VOLVO

Key Elements Procedure 3
Production and Engineering

LIST OF CONTENTS

1 FOREWORD

This booklet describes the requirements concerning the Production and Engineering activities as indicated within the 'Key Elements for a Volvo Group Supplier'.

Link to 'key elements for a Volvo Group supplier':

http://www.volvo.com/Suppliers/global/en-gb/supplierselection/ourrequirements/

The aim of this document is to describe, in a summarised form:

- the technical (engineering) documents for parts used within the Volvo companies.
- the Quality Assurance process to be developed at product development
- the procedures related to examination and assessment of manufacturing process (process audit) as well as the evaluation of finished Product (product audit)

2 TECHNICAL DOCUMENTATION AND TECHNOLOGY / METHODS

It is of fundamental importance to Volvo that the supplier has full knowledge of the contents and structure of Volvo's technical documentation. Volvo's quality system requirements also present demands that should be fulfilled see Key Element Procedure 2 Quality Requirements.

In the text reference is made in several places to Volvo's corporate standards. The references stated are, for example, STD XXXX,yyy and STD XXX-YYYY. Those standards are available on internet. The address to Volvo Corporate Standards' website is:

http://www.tech.volvo.se/standard/eng/

You can also subscribe to Volvo Corporate Standards' newsletter and thereby get information on new standards and updates by adding your e-mail address on the newsletter subscription page. It is recommended that all users of standards at your company subscribe to this newsletter. The newsletter subscription page is found on:

http://www.tech.volvo.se/standard/eng/subscribe.html

2.1 Design Engineering Documentation

The technical product documentation is the output of the design engineering work. This information is communicated to internal customers, suppliers and production units. The complete technical documentation describes the requirements made with regard to an individual part or a system of parts. The different types of documents that can appear are described briefly in this chapter.

The documentation is structured as follows:

- **Principal document**
  Within Volvo the drawing is no longer the principal document for a part or a system and does not provide all necessary requirements. Instead a **part centric view on product documentation** has been adopted. This implies that the part itself is the carrier of all information that is requisite for a complete definition of its properties. By entering the "part's homepage" in the applicable PDM system, links to defining documents stated as primary references are provided along with other primary attributes, e.g. the material and the surface treatment of a part.

  To communicate this important information to those who need it but who cannot access Volvo's PDM systems, a printed extract of the "part's homepage", called Part Version Report (PVR) is used. Only requirements specified as part attributes (material, surface treatment) or given in documents stated as Primary Document references are valid for the manufacturing of a part along with any additional requirements included in the purchasing agreement.
  In communication with parties that cannot access Volvo's PDM systems, the **Part Version Report (PVR)** is considered the **Principal Document** for a part.

- **Primary documents**
  A primary document is a product-defining document that specifies requirements, which a manufactured part shall comply with. These documents are considered as legally binding in agreements between Volvo and a supplier.

  Examples:

Primary Drawings:	The generally used drawing form within Volvo is described in standard STD 910-0001 – *Corporate forms for industrial documents.* Some drawing types are: *Single-part drawing* Drawing which shows a part and specifies its property requirements. *Multi-part drawing* Drawing which shows several similar parts, varying in size or in other characteristics *Assembly drawing* Drawing which shows the parts included in an assembly part *Supplier drawing* Drawing of a supplier part where an external supplier is responsible for the design, documentation and maintenance of the part, and which through a Volvo internal procedure has been pasted onto a Volvo drawing sheet. Agreed additional Volvo requirements may be specified on the resulting Volvo drawing, outside the borders of the supplier document. The procedures for these documents are given in STD 910-0005 – *Supplier parts and supplier documents.*
Digital Shape Model Basis (DSM Basis)	*DSM Basis* 3-D digital model that defines the shape of part. Together with other primary documents it makes up a complete definition of the part. Standard STD 101-0001 – *Digital Shape Model basis – DSM basis*, lays down the rules for interpreting a combination of part drawings and DSMs, e.g. when a dimension is given by the model while applicable tolerances are stated on the drawing.
Primary Technotes	*Technotes* A technote is a text and image-based design-engineering document that is created by means of word-processing technique. The most commonly used type of technote is the *Technical Requirements – TR (*previously called *Technical Regulation - TR)* *Technical Requirements (TR)* Technote which specifies requirements for one specific part or for a group of parts with equal characteristics. This document type should contain product requirements and, when appropriate, information needed for verification of these requirements.

Master Sample	*Master Sample* an object that concretely shows and establishes a particular requirement for the purpose of inspecting other objects. A master sample lays down property requirements on the grain, pattern, colour and gloss of a surface. However, a master sample does not establish requirements on shape, size, thickness or similar.
Standards	Volvo Group standards cover different technical areas. Some standards are directly given as primary attributes to the part, e.g. standards specifying the material and surface treatment to be used. Other standards are referred to from the primary documents, e.g. the part drawing and they provide prerequisites for an unambiguous interpretation of the document or may also stipulate various kinds of standardized requirements to be complied with. Volvo standards are based on applicable international standards. Only in exceptional cases, when no international standards exist, unique Volvo standards are created. **IMPORTANT**! When there is a reference to a standard, the standard is valid. Some standards have been labelled "Not for new design", but also these are valid if referred to.

- **Supplementary documents**
  A supplementary document is a product descriptive document that provides additional information regarding a part but is not needed for manufacturing or verification. These documents, which may be drawings, digital 3-D models or technotes, are usually not distributed to a manufacturer. Supplementary documents may constitute the basis for the requirements expressed in the primary documents.

- **Technical control documents**
  Document that control the production of parts and the introduction of changes to documents, parts and products may occur under different names within the different Business Areas and Business Units of the Volvo Group, e.g. Design Change Notice (DCN) and Engineering Change Notice (ECN). The purpose of the document is to give a notification to concerned parties (purchasing, manufacturing etc) to start up needed activities

2.2 Technology / Methods

The purpose of this chapter is to state the technology and methods used within Volvo for the production and management of technical documentation.

- **CAD / CAM / CAE : Computer Aided Design / Manufacturing / Engineering**

  Modern CAD/CAM/CAE technology is a prerequisite for integrated product development and high interactivity between the parties involved (concurrent engineering).

- **Communication of Technical documentation**

  More and more documents are being produced and managed (in digital form) by using computer systems. Methods/technology and routines for the exchange of this type of information is a necessity. It must also be possible to transfer documents in forms other than digital.

  The method of exchanging data must be tested carefully before it is introduced.

  More extensive collaboration, however, requires a totally different form of integration. This integration requires, for example, direct access to each other's databases, maybe even the same type of CAD system, etc. Exchange of digital information requires a well-controlled format standard. Examples of standards for the exchange of digital documents are, IGES, VDAFS, TIFF, POSTSCRIPT, PDF (ACROBAT), etc.

  Make an agreement with your contact person at Volvo what and how documents will be exchanged (Waft, Exter system…). A basic agreement must contain information about:
  - CAD model data format(e.g. STEP or/and IGES etc)
  - CAD model media (e.g. CD, EXTER etc)
  - Complexity of CAD model (e.g. No radius less than 20 mm etc)
  - Purpose with the CAD model (e.g. DSM, pack model etc)
  - Drawing exchange media (e.g. paper drawings and DHL etc)
  - Drawing exchange format (tif, cals, dxf, paper etc)
  - Contact persons at Volvo (Design department number and name of person)
  - Tests procedures to check if exchange system is working

  The demands are different from company to company and from case to case.

- **Quality Assurance - Document Control**

  Please see the file **Key Element Procedure 2 - Quality requirements**

- **PDM**

  PDM is an abbreviation of Product Data Management.

  PDM is a framework for integrated product development with flexibility, adaptability and openness.

  The term PDM for documents refers to systems and routines established to ensure order among products and product-related documents. Components and document structures are also included. Case handling, the release process, security, availability and access are other important aspects.

3 QUALITY ASSURANCE AT PRODUCT DEVELOPMENT

Quality Assurance in product development comprises, in principle, the following three categories of components purchased by Volvo:

- *New products* which are unique to Volvo, products for which development and engineering are undertaken by the supplier solely on behalf of Volvo. Those products can be also a Group of products which represent a complete function or system.
- *Existing products* whose design is adapted by the supplier to suit the particular requirements and wishes of Volvo.
- *Existing products* (off the shelf).

The Quality Assurance process should encompass activities ranging from the supplier's proposals to system or component solutions onto Volvo's product approval which is based on prototypes, testing and technical product descriptions and specifications as agreed.

This document deals mainly with new products and, where applicable, products whose design is adapted by the supplier.

3.1 The supplier's organization and routines

The supplier's company management should ensure by means of efficient organisation and work routines, that the development project assigned by Volvo progresses according to the established and agreed timetable (time plans and flow charts with check lists).

Development projects are to be handled by qualified personnel with documented authorisation and resources.

Routines should be established for the control of the development effort, co-ordination of sub-contractor's participation, documentation of the current stage of development and the infrastructure required to deal with the day-to-day changes during the product engineering phase.

Documented routines (work guidelines) should be drawn up for regular internal design review meetings and for those meetings which are co-ordinated with Volvo's representatives. Customer and field experience and other experience from similar products should be examined at these meetings. Co-operation between the supplier and Volvo should be structured to permit matching of activities in design review meetings to Volvo's various engineering phases in development and engineering project.

All those requirements are part of AIAG APQP (Automotive Industry Action Group Advance Product and Quality Planning) and ISO TS 16949 routines.

Volvo's is expecting from their suppliers to apply ISO TS 16949 and Volvo's APQP requirements. Volvo's APQP is AIAG APQP + additional Volvo's requirements.
There are described in Key Element Procedure 2 - Quality Requirements

3.2 Requirement Specification

Volvo will supply the engineering parameters in a functional requirement specification or corresponding technical documents, which normally contain:

- *Product description.*
- *Geometrical requirements*
- *Design models*
- *Packaging models*
- *Drawings with different requirements*
- *Reliability requirements.*
- *Product application, environment and other operational conditions.*
- *Installation parameters (available space etc.).*
- *Property requirements, often classified according to critical characteristics (material, function, electrical and mechanical requirements). Critical characteristics definition are described in the Volvo's standard No. 105-0001, "Critical characteristics of design products".*
- *Tests, test methods and verification requirements.*

Prototypes have to be produced in agreed quantities. They have to be produced using a process which is representative of the serial production manufacturing process.

The supplier shall be active in testing- and development work.

3.3 Joint Development Partners

Based on the above requirement specification, Volvo appoints a partner who meets the conditions indicated in section 3.1, with regard to organisation and routines. After this, an agreement defining the scope of the assignment is signed. This can be done in a Development agreement, which may contain target price, confidentiality etc.

As described in section 3.1, it's important that both the supplier and Volvo share their routines of tests validation of the product. It will ensure that the product will meet the specifications with a relevant number of tests.

3.4 Project Groups and Project Plans

The supplier is to establish a project group of suitable size, headed by a development manager as well as contact persons (for technical documentation, tools and samples). The project group, which should represent all the parties relevant to the project, should meet at predetermined intervals with a reference group or representatives from Volvo, to assess, among other things, the current stage of development. A project plan, in which key events relevant to Volvo and the supplier are identified, should be created by the supplier.

The involvement of the supplier in prototype builds at Volvo and subsequent verification, if required, should be agreed upon at the same time as the project plan is established. Lead times and the consequences of changes should also be firmly identified, evaluated and agreed upon.

The workload and need of resources due to the Volvo's needs in quantity of prototypes has to be assessed in order to avoid any issues or delays during the development phase.

3.5 Design Proposals

The supplier is responsible for ensuring that preliminary system and component proposals are presented to Volvo. These proposals should be based on the requirements indicated above and on function analyses. Particular concern should be given to the documentation of critical properties, i.e. properties which have an important impact on the requirements stipulated by Volvo, legal authorities etc. Volvo's principle for critical characteristics should be applied for identification of the relative significance of various characteristics in the event of failure. There should be a plan to contend with these eventualities.

Failure risk analyses of the proposed engineering solutions should be carried out as a basis for evaluation of the various engineering proposals versus Volvo's requirements specifications.

3.6 Reliability

Reliability requirements are usually based on the complete vehicle (end product), and are then broken down into the sub-systems and components.

Reliability work demands the application of modern statistical methods for analyses and testing, as well as formal, systematic design and production reviews, in which the products and processes are carefully studied, taking into account failure potentials, etc.

3.6.1 Reliability analyses

Reliability analyses conducted during the development phase have a twofold purpose:

- to prevent the occurrence of failures and sources of failures while at the same time giving priority to remedies for conceivable failures or sources of failures
- to serve as a means of evaluating the finished product's compliance with the stipulated requirements.

Field Failure prediction
The supplier shall perform estimations of failure frequencies, which take into account operating and environmental conditions. This means that complete operating sub-systems including all functions and components linked to the component must be taken into account and with consideration to extreme operating conditions (worst case).

Field feedback on failures
A rapid system of feedback must be implemented, and it must be designed to ensure that no information is excluded, i.e. individual faults, minor faults and failure tendencies must also be included.

Programme for counter-measures
Based on the failure-frequency estimates, market analyses and failure mode and effect analyses performed, programmes of corrective measures shall be created and implemented to ensure that the level of reliability continues to increase.
Such programme of corrective measures shall also be used as a base for design agreements and tests.

3.6.2 Reliability verification

Verification should be based on the established test programme and should for example include:

- function tests
- service life tests
- climate tests
- electrical and mechanical tests

Planning of the test programme should take particular account of the scope of the tests, their sequence and the effects of various test combinations. The results of these tests must be fed back to the development effort so that the reliability can be assured.

For practical reasons, reliability tests can be performed only to a limited extent. It is therefore important that modern statistical methods are used in planning and evaluation.

3.7 Quality Tools in Development

It is imperative that Volvo's partners have an adequate education in modern test planning and that they apply the following methods/tools systematically:

- D-FMEA: Design Failure Mode and Effects Analysis
- DOE: Design Of Experiments (factorial tests, Taguchi-experiments)
- Functional analysis
- DFM: Design For Manufacturing
- DFA: Design For Assembly

This list is not exhaustive. Two others tools have to be shared with Volvo in the frame of the Volvo's APQP (refer to PQP2):

- RTS: Review of Technical Specifications
- PAA: Part Application Approval

3.8 Result of Product Development

The result from the product development is to be delivered for approval within the agreed time limit. This documentation normally includes:

- Technical documentation (which is classified in critical characteristics where appropriate)
- Failure analyses
- D-FMEA conclusions
- Test results
- Test programme for running production
- Manufacturing instructions which may be necessary
- Any assembly instructions which may be necessary
- Prototypes or samples as agreed

No changes may be made to the technical documentation without prior approval from Volvo. All changes are to be documented carefully and any consequences charted with great attention to accuracy (effects on lead times, other products etc.).