Engineering Process for Electrical system

I. Document revision

Document version	***Modifications***	***Date***	***Modifications done by***
V1.0	Document creation	2021-12-13	L.Schmerber

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II. Reference documents

[R0]	ISO-29110 5-6-2: Systems and software engineering – Lifecycle profiles for very small entities – 2014

III. List of acronyms

SA	System Architect
PM	Project Manager
IVV	Integration, Verification, Validation

IV. Introduction

The goal of this documentation is to propose a guide to ensure the good behaviour of electrical system development projects. Based on the standard [R0], it proposes a set of minimal phases, milestones, and documentations to support any developments.

V. Main process description

The following figure 1 presents the main process diagrams divided in 5 phases, 5 gates and 12 milestones meetings.

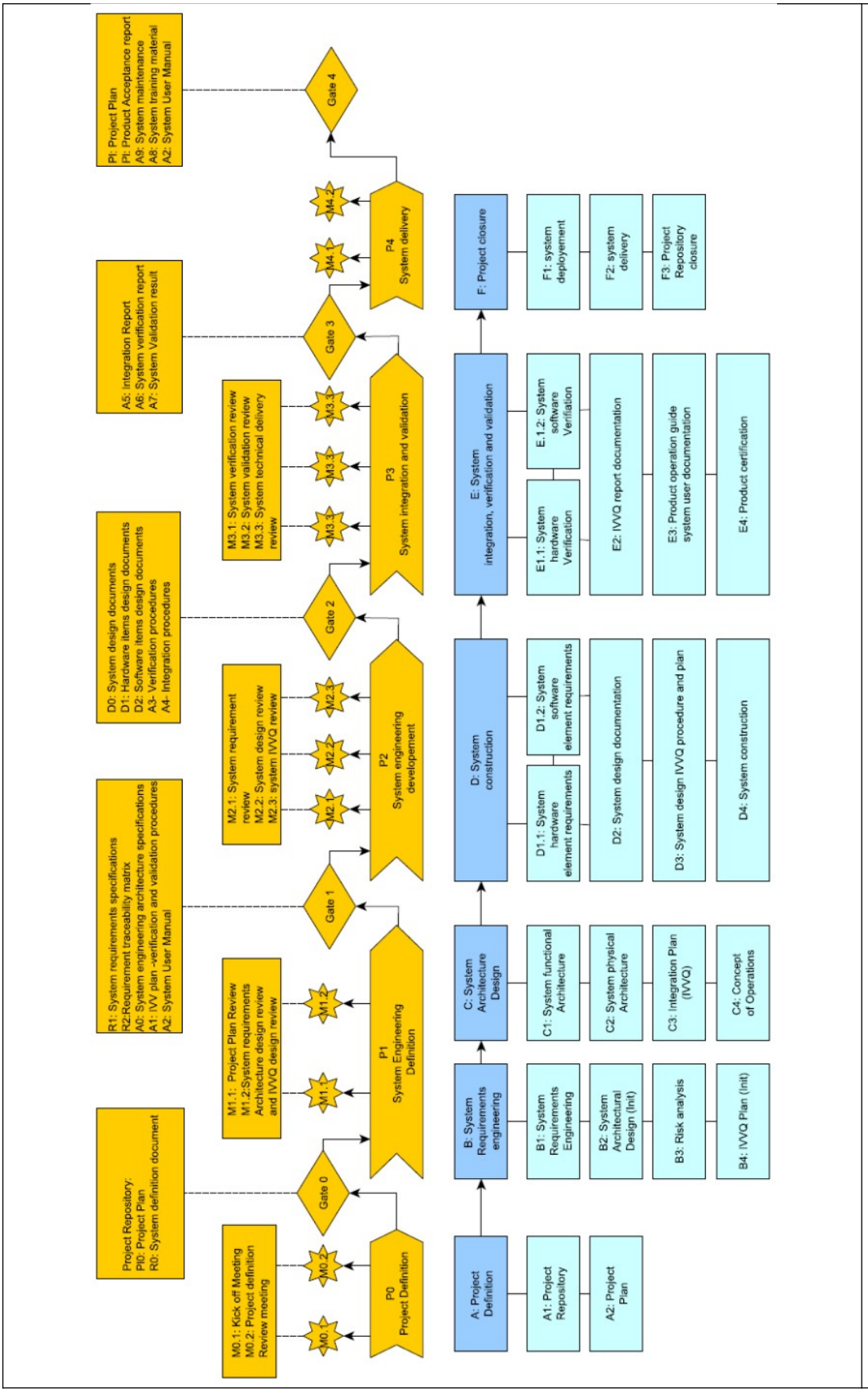

Figure 1: Engineering process – Main view

A. Phases description

Phase #	***Description***	***Objectives***	***Deliverables***
Phase 0 (P0)	Project description Phase: Define and commit with the client on what is the system requirements, the deliverables and timeline.	Definition of the project scope, system requirements, actors, timeline, and deliverables. Have commitment from the client.	R0 and Pl0 (see deliverables description)
Phase 1 (P1)	System engineering definition: Define the system architecture interfaces between sub systems, system functional analysis, sub system requirements. Perform a risk analysis and propose a IVVQ plan to validate the system.	Propose an architecture with definition engineering requirements for each sub system and functional + risk analysis (must be justified/documented with predictive calculation or existing results). This phase is considered as an answer to the client requirement and is submitted to client acceptance. Goal is to define what is proposed based on the client requirements and measure the gaps and commits.	A0, A1, A2, R1, R2 – R0 and Pl0 updated
Phase 2 (P2)	System engineering development: Review the system requirements and the design target for the hardware and software design level, ensure the coherence with the system architecture. Design the hardware, software and document them. Update the IVVQ with details coming from the design. Complete the IVVQ with simulation or calculation that prove the level that will be reached.	Ensure that the design is properly done with respect to the system requirements and the architecture. Produce system design architecture with detailed interfaces (D0). Produce the hardware and software design documentations D1 and D2. At last, produce the verification and integration procedures.	D0-D1-D2-A3-A4
Phase 3			
Phase 4			

B. Gates description

Gate #	***Description***	***Objectives***
Gate 0	Gate 0 is passed when the requirement document R is accepted at R0 level. The Project plan is at level Pl0. And these two documents have been presented and approved in meeting M0.2 – minute meeting must be present end prove the R0-Pl0 acceptation by the client. The two documents must be signed by the client. If not possible, then acceptation must be explicitly given by email.	The objectives of this gate is to have a preliminary project plan, including all the needed resources and clear client requirements define in R document as R0. Gate cannot be passed without proof of approvement from the client for both Pl0 and R0. R0 will serve as basis for Architecture and document A0-A1-A2, requirement specifications R1 and R2.
Gate 1	Gate 1 is passed when the requirement documents R1 and R2 are available with proposed architecture, functional analysis and risk analysis (safety concept must be defined). Architecture documentation A0,A1 and A2 must be also presented and accepted by the client and Pl0 is updated with respect to the first design architecture.	The objectives of this gate is to give an update of the requirement, the architecture of the system with interfaces, the first validation plan and the requirement traceability matrix R2 that will serve to evaluate the distance to the system requirements. All this document must be presented to the client during milestone M1.2
Gate 2		
Gate 3		
Gate 4		

C. Process phases description

1. Project phase (P0):

The objectives and gate descriptions following this phase are given in the previous tables (see section A and B). Complementary details are presented in the figure 2.

They give the following points:

- The owner is mainly the project manager
- 3 key meetings are expected M0.1, M0.2A and M0.2B
- Two main tasks are done: System definition and Project Planning

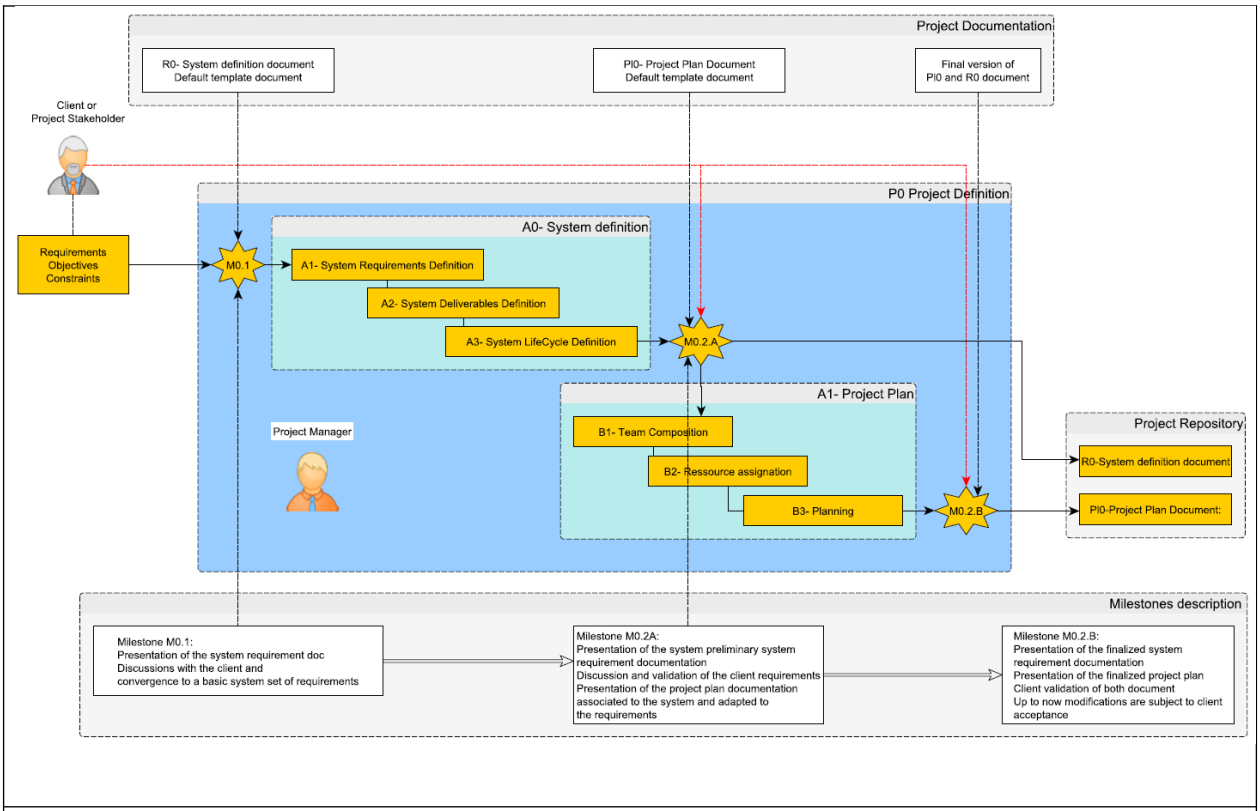

Figure 2: *Phase 0 detailed diagram with tasks decomposition, owners and associated documentation*

2. System engineering definition (P1):

The objectives and gate descriptions following this phase are given in the previous tables (see section A and B). Complementary details are presented in the figure 3.

They give the following points:

- The owner is mainly the system Architect
- 2 key meetings are expected M1.1, M1.2.
- M1.1 is an internal meeting between system architect and project manager to visit the requirement contained in R0.
- M1.2 is a meeting to present the system architecture to the client and the requirement traceability matrix R2 for acceptation
- Two main tasks are done: System Architecture – Quality plan and requirements traceability

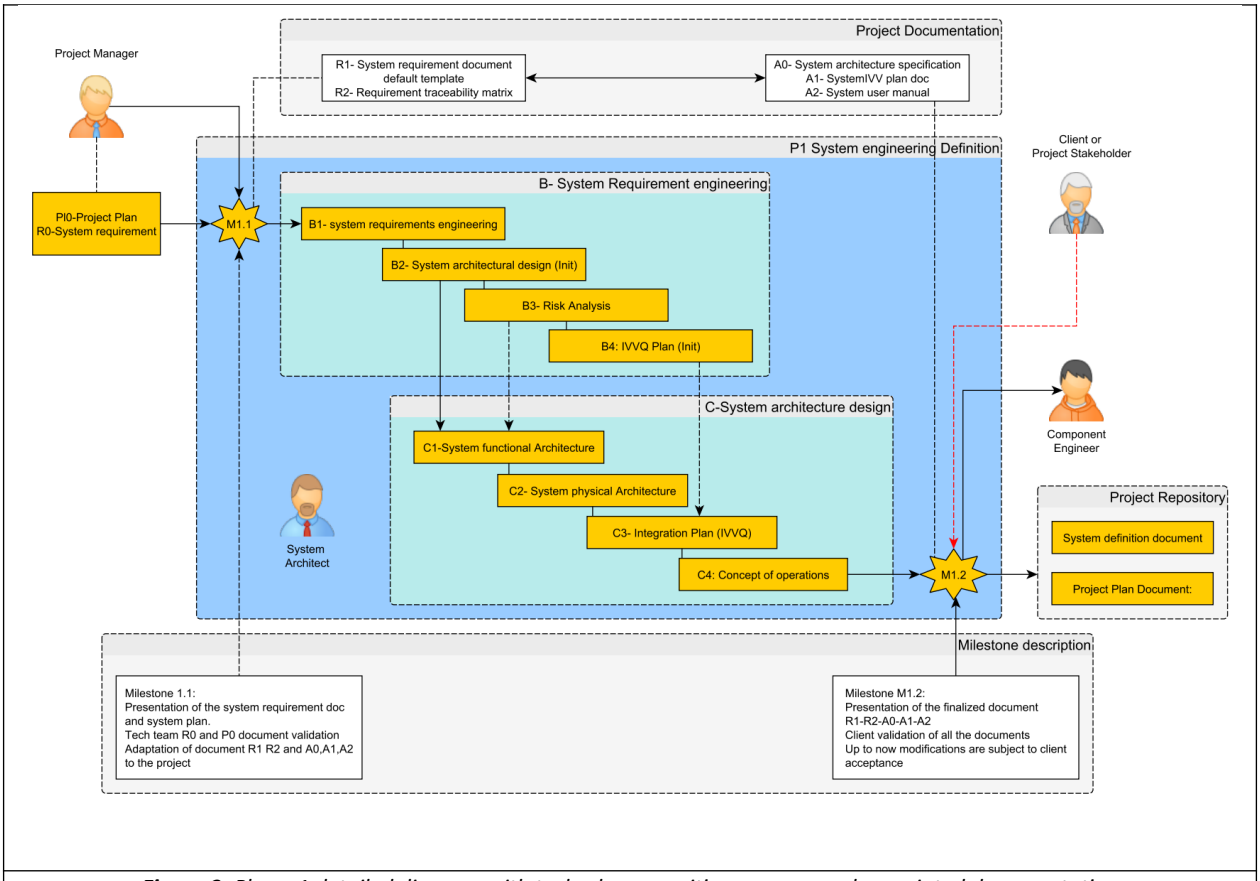

Figure 3: *Phase 1 detailed diagram with tasks decomposition, owners and associated documentation*

3. System engineering development (P2)

The objectives and gate descriptions following this phase are given in the previous tables (see section A and B). Complementary details are presented in the figure 4.

They give the following points:

- The owner is mainly the design engineers- engineering team under the supervision of the System architect
- 3 key meetings are expected M2.1, M2.2 and M2.3
- M2.1 is an internal meeting between system architect and engineering team to visit the requirements documents from phase P1 (R0-R1-R2) and architecture documents (A0-A1-A2). At that stage the interface between hardware and software must be clearly defined.
- M2.2 is a meeting following the hardware and software design and start the redaction of the common design documentation (D0). At this meeting the test/integration procedures must be defined to start the documentation (A3-A4)
- M2.3 is the last milestone used to present the design and validation documentation to the system architect and project manager. All the points included in the matrix of requirement traceability.

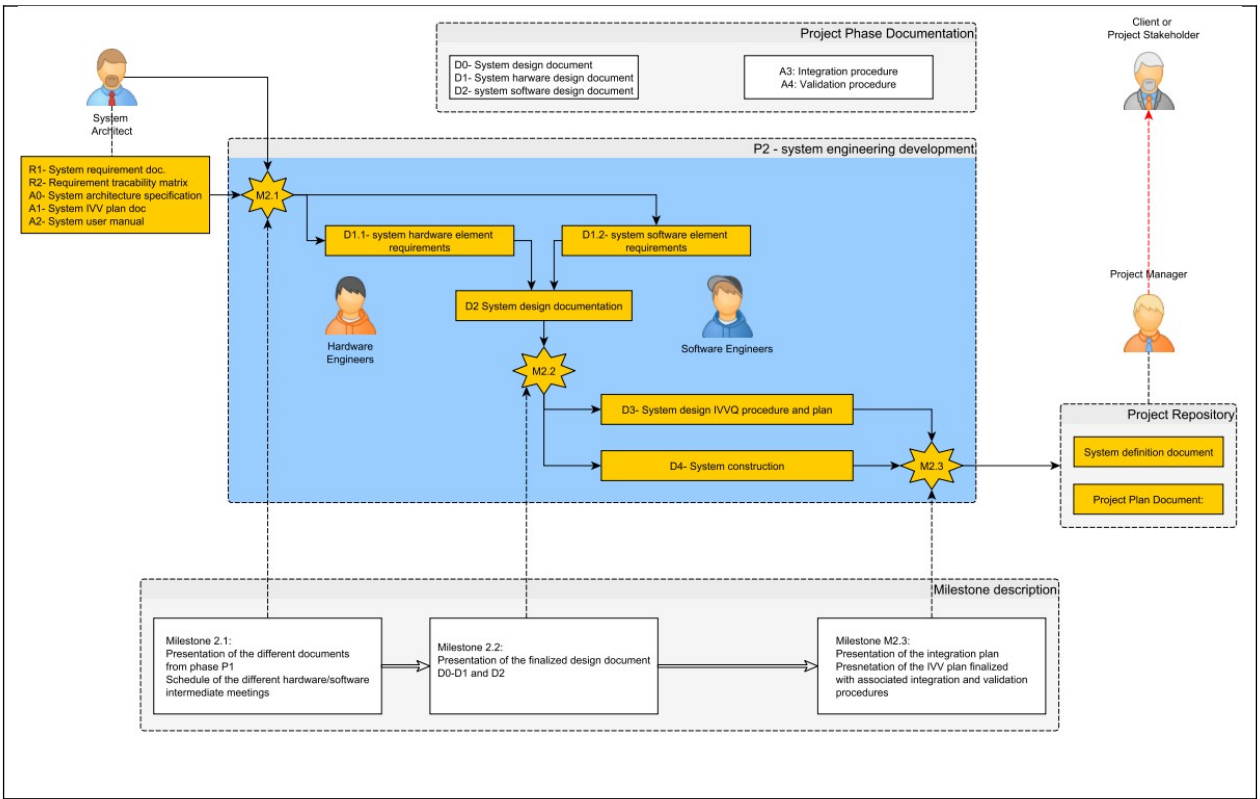

Figure 4: *Phase 2 detailed diagram with tasks decomposition, owners and associated documentation*

4. System integration and validation (P3)
   a) *Objectives*
   Phase description
5. System delivery (P4)
   a) *Objectives*
   b) *Phase description*

VI. List of supporting documents

Doc Name	***Description***	***Creation***	***Owner(s)***	***deliverable***	***Client approval***
R0 (in R)	System definition document. This document must include: 1- A system description 2- A high-level architecture with subsystems definitions and interfaces 3- The requirements definition for the system and for each subsystem 4- Deliverable definition Any modification in this document is submitted to client approval. Client approval are needed at M0.2A to go through the Gate 0.	P0	PM	Yes	Yes (All)
R1 (in R)	System requirement document. This document is an update of R0 at the end of Phase 1. It must include: 1- Every accepted modification of the requirements induced by the Phase 1 analysis. 2- Update of the accepted risk level for every requirement Point 1 and 2 of the documents is updated by/with the client and must be accepted in M1.2 to go through Gate 1.	P1	PM/SA	Yes	Yes
R2 (in a separate document)	Requirement traceability matrix. This document must include: 1- the system requirements 2- the expected/proposed and accepted execution level 3- the measured performance 4- The Procedure and test report reference used to perform the test This document must be accepted with at least points 1,2 at M1.2 and gate 1. The document is a project deliverable, it must be completed for gate 3	P1	PM/SA	Yes	Yes (point 1 and 2 at P1), all the doc at end of P4
Pl0 (in P)	Project Plan Document. This document must include: 1- Role and responsibilities 2- The project timeline (Milestones and Gates) 3- All delivery due date Any modification in this document is submitted to client approval. Needed at M0.2.B and to go through the Gate 0.	P0	PM	Yes	Yes (point 2 and 3)
A0 (in A)	System architecture specification. This	P1	SA	Yes	Yes (All)

	document must include: 1- Proposed architecture description with interface 2- System functional analysis with subsystem involved 3- Risk analysis for each function – mitigation plan 4- Predictive system specifications table with gap to the requirements This document must be proposed as an answer to the client requirement. It must be justified at M1.2 and accepted to go through Gate 1.				
A1(in A)	System IVVQ plan. This document must include: 1- Integration detailed plan 2- Validation detailed plan 3- List of used integration and test procedures 4- List of integration and test reports documents	P1	SA	Yes	Yes (All)
A2(in A)	System user manual. This document must include: 1- Description of system storage 2- Description of system interfaces 3- Description of system use as defined and accepted in P1. The document content is submitted to client approval in M1.2. Needed to go through the Gate 4. Any modification of the document structure is subject to client approval.	P1	SA	Yes	Yes (the document structure in P1)
A3 (in A)	This document must include all the procedures for the verification of the requirements. It completes the document A1 and produce requirements validation needed in R2. The procedures can be presented and must be available to prove that the requirements were reached and measures were done properly	P2	SA/Design engineers	Yes on request only	No, but must be used for R2 document requirements validation
A4 (in A)	This document must include all the procedures to ensure that the system and the different subsystems are integrated and tested in a proper order/way. Integration tests and procedure must be included. It is an internal document under the supervision of the SA	P2	SA/Design engineers	No	No, but must be used to ensure that every point in the integration is made from lower components to system
D0 (in D)	The system engineering design documentation must include all the system level design details It is an internal document under the supervision of the engineering team and SA	P2	Design Engineers+ SA	N0	No, but must be used for R2 document requirements justification
D1 (in D)	The system hardware design documentation must at least include all the design points relative to any requirement as it can be used to validate the design of the system. It is an internal document under the supervision of the engineering team	P2	Design Engineers	No	No, but must be used for R2 document requirements justification
D2 (in D)	The system software design documentation must at least include all the design points/calculation/simulation relative to any	P2	Design Engineers	No	No, but must be used for R2 document

	requirement as it can be used to validate the design of the system. It is an internal document under the supervision of the engineering team				requirements justification