

## Maintainability Assessment

At the onset of a program it is important to identify the maintenance concept and derive the initial system maintainability requirements and design attributes. A maintainability assessment of a system or equipment is one method used to determine and validate the actual design taking into consideration the maintainability characteristics of the system. This could include performing an assessment of the:

- Quantitative characteristics
- Physical Characteristics

## Quantitative Characteristics

The quantitative characteristics that could be considered for a system, are its specific maintainability performance characteristics and could include:

**Mean-Time-To-Repair (MTTR):** The MTTR would be calculated taking into consideration the times needed to implement each of the corrective maintenance and preventative maintenance task for the system for each level of maintenance. The MTTR would be derived through the implementation of Maintainability Modeling.

**Maximum Time to Repair:** An important element of the quantitative characteristics is the max time to repair.

**Built-In-Test (BIT):** The establishment of the BIT capability is important. For example a system (mainly electronic) the principal means of fault detection and isolation to the LRU level requires the use of self-diagnostics or built-in-test. This capability, in terms of its effectiveness may need to be quantified.

**Health Status and Monitoring (HSM):** Incorporated into the design of the system could be a HSM capability. This could be a relatively simple concept, such as the monitoring of the axle temperature of a locomotive to safeguard against the main wheel bearing overheating. Other HSM systems may employ an arsenal of sensors, such as strain gages, thermal sensors, accelerometers etc. to measure electrical and mechanical stresses on a system. However, to determine the effectiveness of this approach needs to be established in quantitative terms.



## Physical Characteristics

The physical characteristics take in consideration the issues such as accessibility and the characteristics that will accommodate the maintainer's for ease of maintenance, and include:

**Ergonomics:** These characteristics would address the physical characteristics for the maintainer. MIL-STD-1472D Human Engineering Design Criteria for Military Systems, Equipment and Facilities, and MIL-STD-46855B Human Engineering Requirements for Military Systems, Equipment and Facilities provide good source when considering issues associated with human factors. This would range from the weight of components and required lifting points to the clearance between electrical connectors etc.

**Mechanical Interfaces:** May require specific criteria for interface issues such as mating and self-alignment, captive fasteners, access for tools, to keyed connectors.

**Test Point:** This effort must be interfaced with the testability engineering effort. A system may require some manual diagnostic interaction, where specific test points will be required for fault diagnostic and isolation purposes.

**Test Equipment:** This assessment would address how test equipment (and tools) would interface with the system or equipment.

**Accessibility:** Is an important attribute. As a system integrator the design of a system must avoid the need to remove other assemblies to gain access to a failed unit or the ability to permit the use of standard hand tools must be observed.

**Reliability degradation:** Caution must be given to reliability characteristics. A system required to provide a continuous service, by utilizing redundant elements should be safeguarded against any maintenance actions. For example to remove and replace a failed unit would not allow the complete system to be powered down.

**Software Characteristics:** With systems using software applications to perform their functions, such as a real-time data processing platform, it must be recognized that these, if required because of a maintenance action, to be powered down, would need time to reboot the system and retrieve any back-up configuration and database files.

When assessing the maintainability characteristics, the maintenance concept must play an influential role. For example to stipulate that a system should be capable to isolate to a

function level of each circuit card assembly, may not be justified if the circuit card, through the Logistics Support Analysis process deemed it to be returned to an third party for repair or even discarded. These could otherwise impose unnecessary developmental cost for a redundant feature.

Line Replacement Unit: Data Control Unit (DCU)
<b>Fault Isolation Detection</b>
<p>The principal fault detection and isolation characteristics for this unit are as follows:</p> <ul style="list-style-type: none"> <li>▪ The DCU uses BIT as the principal method for fault detection and isolation. This includes IBIT and PBIT. The testability report, doc. #. TR 123 453 R1, provides detailed to the BIT effectiveness;</li> <li>▪ The DCU has a design requirement to achieve 90% detection of all electronic failures;</li> <li>▪ The Latch BIT Indicator (front panel) will display a visual indication of the BIT status;</li> <li>▪ The DCU generates a BIT status word (DCU Status). This status word contains the status of the DCU LRU and Shop Replaceable Assemblies;</li> <li>▪ The BIT status word (DCU Status), when requested, is sent over the 1553 interface;</li> <li>▪ The maintainer can access the status of the DCU at Operator Station Console, using the dedicated maintenance menus;</li> <li>▪ A test port is provided on the front panel to allow the maintainer to access the status of the LRU and the SRA; and</li> <li>▪ No special tools or support equipment are required for the purposes of fault isolation for this LRU.</li> </ul>
<b>Accessibility</b>
<p>The accessibility characteristics for this unit include the following:</p> <ul style="list-style-type: none"> <li>▪ The maintainer has direct access to this unit which is mounted in Rack 2;</li> <li>▪ No covers are required to be removed or opened to gain access;</li> <li>▪ For the purposes of removal, this unit slides in and out of Rack 2;</li> <li>▪ Other units and assemblies do not need to be removed to gain access to this unit;</li> <li>▪ The maintainer has direct visual access to the BIT Indicator. A visual indication of Green and Red are provided, signifying whether the unit is "GO" (serviceable) or "NO GO" (unserviceable);</li> <li>▪ This unit has no adjustments or controls that require adjustment for operational and maintenance purposes;</li> <li>▪ The fasteners used to secure this unit, in situ, are captive and are located on the front (face) flange; and</li> <li>▪ The maintainer will not require special tools for the removal and replacement tasks.</li> </ul>
<b>Handling Characteristics</b>
<p>The handling characteristics for this unit are:</p> <p><b>Weight:</b> 120 lbs</p> <p><b>Dimensions (H,W, D) inches:</b> 19.00/12.00/15.75</p> <ul style="list-style-type: none"> <li>▪ For the purposes of removal and handling, this unit requires a three person lift, as detailed in MIL-STD-1472;</li> <li>▪ Handles are provided for lifting; and</li> <li>▪ The Centre of Gravity (C of G) is clearly labeled on the on this assembly.</li> </ul>

**Table:** Example of Maintainability Characteristics Summary