

## 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 both,

- 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 – CS-FSTD(A) Issue 2 and CS-FSTD(H) Initial Issue – cannot serve or not entirely serve as a qualification basis. Following a gap analysis, they have to be amended or modified by special conditions (SCs). The definition and use of SCs is a faster way to amend the existing Certification Specifications than an update by a standard rulemaking process.

## 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 Regulation (EU) No 1178/2011 which reads as follows:

*‘(c) Qualification basis and special conditions*

- (1) The competent authority 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 Regulation (EU) No 1178/2011 reads as follows:

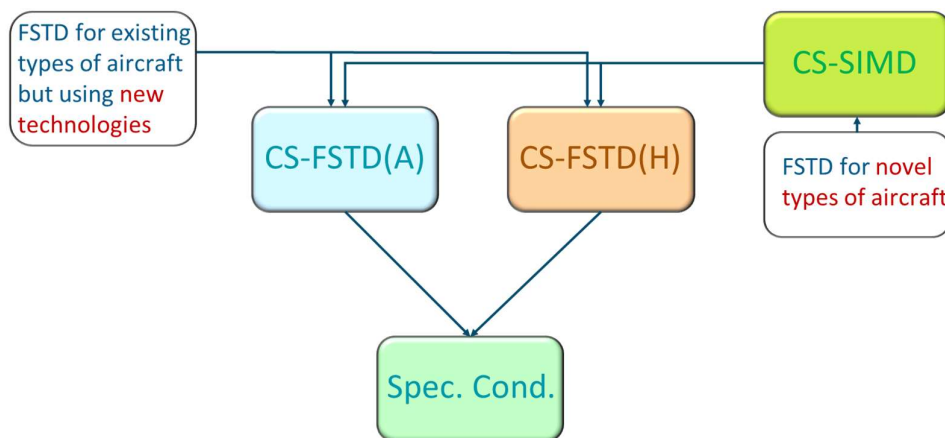
*‘(a) The qualification basis for the issuance of an FSTD qualification certificate shall consist of:*

*[...]*

- (3) any special conditions prescribed by the competent authority 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 'CS-SIMD' will have to be considered (see 4.2). 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 Regulation (EU) No 1178/2011 (the 'Aircrew Regulation').*



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

### 3. Competent authority

The definition of the 'competent authority' is given by ORA.GEN.105 of Annex VII (Part-ORA) to Regulation (EU) No 1178/2011. The competent authority may also be determined by Article 64 of the Basic Regulation, addressing the 'Reallocation of responsibility upon request of Member States' or by Article 65, addressing the 'Reallocation of responsibility upon request of organisations operating in more than one Member State'. Consequently, either EASA or a national aviation authority will become the competent authority.

Special Conditions when established by a national competent authority following ARA.FSTD.100(c)(2):

*'(2) When the competent authority, if other than the Agency, has established special conditions for the qualification basis of an FSTD, it shall without undue delay notify the Agency thereof. The notification shall be accompanied by a full description of the special conditions prescribed, and a safety assessment demonstrating that an equivalent level of safety to that established in the applicable Certification Specification is met.'*

The assessment of FSTD SCs notified by a Member State should follow the assessment process established for alternative means of compliance.

#### 4. Special Condition Development

A general objective is to identify any subject that should be addressed by means of SCs already at an early stage of the FSTD development to ensure a timely planning of compliance demonstration for its qualification. EASA, a national competent authority, as well as the applicant (industry) may identify the need for a special condition. The initial development of SCs requires the 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 competent authority 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 competent authority may decide to involve further contracted/independent third party FSTD expertise (independent assessor) to complement the authority's 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 competent authority shall ensure confidentiality.

For any SC developed by the TDM or the aircraft manufacturer the reason leading to the development of SC should be well described and a justification provided for the application of ARA.FSTD.100(c)(1)

- to ensure subsequent traceability of the intent of a SC subject
- before it can be assessed and accepted by the competent authority and prescribed in the Qualification Certificate (QC) of the device

The assessment and prescription of SCs is with the Competent Authority.

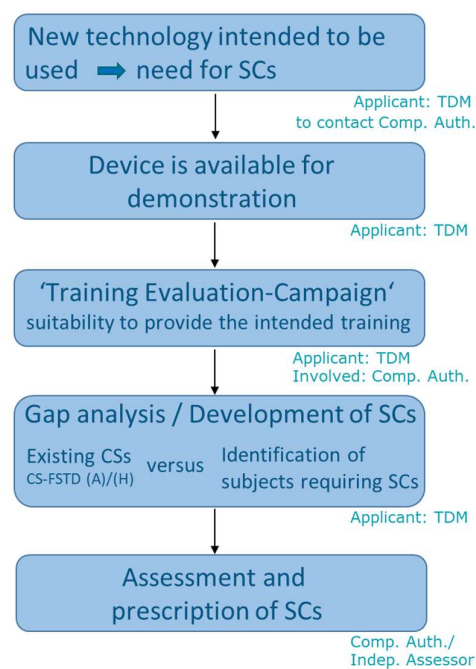
##### 4.1 Identification of SC subjects using new technologies

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 competent authority 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 competent authority, 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. This should be done within a test campaign (fly-outs) performed on the FSTD by nominated pilots and instructor pilots from industry and the competent authority.

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.

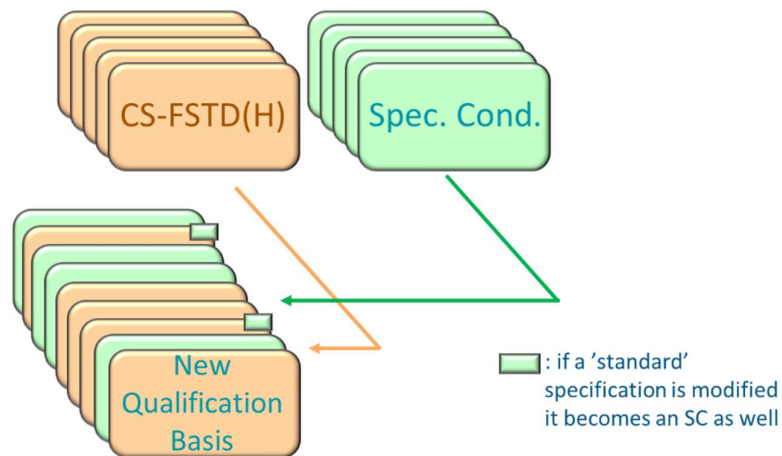


**Figure 2:** Process to determine SCs as elements of a new qualification basis addressing new technologies

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 areas:

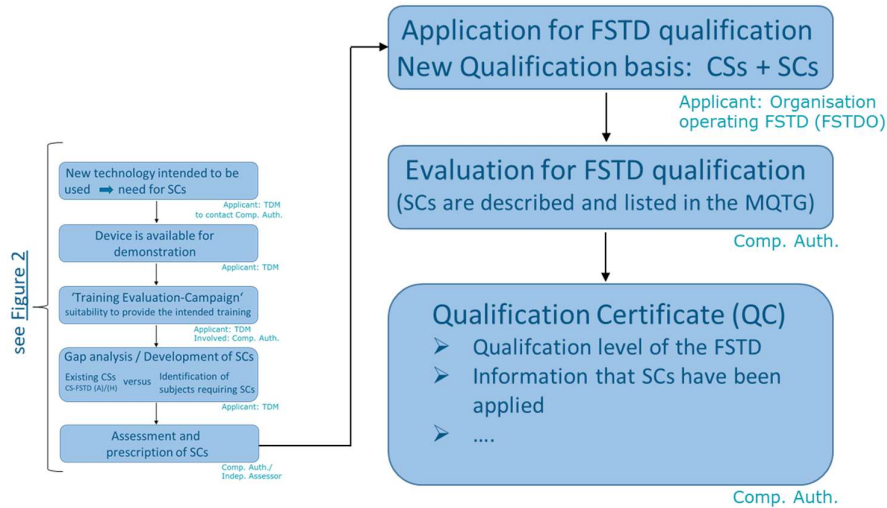
- Cockpit Replica – alignment tests (cockpit alignment, motion compensation for head mounted display (HMD)), HMD tracking delay, colour representation
- Visual System – display system tests (continuous cross-cockpit visual field of view for HMD display systems, system geometry, vernier resolution, *frame 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 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 be depending on the hard-/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

## 4.2 Identification of SC subjects for FSTD representing novel types of aircraft

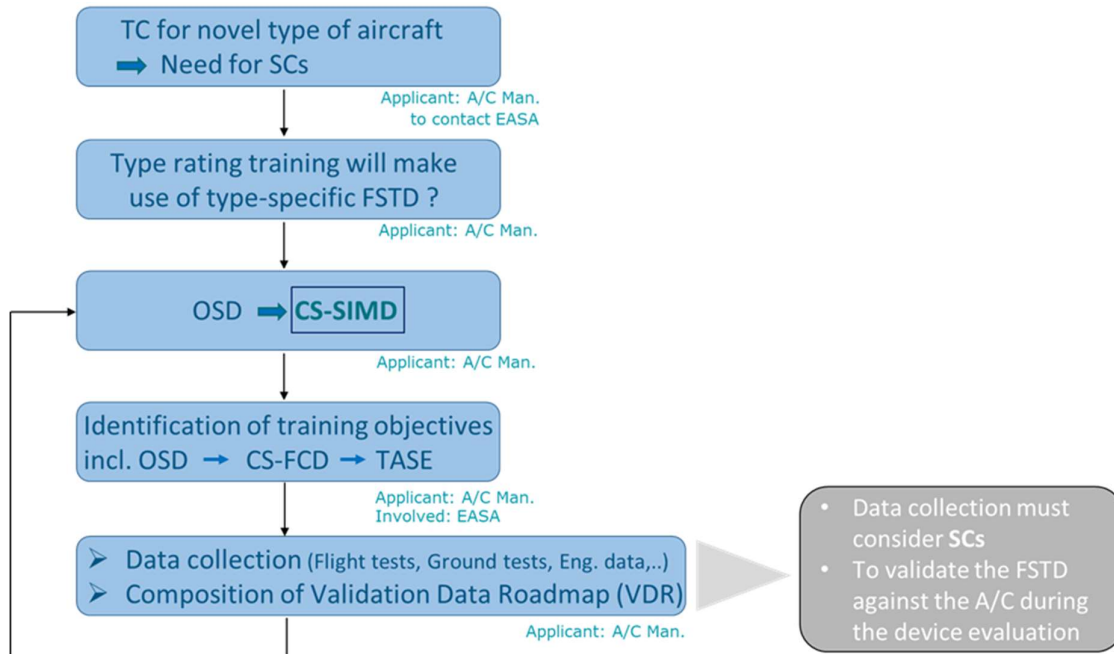
The development of SCs for the qualification of type specific FSTDs (e.g. FFS) for novel types of aircraft (like eVTOL) starts already with the application for EASA aircraft TC if those FSTDs will be used for pilot type rating training and existing certification specifications for FSTD cannot be used entirely. In this case OSD, especially CS-SIMD Issue 2 is applicable (CS SIMD.100(c), CS SIMD.110(b)). Based on the peculiarities of the aircraft and the identified training needs regarding

- equipment,
- configuration,
- operation,
- training areas of special emphasis (TASE) resulting from 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 FSTD (validation data -VD). Therefore, it must be determined at a very early stage which additional SCs (objective tests) have to 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).

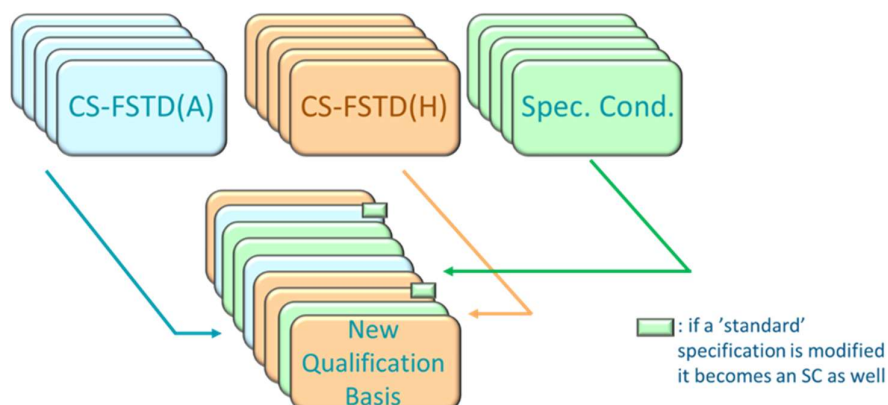
SCs addressing FSTDs for novel types of aircraft will not be related to FSTD components but will address aircraft performance and handling qualities. There could be as well a combination of both, new FSTD technologies and FSTD for novel types of aircraft (e.g., VR used in a training device representing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

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



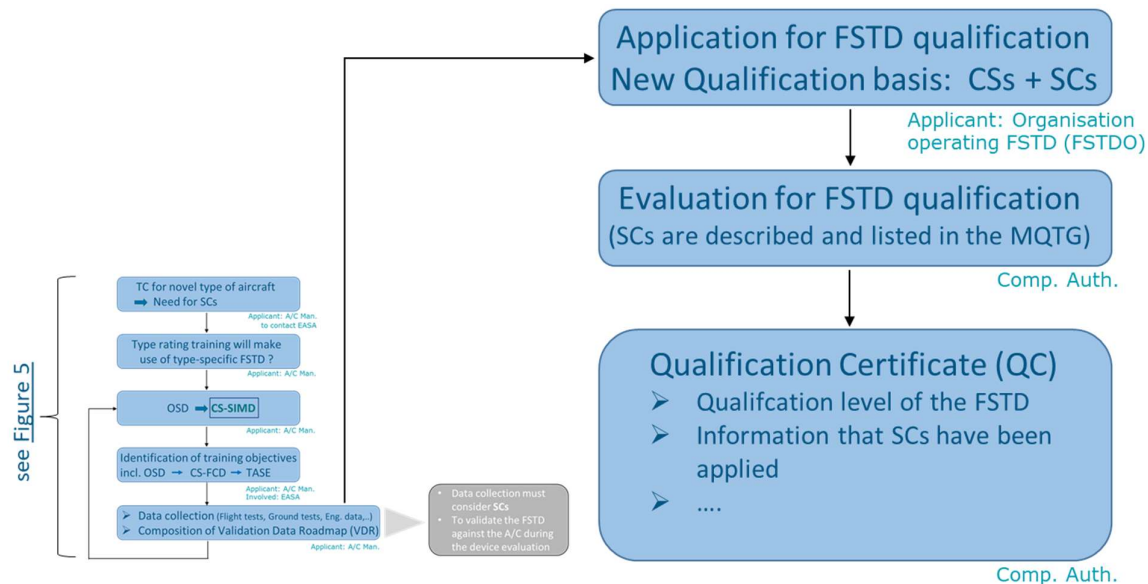
**Figure 5:** Process to determine SCs as elements of a new qualification basis addressing novel types of aircraft

The interaction between EASA being the competent authority for the OSD and the National Competent Authority (NCA) for the qualification of the FSTD can be seen in the diagram as shown in GM3 SIMD.200.



**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

## 5. Application for the use of SCs as a qualification basis for FSTD

In context with the use of special conditions, the competent authority will receive applications from:

- the FSTD0 in case of new technologies (see 4.1) and of FSTD for novel type of aircraft:
  - Form FO.FCTOA.00129-007, to be used by an FSTD0 when applying for the initial qualification of an FSTD, shall contain the information that SCs as assessed and approved by the competent authority will serve as a prescribed qualification basis in addition to or replacing parts of currently applicable certification specifications (CS-FSTD(A)/(H)). This information will be listed in section 'C. Primary reference document' of the associated qualification certificate.

The same process has to be followed by the FSTD0 in case of application for an initial qualification of an FSTD representing a novel type of aircraft.

- the aircraft manufacturer in case of novel type of aircraft (see 4.2):



- 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 CS-SIMD (CS SIMD.100(c)) , where CS-SIMD will refer to the provision of validation data based on CS-FSTD(A)/(H) and the prescribed Special Conditions (CS SIMD.110).

## 6. Drafting of SCs

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

- 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 condition, 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” are to 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.

## 7. Coordination activities

- Close coordination and agreement should take place between a designated FSTD expert of the competent authority and the applicant before the issuance of a SC. This includes
  - o the formal special condition correspondence with the applicant. Correspondence related to SC should be in electronic format. While PDF files are useful for recording purposes, during coordination phases the exchanges between the applicant and the competent authority's experts should rely on editable (e.g. MS Word) documents
  - o discussions of the SC content between the applicant and the competent authority until agreement is reached
- The competent authority's FSTD expert may coordinate the drafting work where SCs cover multiple applicants.
- EASA is the competent authority in case of novel types of aircraft. The Senior Expert OSD-SIM should verify and ensure that the SC process as described in this information is properly applied and considered in the OSD process where applicable. If an NCA is the competent authority for the qualification of the FSTD representing the novel type of aircraft, the relevant NCA section shall closely coordinate with the EASA OSD team.

## 8. Special Conditions prescribed by the Agency

EASA 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.

This EASA FS.3.2 Information contained in this document is made available on the EASA website (<https://www.easa.europa.eu/en/domains/aircrew-and-medical/flight-simulation-training-devices-fstd>)

For any queries on the content of this information please contact either [jens.krueger@easa.europa.eu](mailto:jens.krueger@easa.europa.eu) or the functional mailbox [FSTD.qualification@easa.europa.eu](mailto:FSTD.qualification@easa.europa.eu) .