Appendix N

AIRWORTHINESS QUALIFICATION REQUIREMENTS

HUMS/HAS REQUIREMENTS

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HEALTH AWARENESS SYSTEM (HAS) REQUIREMENTS

N.1 Operational Concept. The contractor shall provide an Operational Concept Description (OCD) of the Health Awareness System IAW DI-IPSC-81430. The document shall describe the proposed system in terms of intended use, capabilities and functions, and its relationship to other aircraft systems and procedures.

N.2 Software Development. Diagnostic software shall be developed, at a minimum, to the integrity level required by the system criticality assessment using RTCA DO-178. A Functional Hazard Assessment (FHA) should determine the Design Assurance Level (DAL) of the HAS. The Safety Assessment Report (SAR) shall define the DAL and rationale. This system-determined level shall be a result of the end-to-end criticality assessment.

N.3 Validation. The contractor shall develop a procedure to validate all credits, cockpit warnings, and continued airworthiness aspects of the HAS. This procedure shall be reviewed and approved by AED. If the validation being performed involves a CSI, then one of the following methods shall be used for validation:

- Actual service experience on HUMS or HAS equipped aircraft.
- “Seeded fault tests” (where the wear, defect or deterioration is introduced, allowed to develop, and the detection technique verified).
- On-aircraft trials, investigation of cause and effect (e.g. introducing degrees of imbalance and calibrating the response).
- The validations would include analysis such as Weibull to determine CI Probability/Confidence. CIs for CSI items shall have at least 90% Probability/Confidence.

Tests shall be representative of the aircraft for which the credit is being sought and of the conditions in the flight regime when data is normally gathered (e.g. cruise). It shall be established that the evidence gathered from on-aircraft trials or rig-based seeded fault tests is valid in flight.

The contractor shall provide the following in the substantiation package:

- Failure descriptions (teardown reports) and applicable sensor data collected during aircraft developmental and qualification testing, if any failures occur for monitored components. The data shall be in a format readable by the HAS ground station software, or as .CSV files or other format used by MATLAB.

The airworthiness substantiation shall include analyses, test plans and test reports. Required deliverables shall be submitted IAW DI-MISC-80711 (analyses), DI-NDTI-80566 (test plans) and DI-NDTI-80809 (test reports).

N.4 HAS Item List. The contractor shall provide a list of all items that will be monitored with the HAS. The selection of components shall be based on the aircraft FMECA(s) and include estimated rate of progression for each failure mode when
applicable. Required deliverables shall be submitted IAW DI-MISC-80711 (analyses) and shall include the rationale for the selection of each item.

N.5 Maintenance Plan for Monitored Aircraft Components. The contractor shall provide a plan IAW DI-SESS-81704 that specifies the maintenance requirement, technical approach, and monitoring criteria (such as intervals and regimes when data must be collected and how often it must be reviewed) for each item monitored by the HAS.

N.6 HAS Hardware. The contractor shall provide documentation for the HAS hardware. The report shall include the following:

- List of all Sensors and their specifications.
- A sensors optimization study performed to identify the best type and mounting location for sensors on each monitored component. Sensor study shall consist of an initial analysis and subsequently verified by on-aircraft testing. Documentation shall include a description of each studied sensor and the testing that was performed, pictures or diagrams of the sensor locations that were tested, and the data plots (such as transmissibility).
- All HAS drawings and applicable schematics.

Required deliverables shall be submitted IAW DI-MISC-80711 (analyses), DI-NDTI-80566 (test plans) and DI-NDTI-80809 (test reports).

N.7 HAS Algorithms. The contractor shall provide a report describing the design and analysis of the HAS algorithms DI-MISC-80711 (Scientific Report). The report shall include the following:

- General description of the algorithms, including the systems where they reside, and data interfaces between all other aircraft systems.
- Detailed description of each algorithm including 1) simplified block diagrams to illustrate end to end processing; 2) filtering methods; 3) Analog to Digital conversion methods; 4) Time Domain to Frequency Domain conversion processes; 5) Sampling rates; 6) all individual algorithms and 7) all other pertinent algorithm features.
- All parameters, such as frequency bandwidth, used for each algorithm and Condition Indicator.
- Description of the development and verification of the HAS algorithms. Documentation shall include background information used to develop the CI. Testing shall verify that the CI detects the type of fault for which it was designed. For each application, evidence shall be provided that the physics involved is understood and therefore that the monitoring technique/algorithm/parameter, rejection criteria, and associated intervention actions are well chosen.

N.8 Failures Impacting the HAS. The contractor shall provide documentation (analysis and/or test) that demonstrates that HAS is capable of self-diagnosis and reporting of all hardware failures that effect prognostic and diagnostic output used for
maintenance decisions. The document shall describe how each type of failure, e.g. one sensor becoming inoperable, impacts the function of the HAS. Required deliverables shall be prepared IAW DI-MISC-80711 (analyses), DI-NDTI-80566 (test plans) and DI-NDTI-80809 (test reports).

N.9 The contractor shall provide documentation that demonstrate that the HAS functions are not adversely affected by the aircraft operational environment. On-aircraft testing shall verify that the fully integrated system does not have false positive indications, signal dropouts, or data loss during routine operations. Required deliverables shall be prepared IAW DI-MISC-80711 (analyses), DI-NDTI-80566 (test plans) and DI-NDTI-80809 (test reports).

N.10 The contractor shall demonstrate all functions of the HAS. The demonstration shall include acquiring data from all sensors via manual and automatic acquisitions on an aircraft, downloading the data, viewing the health indications in the ground station and via cockpit display if applicable, analyzing the raw data in the ground station, and implementing software/CI changes. Required deliverables shall be prepared IAW DI-NDTI-80603A (test procedures) and DI-NDTI-80809B (test reports).

N.11 The contractor shall provide software needed to configure the aircraft type-specific software, which defines aircraft-specific functions such as CI names, CI parameters (e.g. frequency bandwidth), CI limits, regimes, and acquisition trigger times. Software deliverables.

- Interface Control Documents (ICDs) for the HAS and all systems it communicates with. Deliverable shall be IAW DI-SESS-81248B (Interface Control Document.) The ICD shall define and document the physical, environmental, signal characteristics, logic interfaces, sensitivities, electrical requirements and special data requirements.
- The contractor shall prepare a software sustainability package IAW DI-IPSC-82134. Document should include the data structure of all input and output files for HAS.
- The contractor shall provide a description of the HAS output files structure, and shall provide any code needed to read the HAS output files for use the C++ or MATLAB.
- The contractor shall provide software documentation IAW DO-178C.

N.12 The contractor shall provide routine reporting of all overhaul/repair findings for each monitoring component by Serial Number, specifying and describing what faults were found if any. This requirement continues for the duration of the program.

N.13 ADS-79E should be utilized to the maximum extent possible.