad actor LRUs and WRAs
- Reduce ownership cost through quick and correct intermittent fault detection, isolation and repair

IV. AUTHORITY

The CBM⁺ JIT WIPT is established under the authority of the DoD CBM⁺ Advisory Group (AG) Charter.

V. MEMBERSHIP

The CBM⁺ JIT WIPT consists of the Team Members listed at Attachment A. The leader of the CBM⁺ JIT WIPT will be designated.

VI. RESPONSIBILITIES

The CBM⁺ JIT WIPT Chair will direct the preparation and dissemination of required materials. The CBM⁺ JIT WIPT Members shall represent their organizations on coordination and approving any recommendations for intermittent fault detection system equipment. The CBM⁺ JIT WIPT Members shall develop initial capability documentation from their respective user level requirements for each Service. After requirements are staffed by the respective service components, the WIPT will seek to consolidate the valid user requirements into a Joint Requirements Document. Upon concurrence from all WIPT members, the team (with an approved Department of Defense Test Organization) will draft and publish a Mil-PFR document which clearly identifies minimum thresholds for detecting and isolating intermittent wiring faults in various common wiring components (i.e. relays, circuit breakers, LRUs/WRAs) and various aircraft wiring architectures (i.e. conventional wire construction, ribbon wire, solder joints, wire wrap).

VII. PROCEDURES

The CBM⁺ JIT WIPT will meet as required. All relative procedures for WIPTs as outlined in the CBM⁺ AG Charter pertain.

VIII. SCHEDULE

WIPT will meet monthly to discuss progress and path forward.

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Tentative timeline as follows:

TBD

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