

## Space structures

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# 9. Production, manufacturing, quality, in-service, data exchange issue

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## PRODUCTION AND MANUFACTURING (ECSS 4.8.1)

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The production of space structures includes the following:

- procurement, which covers:

- materials,
- components, and
- parts.

- manufacturing/fabrication of components,

- assembly of components,

- assembly of substructures to form the final structure, either within the factory or for payloads and launch vehicles at the launch site.

The production engineering of space structures shall ensure that the structure, and all its component parts, can be manufactured in the way intended and shall be of acceptable quality, reliability and reproducibility.

## PROCUREMENT & MANUFACTURING PROCESS(ECSS 4.8.2 -3)

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### Procurement

- a. Quality assurance requirement for procurement defined in ECSS--Q--20 shall apply.
- b. The successful design and manufacture of space structures relies on the guaranteed supply of materials and parts of specified and acceptable quality as confirmed by test or inspection. Factors to be evaluated during the design stages shall include the following:
  1. specification;
  2. acceptability for the application;
  3. sources identified.
- c. Procurement shall be made to specifications derived by the user and in accordance with any relevant specifications or a fully detailed purchase order.

### Manufacturing process

- a. Quality assurance requirements for manufacture defined in ECSS--Q—20 shall apply.
- b. Standard procedures shall be used to manufacture space components. These procedures shall form part of the overall product assurance requirements and shall conform to all applicable specifications.

## MANUFACTURING DRAWINGS AND TOOLING (ECSS 4.8.4-5)

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### Manufacturing drawings

- a. Manufacturing drawings derived from design drawings and established in accordance with the functional requirements shall be used .
- b. Manufacturing drawings shall take into account the quality requirements, the manufacturing process and the various manufacturing steps.

### Tooling

- a. Requirements for tooling, including assembly jigs and fixtures, shall take into account the following:
  - materials to be used in manufacture;
  - geometry of the part(s);
  - number of parts required;
  - production rate.
- b. Tooling design shall cover the acceptability of the finished components quality, size, shape and surface finish.

## COMPONENT MANUFACTURE & ASSEMBLY (ECSS 4.8.6-7)

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### Component manufacture

- a. During design development, manufacturing requirements shall be carefully considered through the input from the production engineering evaluation.
- b. The manufacturing techniques used form part of the design and shall be considered when competitive designs are evaluated.
- c. All manufacturing operations shall conform to product assurance requirements.
- d. Quality assurance requirements for component manufacture defined in ECSS--Q--20 shall apply.
- e. Special consideration shall be given to contamination and moisture for specified structures.

### Assembly

- a. Quality assurance requirements for assembly defined in ECSS--Q--20 shall apply.
- b. Component assembly procedures shall involve, but are not limited to:
  1. specifications of parts and materials,
  2. assembly instructions which shall include:
    - preparation;
    - equipment;
    - parts and materials;
    - method;
    - cleaning.

## ASSEMBLY (CONT) & PACKAGING ET AL (ECSS 4.8.7-8)

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3. inspection or test.

c. Major assembly shall be classified as the connection of either

- large sub-structures, e.g. launcher stage assembly, or
- final construction of the launch vehicle and its payloads, and the preparation for launch.

d. Major assembly operations shall be accompanied by inspection and mechanical and functional tests.

NOTE 1 The assembly includes component assembly and major assembly.

NOTE 2 Component assembly is the connection together of individual parts to form assemblies or sub-structures. Component may be large or small depending on the design of the structure.

Packaging, handling, transportation

The applicable quality assurance requirements according to ECSS--Q--20 for packaging, handling and transportation shall apply.

## STORAGE, CLEANLINESS, HEALTH AND SAFETY (ECSS 4.8.9-10-11)

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### Storage

- a. Storage conditions shall prevent the degradations of the structure.
- b. To avoid all hazards to personnel or equipment, items that contain hazardous materials or those requiring special storage shall be marked according to recognized procedures.
- c. For parts or components which cannot be inspected prior to flight and for which the possible structural degradation during storage is uncertain, adequate representative specimens (witness specimens) shall be stored together with the flight hardware. Prior to acceptance for flight, the samples shall be sufficiently inspected or tested for any structural degradation.

### Cleanliness

Cleanliness requirements shall be defined and adequately controlled for all stages of manufacture, storage and transportation.

### Health and safety

The health and safety aspects of all processes and materials shall be evaluated to ensure that they conform with all appropriate international, national and company safety policies.

## IN SERVICE (ECSS 4.9)

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### Ground inspection

Ground inspection of integrated structures shall be part of pre-launch action and, for recoverable structures, those undertaken after its return.

NOTE Ground inspection techniques can generally be those which are applied during system integration or during assembly manufacturing stages.

### In-orbit inspection

a. In-orbit inspection equipment shall be able to detect damage in a reliable and cost-effective way, whilst being portable and easy to use, without requiring specialist personnel, extensive resources and expert interpretation.

NOTE The role of in-orbit inspection is to inspect during the use that a structure has not so deteriorated, that further operation renders it unsafe.

b. Built-in-testing (BIT) systems shall be developed for continuous monitoring of long-term deployed structures, primarily where access is limited or the area is critical to the integrity and safety of the structure. BIT systems should identify damaged areas as they occur. Other appropriate techniques shall then be used to investigate local damage sites, as directed by the global monitoring system.

NOTE BIT systems monitor the condition of structures.

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## IN SERVICE (ECSS 4.9) (2)

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### Evaluation of damage

- a. When a defective or damaged area has been located its criticality with regard to the operations and safety shall be assessed.
- b. The following factors shall be considered in determining criticality:
  - defect size;
  - location;
  - propagation rate.
- c. The above factors shall be evaluated taking into consideration the following:
  - operational conditions (loading and environment);
  - maintenance schedules;
  - as-designed structural requirements;
  - service-life of the structure.
- d. Depending on the outcome of the evaluation of the damage , the options shall be to repair or replace the affected parts of the structure.

## IN SERVICE (ECSS 4.9) (3)

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### Maintenance

#### General maintenance requirements

- a. All maintenance action shall be fully documented, including the specification of inspection methods, recording of results, category of damage, repair methods and compilation of service history documents.
- b. The maintenance schedules shall be determined during design process, and procedures are specified for all of the action required.

## IN SERVICE (ECSS 4.9) (4)

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### Repair

- a. On-earth or on-orbit repair procedures shall be defined as relevant.
  
- b. All repair procedures shall consider the following factors:
  1. structural classification;
  2. damage category;
  3. proven repair procedure (supported by mechanical and environmental testing programme);
  4. accessibility to damaged parts (e.g. one or both sides);
  5. availability of equipment (repair material and services, appropriate personal).
  
- c. In-orbit repair procedures shall additionally consider the following factors:
  1. requirements for extra-vehicular activity;
  2. transportability of materials to space (e.g. current adhesive are unstable and could outgass, hazardous cleaning and preparation chemicals);
  3. preparation of surfaces or damage removal (availability of appropriate hand-tools, control of dust, vapours and contamination, avoidance of space debris generation);
  4. repair manufacture difficulties.

## DATA EXCHANGE (ECSS 4.10)

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- a. All data exchange requirements shall be established in a data exchange specification. Wherever possible, electronic data exchange using established standards shall be used.
- b. All data, regardless of the format, shall be accompanied by documentation containing detailed descriptions of the data, including the following:
1. format;
  2. date and status of data;
  3. software version used;
  4. format of media (tape, back-up, operating system);
  5. version of exchange format standard.