

APPENDIX B THE ELEMENTS OF AN AIRWORTHINESS QUALIFICATION SPECIFICATION (AQS) AND THEIR CONTENTS

B-1 INTRODUCTION

The airworthiness qualification specification (AQS) should be prepared by the air vehicle contractor (AC) in response to the requirements established by the procuring activity (PA) in the airworthiness qualification plan (AQP) and the contracts data requirements list (CDRL). The PA should require that the AC prepare for its approval an airworthiness qualification specification (AQS) for each air vehicle and system that requires qualification or requalification because of major modifications. The AQS should identify the means (reviews, analyses, tests, modeling, and demonstrations), performance, and effectiveness criteria needed to validate compliance with the system specification and airworthiness qualification plan. This should include contractor conducted tests with Government surveillance, and also Government conducted tests with contractor support and surveillance. Facilities, targets, and simulators should be identified in the AQS. Pass-fail criteria should be identified by the AC and approved by the PA. A compliance matrix is typically required as part of the AQS.

The minimum scope of the AQS should satisfy all requirements of the AQP but should not necessarily be limited to requirements in the AQP. ACs may propose additional tests, surveys, reviews, and demonstrations deemed necessary to ensure qualification of the modification or development program.

For modifications involving few components or subsystems, the scope of the airworthiness qualification specification (AQS) should be limited to only those systems modified and those related components and subsystems that are affected by modifications and should be subjected to qualification. Modification programs that involve many components or development programs may require an AQS that essentially involves all areas covered by this handbook.

For such extensive modifications or developments, all major elements of an AQS are described in paragraph B-3. The use of distribution statements as provided for in Department of Defense Directive Number 5230.24, *Distribution Statements on Technical Documents*, (Ref. 1) should be considered for use on sensitive technical information.

B-2 OBJECTIVES OF THE MAJOR ELEMENTS

As cited in Department of Defense Regulation DoDR 5000.2-R, *Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MIAs) Acquisition Programs*, (Ref. 2) technical management processes should be applied to reduce technical risk through early test and demonstration of system elements. The major elements of the AQS serve to identify, control, and/or reduce the technical risk associated with modification and development programs from project inception until publication of the Airworthiness Qualification Substantiation Report (AQSR).

Providing aviation systems which are safe for operators is also an objective of the AQS elements. Through the System Safety Program (SSP), establishment of operating limitations, restrictions, and advisory "Notes," "Cautions," and "Warnings" in technical

publications, and determination of component fatigue lives, only acceptable risks to operators are present when the airworthiness qualification program is completed.

Various elements of the AQS also aid in conservation of both contractor and Government assets. As part of a coordinated test program, the AQS delineates facilities to be used, minimum testing requirements, test articles to be used, and responsibilities for conduct, reporting, and support. In this way, duplication of effort is eliminated.

Finally, knowledge of mission capability will be enhanced by use of an AQS. Verification of air vehicle ranges, velocities, mission radii, target detection, acquisition, designation, and engagement capabilities, reliability, availability, and maintainability (RAM) characteristics, and other operational capabilities is necessary to verify specification compliance.

B-3 MAJOR AQS ELEMENTS

A tailored set of AQS elements should be identified for the air vehicle development program. These elements will be chosen from the various elements listed below.

B-3.1 SCOPE*

This element of the AQS should identify the system being modified or under development, and all variants of that system covered by this AQS. Variants may include models with common dynamic components, but different crew, cargo, and mission equipment package (MEP) configurations, and coproduction versions of the air vehicle .

The purpose of the AQS is to define the approach which will be used by the air vehicle contractor (AC) to satisfy the requirements of the airworthiness qualification plan (AQP), described in Appendix A. The minimum scope of the AQS should satisfy all requirements of the AQP, but should not necessarily be limited to requirements of the AQP. ACs may propose additional tests, surveys, reviews, and demonstrations deemed necessary to ensure qualification of the modification or developmental program.

Essential elements of the AQS include:

1. System Safety
2. Design Review and Release of Drawings
3. Mock-ups
4. Procurement and Process Specifications
5. Component Tests
6. System Surveys
7. Formal Contractor Demonstrations. Together, these elements should form the

minimum effort which the AC should expend to ensure that the system developed or modified is qualified for its intended mission, operational, and maintenance environment.

Acquisition cycle phases to which the AQS applies should be identified, as well as the end product of the qualification program (prototype air vehicle or low rate initial production [LRIP] modified air vehicle). If publication of an AQSR for the end product will result from satisfaction of this AQS, that fact should be noted.

*The underlined portion of the paragraph number and title identifies the paragraph number and title in the AQP.

The initial AQS should be prepared by the AC in response to requirements of the request for quotes/request for proposals (RFQ/RFP) developed by the procuring activity (PA). Revision during the development or modification program is often necessary, and the end result will be documentation of the complete qualification effort from RFP/RFQ through fielding of the system. While this effort may be limited for a modification of a previously qualified air vehicle, air vehicles undergoing developmental testing may have more extensive qualification requirements.

This element of the AQS should provide a brief summary of major subsystems undergoing modification, weapons systems which are being developed concurrently and will form a part of the end item (engine development programs, for example, and other information necessary to convey the magnitude of the qualification effort. Responsibilities for accomplishment, surveillance or test witnessing, and support for each AQS element identified in the AQP should be reiterated in this paragraph, and may be identified down to the AQS subelement level, if necessary for clarity.

B-3.1.1 SYSTEM SAFETY

The objective of a system safety program (SSP) is to ensure that, consistent with mission requirements, safety is designed into all materiel, facilities, and support equipment. Relevant information can be found in MIL-STD-882 (Ref. 3). Also, coordination with the environmental hygiene and aeromedical communities of the US Army Health Services Command in support of the requirements of Army Regulation (AR) 40-10, *Health Hazard Assessment*, (Ref. 4) and in support of DoD Acquisition Procedures (Ref. 2), which applies to commercial off-the-shelf (COTS) systems and nondevelopment items (NDI) as well as new developmental systems, is recommended.

To satisfy both qualification and other program requirements, a tailored deliverable stand-alone safety assessment report, including but not limited to results of tailored hazard analyses, and the initiation of hazard tracking, typically should be required. Full development programs may require incorporation of all MIL-STD-882 (Ref. 3) tasks and incorporation of tailored tasks or selected tasks. Only the tasks, rather than the military standard should be specified.

Selected tasks should be identified, and, in the event tasks are tailored, the extent of the tailoring should be specified in the AQS; however, due to the extent of the plan, inclusion by reference may be necessary. In the case of a limited modification program, applicable tasks may be included in the AQS for simplicity. Chapter 3 provides a complete description of the SSP.

B-3.2 APPLICABLE DOCUMENTS

As stated earlier in Chapter 4, applicable documents are documents included by reference in the AQS. All and only those documents referenced elsewhere in the AQS should be listed. If referenced documents are numerous, this listing may occur in an appendix to the AQS.

As system complexity and the number of recognizable subsystems increases, the AC should prepare a specification tree. This tree should contain a listing of all system, subsystem, equipment assembly and component specifications which will be required to support the acquisition, qualification, and spare parts procurement processes. Control of

this tree should allow the documents listed in TABLES 4-1 and 4-2 to be related to each system, subsystem, equipment, assembly, and component, and ensure that each specification adequately defines the actual minimum needs of the Government.

References should be listed by document numbers and titles, and may include specific issues or revision numbers where necessary to rigidly control configuration or implementation. Within the text of the AQS, tailoring or modification of requirements of the referenced documents should be identified. The entire referenced document should not be made applicable by reference unless all of its provisions are clearly required.

B-3.3 DEFINITIONS

The inclusion of definitions for terms or phrases can be avoided if requirements are properly stated. If terms must be defined in the AQS, relevant information can be found in MIL-STD-961, *Standard Practice for Defense Specification*, (Ref. 5).

If appropriate, a definition of the system or functional areas, and functional and physical interfaces, include logic, block, and schematic diagrams, and contain pertinent configuration item undergoing airworthiness qualification should be included in this element of the AQS in the form of a brief description. This definition should identify major physical parts, organizational, operational, and logistics considerations and concepts. If multiple common definition terms are used (future attack rotorcraft [FAR] and Federal Acquisition Regulation [FAR], for example, are used, the applicability and use of these terms should be clearly identified, and the terms defined.

B-3.4 GENERAL REQUIREMENTS

Essential performance requirements which apply to design, reliability, personnel, subsystems, etc., of the aviation system, subsystem, or component, should be stated in this section. These performance requirements apply to all facets of the program.

In contrast, detail requirements apply to only certain components or subsystems. These detail requirements should be stated in subpar. B-3.5.

The subpars. that follow provide essential general requirements for airworthiness qualification for modification and developmental aviation programs.

B-3.4.1 TECHNICAL REVIEWS

Chapter 4 (Par. 4-6 1) covers the purposes and types of technical reviews involved in a modification or developmental program. Also, relevant information can be found in MIL-STD-973, *Configuration Management* (Ref. 6) or equivalent interface standard. The PA should determine the type and frequency of required reviews based on the nature of the program. These reviews may be either technical or non-technical (cost and schedule). Reviews should be conducted to ensure completion of scheduled activities, highlight problem areas, and determine appropriate courses of action to resolve problems. These criteria should be applied when establishing the need for program reviews. For example, qualification of a second source for a component which has an approved design may not require all types of reviews.

When not specifically scheduled by the PA, the AC should schedule required reviews in a manner which will logically support the design and qualification process. The contractor's Systems Engineering Management Plan (SEMP) may be referenced for

detailed scheduling and planning of program reviews. Program events, such as milestone decision points, first flight of prototypes, and gunfire testing, should be considered in scheduling these reviews. Agendas, topics for discussion, approval processes, and minutes for each review should be as specified by the PA in the Contract Data Requirements List (CDRL), DD Form 1423, and supported by Data Item Descriptions (DIDs), DD Form 1664.

Chapter 4 contains more detailed information on the types and purposes of reviews.

B-3.4.2 DATA AND DOCUMENTATION

Data and documentation required to support the airworthiness qualification process should be supplied in accordance with Government direction. DIDs used should be cited, including AQS paragraph number(s) and data requirement titles.

Delivery schedules and methods should be specified in a contractor-prepared CDRL based on Government requirements. When tailoring or contractor format is proposed, changes to DIDs should be reflected in the subject CDRL. Within the AQS, components, computer software configuration items (CSCIs), or subsystems requiring data submissions may be cited along with the appropriate DID. For programs which involve few components, CSCIs, or subsystems, these may be identified in the CDRL.

B-3.4.3 QUALIFICATION ASSURANCE

Depending on the nature of the program, the AC should propose selected elements of the program necessary to ensure specification compliance. Hardware, software, instrumentation, Government participation and approval, validation of test facilities and simulations, testing and specification practices, tooling, standardization, and producibility should be considered for inclusion. Application of selected elements should support transition from development to production.

Chapter 5 of this handbook describes the elements and purposes of the elements of a qualification assurance program. These major elements of the qualification assurance program should be selectively applied (tailored) to fit the scope of the developmental or modification effort. While some may not apply, the contractor should ensure that the elements critical to transition from development to prototype construction to full-rate production are specification compliant.

B-3.5 DETAIL REQUIREMENTS

Detail requirements apply to only certain components or subsystems while general requirements apply to all facets of the program. These detail requirements provide essential detailed requirements for airworthiness qualification of components, subsystems, and CSCIs for modification and developmental aviation programs. The typical detailed requirements of an airworthiness qualification program are described in the following paragraphs.

B-3.5.1 MODELING

Based on PA requirements, the AC should define in the AQS models which should be used to verify airworthiness qualification. The contractor should also define his

validation processes, method of updating models throughout the development program, and the extent to which models should reflect actual air vehicle or subsystem configuration. The use of models for multiple purposes should also be defined. Models may be either physical models (such as aerodynamic models, mock-ups, or ground test vehicles) or simulations. Chapter 6 provides more information about the use of models in the airworthiness qualification process.

B-3.5.2 COMPONENT TESTS

This element of the AQS should provide component qualification procedures which satisfy the requirements set forth in the AQP. The AC should also include identification of components which will undergo the four main types of qualification testing:

1. Functional qualification in accordance with par. 7-5: These tests are usually based on general specifications for that type of component, and should be conducted using a test environment which is similar to the anticipated operational environment. Monitoring of test parameters should be performed.

2. Structural qualification in accordance with par. 7-6: This qualification involves structural design criteria (to include materials and processes), analysis and test of design (fatigue integrity), structural integrity verification, and structural integrity maintenance. Design philosophies should be documented, plans for monitoring of fatigue critical components explained, and structural integrity verification and maintenance plans described.

3. Endurance and screening qualification in accordance with par. 7-8: This testing and screening is intended to identify failures in the laboratory, where the causes of failure are much less expensive to correct than on a fielded system.

4. Environmental testing in accordance with paragraphs 7-9 and 7-10: Environmental qualification should be divided into physical and electromagnetic environment qualification sections, as appropriate. These test conditions should include all expected environmental stresses which the equipment will be subjected to. TABLE B-1 "Component Qualification Matrix" provides a sample component qualification matrix of typical air vehicle components which have airworthiness implications. By completing a similar matrix, the AC should identify the specific components and planned qualification testing for those components. As can be seen from the sample matrix, a minor modification program involving only a few components will permit significant tailoring of the matrix. A full developmental program may well involve many more components than those listed.

If Federal Aviation Administration (FAA) structural qualification is to be used, those procedures should also be identified in this element of the AQS. Other areas to be addressed, as applicable, include the contractor's methods for parts control, survivability, optical and electrooptical, material, process, and spares and repair parts qualification.

Chapter 7 provides more detailed discussions of component test requirements.

B-3.5.3 SUBSYSTEM QUALIFICATION

This element of the AQS should describe qualification of major subsystems and their interface effects with other subsystems and components. For developmental

programs, all components effecting airworthiness should be considered, and their qualification procedures identified. For modification programs, only those subsystems added, modified, or affected by addition or modification of other components should be considered.

Chapter 8 covers major subsystem qualification requirements. These major subsystems which may require airworthiness qualification are shown in the second column of TABLE B-2, "Subsystem Interface Qualification Effects." A table similar to TABLE B-2 should be included in the AQS to define subsystem qualification requirements and interface effects. In all modification or developmental programs, the interface effects of subsystems should be defined. For developmental programs, all major components should be listed under their appropriate subsystem.

The example shown in the sample TABLE B-2 is for the addition or modification of an auxiliary power unit (APU). APU addition or modification may have an effect on engine performance (starting, hydraulic, pneumatic, and cabin pressurization subsystems electrical power subsystem analysis, electrical and electronics cooling subsystems), cockpit and instrument lighting subsystems, and environmental control subsystems. For the APU modification or addition, these subsystems must be requalified according to the procedures specified in the corresponding subparagraph of this handbook. These subparagraphs are cited to the right of the APU entry in the table, indicating that qualification activities described in those subparagraphs must be performed in addition to those for the APU because of the interactions between the APU and their systems.

Other effects of addition or modification may have airworthiness impacts which are not covered in Chapter 8. AR 70-62, *Airworthiness Qualification of US Army Aircraft Systems*, (Ref. 7) defines those modifications which require qualification.

B-3.5.4 SYSTEM QUALIFICATION

This element of the AQS should describe how the air vehicle system will be qualified once subsystems have been qualified. Major system will be qualified once subsystems have been qualified. Major system qualification concerns are covered in Chapter 9, and include these major areas:

1. Structural integrity demonstration
2. Propulsion and power demonstration
3. Flight load survey
4. Dynamic Stability
5. Aerodynamic demonstration
6. Vibration testing
7. Acoustic noise testing
8. Climatic laboratory testing
9. Icing flight tests
10. Electromagnetic Environmental Effects (E) tests
11. Weapons systems effectiveness tests
12. External stores separation testing

TABLE B-1
COMPONENT MATRIX

| QUALIFICATION TEST TYPE | COMPONENT TYPES | | | | | | | | | |
|-------------------------|-----------------|--------------|----------|------------|-----------------------|------------------|----------------|-------------------------|-------------------------|----------------------------------|
| | STRUCTURAL | | | | ELECTROMECHANICAL | | | HYDROMECHANICAL | | |
| | Rotor Blades | Drive Shafts | Castings | Crew Seats | Generator/Alternators | Fuel Boost Pumps | Oil Cooler Fan | Landing Gear Oleo Strut | Flight Control Actuator | Landing Gear Retraction Cylinder |
| Functional | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| Structural | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Endurance & Screening | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Environmental | | | | | 2 | 2 | 2 | | | |

| QUALIFICATION TEST TYPE | COMPONENT TYPES | | | | | | | |
|-------------------------|-----------------|--------------|-------------------|-------------------|----------------------------|----------|----------|------------------|
| | MECHANICAL | | | ELECTRICAL | | AVIONICS | | |
| | Rotor Hub | Transmission | Overriding Clutch | Voltage Regulator | Anti-icing/Deicing Element | Radio | Intercom | Mission Computer |
| Functional | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 |
| Structural | 1 | 1 | 1 | | | | | |
| Endurance & Screening | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Environmental | | | | 2 | | 2 | 2 | 2 |

KEY: 1. PRE-INSTALLATION REQUIREMENT
2. PRE-FLIGHT REQUIREMENT

SOURCE: SDI

13. Survivability testing
14. Avionics testing
15. Test-analyze-fix-test.

Details of the required testing are included in chapter 9. For a major modification or developmental program, all areas may need inclusion in the AQS. Unarmed air vehicles obviously would not need weapons systems effectiveness testing, and minor modification may need application of only a few areas. In major modification and development programs, changes in one subsystem will have an effect on other subsystems and total system performance, as shown in TABLE B-2. The synergistic effects of combining subsystems into a total air vehicle system should be considered in this section of the AQS.

B-3.5.5 FLIGHT SAFETY PARTS QUALIFICATION

Flight safety parts (FSP) are covered in paragraph 3-13. Special qualification requirements are required for these parts, and are covered in subpar. 3-13.2. The contractor should identify their proposed procedures for qualifying FSP, how FSP will be identified, how records will be maintained for FSP, how surveillance will be performed on FSP, and how FSP will be disposed.

B-3.5.6 OPERATIONAL READINESS QUALIFICATION

AR 702-3, *Army Materiel Systems Reliability Availability. and Maintainability*, (Ref. 8) defines operational availability, or readiness, as the proportion of time that a system is either operating or is capable of operating, when used in a specific manner in a typical maintenance and supply environment. The contractor should specify in element 5.6 the AQS planned testing to support this qualification. Accounting methods used for calendar time in a specific period may need to be identified and considered in calculating this proportion. Elements of this calendar time are defined in the glossary of AR 702-3 (Ref. 8), and include operating time (OT), standby time (ST), total corrective maintenance downtime (TCM), total preventive maintenance downtime (TPM), and total administrative and logistics delay time (TALDT). The contractor should specify all deviations from AR 702-3 (Ref. 8) definitions in his AQS.

Operational readiness qualification is covered in more detail in Chapter 10.

B-3.5.7 PREPARATION FOR GOVERNMENT TEST

The AC should identify prerequisites for Government test. These prerequisites may be in the form of events to be completed or resource requirements. The AC should identify all pretest qualification events, instrumentation requirements, and shipping, training and maintenance support. Particular emphasis should be placed on Government support to developmental test and proposed contractor participation in operational test.

B-3.6 GUIDANCE INFORMATION

This element should contain any guidance received by the contractor in preparation of the AQS. This section and associated subsections are provided for information only.

B-3.6.1 TEST INTEGRATION WORKING GROUP (TIWG)

AR 73-1, *Test and Evaluation Policy*, (Ref. 9) provides for the air vehicle program manager (PM) to form and chair a TIWG for programs involving test and evaluation (T&E) for undemonstrated requirements. For fielded air vehicles subject to minor modifications, the TIWG may not be required.

The TIWG serves to implement T&E coordination and solve routine T&E problems. This element of the AQS should detail contractor participation in, and proposed areas for consideration by, the TIWG. Airworthiness qualification areas which have significant risk should be identified in this element.

B-3.6.2 INTEGRATED PRODUCT TEAM (IPT)

This element of the AQS should document all IPTs participating in the decision process. These IPTs should consider both hardware and software. Proposed plans of action and milestones should be documented.

B-3.6.3 GOVERNMENT TESTING

Requirements for Government test participation, witnessing or surveillance, and logistics and maintenance support for Government test should be described in this element of the AQS. The contractor should identify support he will provide in these areas. Independence of Government testing should be addressed, as well as responsibilities for data collection and management, and test planning and reporting.

B-3.6.4 USE OF GOVERNMENT TEST FACILITIES

Government test facilities required for airworthiness qualification should be identified and described in this element of the AQS. When a unique Government test facility, such as an anechoic chamber or large test range, is needed, justification should be provided for use of this facility. Anticipated dates and duration of usage should be provided. When significant Government testing is proposed, this information may be shown in a table or by a graphic.

APPENDIX B
LIST OF ACRONYMS AND ABBREVIATION

| | | |
|----------------|---|---|
| AC | = | air vehicle contractor |
| APU | = | auxiliary power unit |
| AQP | = | airworthiness qualification plan |
| AQS | = | airworthiness qualification specification |
| AQSR | = | airworthiness qualification substantiation report |
| AR | = | army regulation |
| AQS | = | airworthiness specification |
| CDRL | = | contract data requirements list |
| COTS | = | commercial off-the-shelf |
| CSCIs | = | computer software configuration items |
| DIDs | = | data item descriptions |
| E ³ | = | electromagnetic environmental effects |
| FAA | = | federal aviation administration |
| FAR | = | federal acquisition regulation |
| FSP | = | flight safety parts |
| LRIP | = | low rate initial production |
| MEP | = | mission equipment package |
| NDI | = | nondevelopment items |
| OT | = | operating time |
| PA | = | procuring activity |
| PM | = | program manager |
| RAM | = | reliability, availability, maintainability |
| RFQ/RFP | = | request for quote/request for proposal |
| SEMP | = | systems engineering management plan |
| SSP | = | system safety program |
| ST | = | standby time |
| T&E | = | test and evaluation |
| TALDT | = | total administrative and logistics delay time |
| TCM | = | total corrective maintenance downtime |
| TIWG | = | text integration working group |
| TPM | = | total preventive maintenance downtime |

REFERENCES

1. DoDD 5230.24, *Distribution Statements on Technical Documents*, 18 March 1987
2. DoDR 5000.2-R, *Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs*, 15 March 1996.
3. MIL-STD-882. *System Safety Program Requirements*, 30 March 1994.
4. AR 40-10, *Health Hazard Assessment*, 1 October 1991.
5. MIL-STD-961, *Department of Defense Standard Practice for Defense Specification*, 22 March 1995.
6. MIL-STD-973, *Configuration Management*, 17 April 1992
7. AR 70-62, *Airworthiness Qualification of US Army Aircraft Systems*, 15 July 1978.
8. AR 702-3, *Army Materiel Systems Reliability Availability and Maintainability*, 25 March 1985.
9. AR 73-1, *Test and Evaluation Policy*, 27 February 1995.