RA 5720 – Structural Integrity Management

Rationale

The Structural Integrity (SI) of an Air System must be managed throughout the Concept, Assessment, Demonstration, Manufacture, In-Service and Disposal (CADMID) cycle. Losing control of SI may result in a compromised level of Airworthiness. In order to maintain Airworthiness, a comprehensive SI management approach must be applied and utilized.

Contents

Regulation 5720(1)

Structural Integrity Management

5720(1) The Type Airworthiness Authority (TAA) **shall** be responsible for SI Management, for all Air System types within their Area of Responsibility, to ensure an acceptable and demonstrable level of Integrity.

Acceptable Means of Compliance 5720(1)

Structural Integrity Management

1. RA 5720 **should** be applied to all new and legacy Air Systems.

2. SI management **should** be undertaken as a through-life process with Integrity evidence updated and maintained during the life of the Air System.

3. The Establish-Sustain-Validate-Recover and Exploit (ESVRE) management framework **should** be used to counter the threats to SI.

4. Where threats to SI are identified, related risks **should** be managed[1], and continually reviewed in response to In-Service developments and experience.

5. Personnel with responsibility for SI Management and ►Letter of Airworthiness Authority◄ (LoAA) holders with a delegated responsibility for SI **should** ►attend the Aircraft Structural Integrity Course (ASIC). SI knowledge **should** be updated by further attendance of the ASIC every 5 years.◄

6. ►◄

7. Remotely Piloted Air Systems (RPAS) **should** be managed in accordance with RA 5002(10)[2]. ESVRE principles apply in full to class I(d) and above RPAS. A tailored approach for ESVRE for class I(c) RPAS may be applied in accordance with RA 5002.

Guidance Material 5720(1)

Structural Integrity Management

8. SI may be compromised at any stage of an Air System's life cycle by one, or a combination, of the following main threats[3].

   a. Overload.

   b. Fatigue, fretting[4] and wear.

   c. Accidental Damage (AD) and Environmental Damage (ED).

   d. Procedural (Design, Manufacturing, Maintenance or Supply) error.

[1] Refer to RA 1220 – Project Team Airworthiness and Safety.
[2] Refer to RA 5002 – Remotely Piloted Air Systems Type Airworthiness Engineering Regulations.
[3] Refer to *Reliability Centred Maintenance*, Nowlan and Heap, 1978.
[4] Refer to definition in MASAAG Paper 116 Widespread fatigue damage in military aircraft.

Guidance Material 5720(1)

9. It is essential that Airworthiness risks arising from SI concerns are captured, assessed and managed, in order to assure and preserve the assumptions and arguments contained within the Air System Safety Case.

10. Co-operation between the TAA and Aviation Duty Holders (ADHs), Accountable Manager (AM) or AM Military Flying is necessary to ensure the overall risk is As Low As Reasonably Practicable (ALARP) ►and Tolerable.◄

11. It is recommended that reference is made to the SI Handbook[5] for further guidance on all aspects of SI.

Regulation 5720(2)

Establishing Structural Integrity

5720(2) The TAA **shall** establish SI to demonstrate that the Air System and its associated systems are airworthy to operate through all conditions detailed in the ADHs Statement of Operating Intent (SOI)/Statement of Operating Intent and Usage (SOIU)[6] and Release To Service (RTS)[7].

Acceptable Means of Compliance 5720(2)

Establishing Structural Integrity

12. The TAA **should** establish a SI Management Strategy that is:

a. Communicated to stakeholders through the Structural Integrity Strategy Document (SISD) prior to Main Gate or equivalent approval of the project.

b. Managed through a Structural Integrity Management Plan (SIMP) initiated prior to the In-Service Date (ISD).

c. Implemented through a six monthly Structural Integrity Working Group (SIWG) initiated prior to the ISD.

13. The SISD **should** be owned by the TAA and **should** be endorsed on his appointment and following any significant amendment.

14. The SIWG **should** be chaired by the TAA, or a holder of a delegated LoAA that refers specifically to the role of SIWG chair, who is at least OF4 ►(or equivalent).◄

15. The MAA[8] **should** always be invited to the SIWG. Attendance is not guaranteed and is on a risk based assessment.

16. The Chair **should** ensure that the working group comprises a key membership of SQEP stakeholders (identified below), and additional stakeholders[8] as necessary.

a. TAA or LoAA holder.

b. Design Organisation (DO).

c. Delivery Team (DT) member(s) responsible for SI.

d. Service provider/ Support contractor (if applicable).

e. Military Continuing Airworthiness Management Organization (Mil CAMO).

f. Civil Aviation Authority for military registered aircraft subject to civil oversight[9].

g. Independent Structural Airworthiness Advisor (ISAA)[10].

h. DT Safety Manager.

i. ►◄

[5] Refer to **References** paragraph 160 item a. for link to SI Handbook.
[6] ►Refer to RA 1310 – Air System Document Set.◄
[7] Refer to RA ►1300 – Release to Service◄
[8] Refer to paragraph 35 for guidance on additional stakeholders.
[9] Refer to RA 1124 – Civil Aviation Authority Oversight of Military Registered Aircraft.
[10] Refer to MAA02 MAA Master Glossary.

Acceptable Means of Compliance 5720(2)

17. The TAA **should** assess the DT's level of Integrity regulatory compliance and associated Airworthiness risk and report it to the appropriate Airworthiness Management Group.

18. The TAA and ADH **should** ensure that a SOI for all new Air System types and marks, is developed in consultation with, and formally conveyed to, the DO. Once enough In-Service data has been gathered, an SOIU[11] for each type or mark of Air System **should** be created.

19. The TAA **should** ensure that the SOI/SOIU[12] (AP101X-XXXX-15S or equivalent) is part of the Air System Document Set (ADS). Certification and Qualification details **should** be confirmed by the DO.

20. The appropriate ADH **should** own and authorize any amendment to and each issue of the SOI/SOIU.

21. The SOI is the means by which the TAA formally conveys the operating intent for a new Air System type or major mark to the DO. The SOI **should** be published as early as possible, but no later than the ISD.

22. The SOI **should** be converted into an SOIU as soon as sufficient representative In-Service usage data is accumulated, normally within 3 years of the ISD.

23. ►◄

24. The TAA with the cooperation of the DO **should** ensure that appropriate static strength, fatigue strength and loads validation evidence, obtained during design, substantiation and certification of the Air System, is available to support the establishing of SI and identified in the SISD.

25. The TAA **should** ensure that the Maintenance Schedule is cross-referenced to a complete list of items conforming to the definition of Structural Significant Items (SSIs)[10] that is compiled and updated in consultation with the DO.

26. The TAA **should** ensure that the need to capture ►Air System usage◄ data early In-Service to support the validation of usage assumptions is considered well in advance during the development phase.

27. The TAA **should** ensure that thresholds for acceptable capture rates of usage data are defined, so that retirement and inspection of components can be scheduled with adequate confidence.

28. The TAA **should** ensure that SI is supported by a Structural Examination Programme (SEP), created prior to the ISD which **should** include:

a. Classification of significant structure (see SI Handbook[13]) as either At Risk (AR) or Not at Risk (NAR) from AD or ED.

b. Scheduled examinations based on this classification, and examination and retirement of components according to their fatigue clearances.

c. Sampling of components not normally inspected during scheduled examinations (the Structural Sampling Programme (SSP)).

29. The TAA **should** ensure that an Environmental Damage Prevention and Control (EDPC) programme[13] including measures to manage the risk to Airworthiness arising from ED is established in cooperation with the DO.

30. The TAA **should** ensure that a system to record the structural configuration of each Air System and its components within a fleet in sufficient detail to support SI decisions is in place.

[11] Refer to AUVP Aircraft Usage and Validation Process Document on the MAA Certification Website.
[12] Refer to **References** paragraph 159 for link to SOI/U template.
[13] SI Handbook : https://www.gov.uk/government/publications/military-air-systems-integrity-management-related-documents

Guidance Material 5720(2)

Establishing Structural Integrity

Structural Integrity Strategy Document

31. The aim of the SISD is to articulate to key stakeholders how the required Integrity measures for an Air System will be implemented, in terms of methodology, timescale and financial commitment. The SISD also forms part of the Air System Safety Case and, though initiated early in the acquisition cycle, is a living document.

32. The SIMP is referenced or integrated within the SISD and is used for routine management and recording of all significant Air System Integrity events, ideally organized using the ESVRE framework. It is to be made available to all SI management stakeholders.

33. It is recommended that the format of the SISD mirrors that of the SIWG, ie, if an Air System level SIWG is held, the SISD may be an Air System level document, and if separate Structures, Systems and Propulsion IWGs are held, the TAA is to consider having 3 separate Strategy Documents[14].

Structural Integrity Working Group

34. The SIWG discusses SI issues and formally endorses SI management processes, decisions and documentation, taking into account projected usage and known risks. Supplementary specialist working groups may support the SIWG as required.

35. Additional stakeholders (as required):

a. 1710NAS – Structural Repairs, Material Integrity Group for materials, Non-Destructive Testing (NDT) section for rotary wing and Prognostic Health Monitoring issues.

b. 71(IR) Sqn – for fixed wing repair and NDT issues.

c. DSA MAA Certification Division.

d. DSA MAA Oversight and Approvals Division.

e. Release to Service Authority (RTSA).

f. Station/Ship/Unit engineering and/or aircrew.

g. Other regulatory authorities for the same type.

h. Requirements Manager.

i. Multi-national programme office.

j. Original Equipment Manufacturer.

k. Commodity DTs.

l. DE&S Airworthiness Team (DAT).

m. Independent Technical Evaluator (ITE).

n. ►Independent Safety Auditor (ISA).◄

Evidence Baseline

36. Much of the evidence required to establish SI will be generated during the certification of the Air System to appropriate Airworthiness standards in accordance with the MRP and may include:

a. The structural design philosophy adopted for the certification basis as appropriate to the intended operation (required to be compliant with Def Stan 00-970 or an equivalent standard) including shortfalls in the level of assurance (eg as identified in the Type Certification Exposition[15]).

b. The structural verification and validation programme and the assumptions on which this is based.

[14] Refer to DE&S Airworthiness Team “Air safety homepage” for templates.
[15] Refer to RA 5810 – Military Type Certificate (MRP 21 Subpart B).

Guidance Material 5720(2)

c. Structural hazards identified in the Hazard Log ►and as part of the Air System Safety Case.◄

37. During all certification activities, it is recommended that the SI Management requirements of this RA be considered and that reference to the certification and qualification evidence, as and when it becomes available, is captured within the SISD.

38. Through-life activities such as repairs, modifications or changes in usage or configuration may invalidate the original certification and qualification evidence. These activities may prompt re-examination of the original design assumptions and further establishing activities to counter threats to Integrity may be required. These activities are encapsulated within the SISD and are monitored by the SIWG.

Statement of Operating Intent/Statement of Operating Intent and Usage

39. On behalf of the ADH the DT Requirements Manager or equivalent post, may support the drafting and continual review of the SOI up to its conversion to the SOIU. The TAA continues to support subsequent periodic reviews on behalf of the ADH, through life. The SOIU is a descriptive, rather than prescriptive document.

40. The process for review of an SOI/U is contained within the SI management - Aircraft Usage and Validation Process (AUVP) Document, a generic template is also available[16].

Structural Evidence

41. ►The structural design philosophy, verification, validation and structural hazards identified in establishing the evidence baseline will be used in forming the Air System structural evidence in support of SI. This evidence is:◄

a. The structural design philosophy adopted for the certification basis as appropriate to the intended operation (required by RA 5810 to be compliant with Def Stan 00-970 or an equivalent standard) including shortfalls in the level of assurance (eg as identified in the Type Certification Exposition).

b. The structural verification and validation programme and the assumptions on which this is based.

c. Structural hazards identified as part of the Air System Safety Case.

42. This evidence is recorded in the Type Record or equivalent and is usually summarised in the Static Type Record and Fatigue Type Record[17]. These documents, or equivalent, define component lives and inspection intervals.

43. The capture of data for validation purposes, as soon as flying is considered representative of In-Service usage, requires planning during development. RA 5720(4) gives further detail on through-life loads and usage validation. The scope of these activities will depend on the TAA's overall confidence in SI and any variances between actual usage and the design assumptions.

Structural Examination Programme

44. Air System structure is classified according to its relative contribution to the function or residual strength of its higher assembly. Certain items are defined as SSIs and are classified by the DO as either Safe Life or Damage Tolerant.

45. The classification, which helps to ensure that fatigue and damage tolerance clearances are not invalidated by AD and ED, is carried out by the DO or by Reliability Centred Maintenance specialists with access to appropriate structures and materials specialist advice. It also takes account of the interaction of AD with ED (eg the onset of corrosion following impact damage causing the breach of a corrosion protection coating) and their interaction with fatigue or static loading (eg stress-corrosion cracking or corrosion-accelerated fatigue).

46. Authorization and competence of Maintenance Organization staff [18] to carry out structural examinations is conditional on their appreciation of the consequence of

[16] Refer to AUVP Aircraft Usage and Validation Process Document and generic template which are on the MAA Certification Website.
[17] ►Refer to RA 5309 – Fatigue Type Record for Aircraft.◄
[18] Refer to RA 4806 – Personnel Requirements (MRP 145.A.30).

Guidance Material 5720(2)

failure of an SSI and their understanding of the signs of AD and ED, fretting, wear and fatigue.

47. SSIs that are not included in scheduled examinations (because they were deemed to be NAR) are subject to structural sampling. There may be parts of AR structure that are not normally accessible for inspection, such as the inside surfaces of hollow flying control rods or torsion boxes, and these are also sampled.

48. The SSP is carried out on a sample of the fleet and is intended to validate assumptions regarding design, usage, maintenance and the effects of exposure to AD/ED. Guidance on the selection of candidate Air Systems for structural sampling inspections, to maximise the probability of finding unanticipated damage, may be found in the SI Handbook. For further detail on the SSP, see RA 5720(4).

49. The SSI list (both AR and NAR) and inspection/sampling requirement are recorded in the AP101X-XXXX-5V[19] or equivalent document, which is called up in the AP101X-XXXX-5A1, or equivalent Master Maintenance Schedule.

Independent Structural Airworthiness Advisor

50. The ISAA may support the TAA or appointed representative at specialist working groups or other SI meetings and is a competent individual, independent of the Designer, who carries out an evaluation of Air System structures.

Individual Air System Tracking

51. ►The Individual Air System Tracking (IAT) methodology employed on the Air System, eg Fatigue Meter Formula / Structural Health Monitoring / Health and Usage Monitoring System, along with its implementation may be documented as part of the SISD.◄

52. For further detail on acceptable capture rates of usage data, see RA 5720(3).

53. Health Usage Monitoring System equipment that is managed by a Commodity ►Delivery◄ Team may have their responsibilities documented by the TAA in the relevant AP.

Regulation 5720(3)

Sustaining Structural Integrity

5720(3) The TAA **shall** ensure that SI is sustained and In-Service data used in order to continuously monitor and counter the threats to SI.

Acceptable Means of Compliance 5720(3)

Sustaining Structural Integrity

54. The TAA **should** review and monitor outputs from SI Management processes and ensure key issues are reported to the SIWG.

55. The SISD and the SIMP **should** be reviewed prior to every SIWG and both **should** be ratified by stakeholders at the meeting.

56. The TAA **should** ensure that a monitoring system is in place at an individual Air System level for usage data capture, recording and computation, and it **should** be:

a. Developed with the DO, with due consideration to the Air System role.

b. Populated by the user or Mil CAMO[20] so that the TAA can identify significant changes in usage.

c. Used for monitoring usage against safe life and inspection criteria.

d. Used to support changes to safe life and inspections as required.

57. Usage Monitoring systems **should** be maintained in a serviceable state in order to maximise the capture, use and monitoring of usage data by the CAMO[21], the DT and the SIWG, respectively.

[19] Refer to Air System Document Set for Topic 5V - Structural sampling requirements and procedures or equivalent.
[20] Refer to RA 1016 – Continuing Airworthiness Responsibilities.
[21] Refer to RA 4947 – Continuing Airworthiness Management – MRP Part M Sub Part G.

Acceptable Means of Compliance 5720(3)

58. The TAA **should** ensure that the necessary information is captured by the User units and sent to the DO for analysis, which may result in a re-calculation of component life.

59. The TAA and DO **should** agree the access to, and the means of providing, service data from the Forward and Depth domains.

60. The procedure for the reporting of service data **should** be promulgated by the TAA in the Support Policy Statement[22] of the AP101X-XXXX-2(N/A/R).

61. The TAA **should** ensure that a system is established to record the structural configuration and condition of each Air System and interchangeable components in the fleet in sufficient detail to maintain Structural Configuration Control (SCC) and in order to support SI decisions.

62. SCC **should** reflect the as-flown configuration. It may be necessary to carry out a structural survey of the whole fleet to establish a baseline. Where this is not possible, the risks associated with not carrying out a survey to establish SCC **should** be identified, and formally accepted by the TAA[1]. A database **should** be populated with all relevant arisings of an individual Air System and maintained for the life of the Air System.

63. The key elements of SCC that **should** be recorded are:

a. Build concessions.

(1) The extent of damage (such as AD and ED) present before repair.

(2) The condition of the material after the repair has been carried out (such as the thickness remaining after blending).

b. Repairs, which may originate from the AP101X-XXXX- 6/Structural Repair Manual (SRM) or from an approved DO.

(1) Un-repaired damage (damage within authorized limits).

(2) Modifications: DO-produced and or Service-produced.

64. The TAA **should** ensure that a SEP is implemented and a summary of the results (to include nil returns) reported to the TAA via the SIWG.

65. Results from the SEP **should** be collated, reviewed and subjected to trend analysis to inform Maintenance Schedule reviews, update the SIWG on the efficacy of the SEP (including the SSP), and allow data to be fed back to the DO.

66. The TAA, in consultation with the DO, **should** consider introducing an exceedance monitoring system in order to capture events such as overloads, over-speeds and hard landings.

67. The TAA **should** ensure that component lifing, recording processes and metrics, are periodically reviewed.

68. Remedial action **should** be taken, and the SIWG notified, if significant deviation in individual Air System weight and balance is identified by the Mil CAMO.

69. All changes to SSI lives, or maintenance thresholds or intervals **should** be:

a. Supported by a risk assessment.

b. Conveyed to the SIWG and reviewed periodically.

c. Considered within the Air System Safety Assessment.

d. Authorised by personnel with the appropriate delegated authority.

70. The TAA **should** identify any unmitigated or un-quantified Airworthiness risks to the Platform Safety Panel (PSP)►[23]◄ and/or the Platform Safety Working Group (PSWG).

[22] Refer to RA 4214 – Support Policy Statements.
[23] ►Refer to RA 1220 – Project Team Airworthiness and Safety.◄

Acceptable Means of Compliance 5720(3)

71. The TAA **should** ensure that the EDPC programme is implemented, to manage the risk to Airworthiness arising from AD/ED, with significant findings reported to the SIWG.

Lost Usage Data

72. The TAA **should** ensure that Commodity DTs assess the lifing details of components for which they are responsible; they **should** follow the same criteria as prescribed for Preventative Maintenance[24] and present their evidence to the TAA for final authorization.

73. The TAA **should** define limits for investigation/urgent action on any structural monitoring data loss and implement a process and system to monitor and react. Limits may differ depending on the system complexity, reliability and criticality. ►◄

74. The rate of unmonitored sorties **should** be monitored by the SIWG.

Guidance Material 5720(3)

Sustaining Structural Integrity

Structural Integrity Strategy Review

75. It is suggested that the TAA reviews the SISD prior to each SIWG and amend/update as required. It is recommended the SISD is distributed with the SIWG Agenda.

Usage Monitoring

76. Usage, or change in usage, that is unmonitored can lead to the exceedance of inspection intervals or to the operation of Air Systems beyond their cleared life. Usage monitoring is essential to the management of Air Systems and interchangeable components within the fleet. In addition, it may be used to identify the need for usage budgeting to achieve the planned Out-of-Service date (OSD) or, where this cannot be achieved within existing clearances, the need to carry out Exploiting activities. For further guidance see the Aircraft Usage Validation Process (AUVP)[25].

77. Usage Monitoring can comprise direct or parametric measurement techniques at both fleet and individual Air System level. Depending on Air System type and role, these may include:

a. Structural Health Monitoring.

b. Health and Usage Monitoring Systems.

c. Fatigue meter and fatigue meter formula.

d. On-board data collection.

e. Post-sortie feedback.

f. MOD Form 724/MOD Form 725 paper flying logs, or equivalent.

g. Integrated Vehicle Health Monitoring systems.

78. Exceedance monitoring involves using thresholds and algorithms to capture events such as overloads, over-speeds, hard landings, parameter values outside design envelopes and durations spent outside these envelopes.

79. The appropriate ADH may act on the TAA's recommendation when implementing a usage budget for the fleet, which provides confidence that it will retain life up to the planned OSD. In some cases, usage budgeting can be applied to individual Air Systems.

80. For further detail on the investigation into compromised usage data and actions to recover it, see RA 5720(5).

Data Collection

81. The DO requires In-Service, as-flown usage parametric data in order to monitor and evaluate component lives and maintenance schedules.

[24] Refer to RA 4203 – Preventative Maintenance.
[25] Refer to **References** paragraph 159.

Guidance Material 5720(3)

82. DTs require in-use failure data in order to ascertain actual failure rates. This will allow preventative maintenance schedules to be amended or adjusted accordingly.

Configuration Control

83. The configuration of Air Systems at the point of delivery may vary from the baseline design. Configuration Control (CC) data provides confidence in the as-flown configuration of Air Systems and may be held within a variety of systems as long as it is effectively managed, its location is known and it is accessible to key stakeholders. The Mil CAMO manages CC of individual Air Systems as part of the Continuing Airworthiness record[21].

84. CC information is to be recorded in sufficient detail to allow retrieval and analysis so as to inform Integrity Management decisions. The DO may use this information to mitigate the risk from cumulative deviations from the build standard.

Structural Evidence

85. ►An Air System's structural evidence record and supporting qualification evidence, including configuration, operation and usage, may evolve significantly over the life of a type.◄ The DO may be tasked to review and update the structural qualification evidence so that it remains relevant to the In-Service Air System.

86. A periodic review of component lifing, and recording processes and metrics, provide an additional measure of assurance, particularly where components that do not have individual lifing records may be moved between Air Systems and may exceed their original cleared life. The results can inform Maintenance Schedule reviews (see RA 5720(4)) and may be followed by appropriate action to recover SI.

Weight and Balance

87. Failure to keep mass properties within limits, while hazardous for other reasons, can also affect life consumption. Up-to-date information concerning individual Air System weight and balance, made available via the SIWG, can:

a. Ensure the accuracy of usage records.

b. Inform updates to the SOIU.

c. Inform updates to the structural evidence record.

Extensions

88. In exceptional cases, for a limited number of Air Systems, there may be a need to change component lives, thresholds or intervals. Authorizing the life of aerospace components is the responsibility of the TAA for the Air System on which the component is installed. The SIWG may be made aware of the number of extensions in place, in accordance with its risk management role.

89. Arrangements are to be made to ensure that the DO and other operators of the same Air System type report any potential read-across information, via the SIWG.

Environmental Damage Prevention and Control

90. As Air Systems age, ED becomes more widespread and is more likely to occur concurrently with other forms of damage such as fatigue cracking. ED degrades SI and, if uncontrolled, will reduce the inherent ability of the structure to sustain loads in the presence of other forms of damage.

91. DTs are required to include an EDPC programme prior to Main Gate approval.

92. A dedicated EDPC Working Group is a useful forum to manage Air System ED issues. The TAA may decide whether to initiate this working group, in consultation with the ADH and based on an assessment of the risk posed by ED to the fleet. The EDPC Working Group reports to the SIWG.

Data Loss

93. Provided the data loss is not from the same platform or Station/Ship/Unit, or within a single or the most damaging Sortie Profile Code (SPC) or sortie/flight type, the following is considered to be a useful guide for data loss in fatigue meters:

a. Less than 2%: Acceptable.

Guidance Material 5720(3)

b. Between 2% and 5%: Further investigation may be required.

c. More than 5%: The Structural Airworthiness of the fleet is considered to be compromised. Assessment and detailed investigation is required.

Obsolescence

94. Obsolescence of components may compromise Integrity and is normally managed in line with the Defence Logistic Framework.

95. Obsolescence may be managed by the DO on behalf of the TAA. However, the TAA retains overall responsibility.

Ageing Aircraft Audit

96. Regulation and guidance on Ageing Aircraft Audits can be found in RA 5723[26] and for RPAS within RA 5002[2].

Structural Examination Program

97. For further detail on the SEP, see RA 5720(2).

Regulation 5720(4)

Validating Structural Integrity

5720(4) The TAA **shall** ensure that assumptions supporting SI are periodically validated.

Acceptable Means of Compliance 5720(4)

Validating Structural Integrity

98. The following SOIU reviews **should** be initiated through the SIWG:

a. A basic annual review by the appropriate ADH, to confirm that the SOIU remains an accurate record.

b. A triennial review by an appointed competent organization, using usage data to carry out a quantitative update.

c. Stakeholders **should** report any significant changes in usage or operation to the SIWG.

d. Any Stakeholder can trigger an SOIU review at any time through the SIWG.

99. Following SOIU reviews:

a. An audit trail of all changes **should** be retained in accordance with current regulations[27].

b. The Release To Service Authority (RTSA) **should** check that the validated usage is within the limits of the RTS.

c. DO support **should** be available to determine the effect of any changes on component lives and maintenance.

d. The ADH **should** make aircrew familiar with the Sortie Profile Codes (SPC) within the SOIU and the need for both accurate recording and efficacy of reporting of any changes in usage.

100. Operational Loads and Structural Usage Validation **should** be carried out through engagement with the DO, by means of an Operational Loads Measurement (OLM)[28] or Operational Data Recording (ODR) programme on a representative sample of In-Service Air Systems. ►For guidance on Helicopter Operational Loads Measurement Programmes refer to MASAAG Paper 120[29].◄

101. The timing of OLM/ODR programmes **should** be determined by its aims and, as a minimum:

a. An initial approach to OLM/ODR **should** be identified during design/introduction to service of the Air System. The first OLM/ODR programme

[26] Refer to RA 5723 – Ageing Aircraft Audit.
[27] Refer to RA 1225 – Air Safety Documentation Audit Trail.
[28] Refer to MASAAG Paper 109 Guidance for Aircraft Operational Loads Measurement Programmes.
[29] ►Refer to MASAAG Paper 120 - Guidance on Helicopter Operational Data Recording.◄

Acceptable Means of Compliance 5720(4)

should commence once usage is considered to be stable or no later than 3 years after entry into service.

b. The requirement to carry out OLM/ODR **should** be reviewed at least every 6 years by the TAA (concurrently with a triennial SOIU review) the decision and justification **should** be supported by evidence[30] and this **should** be documented within the SISD.

c. An OLM/ODR programme **should** be considered following any Major Change in usage or rate of life consumption or in conjunction with any plans for a Major modification or life extension, ie, where re-validation of loads is necessary, decisions on OLM/ODR requirements **should** be documented in ►the SISD.◄

102. The SSP **should** be implemented, with the results reported to the DO and the SIWG.

103. Examples of all SSIs **should** be examined through either scheduled maintenance or sampling by the time the fleet leader reaches 80% of its original design life (or revised life, if less).

104. Structural ►Integrity arisings◄ **should** form part of maintenance schedule reviews and be supported by trending and analysis conducted by the Mil CAMO. The review **should** ensure that:

a. ►The SEP is being updated in response to these findings, and remains linked to current fatigue and Damage Tolerance clearances.

b. Failures and In-Service structural arisings are being fed back into the SEP.

c. Change in usage, operation and configuration are being fed back into the SEP.

d. SEP (including SSP) findings related to SSIs are being collated and reviewed by the SIWG, and used by the DO to update lifing predictions.◄

105. Any recommendations at a SIWG to amend inspection intervals **should** be ratified by the LoAA holder prior to incorporation in the Maintenance Schedule.

106. The structural evidence record **should** be reviewed and updated, with the support of the DO, in response to findings occasioned by validating activities.

107. The TAA **should** ►ensure that a sampling programme is implemented that includes the requirements for◄ teardown.

108. The TAA **should** review and validate maintenance processes to enhance SI.

Guidance Material 5720(4)

Validating Structural Integrity

SOI/SOIU

109. It is necessary to ensure that the SOIU continues to represent the actual usage, operating environment and configuration (including mass properties). Accurate recording of SPCs by aircrew is critical to the continued validity of DO-originated lives and maintenance intervals.

110. As technical information sponsor and manager of the SOIU, the TAA supports, and may arrange for independent assurance of, the following periodic reviews:

a. **Annual review.** The appropriate ADH, often supported by the Requirements Manager, reviews SPCs and their contents.

b. **Triennial review.** The TAA may appoint a competent organization to perform the usage data analysis and to coordinate inputs from other stakeholders. The TAA ensures that validated usage data is available for the review.

[30] Refer to paragraph 117.

Guidance Material 5720(4)

111. The TAA may arrange tasking of DO support, to include an evaluation of actual usage against design assumptions and to determine the effect of any changes on component lives and maintenance.

Operational Loads and Structural Usage Validation

112. Operational Loads and Structural Usage Validation is a usage substantiation[31] activity involving the capture, analysis and reporting of representative, directly measured strain data or derived loads and associated flight parameters from a sample of suitably instrumented In-Service Air Systems within a fleet. This structural substantiation is normally carried out by means of an OLM programme for a fixed-wing Air System or ODR programme for a rotary wing Air System, which the TAA must review periodically.

113. The activity may be carried out on a representative subset of the fleet and may be supplemented by a Manual Data Recording Exercise (see SI Handbook). Limited guidance on the specification of an OLM/ODR system can be found within Def Stan 00-970, Part 1, Section 3, Leaflet 38. Comprehensive guidance for planning and undertaking an OLM programme can be found within MASAAG Paper 109[32]. For guidance and advice on ODR programmes, Desk Officers may contact MAA Certification Division.

114. The main aims of the OLM/ODR programme are:

a. The validation of the fatigue usage spectrum and the assumptions used during the design, structural qualification and test of the Air System, including the review of fatigue clearances as well as maintenance and inspection periodicities.

b. The validation of the Air System's usage monitoring system, including any lifing, damage or Fatigue Index algorithms.

115. An Operational Loads and Structural Usage Validation programme is often initiated due to changes in usage being identified during the triennial SOIU review. Results from the OLM/ODR programme may then inform further updates to the SOIU.

116. The complexity of the solution chosen in conducting an OLM/ODR, usually developed with the DO, will be determined by the particular aims of the programme and existing confidence not only in actual usage, but also in the relationship between usage and the loads experienced by the airframe. It will also depend on the extent of loads validation undertaken during the design and development of the Air System.

117. The DO has the necessary understanding of the aircraft design, substantiation and wider service history to identify where validation of In-Service usage against design assumptions may be required.

118. The TAA may wish to consult the DO and ►his appointed◄ ISAA for help with defining the approach and articulating the justification of the method taken to fulfil requirements for OLM/ODR along with collation of appropriate evidence.

119. Direct measurement of loads or strains using strain gauges is the preferred method of validating fatigue spectra within OLM/ODR programmes. However, there are circumstances where measuring strains may not be practicable and structural usage validation using parametric methods may be a more appropriate alternative acceptable means of compliance. The TAA, in consultation with the DO, may make use of parametric data, routine Usage Monitoring systems and dedicated instrumentation systems.

120. However, OLM and ODR remain the reference standard solution for Operational Loads and Structural Usage Validation. Data obtained initially from less complex systems may well confirm a need to progress the Structural Usage Validation programme to the use of a more complex OLM/ODR system.

[31] Substantiation in this context refers to the assessment of structural usage in relation to the assumptions and methods used in design and qualification.
[32] Refer to MASAAG Paper 109 - Guidance for Aircraft Operational Loads Measurement Programmes on the MAA Certification website.

Guidance Material 5720(4)

Sampling Programme

121. Sampling may be considered during:

a. Scheduled maintenance.

b. Emergent opportunities, eg modification or repair.

c. Directed out-of-phase inspections.

d. Teardown.

e. Post-crash recovery.

Maintenance Schedule Review

122. The conduct and frequency of Structures aspects of the maintenance schedule review may be detailed in the SISD. If sampling uncovers unexpected damage, Recovering and/or Exploiting activities can be employed.

Evidence Baseline

123. As information becomes available from validating activities, it will become necessary to add to the structural qualification evidence.

Teardown

124. Teardown[33] and forensic examination are progressive, detailed and controlled examinations of Air System structure, over and above the SSP.

125. Although sometimes destructive, this activity can also be carried out on out-of-use suitably representative Air System or components on an opportune basis.

126. The findings may be used in support of life extension or activities to ensure that the Airworthiness risks of ►an ageing◄ fleet are being managed appropriately.

127. The TAA may keep records via the SIWG and forward findings to the DO, especially where In-Service damage differs significantly from that expected.

128. Unexpected fatigue damage may indicate a lack of understanding of local in-service loading that could be addressed by directed OLM/ODR. The resulting knowledge is captured in the SISD.

Regulation 5720(5)

Recovering Structural Integrity

5720(5) The TAA **shall** ensure that loss, or potential compromise, of SI is monitored, recorded, evaluated for its wider significance and recovered using established processes.

Acceptable Means of Compliance 5720(5)

Recovering Structural Integrity

129. The TAA **should** ensure that processes are in place to manage the reporting, monitoring and evaluating of significant arisings by the SIWG.

130. The TAA as chair of the SIWG **should** evaluate, authorize and record recovery action including changes to operating procedures.

131. The TAA **should** have a system to investigate the cause of, and prevent recurrence of, compromised integrity with the DO or independent advisers.

132. The TAA **should** have a system in place to manage:

a. The recording of damage within the SCC system.

b. The identification of any emerging issues.

c. The reporting (using MOD Form 760 or equivalent fault report) by Forward and Depth environments and monitoring by the SIWG, of significant structural arisings.

133. The TAA **should** ensure that lost usage data is recovered if possible, or else a technical assessment of the loss carried out. The TAA **should** ensure that procedures

[33] Refer to MASAAG Paper 105 Guidance and Best Practice for Teardown Inspections.

Acceptable Means of Compliance 5720(5)

for introducing appropriate fill-in rates for unrecoverable usage data are in place and applied as required.

134. The TAA **should** ensure that Structural repairs (see SI Handbook[34]) are:

a. Undertaken in accordance with the Air System Document Set (AP101X-XXXX-6/Structural Repair Manual) or schemes provided by either the Air System Repair Organization or the DO.

b. Assessed against the appropriate design standard, with lifing and inspection requirements clearly established and consideration given to the effect of adjacent and/or previous repairs.

c. Recorded in the CC system.

135. The TAA **should** ensure that any findings occasioned by validating activities, are followed up with appropriate action to recover SI.

136. The TAA **should** consider the need for modification, refurbishment or component replacement to mitigate fatigue damage in order to meet fleet planning objectives.

137. Recovery action **should** initiate activity in other areas of the ESVRE framework.

Guidance Material 5720(5)

Recovering Structural Integrity

138. Failure can be caused by any of the threats to Integrity and, where clearly detectable, can be readily assessed. ►Investigation is required even where compromised SI does not result in detectable damage, eg following exceedance of cleared fatigue life or occurrence of a triggering event.◄

139. Significant arisings will be referred to the SIWG by stakeholders and from other working groups, particularly where recovery action is likely to cross one or more organizational or process boundaries and where recovery action is likely to involve a number of stakeholders.

140. Type-specific procedures for investigating and recovering compromised SI may be published within the ADS. The need to seek the advice of the DO may be determined based on the threat, the components affected and the nature of the incident.

141. Recovery measures may include repairs, modifications, additional or more frequent examinations or testing, changes to components or their lives, or the imposition of operating restrictions. Additionally, the results of validation activities and In-Service experience may bring fleet-wide SI into question, which may impose or reinforce any imposed operating restrictions.

Lost Usage Data

142. If usage data is lost or not recorded at either whole-Air System or lifed-item level, the trigger points for retirement of Safe Life structure or examination of Damage Tolerant structure become uncertain. Conservative assumptions are therefore to be made about the missing usage data.

143. Sorties for which usage data is lost may be positively identified within the usage record so that fill-in data can be applied and subsequently re-evaluated, if necessary.

Compromised Structural Integrity

144. Information on changes to lifing inspection requirements occasioned by the compromise of SI, or identified by validating activities (eg SOIU reviews and Operational Loads and Structural Usage Validation), needs to be made available so that:

a. The TAA may initiate any necessary modifications, repairs or component exchanges.

[34] Refer to **References** paragraph 159.

Guidance Material 5720(5)

b. The ADH may make any changes to fleet operation necessary to ensure that risk is reduced to at least ALARP ►and Tolerable◄ and that fleet management objectives are achieved.

c. The DO is consulted on its involvement at each stage and notified of any changes to operation.

145. Recording of damage, repairs, concessions and modifications, within a CC system, is necessary to allow the SIWG to make a fleet-wide assessment of structural health.

146. Air System Repair Schemes are to be designed by an approved organization[35].

Regulation 5720(6)

Exploiting Structural Integrity

5720(6) The TAA **shall** ensure that SI is exploited to make best use of the inherent capabilities of the Air System.

Acceptable Means of Compliance 5720(6)

Exploiting Structural Integrity

147. The TAA **should** ensure that where available information on relevant occurrences from other operators, both military and civilian, is used to better predict threats to SI.

148. The TAA **should** ensure that experience and data from the fleet and other operators (of the same Air System or Air Systems in similar roles) is analysed and used to improve SI of the Air System, provided that operation, configuration and usage are comparable.

149. The TAA **should** sentence any recommendations from formal analysis of Integrity data presented to further enhance SI.

150. ►The TAA **should** exploit any appropriate Learning From Experience from current and previous maintainers and operators of the Air System or similar Air Systems and roles to enhance SI.◄

151. The TAA **should** ensure that the need for measures to conserve life is considered where life may be insufficient to reach the planned OSD.

152. The TAA **should** ensure that revised static and fatigue clearances **should** be developed to achieve fleet planning requirements.

153. The TAA **should** ensure that Cleared life is reviewed in response to changes to fleet planning assumptions.

Guidance Material 5720(6)

Exploiting Structural Integrity

154. Exploitation may make use of accident rates, investigations, maintenance databases and usage data.

155. Data from other Air Systems or operators whether UK military, overseas military or civil operators, may be exploited by DTs to further support SI activities, subject to the following considerations:

a. The period and nature of operations considered is to be broadly representative of UK military usage.

b. The current and expected UK military operating envelope is to be either benign in comparison with that of other users or the future operating envelope is to be restricted as necessary.

c. Configuration differences between the Air System and/or engines being compared.

156. Various practices exist for the read-across and exploitation of strength and life data from the wider fleet, as well as from UK or overseas, military or civil, operators.

[35] ►Refer to RA 5865 – Repairs (MRP 21 Subpart M).◄

Guidance Material 5720(6)

These may be used as part of revised structural hazard analyses carried out in support of Airworthiness related decisions intended to exploit SI.

Life Conservation

157. The rate of usage of an airframe determines when the Safe Life is reached or, for Damage Tolerant designs, the point at which the airframe becomes uneconomic to examine and repair. Life conservation is an Exploiting activity required when the existing life may be insufficient to reach the planned OSD. This is different from routine usage budgeting (see RA 5720(3)).

Structural Evidence Qualification

158. Where fleet planning assumptions change, a review of the evidence baseline may reveal ways in which the inherent capabilities of the Air System structure can be exploited, so that cleared static and fatigue lives are maintained ahead of the fleet leader.

Life Extension

159. Where the usage budget is inadequate to achieve the required OSD and there is no further relief available from life conservation measures, a Life Extension Programme[36] may be needed to extend the life of an Air System. A distinction is made here between an OSD deferment achievable within existing structural life and a genuine structures life extension requirement.

References

160. Additional Integrity Management related guidance and referenced RAs are available online:

a. https://www.gov.uk/government/publications/military-air-systems-integrity-management-related-documents.

b. https://www.gov.uk/government/organizations/military-aviation-authority.

[36] Refer to RA 5724 – Life Extension Programme.