UK Civil Aviation Authority

Position Paper – FSTD Special Conditions development and assessment process

CAP 3126

Published by the Civil Aviation Authority 2025

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First published Month June 2025

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The latest version of this document is available in electronic format at: www.caa.co.uk/CAP3126

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Chapter 1

Introduction

The development of applicable standards for the validation of Flight Simulation Training Devices (FSTD) should move in parallel with the pace of innovation.

This innovation goes two ways or is a combination of the below:

a. new technologies or features used for existing types of FSTD, like the use of virtual reality (VR) or augmented reality (AR). New technologies may lead to innovative FSTDs enabling an improvement of the quality of training or the increase of training capabilities.

b. the development of novel types of aircraft, like eVTOL, and the need to perform pilot training on FSTDs representing these types of aircraft.

In both cases the existing Certification Specifications (so called Primary Reference Documents – PRD) to evaluate and qualify FSTDs for pilot training – (UK) CS-FSTD(A) Issue 2 and (UK) CS-FSTD(H) Initial Issue – cannot serve as a qualification basis on their own. Following a gap analysis, they must be amended or modified by special conditions (SCs). The definition of the scope and use of SCs is a faster way to amend the existing Certification Specifications than an update by a standard rulemaking process.

Chapter 2

Regulatory Basis

The legal basis for an amendment or modification of the existing qualification basis by developing and using SCs in the context of FSTD qualification is set out in ARA.FSTD.100(c)(1) of Annex VI (Part-ARA) to UK Regulation (EU) No. 1178/2011 which reads as follows:

> (c) Qualification basis and special conditions
>
> (1) The CAA may prescribe special conditions for the FSTD qualification basis when the requirements of ORA.FSTD.210(a) are met and when it is demonstrated that the special conditions ensure an equivalent level of safety to that established in the applicable certification specification.

Also note that point ORA.FSTD.210(a)(3) of Annex VII (Part-ORA) to UK Regulation (EU) No. 1178/2011 reads as follows:

> (a) The qualification basis for the issuance of an FSTD qualification certificate shall consist of: […]
>
> (3) any special conditions prescribed by the CAA if the related Certification Specifications do not contain adequate or appropriate standards for the FSTD because the FSTD has novel or different features to those upon which the applicable Certification Specifications are based.'

For novel types of aircraft, the requirement for Operational Suitability Data (OSD) may be applicable and the Certification Specifications and Guidance Material for Simulator Data '(UK) CS-SIMD' will have to be considered (see 3.2). The use of special conditions is covered by CS SIMD.110(b) which reads as follows:

These certification specifications apply to other categories of aircraft when special conditions are established based on ORA.FSTD.210(a)(3) 'Qualification basis of UK Regulation (EU) No 1178/2011 (the 'Aircrew Regulation').

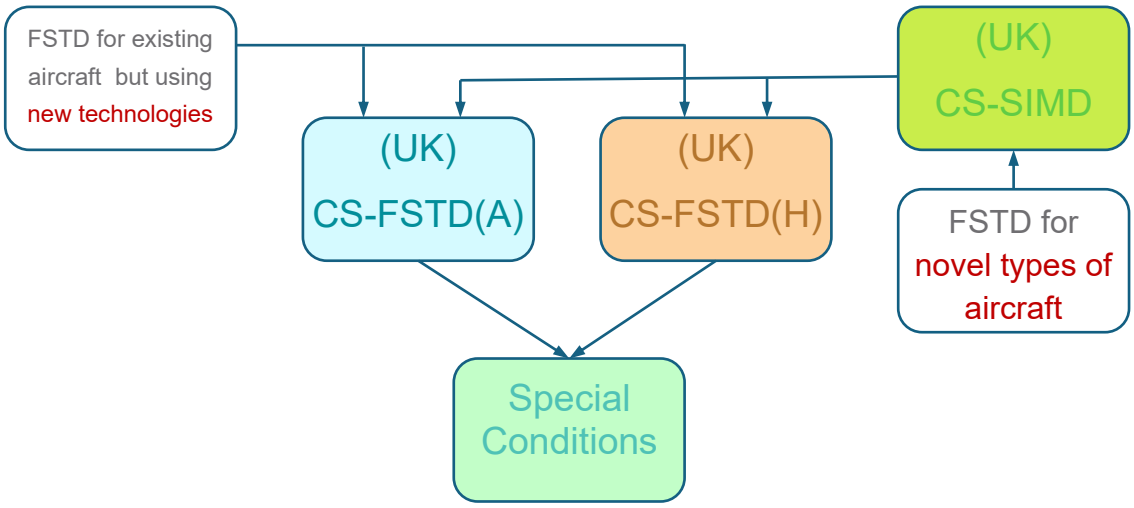

Figure 1: Regulatory basis for the development of special conditions.

Chapter 3

Special Condition Development

A general objective is to identify any subject that should be addressed by means of SCs at an early stage of the FSTD development to ensure the timely planning of a compliance demonstration for its qualification. The CAA or the applicant (industry) may identify the need for a special condition.

The initial development of SCs requires expertise regarding the subject. In case of new FSTD features this expertise is with the training device manufacturer (TDM) building a device to be qualified, or in case of novel types of aircraft with its manufacturer. Therefore, it is normal practice that TDMs or aircraft manufacturers engage with the CAA to develop special conditions and demonstrate how they can comply with such SCs using new FSTD features, ensuring an equivalent level of safety to that established in the applicable certification specifications (more details see section 6.).

The CAA may decide to involve further contracted/independent third party FSTD expertise (independent assessor) to complement the authority's own expertise and/or for the purpose of an independent validation/review. This involvement shall take place only after explicit agreement with the applicant. The contract with the third party working on behalf of the CAA shall ensure confidentiality.

For Special Conditions to be assessed, accepted and prescribed in the Qualification Certificate (QC) of the device by the CAA, any SC developed by the TDM or the aircraft manufacturer should be thoroughly justified and evidence provided for the application of ARA.FSTD.100(c)(1)

This also ensures subsequent traceability of the intent of a SC subject.

The assessment and prescription of SCs is at the discretion of the CAA.

Chapter 3.1

Identification of SC subjects

New technologies used in existing types of FSTD (like FFS, FTD or FNPT) require the identification of subjects to be covered by SCs following a gap analysis related to existing qualification criteria (existing CSs). The new set of criteria composed by CSs and SCs will be applied during the device evaluation conducted by the CAA in the qualification process. Since the new technologies will not be related to performance and handling qualities of the aircraft (respectively the FSTD) or the atmospheric models, only the motion, visual, sound system, the representation of the cockpit itself and the interaction / synchronisation of the different systems could be subject to SCs.

Before the use of new technologies and any required SCs applied for the evaluation and qualification of an FSTD can be prescribed by the CAA, the training device should be assessed by conducting a 'training evaluation'. The purpose of this evaluation is to investigate the abilities and limitations of using such novel technology to deliver flight training according to the intended training programme and if the device would meet the requirements for the desired qualification level. The evaluation should be done within a test campaign (fly-outs) performed by pilots/instructors established by the CAA.

If the subjective / functional assessment is positive and the fidelity of the device allow for transfer of training, the identified areas where SCs on the objective side are required shall be specified.

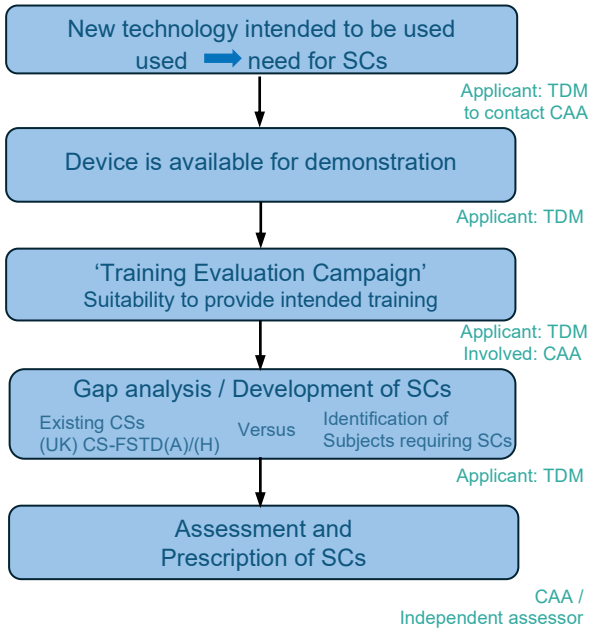

Figure 2: Process to determine SCs as elements of a new qualification basis addressing new technologies

Example:

- If the type of FSTD is an FTD using Virtual Reality (VR) and being equipped with a motion system, the SCs should address the following areas
- Cockpit Replica – alignment tests (cockpit alignment, motion compensation for head mounted display (HMD)), HMD tracking delay, colour representation
- Visual System – display system tests (continuous cross-cockpit visual field of view for HMD display systems, system geometry, vernier resolution, *frame rate, colour degradation, black level, chromatic aberration, IPD setting and 3D projection, grating resolution*)
- Motion System for VR FSTD – motion envelope (vertical, lateral, longitudinal)
- FSTD Systems – transport delay (visual-/motion-/cockpit instrument responses)

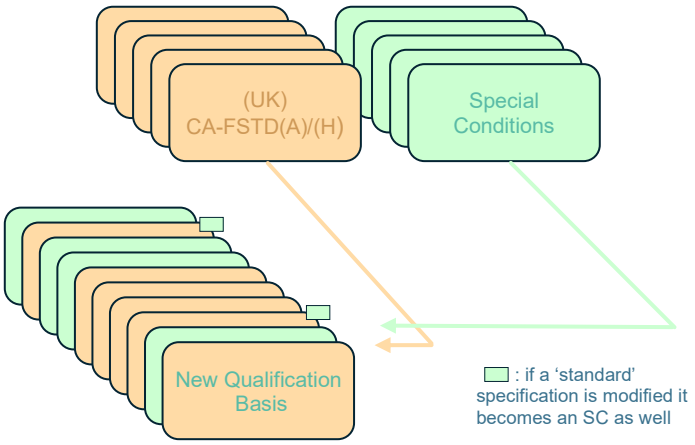

Figure 3: Example for the composition of a new Qualification Basis for a new technology used in a helicopter FSTD

When Special Conditions have been prescribed for a certain FSTD configuration proposed by a certain TDM it cannot be assumed that the same conditions apply to the same new features implemented by other TDMs within another FSTD configuration. SCs may for instance be different if VR is used on a fixed based FSTD or on an FSTD equipped with a motion system (cueing to be synchronised). SCs may change as well with the use of components provided by other manufacturers due to different capabilities and performance of the part(s) used and may change as well with the type of aircraft represented.

The determination of tolerances on the SCs may depend on the hardware / software used and the accuracy to be expected from the simulation model as well as to minimise

simulator sickness. Tolerances determined for a certain configuration may not be applicable to other configurations.

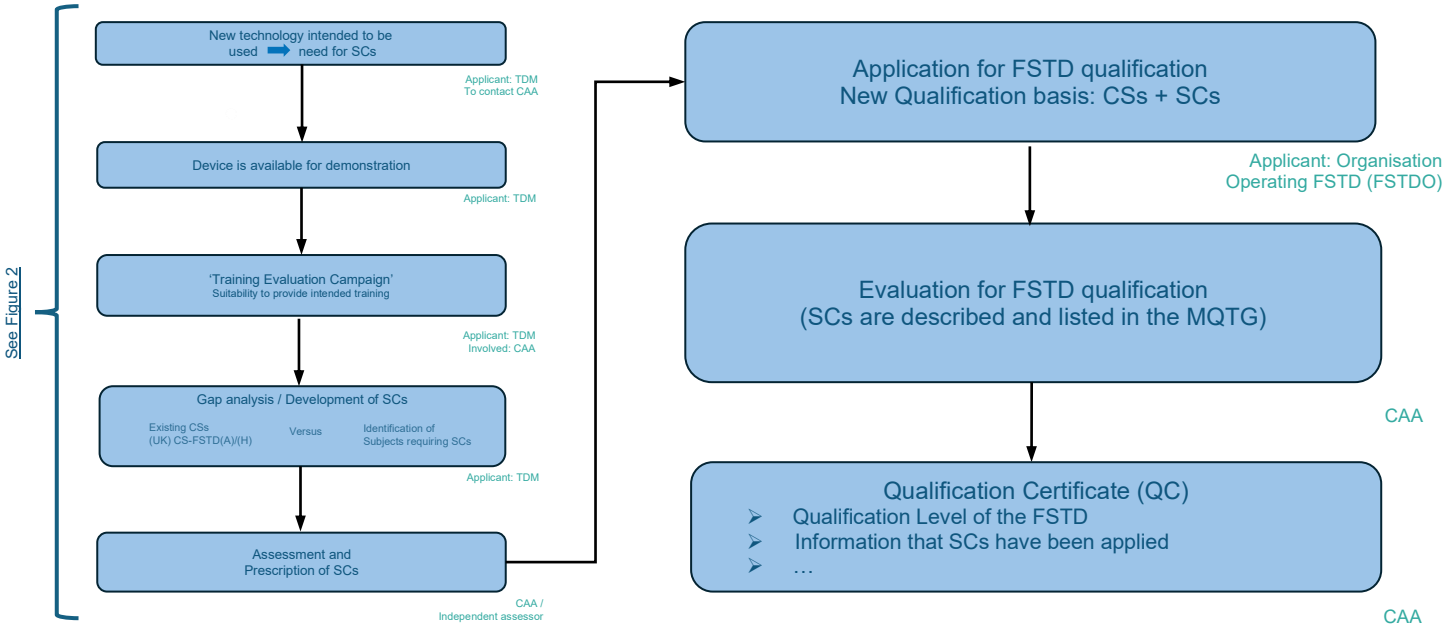

Figure 4: Entire process when using SCs as elements of a new qualification basis addressing new technologies

Chapter 3.2

Identification of SC subjects for FSTD representing novel types of aircraft

The development of SCs for the qualification of type specific FSTDs (e.g. FFS) for novel types of aircraft (like eVTOL) starts with the application for CAA aircraft TC if those FSTDs are to be used for pilot type rating training and the existing certification specifications for FSTD cannot be used entirely.

In this case OSD is applicable, especially (UK) CS-SIMD Issue 2 (CS SIMD.100(c), CS SIMD.110(b)).

Based on the peculiarities of the aircraft and the identified training needs regarding equipment, configuration, operation and training areas of special emphasis (TASE) resulting from (UK) CS-FCD, specific or additional features need to be considered for flight or engineering tests when the aircraft manufacturer collects data to be used as a reference for the validation of the FSTD (validation data, VD).

Therefore, it must be determined at a very early stage which additional SCs (objective tests) must be developed to address the particularities of the aircraft. The flight and engineering tests selected to provide validation data are listed in the validation data roadmap (VDR).

SCs addressing FSTDs for novel types of aircraft will not be related to FSTD components but will address aircraft performance and handling qualities. There could also be a combination of both, new FSTD technologies and FSTD for novel types of aircraft (e.g., VR used in a training device representing eVTOL aircraft).

The conditions for those tests should be discussed with the CAA as soon as the need for those tests is identified.

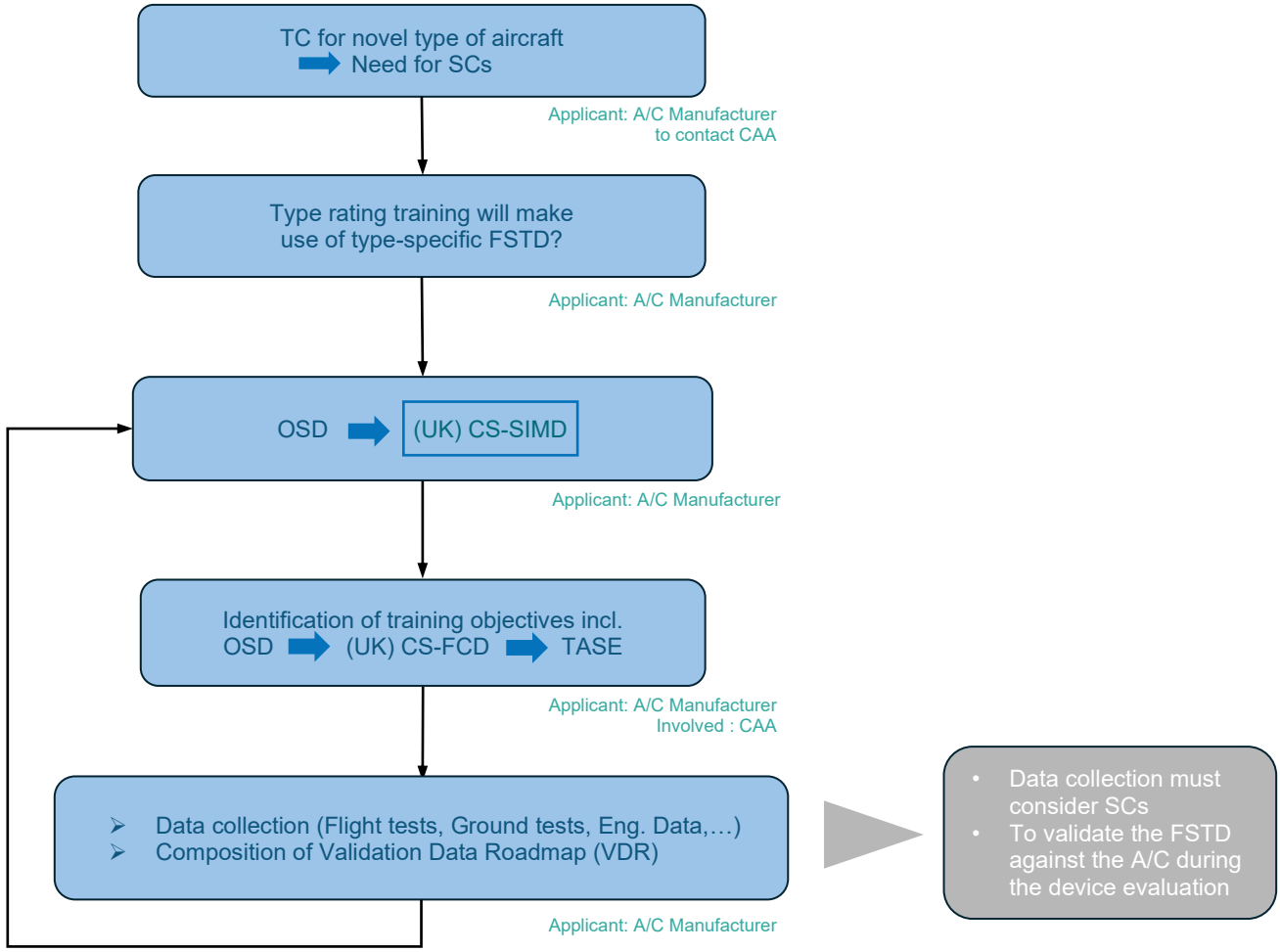

Figure 5: Process to determine SCs as elements of a new qualification basis addressing novel types of aircraft

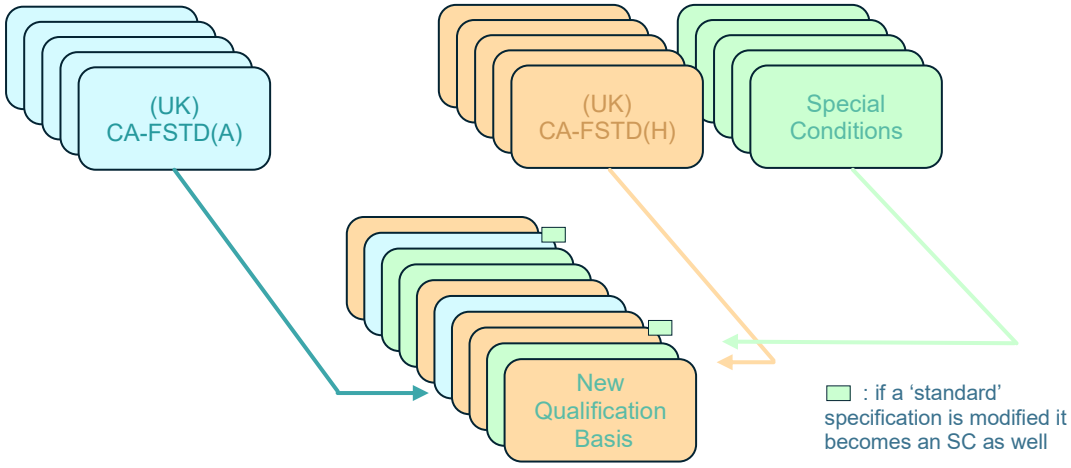

Figure 6: Example for the composition of a new Qualification Basis for an FSTD representing an eVTOL with wings.

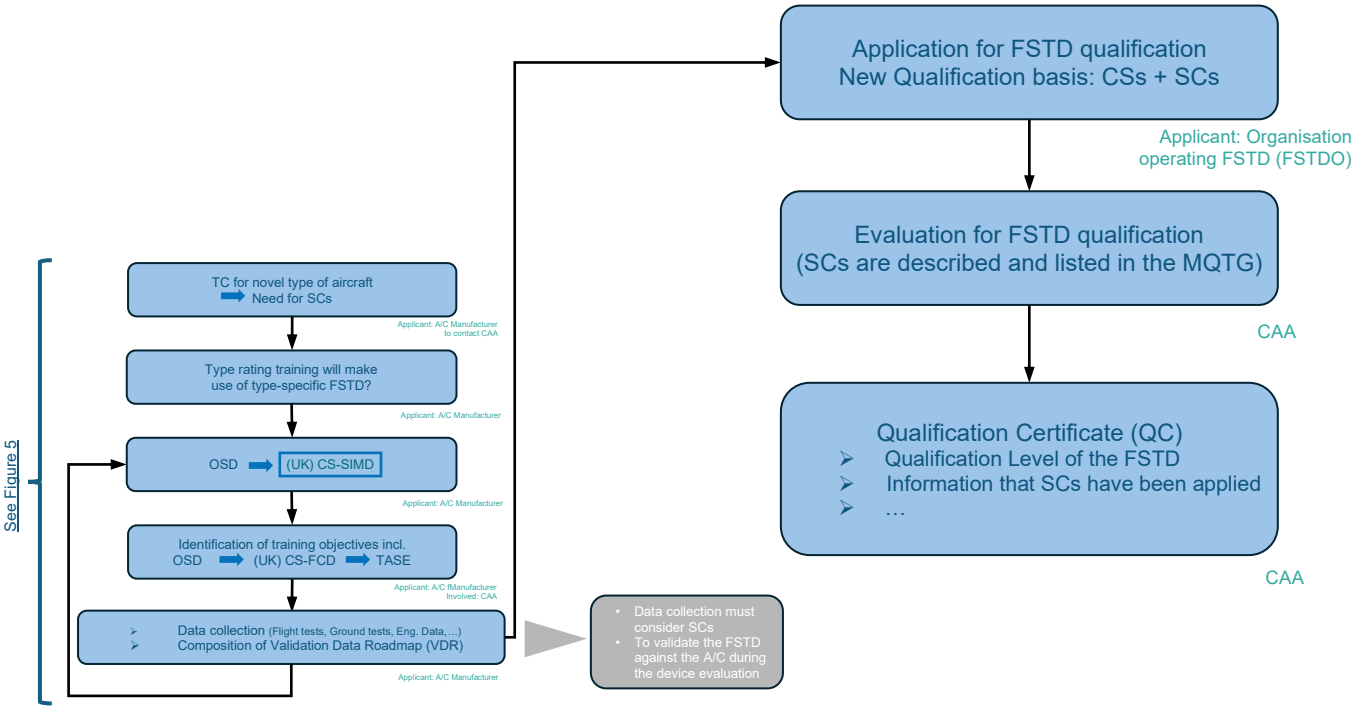

Figure 7: Entire process when using SCs as elements of a new qualification basis addressing novel types of aircraft

Chapter 4

Application for the use of SCs as a qualification basis for FSTD

In context of the use of special conditions, the CAA will receive applications from:

a. the FSTD operator (FSTDO) in case of new technologies (see 3.1) and FSTD for novel type of aircraft:

- CAA Form SRG2198, is to be used by an FSTDO when applying for the initial qualification of an FSTD.

  The application must contain the information that SCs, as assessed and prescribed by the CAA, will serve as a qualification basis in addition to or replacing parts of currently applicable certification specifications ((UK) CS-FSTD(A)/(H)). This information will be listed in section 'C. Primary reference document' of the associated qualification certificate.

  The same process should be followed by the FSTDO in case of application for an initial qualification of an FSTD representing a novel type of aircraft.

b. the aircraft manufacturer in case of novel type of aircraft (see 3.2):

- The aircraft manufacturer applies for the Type Certificate (TC). An element of the TC process is the Certification Review Item (CRI) containing a reference to (UK) CS-SIMD (CS SIMD.100(c)), where (UK) CS-SIMD will refer to the provision of validation data based on (UK) CS- FSTD(A)/(H) and the prescribed Special Conditions (CS SIMD.110).

Chapter 5

Drafting of SCs

The development of special conditions is followed by a drafting of its content by the applicant while CAA may advice on drafting techniques. The draft should be accompanied by explanatory notes and statements, as below:

- A description of the component(s) requiring SCs and the FSTD type(s) where they will be applicable (new technologies).
- Background information why a component has been added or why it is replacing a component covered by the existing CSs (new technologies).
- A description of the applicability with regards to training tasks (new technologies/novel type of aircraft).
- Statements regarding the requirements ensuring that the introduction of the new feature will not adversely affect the fidelity as required by existing CSs for FSTD without that feature (new technologies).
- Statements that include a demonstration of how an equivalent safety level (compared to existing CS, as applicable) is ensured (new technologies/novel type of aircraft).
- New objective tests (name of test, tolerance, flight conditions, comments).

A SC should be written in a way that is:

- clear, easy to understand and unambiguous.
- simple and concise, avoiding unnecessary elements.
- precise enough to leave no uncertainty in the mind of the reader.

For additional or alternative specifications to existing CS through a SC, present tense or the wording “should” must be used. Additional specifications should be objective-based and by that describing their intention. Technical content should be structured and phrased in such a way that it can be easily transferred into a future revision of an existing CS or into a new CS when considered mature.

Chapter 6

Coordination activities

Close coordination and agreement should take place between a designated FSTD expert of the CAA and the applicant before the issuance of a SC.

This includes the formal special condition correspondence with the applicant. Correspondence related to an SC should be in electronic format. While PDF files are useful for recording purposes, during coordination phases the exchanges between the applicant and the CAA's experts should rely on editable (e.g. MS Word) documents.

This also includes discussions of the SC content between the applicant and the CAA until agreement is reached.

The CAA's FSTD expert may coordinate the drafting work where SCs cover multiple applicants.

In the case of novel types of aircraft, the CAA's FSTD / OSD-SIM expert should verify and ensure that the SC process as described in this information is properly applied and considered in the OSD process where applicable.

Chapter 7

Special Conditions prescribed by the CAA

The CAA will publish SCs that it prescribed duly considering property rights of the applicant. When consulting those SCs for an applicant, industry can then make use of them as a reference when proposing their own SCs for similar technologies.