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Reliability and Maintainability Control Plan Series 400 Aircraft

PRACTICE: **ESP 91**

ISSUE **3**

RELIABILITY AND MAINTAINABILITY CONTROL PLAN SERIES 400 AIRCRAFT

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1.0 SCOPE

This Control Plan defines Supplier deliverables, detailed in EPS 1-18 and the associated DTRD's, and the required time of submittal to de Havilland Reliability and Maintainability (R&M) Engineering. Each deliverable is addressed, indicating when preliminary and/or final documents are required.

All Supplier R&M deliverables have been scheduled in relation to DHI's DHC-8-400 Tier 1 engineering schedule and in accordance with the BAGNA Engineering System. Since document delivery dates may vary between Suppliers, separate customized GANTT charts will be provided to each Supplier.

Where Suppliers require DHI R&M data to proceed with their deliverables, dates have been provided indicating when the data will be available to the Suppliers.

Note that in general, deliverable dates have been set in relation to PDR and CDR. Therefore, if these reviews do not occur when scheduled on the Supplier GANTT charts, the time-relationship between their scheduled dates and the deliverable dates should remain the same unless otherwise indicated by de Havilland. If discrepancies exist between dates specified in this Control Plan and Supplier GANTT chart dates, the GANTT chart dates will take precedence.

This Control Plan manages all R&M data deliverables from DHC-8-400 program launch until aircraft certification.

Each Supplier is not necessarily required to respond to all deliverables identified in the Control Plan; therefore, DHI will provide Suppliers with specific requirements.

To ensure common document formats and a consistent approach to assessments and analyses, Supplier deliverables shall conform with ESP 92 (R&M Policies & Procedures) unless otherwise agreed to by DHI.

2.0 APPLICABLE DOCUMENTS

DTRD 8-010	de Havilland Technical Requirements Document - General
EPS 1-18	R&M Specification Requirements (DHC-8 Aircraft)
ESP 79	Design of Inspectable Structure
ESP 92	R&M Policies & Procedures

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3.0 DEFINITIONS, ABBREVIATIONS AND ACRONYMS

BAGNA	Bombardier Aerospace Group North America
CDL	Configuration Deviation List
CDR	Critical Design Review
DHI	de Havilland Incorporated
DTRD	de Havilland Technical Requirements Document
ESP	Engineering Standard Procedure
EPS	Engineering Procurement Specification
MDS	Maintenance Data Sheet
MMEL	Master Minimum Equipment List
MSG	Maintenance Steering Group
MSI	Maintenance Significant Item
PDR	Preliminary Design Review
R&M	Reliability & Maintainability
SSA	System Safety Analysis
SSI	Structurally Significant Item

4.0 R&M CONTROL PLAN

4.1 Supplier Schedule

DHC-8 Series 400 Supplier Schedule - R&M Engineering Deliverables (customized GANTT chart to be separately provided).

4.2 R&M Engineering Deliverables

4.2.1 Reliability Program Plan

In accordance with ESP 92 and within one month following contract award, Suppliers shall provide DHI with a finalized Reliability Program Plan.

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4.2.2 Functional Hazard Assessment

The Supplier shall produce a Functional Hazard Assessment (FHA) to identify potential failure conditions which systems may cause or contribute to and the severity of their failure effect (i.e. major, hazardous, etc.). In identifying failure conditions and their effects, the FHA establishes the scope of additional safety analyses.

DHI shall produce an aircraft FHA and a preliminary systems FHA, which will both be made available to Suppliers as soon as possible after program launch. Upon receipt of the systems FHA, Suppliers shall review and amend/expand the assessment to reflect final system definitions. The Supplier updated preliminary systems FHA shall be submitted to DHI for approval eight weeks prior to Preliminary Design Review (PDR) and a final systems FHA submitted by Critical Design Review (CDR).

The scope of Supplier's Safety Analyses, which must be provided as a result of FAR/JAR airworthiness regulations, shall be based on the finalized aircraft and systems FHA's.

4.2.3 General Aircraft Safety Analysis

A General Aircraft Safety Analysis shall be prepared by DHI and is not applicable to Suppliers.

4.2.4 System Safety Analysis

System Safety Analyses (SSA) shall be produced by Suppliers to demonstrate compliance of their structure/system with applicable airworthiness regulations.

Preliminary SSA shall be submitted to DHI, prepared in accordance with ESP 92 six weeks prior to PDR. Final SSA shall be submitted to DHI no later than August 1, 1997.

4.2.5 Failure Mode, Effects and Criticality Analysis

Suppliers shall identify all systems/LRU's requiring a Failure Mode, Effects and Criticality Analysis (FMECA) from the aircraft and systems Functional Hazard Assessments (FHA).

The FHA shall be considered comprehensive but not absolute. As such, in addition to FHA requirements, Suppliers shall provide FMECA's for systems/ LRU's specifically requested by DHI.

Suppliers shall identify all foreseeable failure modes and comprehensively provide the required information in accordance with ESP 92.

Preliminary FMECA's, integrated into the preliminary SSA, shall be submitted to DHI six weeks prior to PDR for appraisal of single critical functional failures. Final FMECA's, integrated into the final SSA, shall be submitted to DHI by August 1, 1997.

4.2.6 Fault Tree Analysis

Suppliers shall determine Failure Conditions requiring a quantitative Fault Tree Analysis (FTA) from the aircraft and system Functional Hazard Assessment.

Failure Conditions involving multiple systems (e.g. Engine Failure and Rudder Seizure) not supplied by a single Supplier will be coordinated by DHI.

Preliminary fault tree analyses, integrated into the preliminary SSA, for all required failure conditions shall be submitted to DHI six weeks prior to PDR. Final fault tree analyses, integrated into the final SSA shall be submitted to DHI by August 1, 1997.

4.2.7 Reliability Modeling & Predictions - MTBF's

Reliability Modeling includes both Functional and Reliability Block diagrams.

Functional Block diagrams shall be provided for all systems and integrated into the SSA.

Reliability Block diagrams shall be provided for all systems which incorporate redundancies and shall also be included in the SSA. Reliability Predictions (failure rates) shall be allotted to each block, which shall be used to compute the probability of system failure.

Preliminary Reliability Models and Predictions, integrated into the preliminary SSA, shall be submitted to DHI six weeks prior to PDR. Final Models and Predictions, integrated into the final SSA, shall be submitted to DHI by August 1, 1997.

4.2.8 Parts Derating Analysis

Parts derating analyses shall be provided for electronic components and those components where specifically requested.

Preliminary parts derating analyses shall be submitted to DHI six weeks prior to PDR and final analyses shall be submitted to DHI by August 1, 1997.

4.2.9 Reliability Allocations - MTBF's

Reliability Allocations (Apportionments) shall be performed to ensure required system MTBF's/MTBUR's are achieved.

Preliminary Reliability Allocations shall be submitted to DHI six weeks prior to PDR and final allocations shall be submitted to DHI by June 1, 1996.

4.2.10 Fire Hazard Assessment

Suppliers shall produce a Fire Hazard Assessment to identify potential fire hazards, ensure that they are eliminated or minimized and monitored, and demonstrate compliance with applicable airworthiness fire protection regulations.

Structural Suppliers shall be responsible for systems integration and as such shall perform an assessment on all integrated systems and structure within the boundaries of their aircraft section. Systems Suppliers shall provide assistance to structural Suppliers and satisfactorily address all fire hazard issues.

Preliminary assessments shall be submitted to DHI six weeks prior to PDR and final assessments shall be submitted to DHI by November 17, 1996.

DHI shall produce an Aircraft Fire Hazard Analysis, using the Suppliers assessments, for submittal to the certification authorities.

4.2.11 Rotor Burst Assessment (Engine, Propeller & APU)

4.2.11.1 Engine Fragment Information

Suppliers shall provide DHI with preliminary Engine (and Propeller) Fragment information (i.e. blade or impeller size, mass, location) by September 1, 1995 to allow DHI to proceed with Rotor Burst Model development. Final fragment information shall be submitted to DHI six weeks prior to Critical Design Review (CDR).

4.2.11.2 Systems Layouts

Suppliers shall supply DHI with preliminary system and structural layouts appropriate for reviewing Rotor Burst susceptibility six weeks prior to PDR. Final system layouts accommodating potential rotor burst trajectories shall be submitted to DHI by CDR.

DHI shall provide guidance to Suppliers for the installation of critical, redundant, etc., systems within the rotor burst/propeller blade release zones.

4.2.12 Dispatch Reliability Analysis

Suppliers shall submit a preliminary Dispatch Reliability Analysis to DHI six weeks prior to PDR and a final analysis no later than November 17, 1996.

4.2.13 Software Certification Requirements

Software Plans shall be provided to DHI one month prior to PDR. Software documents shall be provided to DHI one month prior to CDR. Software reports shall be provided to DHI three months after CDR with the exception of Problem Reports which shall be provided to DHI on a bi-weekly basis following CDR.

4.2.14 Maintainability Program Plan

In accordance with ESP 92 and within one month following contract award, Suppliers shall provide DHI with a finalized Maintainability Program Plan.

4.2.15 Maintenance Costs

Suppliers shall submit Maintenance Cost Allocations to DHI six weeks prior to PDR. A preliminary Maintenance Cost Analysis shall be submitted to DHI at PDR and a final analysis shall be submitted by August 1, 1997.

4.2.16 Maintenance Requirements

4.2.16.1 Access Panel Definition

Structural Supplier shall provide DHI with a preliminary Access Panel Listing six weeks prior to PDR at which time the Supplier shall also provide de Havilland with a preliminary Basic Zone and Access Panel Definition (Numbering designation and format can be found in Chapter 6 of the Dash 8

Maintenance Manual). Preliminary Maintenance Data sheets (MDS) and updated Zone and Access Panel Definitions shall be provided to DHI six weeks prior to CDR. Final MDS and Access Panel Definitions shall be provided by December 1, 1997.

4.2.16.2 Removal/Replacement Task Analysis (Maintenance Data Sheets)

Suppliers shall provide DHI with preliminary MDS for all Maintenance Significant Items (MSIs) six weeks prior to PDR. Updated MDS shall be provided to DHI six weeks prior to CDR. Final MDS shall be provided by December 1, 1997.

4.2.16.3 Scheduled Maintenance Analysis (Maintenance Steering Group 3)

Suppliers shall provide DHI with recommended scheduled task list with substantiation, six weeks prior to PDR. A preliminary scheduled maintenance analysis in accordance, in accordance with the latest revision of MSG-3, and specific maintenance procedures to detect failures or potential failures shall be provided six weeks prior to CDR. Final MSG-3 analysis and procedures to be submitted to DHI by December 1, 1997.

4.2.16.4 Unscheduled Maintenance Analysis

Suppliers shall provide DHI with recommended unscheduled inspections as a result of hard landing, bird strike, volcanic ash ingestion, lightning strike, etc. (Maintenance Manual Chapter Five inspections), six weeks prior to PDR. Suppliers are to provide preliminary inspection procedures six weeks prior to CDR. In addition to the above inspection procedures, on-aircraft maintenance and off-aircraft aircraft repair analyses (as per EPS 1-18) is required using the Maintenance Data Sheets. Final Inspection procedures, on-aircraft maintenance, and off-aircraft repair analyses are to be submitted to DHI by December 1, 1997.

4.2.17 Master Minimum Equipment List (MMEL)

DHI shall provide Suppliers with a preliminary MMEL and definition following contract award. Suppliers shall prepare their preliminary MMEL with justification six weeks prior to PDR. Supplier shall update MMEL and prepare preliminary procedures six weeks prior to CDR. The final MMEL and procedures are to be submitted to DHI by December 1, 1997.

4.2.18 Configuration Deviation List (CDL)

DHI shall provide the structural supplier with preliminary CDL and definition following contract award. The Supplier shall then supply DHI with their preliminary candidates for CDL six weeks prior to PDR. Supplier to submit final candidates for CDL six weeks prior to CDR.

4.2.19 Structurally Significant Item (SSI)

DHI shall supply the Structural Supplier with a preliminary SSI list and definition following contract award. The Supplier shall submit an updated SSI list and preliminary MDS stating the inspection methods, six weeks prior to CDR. The Supplier shall submit the final SSI list and final MDS stating, inspection methods and procedures by December 1, 1997.

4.2.20 Reliability Development Growth Program

For newly designed equipment, Suppliers may be required to establish a reliability growth program. As such, Suppliers shall provide DHI with test results no later than May 1, 1997.

4.2.21 Worst Case Analysis

If requested by de Havilland, Suppliers shall provide a Worst Case Analysis no later than March 1, 1997

4.2.22 Environmental Stress Screening

For newly designed equipment, Suppliers may be required to subject their equipment to Environmental Stress Screening (Burn-in). As such, Suppliers shall provide DHI with test results no later than March 1, 1997.

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5.0 Deliverables Reference Numbers

Deliverables submitted to DHI R & M Engineering shall have the following reference numbers as per Project Plan S400-026 clearly displayed on an accompanying cover sheet:

R & M Deliverables	Deliverable Reference Number
Reliability Program Plan	XXX-S400-PLRL-100-##
Functional Hazard Assessment	XXX-S400-RPRL-101-##
System Safety Analysis	XXX-S400-RPRL-102-##
Failure Mode, Effects and Criticality Analysis	XXX-S400-RPRL-103-##
Fault Tree Analysis	XXX-S400-RPRL-104-##
Reliability Modeling and Predictions - MTBF	XXX-S400-RPRL-105-##
Parts Derating Analysis	XXX-S400-RPRL-106-##
Reliability Allocations - MTBF	XXX-S400-RPRL-107-##
Fire Hazard Assessment	XXX-S400-RPRL-108-##
Engine Fragment Information	XXX-S400-RPRL-109-##
Dispatch Reliability Analysis	XXX-S400-RPRL-110-##
Software Certification Requirements	XXX-S400-RPRL-111-##
Maintainability Program Plan	XXX-S400-PLMN-200-##
Maintenance Cost Analysis	XXX-S400-RPMN-201-##
Access Panel Definition	XXX-S400-RPMN-202-##
Maintenance Data Sheets	XXX-S400-RPMN-203-##
Scheduled Maintenance Analysis(MSG3)	XXX-S400-RPMN-204-##
Unscheduled Maintenance Analysis	XXX-S400-RPMN-205-##
Master Minimum Equipment List	XXX-S400-RPMN-206-##
Configuration Deviation List	XXX-S400-LSMN-207-##
Structurally Significant Item	XXX-S400-RPMN-208-##
Reliability Development Growth Program	XXX-S400-RPPL-112-##
Worst Case Analysis	XXX-S400-RPPL-113-##
Environmental Stress Screening	XXX-S400-RPPL-114-##
	xxx = Supplier code as per Project Plan S400-022 ## = revision number (first release is “NC”; first revision is “A” etc

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