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Saab Aeronautics Handbook for Development of Simulation Models

Public Variant

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1 SUMMARY

This handbook describes a framework for development, validation, and integration of multipurpose simulation models. The presented methodology enables reuse of models in different applications with different purposes. The scope is simulation models representing physical environment, physical aircraft systems or subsystems, avionics equipment, and electronic hardware.

The methodology has been developed by a small interdisciplinary team, with experience from Modeling and Simulation (M&S) of vehicle systems as well as development of simulators for verification and training. Special care has been taken to ensure usability of the workflow and method descriptions, mainly by means of 1) a user friendly format, easy to overview and update, 2) keeping the amount of text on an appropriate level, and 3) providing relevant examples, templates, and checklists. A simulation model of an aircraft Environmental Control System (ECS) is used as an example to guide the reader through the workflow of developing and validating multipurpose simulation models.

2 CONTENTS

3 DEFINITIONS

The terms and definitions used in this handbook have evolved during several years of usage of simulation systems at Saab and are in many cases aligned with standard definitions found in literature on systems- and software engineering and modeling & simulation.
Standards that are found useful in the scope of this handbook are:

- RTCA/DO-178B, "Software Considerations in Airborne Systems and Equipment Certification", RTCA, Washington, DC, 1992
- GM-VV PDG, "Generic Methodology for Verification and Validation (GM-VV) to Support Acceptance of Models, Simulations, and Data, Reference Manual", SISO-GUIDE-00X.1-201X-DRAFT-V1.2.3, 2010
- NASA-STD-7009, "Standard for Models and Simulations", NASA, Washington, DC, 20546-0001, 2008
- Functional Mockup Interface, FMI, www.modelisar.com

Table 1: Terms and definitions.

Adapter	Mid-level Integration layer for eventual programming language adaptations, e.g. if the model code consists of C-code and the simulator architecture is developed in Ada.
Component	Low level part of a model or sub model. In component based modeling of physical systems, a component normally is a model of a single piece of equipment, e.g. a pipe or a valve. A component may also represent an even lower level model entity, e.g. a table or an interpolation function.
Configuration Item	An object that is treated as a self-contained unit for the purposes of identification and change control.
Connector	High level integration layer, communicating with the simulator kernel and the connectors of other models integrated in the simulator.
Core model	The model prior to export for integration in a simulator. The core model may be manually written or developed in an M&S tool such as Dymola or Simulink. For the latter case, simulation is performed by executing the model in the M&S tool. Model code may be generated directly from the core model in the M&S tool, for integration in a simulator.
Integration layer	Code enabling integration of the model code into a simulator, see model wrapper, adapter, and connector.
MGA	Materiel group manager (Swedish: MatrielGruppsAnsvarig) is the role responsible for a certain part of the aircraft product structure e.g. the fuel system.
Model	A mathematical or logical representation of a system (e.g. a physical system with or without control software) realized in software. A model may consist of several sub models.
Model code	An exported version of the core model, to be integrated in a simulator. The model code may be manually written or generated from an M&S tool.

Model storage	A database containing models with well-known properties. Simulation models and model connectors are stored in the model storage. Ideally, models are well-specified, tested, and validated.
Model wrapper	Low level integration layer closest to the model code. Includes functionality for e.g. initializing, stabilizing, and simulating the model.
Parameter	A simulation value representing a physical or logical quantity which is constant during a simulation run.
Sub model	Mid-level part of a model. A sub model may consist of several components.
System simulator	A simulator where a set of the aircraft subsystems are represented by models in a computer in combination with equipment, system hardware, test rigs etc. for simulation in a realistic environment.
Validation	Determining whether the model is a sufficiently accurate representation of the real system of interest from the perspective of the intended use of the model.
Variable	A simulation value representing a physical or logical quantity which may vary during a simulation run.
Verification	Determining whether the model is compliant with the model specification and if it accurately represents the underlying mathematical model.

4 INTRODUCTION

This handbook covers basic and important parts of model development and integration, but is not intended to include all aspect of the complete modeling process. Simulation models do not always have the same functionality as the represented components (a/c equipment). The models may be enhanced with fault-simulation functions, but simplified in other respects. Variations and combinations of the simulation models are constrained by the aircraft's components and functions. To increase the potential for reuse, the simulation models are designed to be included in different kinds of simulators, i.e., they are multipurpose models. There are specific characteristics of a model used for aircraft simulation:

- Properties of system safety require a robust methodology, including change control, traceability, verification and validation of models.
- A simulation model for an entire aircraft consists of several unique sub-models developed by different teams, during different times, using different modeling techniques.

Simulation models should be developed in phases enabling validation of basic functionalities in the first phase, and extension of the model in later phases. Models for product development should be available early. Elicitation of "all" requirement requires effort and time and delays the model. The delay, which a full specification may cause, will thereby prevent an efficient model-based methodology. The architecture must be properly defined and the basic requirements should however be known from the outset. The standard ARINC-610 (2009) *"Guidance for Design of Aircraft Equipment and Software for Use in Training Devices"* is intended for training simulators and relevant for creating the initial specification of a multipurpose model.

A basic component of a simulation environment is the model storage, which contains models with well-known properties. Simulation models and connectors are stored in the model storage. Ideally, models are well-specified, tested, validated and declared for which purposes they are ready to be used.

5 WORKFLOW

5.1 Overview

This section presents the workflow of development and maintenance of multipurpose simulation models at Saab Aeronautics. The workflow is internally at Saab Aeronautics in the form of a continuously updated wiki handbook. The aim is to present a way to produce a simulation model of good enough quality to be included in the model storage for reuse purposes. The scope of the handbook is simulation models representing physical environment, physical aircraft systems or subsystems, avionics equipment, and electronic hardware. Models of embedded software are for the most part developed according to other established processes, but some support may be obtained from this handbook. The figure below shows an overview of the workflow.

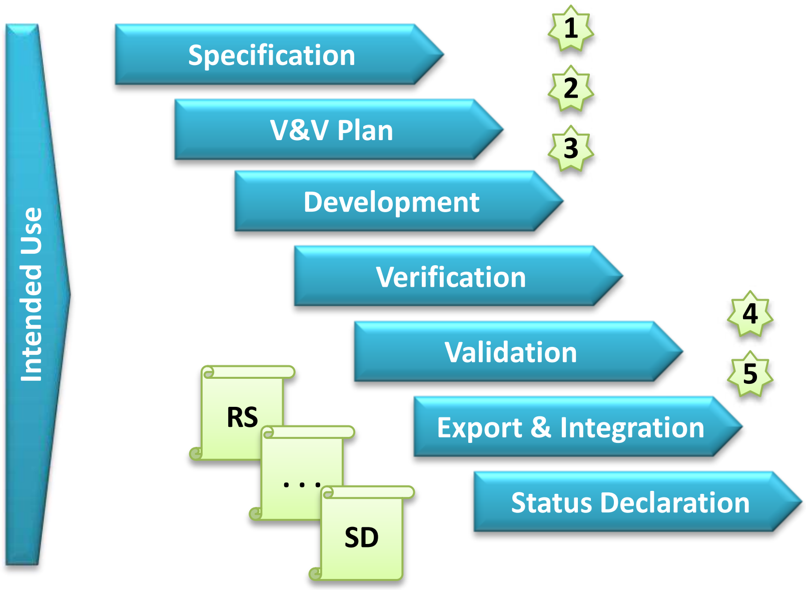

Figure 1: Workflow for development of multipurpose simulation models.

The blue blocks correspond to activities described in the following sub sections. The overview provides a chronological view of the workflow; it must, however, be stressed that the duration of each activity may vary significantly depending on the character and intended use of the simulation model of interest. Another important aspect is that activities normally overlap, i.e. the workflow is not sequential. The stars in the figure depict output items such as code, test cases, or interface descriptions. The symbols named “RS” and “SD” represents documentation such as Requirement Specification and Status Declaration. It should be noted that all activities, output items, and documents related to this workflow concern the product “simulation model”, i.e. the term “simulation model” could be placed before each name used in this workflow.

The table below provides an overview with a brief description of activities, and links to applicable templates and checklists included as appendices. A somewhat more detailed description of the activities is included in the following section.

Table 2: Overview of activities, templates, and checklists.

Activity	Brief description	Template	Checklist
Intended Use	Define a simulation model's intended use by identifying usage cases from an actor perspective and chosen limitations. Also, create model overview diagrams.		
Requirement Specification	From the intended use, derive requirements on the simulation model and group them in functional and characteristic requirements. Also, define the interface for the input to and the output from the simulation model.	Simulation Model Requirement Specification Simulation Model Interface description	Simulation Model Requirement Specification Simulation Model Interface description
V&V Plan	Define how the simulation model requirements will be verified and how the model will be validated.	Simulation Model V&V/Test Plan	Simulation Model V&V/Test Plan
Development	Update an existing model or create a new model. Identify what is modeled and what is not included. For a model to be integrated in a simulator, it must follow the requirements and design standards according to the applicable simulator software architecture.	Simulation Model Description	Simulation Model Description
Verification	Verification of compliance with the requirements stated in the Simulation Model Requirement Specification.	Simulation Model Verification/Test Report	Simulation Model Verification/Test Report
Validation	Is the model fit for purpose? Does the model behave as intended? Comparison of model results against measurement data. Uncertainty analysis to assess accuracy in operating points. Perform system tests to verify that the model can handle the identified use cases.	Simulation Model Validation Report	Simulation Model Validation Report
Export and Integration	Integration of model into a simulator environment. Follow guidelines and standards according to the applicable simulator software architecture.		
Status Declaration	All models in the model storage must have a Status Declaration, which includes information on what system the model represents, a model overview, limitations, known errors/problems, and a verification/quality summary.	Simulation Model Status Declaration	Simulation Model Status Declaration

5.2 An Industrial Application Example – Aircraft ECS Model

The Environmental Control System (ECS) for an aircraft is used here as an example of an industrial application. In the following sections, the reader is guided through the process of developing multipurpose simulation models at Saab Aeronautics by means of an ECS hardware (H/W) model. The ECS can be regarded as a complex system and includes a significant amount of hardware and software (S/W)[1].

[1] A general description of functionality of ECS systems is found in http://en.wikipedia.org/wiki/Environmental_Control_System

The main purpose of the ECS used in this example is to provide equipment cooling and tempering/pressurizing the cabin. It also pressurizes other aircraft systems e.g. the fuel and anti-g systems. The main hardware components in the ECS are heat exchangers, compressor, turbine, water separator, pipes, and control valves. The ECS S/W controls and monitors pressure, temperature, and flow levels in various parts of the system.

As described in later sections, the ECS H/W model has variants, e.g. one simple and one detailed variant. The model layout is hierarchical and the Modelica construction replaceable is utilized to obtain different variants applicable for model time binding. Additional variant handling is performed by parameter selection at load time and run time. One view of one of the model variants is shown in Figure 2.

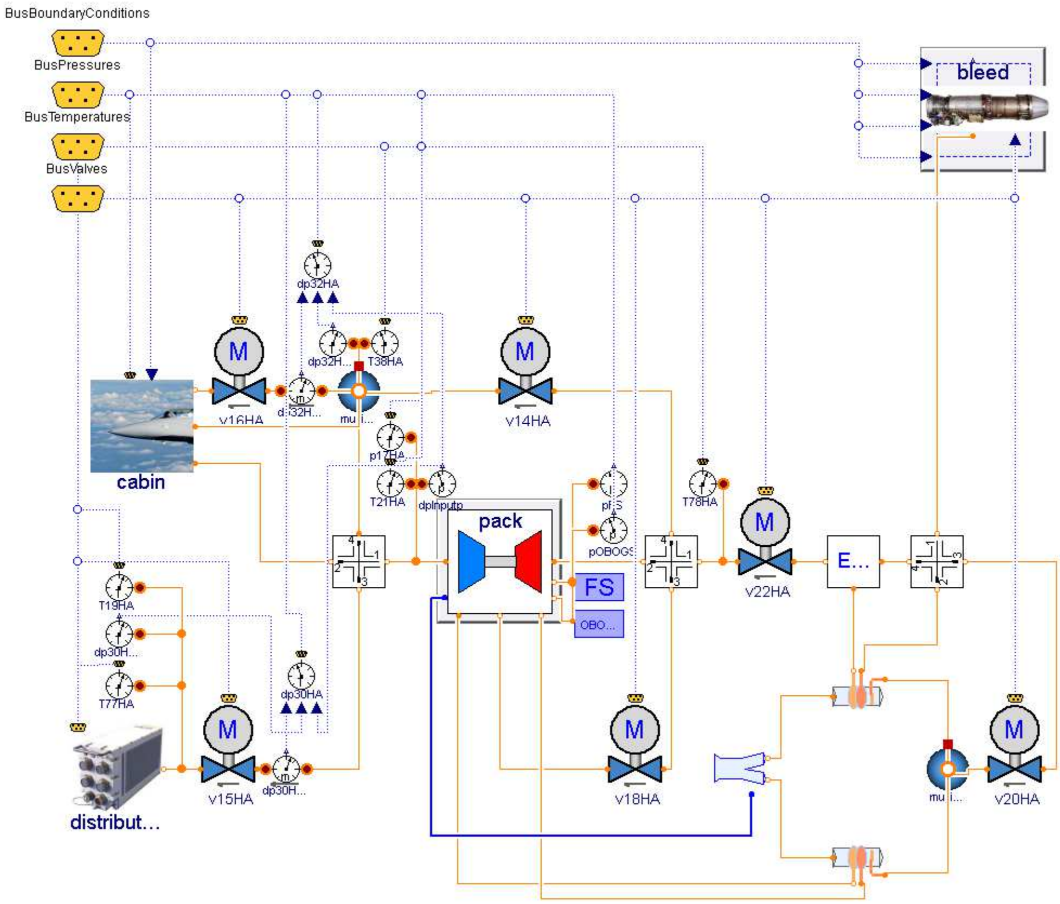

Figure 2: ECS H/W model.

The figure shows the detailed physical model with its sub-models. This view is actually one step down from the ECS H/W model top level, in which either detailed or simplified model variant is selected.

5.3 Activity Description

This section describes the activities of the workflow illustrated in Figure 1.

5.3.1 Intended Use

Prior to initiating the actual development of a simulation model, a prerequisite is to specify the intended use of the model. Best practice is to define one or several use cases covering as much as possible of the intended use. Deriving use cases from an actor perspective is a way to establish a common understanding of the model scope.

The ECS model has a wide range of applications, made visible by the definition of use cases covering system development, verification and training. The main actors found in the use cases derived for the ECS model are M&S specialists, system engineers (H/W and S/W), test engineers, system safety engineers, pilots, and aircraft technicians. Some examples of usage are:

- ECS performance simulations
- ECS conceptual design and decisions (H/W and S/W)
- Simulation of static load conditions (temperature and pressure levels)
- Dynamic/transient simulations
- Fault simulation and incident analysis (H/W and S/W)
- Control design
- Flight-critical system/built-in test of fault diagnostic functions
- Part of system simulation including other vehicle systems, such as the fuel system
- Pilot training
- Technician training

Analyzing the results from this activity also includes recommendations as to which modeling technique and (appropriate) language/tool to choose for the remaining activities in the workflow. The final choice may further depend on business aspects such as relationships with development partners, available skills, enterprise directives, and license policies.

5.3.2 Requirement Specification

From the intended use, requirements concerning the simulation model are derived. To obtain as complete a requirement set as possible, it is essential to collect information from all major stakeholders. The requirements can be grouped into categories such as:

- Functional requirements: Derived from the intended use, e.g. what types of physical phenomena are to be captured, fault simulation capabilities, and model states/modes.

- Characteristics requirements: Examples include modeling language, coding standards, model export capabilities, real-time computational capabilities, S/W compatibility and H/W compatibility. These requirements also contain design restrictions on model complexity and model quality, preferably expressed in terms of defined quality measures such as steady-state error, overshoot, and variance. This category may also include requirements on model credibility.

This activity also covers the definition of model architecture and identification of interfaces. The design is typically described in a separate Simulation Model Description document, but for simpler models, an alternative is to include the design description in the Model Requirement Specification. Using a Model Based System Engineering (MBSE) approach, the design description may consist of some viewable format of the model itself. Typically, the interface definition will evolve during the model's development, but the interface should be as mature as possible prior to the development stage. At this early stage, the interface description of the ECS application example consists of a spreadsheet containing the most essential information for each identified signal. A formal interface description is produced during the development stage, as described below.

Requirements from different stakeholders may be conflicting. In the ECS application example, this is the case for model fidelity versus real-time execution requirements. These requirements, together with constraints in available computational H/W resources, result in two model variants, i.e. one simpler real-time-oriented model and one high fidelity model. These two models have a common top-level interface, and the Modelica construction replaceable is used to select the model variant at model time.

5.3.3 Verification and Validation Plan

The purpose of the plan for verification and validation (V&V) is to define how the model requirements will be verified, and how model quality and fit for purpose will be validated. One basic source of information for this plan is the V&V strategy and test plans for the modeled/represented system. The different test environments should be stated, as well as what measurement data needs to be available for verification and validation purposes.

In the ECS application example, the major part of the verification consists of testing activities carried out in the different applications in which the model is integrated. The validation is performed using measurement data from aircraft, test rig and bench tests. In the early V&V stage, data from a predecessor ECS model is used for comparison of model results.

5.3.4 Development

This activity involves choosing an existing model which meets the requirement specification, adjusting an existing model, or developing a new model from scratch. The model may be written manually or developed in an M&S tool. This activity also includes the development of documentation describing the model on sub-model level, regarding what is modeled and what is not, underlying equations, etc. A Simulation Model Description may be written manually, or generated using the applicable M&S tool from information embedded in the model. As shown in Figure 1, the development task has three main output items, consisting of 1) core model, 2) interface description, and 3) test cases.

In the ECS application example, the development of the Dymola model is based on a predecessor Easy5 model. The model development, ranging from development of components to sub-models and further on to assembling the top-level model, was carried out by a small team applying scrum methodology. The team members' experience is that the scrum methodology, with its iterative approach, is well suited for this kind of activity, supporting a collaborative development.

5.3.5 Verification

The main purpose of this activity is to answer the question *"Are we creating the model right?"*. The answer is given by verification of compliance with the requirements stated in the Simulation Model Requirement Specification. The main activity is usually testing, but other kinds of analysis according to the V&V plan are also performed.

5.3.6 Validation

This activity should answer questions like *"Are we creating the right model?"* and *"Is the model fit for purpose?"*. A model cannot be fully validated in all operating points, but validated to a specified degree in a certain range of operation. To make the validation of multipurpose simulation models feasible, an efficient method may be to perform as much of the validation effort as possible in the environment best suited for this activity. Validation is typically related to comparing simulation results with measurement data, and preferably also analysis of model uncertainties, e.g. by means of sensitivity analysis.

For models representing physical systems, these activities are normally easiest to perform as close to the core model as possible, i.e. in the M&S tool. To ensure that the results from the validation performed in the M&S tool are applicable for the generated code as well as in all other integration layers up to the simulator top level, a viable approach is the use of common test cases. Preferably, such common test cases should be implemented in test scripts for reuse in applicable integration layers, as illustrated in Figure 3.

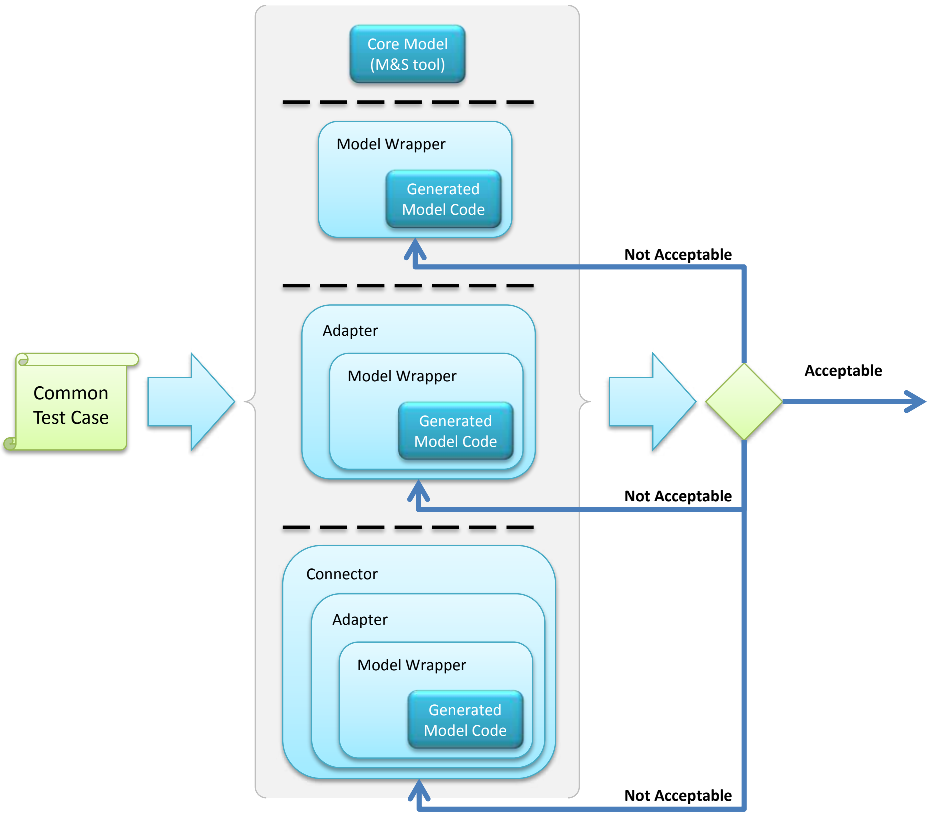

Figure 3: Common test cases reused in several integration layers. Note: Generated Model Code also represents manually written code.

This approach is utilized in the ECS application example, for which most of the validation against measurement data has been carried out in Dymola, with additional pre- and post-processing support in MATLAB. The validation effort carried out in Dymola is followed by the execution of common test cases at applicable integration layers. Ideally, the test cases should be specified in test scripts, directly reusable in the applicable integration layers. However, there may be practicalities complicating direct reusability, e.g. the fact that the different integration layers are implemented in different languages, or that signal names or data types may have been changed between the different integration layers.

5.3.7 Export and Integration

In this activity, applicable guidelines should be followed to export the model to the model storage, for integration in applicable simulator environments. See the introduction section for a description of the model storage structure. As shown in Figure 1, the export and integration task has two main output items consisting of 1) model code and 2) integration layers.

In the ECS application example the model code consists of C-code, generated directly out of the M&S tool. The other integration layers, i.e. model wrapper, adapter, and connector, are manually written in C and Ada respectively. Ideally, all functionality shall be placed in the core model developed in the M&S tool, i.e. the additional integration layers should only concern signal interface, with possible changes in signal names, data types, and, if necessary, unit transformations. If functionality is spread out over the different integration layers, it implies an increased risk of functional errors. This may also make it difficult to obtain an overview of the model functionality and it complicates model updates.

5.3.8 Status Declaration

The purpose of the status declaration is to describe the current status of the model and its related documentation. It refers to applicable documentation of the model and states e.g. model version, general information, model purpose, known limitations, and conclusions from performed V&V activities. The purpose of the status declaration is also to ensure that model export and integration in applicable simulators in itself do not affect the conclusions of the V&V. As discussed above, the general rule is that all functionality shall be placed in the core model. If there are exceptions, these shall be documented in the Status Declaration.

5.4 Recommended Documentation

The need for documentation may differ depending on the type of model and its intended use. The documentation suggested in the presented workflow is listed below. The minimum documentation, that is mandatory, is denoted “(m)”.

- Simulation Model Requirement Specification (m)
- Simulation Model Interface Description (m)
- Simulation Model V&V/Test Plan
- Simulation Model Description
- Simulation Model Verification/Test Report
- Simulation Model Validation Report
- Simulation Model Status Declaration (m)

The interface description, which is mandatory, may for small models, be included in the Simulation Model Requirement Specification or in the Simulation Model Description.

APPENDIX A: DOCUMENT TEMPLATES

Simulation Model Requirement Specification

The template name is Simulation Model Requirement Specification. Guidelines and example texts are written with marked italic yellow color. Those texts must be removed or converted to regular text before the Specification is issued.

Title of the document should be "Simulation Model Requirement Specification for model xxxx_nn".

This specification should be approved by the materiel group manager (MGA) for the Configuration Item the model represents and reviewed by other requirement stakeholders.

1 AMENDMENT RECORD

Issue	Definition of change	Affected chapters	Name	Date
1	Original issue	All	name	yyyy-mm-dd

2 TABLE OF CONTENTS

3 SCOPE

This document is a Simulation Model Requirement Specification for the model xxxx_nn related to Configuration Item (CI) XXX.
This could possibly be several CI numbers, and/or including several different variants of aircraft configurations. It should be easy to find the model for given equipment.

3.1 Identification

This Simulation Model Requirement Specification is valid for simulation model xxxx_nn. Relevant model name, e. g. ecs_01.

3.2 System overview

A graphical system overview.

3.3 Model overview

Overview figure of the external model description e.g. using SysML block definition diagram which typically is used to describe the known environment of a black box model.

Overview figure of the internal model description e.g. using SysML internal block diagram which typically is used to describe the model architecture.

The following list could have the Tier 2/3 functions from the system function list as starting point.

The model xxxx_nn represent the following system functions:

System function	Description	Comments

3.4 Purpose and end users

Describe intended usage of the model, both for system development, formal testing and training. Include which simulators that the model is intended to be part of. Describe what categories of users who will come in contact with the model or what simulators that the model will be a part of, e.g. system engineers, test engineers, pilots, technicians.

The model xxxx_nn is primarily intended to be used for:

- xxx
- xxx
- xxx

Simulator type	Short description & reference number	Primary requirement stakeholders	Primary end users	Applicable [yes/no]	Limitation (fulfill user needs?)
Desktop, software based simulator	Software based simulator for system development purposes in a desktop environment with non-real-time constraints	MGAnn, test engineers MGnn, applicable chief engineer, and product leader	System engineer for the CI the model represent, System engineer for surrounding systems		See Section YY
Software based simulator	Software based simulator for system development purposes with real-time constraints	MGAnn, test engineers MGnn, applicable chief engineer, and product leader	System engineer for the CI the model represent, System engineer for any other system		

Simulator type	Short description & reference number	Primary requirement stakeholders	Primary end users	Applicable [yes/no]	Limitation (fulfill user needs?)
Hardware in the loop simulator	Software based simulator and hardware rig for system development and formal testing purposes	MGAnn, test engineers MGnn, applicable chief engineer, and product leader	System engineer for the CI the model represent, System engineer for any other system, flight test department, Saab EDS (MG66, MG67, MG68)		
Pilot training simulator	Mission trainer for pilot training and mission support	Training simulator MGA, pilot education staff, applicable chief engineer, and product leader	Pilot, Pilot instructor,		
Ground crew training	Virtual maintenance trainer for ground crew education	Training simulator MGA, ground crew education staff, applicable chief engineer, and product leader	Ground crew technicians		
Small-scale simulation tool environment, e.g. Simulink, Dymola	Add description	Add stakeholder	Add user		

It is possible to add other relevant simulation environments in the above table.

4 REFERENCES

The first four items in the table below are standard references that need consideration when defining simulation model requirements.

Ref	Reg. no.	Issue	Title
[1]			
[2]			
[3]			
[4]			
[5]			

5 ASSUMPTIONS

Any assumptions made.

6 REQUIREMENTS

Requirements can be written in several different ways. When it is appropriate, give reference to requirements in the product documentation for the CI the model represent. If the requirement is unclear with respect to the model, it can be reformulated. When the function of the simulator model cannot be derived from the product, new requirements are written. A well established way to find relevant requirements is to start from use cases for the model and simulators.

It is recommended that it is made clear who is responsible for fulfilling each requirement and who is responsible for verifying each requirement.

6.1 States and Modes

Examples of states may be: initialize, IC-xx (start conditions), update, freeze, and shutdown.

6.2 Functional Requirements

Requirements connected to the function of the model.

6.2.1 User interface

Requirement on typical monitor signals.

6.2.2 Ability to represent faulty behaviour

Requirements for what control signals the model should be equipped with to introduce faults typical for the CI it represents to meet usage needs. It is recommended to keep track of the stakeholders.

6.2.3 Interface Identification

What are the interfaces of the model? There is no need to list individual signals, but major interfaces are to be identified. Are there any specific requirements regarding quality of input signals?

6.2.4 Parameters

Are there parameters that need to be set before simulation in order for the model to meet usability requirements?

6.2.5 Function XXX

R-xxx: requirement header

CI N shall produce some output when conditions (original req. reference).

Reformulated requirement applicable on this related model. Responsible.

6.2.6 Function YYY

6.3 Characteristics Requirements

6.3.1 Target Hardware

The model xxxx_nn shall execute on hardware specified by xxx.

6.3.2 Resource Utilization

6.3.2.1 Performance

Available computation resources on target.

6.3.2.2 Solver/computation methods

What type of solver should be used?

6.3.3 Design Restrictions

6.3.3.1 Model structure and architecture

Requirements that correspond to readability, reusability, mapping to CI-structure and to simulator needs.

6.3.3.2 Complexity and detail of description

Define how detailed the model must be in order to meet usability needs and simulator constraints. Note that different simulators very well can have different needs due to difference in usage and that the simulator constraints possibly can give no design freedom for the model regarding level of detail.

6.3.3.3 Model Quality

Any specific requirements on monitor or output signals regarding similarity to related CI.

6.3.4 Exception Handling

6.3.5 Process Requirements

6.3.5.1 Code type

Which language, Ada, C, Fortran? Should code generation be used? Specific settings for code generator?

6.3.5.2 Configuration management

For some simulators there are for example conventions regarding file headers that must be followed in order to support configuration management.

6.3.6 National and Company Security Classes

6.3.7 Other Requirements

6.3.7.1 Naming conventions

There are often tool and/or area specific naming conventions to consider.

6.3.7.2 Units

Strict usage of SI-units is recommended, except when the model interface needs other units in order to describe the CI it represent.

7 TERMS AND ABBREVIATIONS

Term	Description

APPENDICES

Append relevant use case descriptions or documents from requirements stakeholders as appropriate.

Simulation Model Interface description

The following table shows an example of an interface description. An explanation of each column is provided in Table A-2.

Table A-1: Example of interface description.

Signal	Description	Causality	Data Type	Unit	Range	Default IC Warm	Default IC Air	Corr. Unit	Corr. Range	Comment	Interfacing model
S1	Pack pressure	Output	Real	V	0.5-5.5	1	2	kPa(g)	0-140	Linear	M1
S2	Cabin pressure	Output	Real	V	0.5-5.5	5	3	kPa(a)	0-110	Linear	M1
S3	Temperature at main avionics inlet	Output	Real	Ohm	750-2000	1070	1000	°C	-	Pt1000, expected range values provided	M1, M2
S4	Cabin temperature valve control signal close	Input	Real	-	0-1	0	0	%	0-100	Simplified PWM signal	M1
S5	Cabin temperature valve control signal open	Input	Real	-	0-1	0	0	%	0-100	Simplified PWM signal	M1
S6	Cabin temperature valve position	Output	Real	V	-3.334-1.665	0	0	°	0-90	Linear	M1
S7	Cabin temperature valve end limit switch idicating fully closed	Output	Boolean	-	0-1	0	0	-	-	0 = false, 1 = true	M1
S8	Cabin temperature valve end limit switch idicating fully open	Output	Boolean	-	0-1	0	0	-	-	0 = false, 1 = true	M1
ERR_S1	Enable signal for fault simulation of cabin temperature valve 0: No fault simulation 1: Fault simulation of actual valve shaft angle 2: Fault simulation of valve shaft angle measurement signal	Control	Integer	-	0-2	0	0	-	-	-	M1
ERR_S2	Command signal for fault simulation of cabin temperature valve	Control	Real	°	0-90	0	0	-	-	-	M1

Table A-2: Explanation of columns in Table A-1.

Column Name	Description	Mandatory
Signal	Name of signal. Case sensitve.	Yes
Description	Description of signal, preferably stating type of signal, e.g. control signal, sensor signal, fault simulation signal. If the signal is of enumeration type or integer representing different alternatives, all applicable values shall be described.	Yes
Causality	States if the signal is *Input* to, *Output* from, *Control* to, or *Monitor* signal from the applicable model. A control signal is used to control model behavior, e.g. fault simulation signals. A monitor signal is additional output signals enabling monitoring of model behavior. The monitor signals are not connected to any other model.	Yes
Data Type	E.g. Real, Boolean, Double, Integer.	Yes
Unit	Unit of signal, e.g. Pa(a), Pa(g), Ohm, V, °C, K, %.	Yes
Range	Expected range of signal.	Yes
Default IC Warm	Default value at Initial Condition Warm. For signals which do not have a default value, a typical value shall be provided. IC Warm = Initialize the system to a state on the ground, with the engine running and all systems powered up.	Yes
Default IC Air	Default value at IC Air. For signals which do not have a default value, a typical value shall be provided. IC Air = Initialize the system to a state in the air, with the engine running and all systems powered up.	No
Corresponding Unit	Underlaying unit which adds information to the user. Example: For a pressure sensor, the output signal is usually given in Volt, corresponding to a pressure (either absolute or gauge). In this case the *Unit* is V, and the *Corresponding Unit* is for example Pa(a) or Pa(g).	No
Corresponding Range	Underlaying range which adds information to the user. Example: For a pressure sensor, the output signal my be given in Volt in the range of 0.5 - 5.5 V, corresponding to a pressure given in for example Pa(a), in the range of 0 - 150000 Pa(a). In this case the *Range* is 0.5 - 5.5, and the *Corresponding Range* is 0 - 150000.	No
Comment	Additional information, e.g. regarding signal scaling, bus type information etc.	No
Interfacing model	States which model/models the signal is connected to.	No

Simulation Model V&V/Test Plan

The template name is Simulation Model V&V/Test Plan. Guidelines and example texts are written with marked italic yellow color. Those texts must be removed or converted to regular text before the plan is issued.

Title of the document s*hould be "Simulation Model V&V/Test Plan for model xxxx_nn".*

This plan should be approved by the materiel group manager (MGA) for the Configuration Item the model represents and reviewed by other requirement stakeholders.

The scope of the activities planned here should be to cover the verification and validation needs for the model up to and including the component layer in the simulators. The subsystem layer and the integration in the simulator are out of scope.

Use this template as a starting point. As there are many different tools and techniques to build models it is not certain that it covers all needs. Add sections as you find appropriate. **The level of detail of this plan should be sufficient to show that the verification & validation needs will be met for all requirements.** The most basic form for the plan is to group requirements and state verification and/or validation method for each group. More elaborate plans can use tools as DOORS to plan and track verification and/or validation for each requirement and also include detailed specifications for each test.

1 AMENDMENT RECORD

Issue	Definition of change	Affected chapters	Name	Date
1	Original issue	All	name	yyyy-mm-dd

2 TABLE OF CONTENTS

3 SCOPE

This document is a Simulation Model V&V/Test Plan for the model xxxx_nn related to Configuration Item (CI) XXX.
This could possibly be several CI numbers, and/or including several different variants of aircraft configurations. It should be easy to find the model for given equipment.

3.1 Identification

This Simulation Model V&V/Test Plan is valid for simulation model xxxx_nn. Relevant model name, e. g. ecs_01.

3.2 System Overview

Copy the system overview from the Simulation Model Requirement Specification [1].

3.3 Model Overview

Copy the model overview from the Simulation Model Requirement Specification [1].

3.4 Introduction

Reading instructions for this document.

4 REFERENCES

Ref	Reg. no.	Issue	Title
[1]	XXXXX	n	Simulation Model Requirements specification for model xxxx_nn.
[2]			
[3]			
[4]			
[5]			

5 REQUIREMENTS TRACEABILITY

In order to issue test worthiness for a simulator, it is necessary to know if model requirements are verified and/or validated. To plan the needed activities, the following type of table can be used. If DOORS is used to track requirements for the model, the table can be generated from DOORS.

Requirement	Qualification method	**Description** Brief description of how the requirement shall be qualified or cross-reference to fuller description
R-001	Test	
R-002	Inspection	

6 PERSONNEL

Are there specific requirements on what type of personnel performs the verification and/or the validation activities?

7 TEST AND INSTRUMENTATION EQUIPMENT

What kind of equipment and test resources must be available to perform the planned verification and/or validation tests? E.g. time in simulators or rigs, interfaces for manipulating model and data acquisition.

8 OTHER TEST RESOURCES

8.1 In-house resources

8.2 External resources

9 TEST DESCRIPTION

If tests need to be described in order to show that all requirements are verified, do that here.

9.1 Test case 1

10 RESTRICTIONS AND LIMITATIONS

What will not or cannot be verified and or validated and why? How does this affect the test worthiness for the simulator?

11 DEVIATIONS FROM EXISTING REGULATIONS

If any test resource will be used in a manner that do not adhere to existing regulations, this should be stated here.

12 DATA REDUCTION AND TEST REPORTING

How should test data be reduced and stored and how should the results be reported.

13 NATIONAL AND COMPANY SECURITY CLASSES

State the security classes for all resulting data.

14 SAFETY REGULATIONS

Are there any safety regulations that must be considered during testing?

15 TERMS AND ABBREVIATIONS

Term	Description

Term	Description

APPENDICES

Simulation Model Description

The template name is Simulation Model Description. Guidelines and example texts are written with marked italic yellow color. Those texts must be removed or converted to regular text before the description is issued.

Title of the document should be "Simulation Model Description for model xxxx_nn".

This description should be approved by the materiel group manager (MGA) for the Configuration Item the model represents and reviewed by other requirement stakeholders.

Use this template as a starting point. As there are many different tools and techniques to build models it is not certain that it covers all needs. Add sections as you find appropriate.

1 AMENDMENT RECORD

Issue	Definition of change	Affected chapters	Name	Date
1	Original issue	All	name	yyyy-mm-dd

2 TABLE OF CONTENTS

3 SCOPE

This document is a Simulation Model Description for the model xxxx_nn related to Configuration Item (CI) XXX.
This could possibly be several CI numbers, and/or including several different variants of aircraft configurations. It should be easy to find the model for given equipment.

3.1 Identification

This Simulation Model Description is valid for simulation model xxxx_nn. Relevant model name, e. g. ecs_01.

3.2 System Overview

Copy the system overview from the Simulation Model Requirement Specification [2].

3.3 Model Overview

Copy the model overview from the Simulation Model Requirement Specification [2].

3.4 Introduction

Reading instructions for this document.

4 REFERENCES

Ref	Reg. no.	Issue	Title
[1]	XXXXX	n	Simulation Model Requirements specification for model xxxx_nn.
[2]			
[3]			
[4]			
[5]			

5 ASSUMPTIONS

Give a description of all assumptions and modeling simplifications. Describe differences to the real Configuration Item.

6 ARCHITECTURAL DESIGN

6.1 Submodels

Identify which submodels the model is divided into. Make a brief description of the purpose of each subsystem and identify the interfaces between the submodels.

6.2 Design Concepts

6.2.1 Concept of Execution

Special designs for scheduling, exception handling, etc.

6.2.2 Input/Output Handling

What are the principles for data exchange?

6.2.3 6.2.3 States and Modes

How is initialization handled?

6.2.4 Simulation Parameters

Describe simulation parameters, variables that are constant during simulation, but changeable between simulation runs, e.g. configuration switches.

6.2.5 Data set

Are there any set of data (parameters) to be loaded before simulation, e.g. aerodynamic coefficients or a pump curve?

6.2.6 Resource Management

How has demands on real time capability and memory usage been handled?

6.2.7 Maintainability and Testability

What design issues are used to achieve an easily maintained model?

What is required to get a testable model? Which variables can be logged during simulation?

6.2.8 Exception Handling

6.2.9 Reuse of Submodels

Are some submodels or parts of submodels reused in other submodels/models? Are some parts of the model appropriate to have in a library?

6.2.10 Used Libraries

What libraries will be used?

6.2.11 National and Company Security Classes

6.2.12 Model Variants

Different model variants, depending on customer, one or two seater etc. Debugging support.

6.2.13 Model Identification

Description of mechanism used to identify from simulation data what internal model configurations have been used, if any.

6.2.14 Other Concepts

6.3 Design Decisions

What design decisions are made?
DD-xxx: design decision

6.4 Memory Usage

How is the memory used for communication?

6.5 Source Code File Structure

How is the source code divided into source code files?

Note especially which linked libraries are used.

6.6 Implementation Constraints

Are there any constraints in the implementation, e.g. operating system requirements or little/big-endian constraints?

7 FUNCTIONAL DESIGN

Detailed design of each function. The disposition of the model description based on functional design and/or submodel design depends on modeling technique.

7.1 Ability to represent faulty behaviour

Design to handle the requirements on fault injections [2].

7.2 Function XX

A detailed description of the function.

8 SUBMODEL DESIGN

Detailed design of each submodel.

8.1 Submodel XX

A detailed description of the purpose of the submodel.

8.1.1 Submodel Architecture

8.1.2 Submodel Functions

What system functions (see [2]) does this submodel take care of.

9 REQUIREMENTS TRACEABILITY

It is recommended to check that the design covers the requirements. The following type of table can be used. The qualification method indicated in the table can be completely omitted from this document if a Simulation Model V&V/Test Plan is issued.

Design decision	Page	Qualification method	Derived from
DD-001	x	Test	[2], R-001

Design decision	Page	Qualification method	Derived from

10 TERMS AND ABBREVIATIONS

Term	Description

APPENDICES

Autogenerated documents typically goes here.

Simulation Model Verification/Test Report

The template name is Simulation Model Verification/Test Report. Guidelines and example texts are written with marked italic yellow color. Those texts must be removed or converted to regular text before the plan is issued.

Title of the d*ocument should be "Simulation Model Verification/Test Report for model xxxx_nn"*.

This report should be approved by the materiel group manager (MGA) for the Configuration Item the model represents and reviewed by other requirement stakeholders.

The scope of this report is verification of the requirements in the Simulation Model Requirements Specification. For verification that needs extensive comparison with measurement data and for validation of fit for purpose, the Simulation Model Validation Report is better suited.

Use this template as a starting point. As there are many different tools and techniques to build models it is not certain that it covers all needs. Add sections as you find appropriate. **The level of detail of this report should be sufficient to show that the verification needs has been met for all requirements.** The most basic form for the report is to group requirements and state the performed verification method for each group. The verification of each (group of) requirement should be motivated and supported by evidence. More elaborate plans can use tools as DOORS to track the performed verification activities for each requirement. Detailed descriptions for each performed test typically belong to this report.

1 AMENDMENT RECORD

Issue	Definition of change	Affected chapters	Name	Date
1	Original issue	All	name	yyyy-mm-dd

2 TABLE OF CONTENTS

3 SCOPE

This document is a Simulation Model Verification/Test Report for the model xxxx_nn related to Configuration Item (CI) XXX.
This could possibly be several CI numbers, and/or including several different variants of aircraft configurations. It should be easy to find the model for given equipment.

3.1 Identification

This Simulation Model Verification/Test Report is valid for simulation model xxxx_nn. Relevant model name, e. g. ecs_01.

3.2 System overview

Copy the system overview from the Simulation Model Requirement Specification [2].

3.3 Model overview

Copy the model overview from the Simulation Model Requirement Specification [2].

4 REFERENCES

Ref	Reg. no.	Issue	Title
[1]	XXXXX	n	Simulation Model Requirements specification for model xxxx_nn.
[2]	XXXXX	n	Simulation Model V&V/Test Plan for model xxxx_nn.
[3]			
[4]			
[5]			

5 PERSONNEL

What personnel have performed the verification activities?

6 TEST AND INSTRUMENTATION EQUIPMENT

What kind of equipment and test resources has been used? Which edition for the software was used? Describe known deviations from normal behavior for the used resources.

7 OTHER TEST RESOURCES

7.1 In-house resources

7.2 External resources

8 MEASUREMENT UNCERTAINTY

Use this section only if applicable, e. g. if verification tests have been driven by measured data. See the guiding document for validation in [2] for examples of what to consider.

9 TEST PERFORMED AND RESULTS

Describe the tests used for verification of the requirements in the Simulation Model Requirement Specification, including simulation setup. Give, if possible, a visualization of the verification results both on specific (with regard to signals, scenarios and working points) and general level in a detailing level sufficient for the model usage.

9.1 Test case 1 alternative Requirements Group 1

10 EVALUATION OF RESULTS

11 DEVIATIONS

Describe known sources of deviations between the physical system and the model.

12 RESTRICTIONS AND LIMITATIONS

What will not or cannot be verified and or validated and why? How does this affect the test worthiness for the simulator?

13 DATA REDUCTION

How have test data been reduced and stored.

14 NATIONAL AND COMPANY SECURITY CLASSES

State the security classes for all resulting data.

15 CONCLUSIONS AND RECOMMENDATIONS

16 TECHNICAL RESULTS AND 'LESSONS LEARNED'

17 REQUIREMENTS TRACEABILITY

In order to issue test worthiness for a simulator, it is necessary to know if model requirements are verified. To keep track of the performed activities, the following type of table can be used. If applicable, refer also to the requirements traceability in [3]. If DOORS is used to track requirements for the model, the table can be generated from DOORS.

Requirement	**Qualification method**	**Description** Brief description of the test outcome or cross-reference to fuller description of test results	**Compliant**
R-001	Test		Yes/no

Requirement	**Qualification method**	**Description** Brief description of the test outcome or cross-reference to fuller description of test results	**Compliant**
R-002	Inspection		

18 TERMS AND ABBREVIATIONS

Term	**Description**

APPENDICES

Append relevant test data and other evidence.

Simulation Model Validation Report

The template name is Simulation Model Validation Report. Guidelines and example texts are written with marked italic yellow color. Those texts must be removed or converted to regular text before the plan is issued.

Title of the document should be "Simulation Model Validation Report for model xxxx_nn".

This report should be approved by the materiel group manager (MGA) for the Configuration Item the model represents and reviewed by other requirement stakeholders.

Validation refers to checking that the model is sufficient for its intended use. Requirements on model accuracy and signal quality compared to the real physical product are more likely to lead to validation than verification activities.

Use this template as a starting point. As there are many different tools and techniques to build models it is not certain that it covers all needs. Add sections as you find appropriate. **The level of detail of this report should be sufficient to show that the validation needs has been met for all requirements.** The most basic form for the report is to group requirements and state the performed validation method for each group. The validation of each (group of) requirement should be motivated and supported by evidence. More elaborate plans can use tools as DOORS to track the performed validation activities for each requirement. Detailed descriptions for each performed test typically belong to this report.

1 AMENDMENT RECORD

Issue	Definition of change	Affected chapters	Name	Date
1	Original issue	All	name	yyyy-mm-dd

2 TABLE OF CONTENTS

3 SCOPE

This document is a Simulation Model Validation Report for the model xxxx_nn related to Configuration Item (CI) XXX.
This could possibly be several CI numbers, and/or including several different variants of aircraft configurations. It should be easy to find the model for given equipment.

Validation refers to checking that the model is sufficient for its intended use. This includes verifying requirements on model accuracy and signal quality compared to the real CI.

3.1 Identification

This Simulation Model Validation Report is valid for simulation model xxxx_nn. Relevant model name, e. g. ecs_01.

3.2 System overview

Copy the system overview from the Simulation Model Requirement Specification [2].

3.3 Model overview

Copy the model overview from the Simulation Model Requirement Specification [2].

4 REFERENCES

Ref	Reg. no.	Issue	Title
[6]	XXXXX	n	Simulation Model Requirements specification for model xxxx_nn.
[7]	XXXXX	n	Simulation Model V&V/Test Plan for model xxxx_nn.
[8]			
[9]			
[10]			

5 PERSONNEL

What personnel have performed the verification activities?

6 TEST AND INSTRUMENTATION EQUIPMENT

What kind of equipment and test resources has been used? Which edition for the software was used? Describe known deviations from normal behavior for the used resources.

7 OTHER TEST RESOURCES

7.1 In-house resources

7.2 External resources

8 MEASUREMENT UNCERTAINTY

See e. g. guiding document for validation in [2] for examples of what to consider.

9 TEST PERFORMED AND RESULTS

Describe the physical test setup and any data transformations done if a comparison with physical test is done. Describe the simulation setup. Give a visualization of the validation results both on specific (with regard to signals, scenarios and working points) and general level in a detailing level sufficient for the model usage. Define and use relevant uncertainty measures.

9.1 Test case 1

10 EVALUATION OF RESULTS

11 DEVIATIONS

Describe known sources of deviations between the physical system and the model. If useful, describe differences and similarities between replaceable subsystems in a modular architecture.

12 RESTRICTIONS AND LIMITATIONS

What will not or cannot be validated and why? How does this affect the test worthiness for the simulator?

13 DATA REDUCTION

How have test data been reduced and stored.

14 NATIONAL AND COMPANY SECURITY CLASSES

State the security classes for all resulting data.

15 CONCLUSIONS AND RECOMMENDATIONS

16 TECHNICAL RESULTS AND 'LESSONS LEARNED'

17 REQUIREMENTS TRACEABILITY

In order to issue test worthiness for a simulator, it is necessary to know if model requirements are validated. To keep track of the performed activities, the following type of table can be used. If applicable, refer also to the requirements traceability in [3]. If DOORS is used to track requirements for the model, the table can be generated from DOORS.

Requirement	**Qualification method**	**Description** Brief description of test outcome or cross-reference to fuller description of test results	**Compliant**
R-001	Test		Yes/no
R-002	Inspection		

18 TERMS AND ABBREVIATIONS

Term	**Description**

APPENDICES

Append relevant test data and other evidence.

Simulation Model Status Declaration

The template name is Status Declaration of Simulation Model. Guidelines and example texts are written with marked italic yellow color. Those texts must be removed or converted to regular text before the plan is issued.

Title of the document should be "Simulation Model Status Declaration for model xxxx_nn".

1 AMENDMENT RECORD

Issue	Definition of change	Affected chapters	Name	Date
1	Original issue	All	name	yyyy-mm-dd
	Short definition of changes in the Status Declaration issue			

2 DOCUMENT PURPOSE

This document is a status declaration for the simulation model Model_variant. Every simulation model included in a model storage is required to be status declared in order to be approved for integration in a simulator. The status declaration is a basis for e.g. test worthiness declaration of development simulators and product declarations for training products where the model is included.

3 IDENTIFICATION

Model data summary table

Info Type	Value
Model name	Model name including variant identification if applicable
Description	Short description of the model
Version/Issue	Version/Issue or release number of the model
Materiel Group	Responsible domain, MG
Represents	What the simulation model represents, part number (if suitable)
Variants	What variants does the model represent (e.g. single/dual seater)
Security class company	Company security classifications
Security class national	National security classifications

Info Type	**Value**
Technical Assistance Agreement	Is there a Technical Assistance Agreement (TAA) related to the model
Inputs	Number of model input signals. Data bus inputs (Yes/No)
Outputs	Number of model output signals. Data bus outputs (Yes/No)
No of model states	Number of true states in the model
No of parameters	Number of model parameters (constant during simulation)
Source format	Model format/language (Modelica, Simulink, ADA, FORTRAN…)
kLoC	Number of kilo Lines of Code. Blank and comment lines excluded
Endianness	Is there any implementation limitation (No / Big-endian / Little-endian)

4 MODEL/SYSTEM OVERVIEW

Include a clear stated purpose of the model

A simple drawing of the model and its main connections ([33])

5 REFERENCES

[1] Saab Aeronautics Handbook for Development of Simulation Models
[2] Simulation Model Requirement Specification
[3] Simulation Model Description
[4] Simulation Model Interface Description
[5] Simulation Model V&V/Test Plan
[6] Simulation Model Verification/Test Report
[7] Simulation Model Validation Report

6 LIMITATIONS AND KNOWN ERRORS/PROBLEMS

State limitations and known errors/problems, if possible with reference to PR, FPA, SPR, bug report or similar.

Does known limitations/errors give any restrictions of usage?

7 MODEL CHARACTERISTICS

For what usage and purpose (which simulation types) was the model built (Saab Aeronautics Handbook for Development of Simulation Models
[22])

What are the assumptions and requirements for the model (Saab Aeronautics Handbook for Development of Simulation Models [22])

Interfaces ([44])

Design description ([33])

Is there known performance constraints?

8 MODEL DEVELOPMENT SUMMARY

Changes since the last version

Other models the actual model may replace

Model development plan (ref.)

9 MODEL VERIFICATION/QUALITY SUMMARY

Model verification ([55],[66]) – does the implementation satisfy the requirements?
Model validation ([5],[7]) – is the model sufficient for its intended use?

Integration test (ref.) – does the implementation work in the intended simulator configuration(s)?

Other checks performed (e.g. inspection, static code check…)

10 IMPLEMENTATION

Implementation specific data e.g. endianness implementation limitation, configuration switches

Source/binary code configuration, if applicable (ref to external model version number for imported models)

Operating systems and environment version information

Real-time dependency – are there any calls to the clock of the operation system?

Are there compilation warnings? If there are, state the compiler settings and the number of warnings

11 TERMS AND ABBREVIATIONS

FPA – Fel- och ProblemAnmälan (problem notification)

MG – Materiel Group
PR – Problem Report
SPR – System Problem Report

APPENDIX B: CHECKLISTS

Simulation Model Requirement Specification

ID	Checklist	Comment	Done
	Front page		
1	Does the meta data include model name, issue and date?		
2	Are the following persons identified for approval of the specification? a. MGA for the CI the model represents		
3	Are the following persons identified for review of the specification? a. Model responsible or reviewer at the MG b. MGAs for the simulators that will use the model alt. the rig responsible c. Integration responsible at department “Support Systems and Simulators” (simulatorcentralen)		
	Scope and References		
4	Is an amendment record provided and updated?		
5	Is the scope of the requirements module identified? I.e. a. Simulation model name b. Related CI		
6	Is there a system overview and a model overview?		
7	Is the usage of the model identified? I.e. a. Simulators b. End users		
8	Does section 4 include all external references in the text?		
9	Do references have correct registration number, issue and date of issue?		
10	Are all assumptions identified and described?		
	Requirements		
11	Does each requirement have a unique requirement identifier?		
12	Is each requirement possible to verify?		
13	Is each requirement unambiguous?		
14	Do all requirements together define the behaviour of the model without conflicts?		
15	Do the requirements cover all higher level requirements and use cases?		
16	Do the requirements cover all of the model storage’s requirements concerning		

	a. Architecture (GC model, Component, Sub system) b. Modes and states (IC-xx, initialize, update,…) c. Interface (input, output, ctrl, monitor)		
17	Are the requirements on control signals enough to cover all simulation of faulty behaviour needed on this model?		
18	Are requirements on the simulation environment identified? I.e. a. Calling frequency b. Computation resources c. Hardware		
19	Are requirements on format of file headers identified?		
20	Are all model interfaces identified?		
	Terms and Appendixes		
21	Are all terms and abbreviations which are used in the document described?		
	Lessons Learned		
22	Update this checklist if needed		

Simulation Model Interface description

ID	Checklist	Comment	Done
	Front page		
1	Does the meta data include model name, issue and date?		
2	Are the following persons identified for review of the interface description? a. Model responsible or reviewer at the MG b. Reviewer at the MGs for interfacing models.		
	Interface Descriptions		
3	Are all interface signals included in the description?		
4	Are all interface signals agreed to by interfacing models' MGs?		
5	Is mandatory data complete for each interface signal?		
6	Are the descriptions detailed enough?		
7	Is all desired optional data complete for each interface signal?		
	Lessons Learned		
8	Update this checklist if needed		

Simulation Model V&V/Test Plan

ID	Checklist	Comment	Done
	Front page		
1	Does the meta data include model name, issue and date?		
2	Are the following persons identified for approval of the plan? a. MGA for the CI the model represents		
3	Are the following persons identified for review of the plan? a. Model responsible or reviewer at the MG b MGAs for the simulators that will use the model alt. the rig responsible c. Integration responsible at department “Support Systems and Simulators” (Simulatorcentralen)		
	Scope and References		
4	Is an amendment record provided and updated?		
5	Is the scope of the description module identified? I.e. a. Simulation model name b. Related CI		
6	Is there a system overview and a model overview?		
7	Does section 4 include all external references in the text?		
8	Do references have correct registration number, issue and date of issue?		
	Methods		
9	Is the qualification method identified for all requirements?		
10	Is it possible to judge whether the used qualification method (including complementary test description) will be sufficient for verification and/or validation for each requirement or not?		
11	Does the described test refer to the use cases?		
	Resource planning		
12	Is necessary type of personnel clearly identified?		
13	Are all needed test resources clearly identified?		
14	Are means for data storing and data security classes identified?		
15			
	Restrictions		
16	Are any restrictions and/or limitations clearly described?		

17	Are any deviations from existing regulations clearly described?		
18	Are applicable safety regulations clearly identified?		
	Terms and Appendixes		
19	Are all terms and abbreviations which are used in the document described?		
	Lessons Learned		
20	Update this checklist if needed		

Simulation Model Description

ID	Checklist	Comment	Done
	Front page		
1	Does the meta data include model name, issue and date?		
2	Are the following persons identified for approval of the description? a. MGA for the CI the model represents		
3	Are the following persons identified for review of the description? a. Model responsible or reviewer at the MG b MGAs for the simulators that will use the model alt. the rig responsible c. Integration responsible at department "Support Systems and Simulators" (Simulatorcentralen)		
	Scope and References		
4	Is an amendment record provided and updated?		
5	Is the scope of the description module identified? I.e. a. Simulation model name b. Related CI		
6	Is there a system overview and a model overview?		
7	Does section 4 include all external references in the text?		
8	Do references have correct registration number, issue and date of issue?		
9	Are all assumptions identified and described?		
	Architectural Design		
10	Are all submodels of the model identified and described?		
11	Are all external interfaces identified, and are they connected to the submodels?		
12	Are interfaces between submodels identified and described?		
13	Are the design concepts described in detail for each applicable subject?		
14	Does the design for testability conform to the V&V plan and use cases?		
15	Do the design decisions conform to the design concepts?		
16	Does every major design decision have a unique identifyer?		
19	Is the source code file structure described?		
20	Is the architecture compatible with the requirements on the model?		
	Functional and Submodel Design		

21	Are the role of the sub models described for each functional design?		
22	Is the typical interaction between submodels described for each function?		
23	Does the design make it possible to simulate all of the required fault injections?		
24	Do the model cover all system functional requirements which have been allocated to the model?		
	Requirements Traceability		
25	Are all design decisions included in the requirements traceability table, if applicable?		
	Terms and Appendixes		
26	Are all terms and abbreviations which are used in the document described?		
	Lessons Learned		
27	Update this checklist if needed		

Simulation Model Verification/Test Report

ID	Checklist	Comment	Done
	Front page		
1	Does the meta data include model name, issue and date?		
2	Are the following persons identified for approval of the report? a. MGA for the CI the model represents		
3	Are the following persons identified for review of the report? a. Model responsible or reviewer at the MG b MGAs for the simulators that will use the model alt. the rig responsible c. Integration responsible at department “Support Systems and Simulators” (Simulatorcentralen)		
	Scope and References		
4	Is an amendment record provided and updated?		
5	Is the scope of the description module identified? I.e. a. Simulation model name b. Related CI		
6	Is there a system overview and a model overview?		
7	Does section 4 include all external references in the text?		
8	Do references have correct registration number, issue and date of issue?		
	Requirements Traceability		
9	Is it clear which model requirements are verified by the evidence identified in this report?		
10	Is it possible to judge whether the used qualification method, including complementary test description, is sufficient for verification for each requirement or not?		
11	Does the described test design refer to the use cases?		
	Resource usage		
12	Does the involved personnel have sufficient qualifications for the performed test activities?		
13	Are all used test resources clearly identified?		
14	Are means for data storing and data security classes identified?		
	Uncertainty and deviations		
15	Are sources for measurement uncertainty and simulation uncertainty identified and valued?		
16	Are any deviations between the physical system and the model sufficiently well described?		
	Terms and Appendixes		

17	Are all terms and abbreviations which are used in the document described?		
	Lessons Learned		
18	Update this checklist if needed		

Simulation Model Validation Report

ID	Checklist	Comment	Done
	Front page		
1	Does the meta data include model name, issue and date?		
2	Are the following persons identified for approval of the dreport? a. MGA for the CI the model represents		
3	Are the following persons identified for review of the report? a. Model responsible or reviewer at the MG b MGAs for the simulators that will use the model alt. the rig responsible c. Integration responsible at department “Support Systems and Simulators” (Simulatorcentralen)		
	Scope and References		
4	Is an amendment record provided and updated?		
5	Is the scope of the description module identified? I.e. a. Simulation model name b. Related CI		
6	Is there a system overview and a model overview?		
7	Does section 4 include all external references in the text?		
8	Do references have correct registration number, issue and date of issue?		
	Requirements Traceability		
9	Is it clear what model requirements are validated by the evidence identified in this report? E. g. requirements derived from use cases will be validated if the use case can be run.		
10	Is it clear what model accuracy and/or signal quality requirements are verified due to the validation activities reported?		
11	Is it possible to judge whether the used qualification method, including complementary test description, is sufficient for validation for each requirement or not?		
12	Does the described test design refer to the use cases?		
	Resource usage		
13	Does the involved personnel have sufficient qualifications for the performed test activities?		
14	Are all used test resources clearly identified?		
15	Are means for data storing and data security classes identified?		
	Uncertainty and deviations		

16	Are sources for measurement uncertainty and simulation uncertainty identified and valued?		
17	Are any deviations between the physical system and the model sufficiently well described?		
	Terms and Appendixes		
18	Are all terms and abbreviations which are used in the document described?		
	Lessons Learned		
19	Update this checklist if needed		

Simulation Model Status Declaration

In this version of the handbook, there is no checklist available for the Simulation Model Status Declaration.