Work Package 2 Target Systems detailed design, installation, testing and manufacturing requirements for the target wheel, drive and shaft

Review

	Name	Role/Title
Owner	Sjögreen, Kristoffer	Work unit leader - Target Wheel, Drive and Shaft
Reviewer	Cecilia Lowe	Quality Officer
	Fernando Sordo	ESS Bilbao Target division manager
Approver	Ulf Oden	Lead engineer - Target Systems

DOCUMENT REVISION HISTORY

Revision	Reason for and description of change	Author	Date
1.0	First issue	Kristoffer Sjögreen	2016-05-26

Review

TABLE OF CONTENTS

Review

Review

1. INTRODUCTION

1.1 Background

This document provides the detailed mechanical design, manufacturing and installation requirements for the Target Wheel, Drive and Shaft, part of Target Systems within the Target Station project at the ESS.

According to Swedish Radiation Safety Authority (SSM) document "Specific Requirements for the ESS Facility in Lund" [2], each mechanical component shall have a specific safety and quality classification. This gives the design requirements and quality assurance measures for the design, manufacture and installation as well as repair of components intended for use in the facility.

The procedure for defining the classifications shall follow the guideline in [4]. The design and construction rules for mechanical components are consistent with the RCC-MRx 2012 Edition, Addenda 2013 [6] code.

1.2 Purpose and use of this document

The main purpose of this document is to set detail design, testing and manufacturing requirements in order to comply with the regulatory requirements.

1.3 Applications

The regulations apply to detail design and manufacturing of mechanical components.

- Drive Unit
- Shaft
- Shroud including beam entrance window
- Cassettes
- Spallation material

1.4 System Requirements and Description

For an overall detailed design description of the system refer to [1] .

Review

1.5 Definitions and Abbreviations

Abbreviation	Definition
AIB	Accredited Inspection Body
ASTM	American Society for Testing and Material
EN	European Norm
ETA	European Technical Approval
ETAG	European Technical Approval Guidelines
$N2_{RX}$	RCC-MRx Class 2 of mechanical components
$N3_{RX}$	RCC-MRx Class 3 of mechanical components
NDT	Non-Destructive Testing
PT	Penetrant testing
QA	Quality Assurance
QC	Quality Control
RCC-MRx	Design and Construction Rules for Mechanical Components of Nuclear Installations
SSM	Strålsäkerhetsmyndigheten (Swedish Radiation Safety Authority)
SWEDAC	Swedish Board for Accreditation and Conformity Assessment
VT	Visual testing
WPS	Welding Procedure Specification
WPQR	Welding Procedure Qualification Record
SDD	System description document

Also refer to ESS Glossary [8].

1.6 Design of mechanical components under regulatory requirements

The requirements for the design of mechanical components that are a part of a safety function and whose failure or malfunction can cause radioactive emissions is described in chapter 5 of the Specific Requirements for the ESS Facility in Lund [2].

Mechanical components has different classifications, which gives design requirements and quality assurance measures applicable for the design, manufacture and installation as well as repair of the component. A classified mechanical component can only be used for the first time when the Certificate of Conformity according to chapter 5, in [2] is approved.

Review

1.7 Classification

The classifications shall follow the document Guideline- Identification and ranking criteria for ESS Safety Functions and Safety Important Components [4].

1.7.1 Safety Classes

Mechanical components can have different safety classes. The quality of mechanical components must correspond to the requirements of the safety related functions.

1.7.2 Mechanical Quality Class

The mechanical components in process systems at ESS have two different quality classes defined in [9].

- MQC2 corresponds to RCC-MRx class $N2_{RX}$
- MQC3 corresponds to RCC-MRx class $N3_{RX}$

GENERAL PROVISION

1.8 Quality Assurance

The entire supply is subjected to generic quality requirements in accordance with SS-EN ISO 9001. In addition, according to RCC-MRx 2012 Edition Addenda 2013 [6], all suppliers exercising any activity that might affect the radiological safety function of a component, must identify and implement the processes of the Management System that meets the requirements of the SS-EN ISO 9000 and SS-EN ISO 9001 standards as stipulated and completed in the paragraphs below:

- **§7.3.5 of SS-EN ISO 9001: design verification**
  Individuals other than those who perform the design tasks shall perform design verification.
- **§7.3.2 and 7.3.3 of SS-EN ISO 9001: document and data control**
  Individuals other than those who established the document or data, before they are distributed shall perform documents and data verification.
- **§7.4.1 of SS-EN ISO 9001: purchasing data**
  Regardless of its position in the supply chain, the Supplier shall take necessary provisions to ensure that any purchasing data they issue contains suitable provision for ensuring that the subcontractor fulfills the client's contractual requirements. All tests and verification results shall be recorded.
- **§7.5.3 of SS-EN ISO 9001: product identification and traceability**
  All documents required by this Design Specification Document or stipulated in the purchase order shall be clearly identified and related unambiguously to the products concerned.

Preview

- **§7.6 of SS-EN ISO 9001: inspection and testing – general**
  Individuals performing inspections required either by this Design Specification Document or the purchase order, shall be different than those performing the activity to be inspected.
- **§8.3 of SS-EN ISO 9001: control of non-conforming product**
  Supplier arrangements regarding the processing of non-conformities shall be in accordance with the requirements of section 1.10 in this Document.

Following information must be documented independently of the defined quality class:

a) Organization chart and senior staff responsible for each part of the execution
b) The applicable procedures, methods and work instructions
c) Inspection plan specific to the design
d) The procedure for handling of changes
e) The procedure for handling deviations, requesting authorization and contradictions in the documents
f) Specified milestones or requirements for witnessing of inspections or tests, and any access requirements

1.9 Accreditation

1.9.1 General

An Accredited Inspection Body according to [2] shall issue a Certificate of Compliance for approved manufacturing and installation for mechanical quality classed components in MQC2 and MQC3.

1.9.2 Requirements for Accredited Inspection Body and Certification Body in the position of third party

The Inspection Body that performs inspection and issues Certificate of Conformance according to requirements in [2], shall be accredited by SWEDAC (or similar national accreditation body) to fulfill Specific Requirements for the ESS-facility in Lund and the requirements in SS-EN ISO/IEC 17011. Accredited Certification Bodies performing services such as certification of quality systems, certification of personnel for joining of material and testing, shall at least fulfil the requirements in SS-EN-ISO/IEC 17021-1/17024.

1.9.3 Requirements for Accredited Laboratories in the position of third party

SWEDAC (or similar national accreditation body) shall accredit testing Laboratories performing prescribed NDT and services at material laboratories in accordance to SS-EN ISO/IEC 17025.

Review

1.10 Non-Conformance Report

Any deviations from this report, or the Equipment Specification shall be documented in a non-conformance report. The content of this report shall provide the following information:

- Identification of the component and technical document concerned
- Description of the non-conformance and comparison with the specified criteria
- The solution adopted by the Manufacturer, - corrective action envisaged

After the review and possible approval of the non-conformance, the purchaser applies for any disposition that may be required by authorities and the Accredited Inspection Body.

1.11 Deviation Report

All deviations shall be processed, corrected and approved before the relevant work operations are finalized.
The Deviation Report allows the non-conformance to be dealt with in accordance with the cases described in section 1.10. In addition to the information provided by the corresponding non-conformance report, the deviation report shall include at least the solution adopted by the supplier.

Review

2. DOCUMENTATION AND DOCUMENTATION REQUIREMENTS

2.1 General requirements

All types of documents shall be written in English.

2.2 Applicable documents

2.2.1 Equipment Specification Documents

The Equipment Specification documents are a set of documents that presents the essential data for a specific equipment or mechanical component.

- Spallation material
- Cassette
- Shroud
- Shaft
- Drive Unit
- Controls and sensors

2.3 Review and Approval Procedure of Documents

The documents must be submitted to ESS for review and approval. As a minimum shall each of the document be reviewed by responsible Work Unit Leader and approved by Work Package Manager.

2.4 Required documentation for Standard Components

Required Documents for Components defined as "from catalogue", i.e. standard components shall have the following documentation prepared:

- **Component Reference File**
  This file completely identifies a component and shall contain not only the component description and nomenclature, but also the procurement, manufacture, control and test conditions for the component.
- **Acceptance test report**
- **Validation File** comprising the test program that includes the target results and the validation test report.
- **The sizing report**, if specified in the purchase order
- **The certificate of compliance** in particular certifying compliance with the Component Reference File.

Review

2.5 Definition and description of required documentation

Requirements defined in chapter 2.5 are applicable both during manufacturing and installation.

2.5.1 Inspection Plan Documents = Follow-up documents

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM Additional requirements Chapter/ section	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 1 Article RDG 3400	See below	-	Yes	Yes

For all design, manufacturing, assembly and testing activities, it shall be possible to demonstrate that the required level of quality has been adequately defined, that the activities have been performed in a satisfactory manner and that the required degree of quality has been reached. Inspection plan documents go through two successive phases:

- **Before/During/After Manufacturing (phase 1)**: In this phase, the Inspection Plan document contains a chronological list of the requirements for contractor, expected design, procurement, manufacturing, examination and testing operations for the component before release to ESS. Documents for this phase has been entirely completed and consigned to the End-of-Design and Manufacturing Report, defined in section 2.5.14.
- **Before/During/After Installation (phase 2)**: In this phase, the Inspection Plan document contains a chronological list of the requirements for contractor for site installation, procurement, installation work, examination and testing operations for the component before installation acceptance. The installation is finalized once the End-of-Installation Report is signed, defined in section 2.5.15. A certificate of Compliance shall be issued by the AIB after approved installation, defined in section 2.5.16.

Every operation must have a space provided to mark the operations of which the Manufacturer must notify the ESS representatives and/or the Surveillance Agent. There are three types of "notification points":

1. **A witness point**. This point is marked with the letter "**W**", and is used to designate an operation that the Surveillance Agent or ESS representatives wishes to be notified about.

Review

2. **A hold point**. This point is marked with a letter "**H**" and is used to designate an operation that the Manufacturer is not allowed to perform or begin without the Surveillance Agent's or ESS permission.
3. **A review point**. For each operation important to ensure that the agreed requirements are fulfilled, a space shall be provided to mark with a letter "**R**" the operations of which the ESS representatives or Surveillance Agent must review.

Other four interventions are "designation points":

1. **Quality Assurance Department Sign-off.** This point is marked with abbreviation "**Q**", and is used to indicate an important checkpoint where the ESS Quality Control Department must sign, in order to proceed further with the project.
2. **Project Manager Sign-off**. This point is marked with letter "**M**", and is used to indicate an important checkpoint where the ESS project manager must sign, in order to proceed further with the project.
3. **Performer**. This point indicates the performer of the task and is marked with letter "**P**" and that the internal review is carried out by appropriate department.
4. **Accredited Laboratory.** This point is marked with letter "**L**", and is used to indicate an important checkpoint where the Accredited Laboratory must perform the testing and then sign, in order to proceed further with the project.

These interventions are applicable for all defined quality classes.

The Inspection Plan documents covering quality control of manufacturing and installation work are described in Figure 1 – Figure 2. The phase before/during/after manufacturing is covered by Inspection Plan sections IP100 - IP400, while phase before/during/after installation is covered by sections IP100, IP200, IP500 and IP600.

Review

2.5.1.1 Inspection Plan IP100-IP400: Before/During Manufacturing

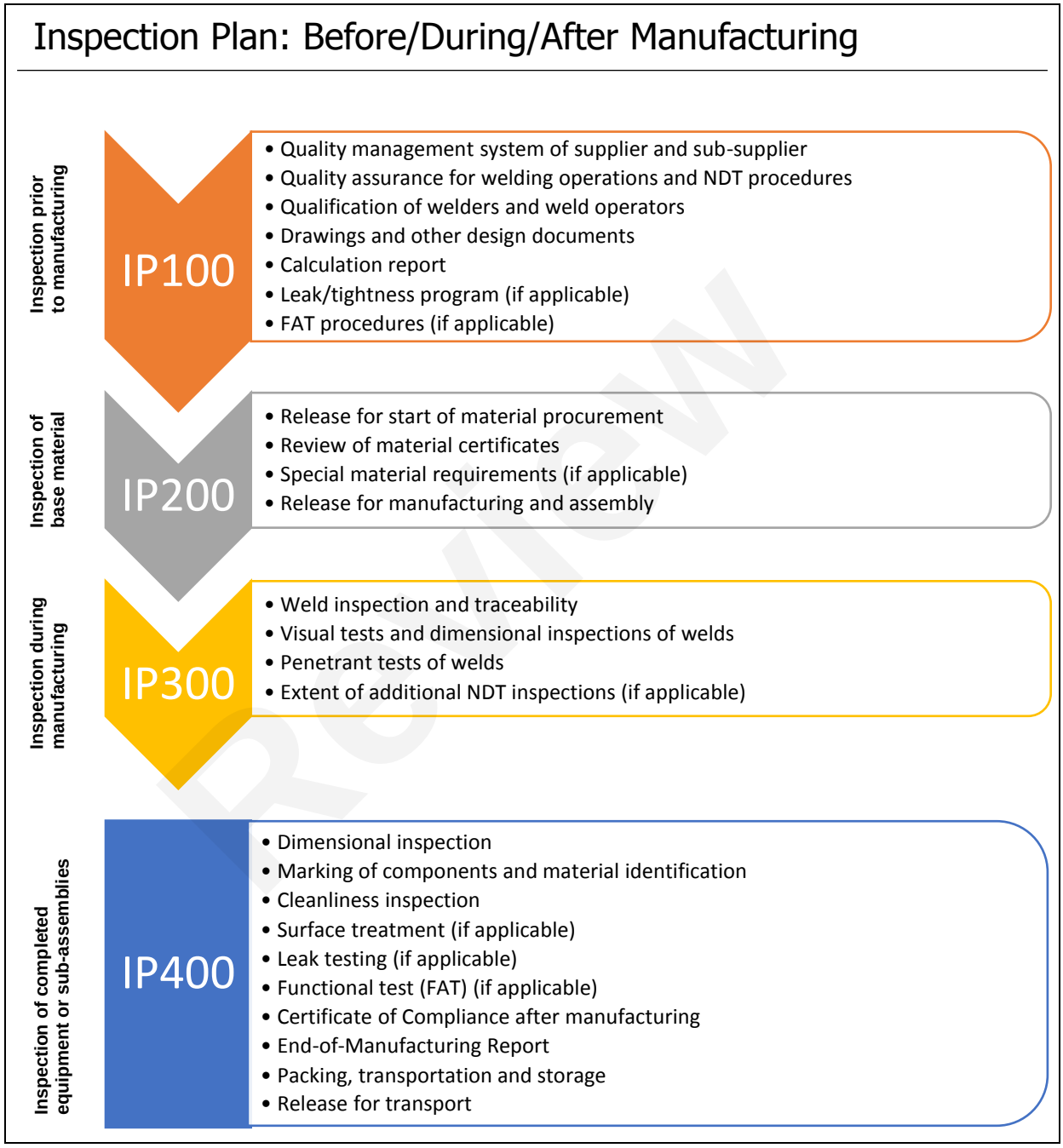

Figure 1 - Inspection Plan before/during/after manufacturing

The Inspection Plan IP100 covers checkpoints in order to ensure the quality of the manufacturers and design documents.

2.5.1.2 Inspection Plan IP100-IP200, IP500-IP600: Before/During/After Installation

The Inspection Plan document applicable for installation phase, covers all the necessary quality control checkpoints for the installation work on site.

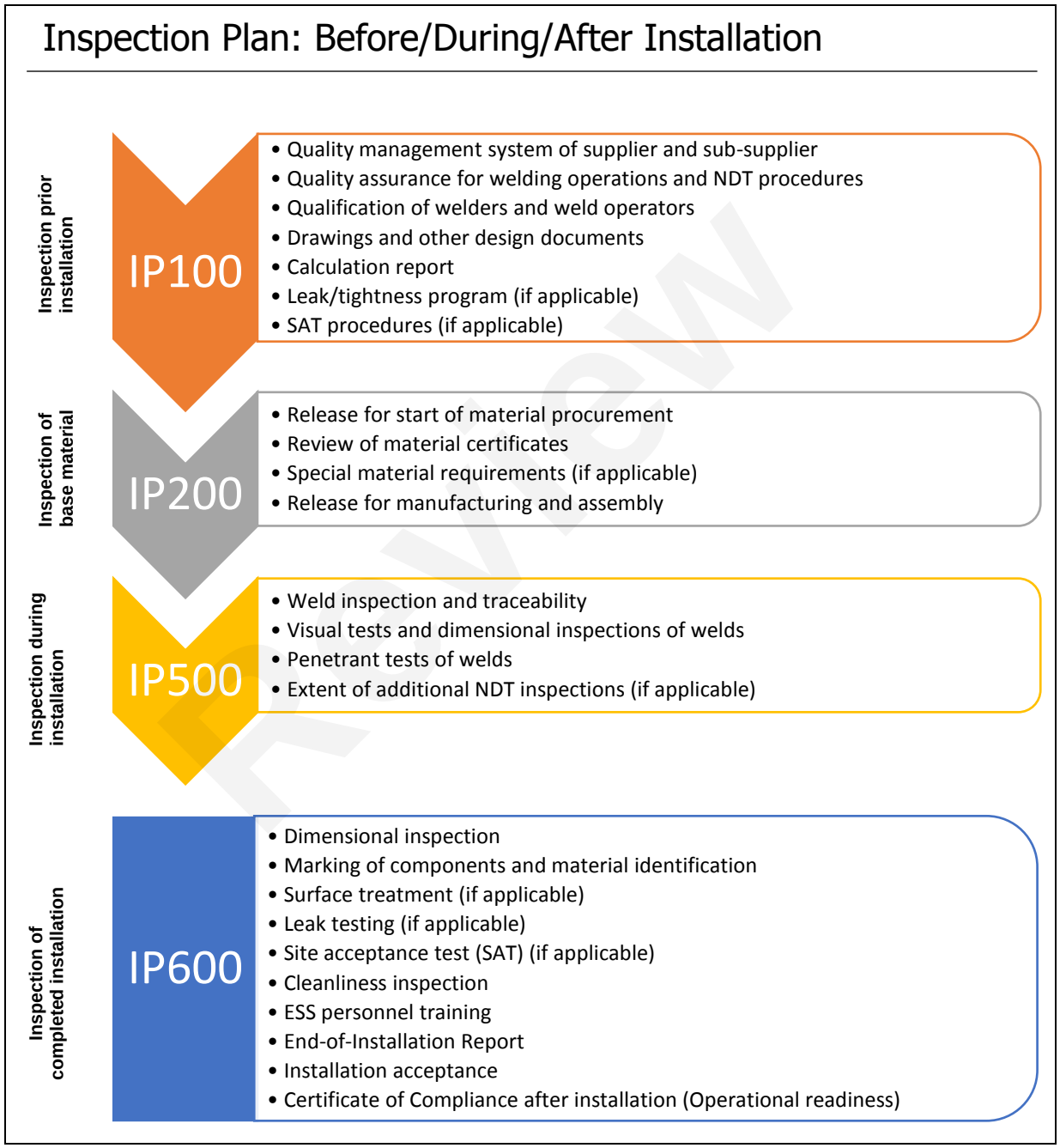

Figure 2 - Inspection Plan before/during/After installation

2.5.2 Drawings = comprehensive layout and referencing documents

The scope is to provide an overall description of a component or a major component part. They shall determine geometrical characteristics and give a comprehensive description of the interconnection of parts from the fabrication and installation point of view.
Documents must contain all necessary information for review and approval that at least consists of:

- System identification, Mechanical Component identification
- Design data in SI-units
- Material identification, material standard and the type of material certificate
- WPS and WPQR reference, if applicable
- Inspection Plan documents reference

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RA 3210	See above	-	Yes	Yes

2.5.3 Work and testing instructions = description of fabrication shops

The document shall consist of at least the following information:

- Purpose and background information
- Work instructions (Laser and water jet cutting, bending, rolling, cutting, turning, milling, drilling, welding, grinding, etc.)
- Welding manual
- Specific project quality plan (Responsibility, purchasing, planning, preparation, inspections etc.)
-

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RA 3220	See above	-	Yes	No

Review

2.5.4 Design and calculation reports

The design and calculation reports of mechanical components must be done in accordance with the component's requirements stated in the Equipment Specification and requirements stated in section **Error! Reference source not found.** of this document. The calculation eport must contain information about loads, calculation methods, applicable drawings, as well as calculation software qualification and other information necessary for verification of the results.

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RA 3310	No	-	Yes	Yes

2.5.5 Technical part and product manufacturing program = material procurement specification and documentation

Procurement specifications, certificates and testing related to applicable parts of RCC- MRx Tome 2.

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RA 3410 and RA 3430	See chapter 5.	-	Yes	Yes

2.5.6 Specification of fabrication processes other than welding

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RA 3510	See chapter 6.	-	Yes	Yes

Review

2.5.7 Welding Data Package

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RA 3610	No	-	Yes	Yes

2.5.8 Filler materials acceptance specification and welding procedure documents

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RA 3620	No	-	Yes	No

2.5.9 Welding reports

Manufacturer must prepare a document for Welding Inspection Methods that describes the examination procedures of a component's welds.

Mechanical components requires a weld traceability document in order to track each weld specified in the components drawings and the Welding Data Package in section 2.5.7. This documents records the results of each weld that is subject to a specific examination method.

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RA 3630	See above.	-	Yes	According to AIB internal rules

Review

2.5.10 Examination and test procedures or instructions

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RA 3710	In addition [5] Helium leak test procedure	-	Yes	Yes

2.5.11 Examination and test reports

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RA 3720	In addition [5] Helium leak test report	-	Yes	Yes

2.5.12 Hydrostatic test reports

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RA 3730	No	-	Yes	Yes

2.5.13 Certificate of Compliance after manufacturing

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RA 3920	No	-	Yes	Yes

Review

2.5.14 End-of-Design and Manufacturing Report

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RA 3930	See below.	-	Yes	Yes

The End-of-Design and Manufacturing Report shall comprise at least the following according to the Inspection Plan:

1. The certificate(s) of compliance or Product Inspection Certificate
2. Inspection Plan documents during manufacturing phase
3. The following documents:
   a) Examination and test results
   b) Welding Inspection and Traceability Document [19]
   c) Heat treatment records if applicable
   d) Non-conformance reports and deviation reports
   e) Documents relating to procurement
   f) Material Overview List
4. The welding data package
5. Filler Material Acceptance Specification
6. Manufacturing procedures or instructions
7. The as-built drawings

2.5.15 End-of-Installation Report

The report must contain all documents according to the Inspection Plan incl. Non-Conformance reports and Deviation Reports acc. to section 1.10 respective section 1.11. The Final Quality Control documentation shall use applicable Inspection Plan as an index.

2.5.16 Certificate of Compliance after installation

Certificate of Compliance after installation is to certify that the supply complies with the technical and quality requirements stipulated in the detailed inspection plan.

The Certificate of Compliance shall be issued by an Accredited Inspection Body as described in section 1.9.

Review

3. APPLICABLE STANDARDS

3.1 Swedish Regulatory Requirements

Swedish Radiation Safety Authority's document SSM 15-36 [2] gives the specific requirements for ESS Facility.

3.2 Design and construction standards

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Table RA 1300	See below.	-	Yes	Yes

Review

4. DESIGN CRITERIA

4.1 Design Requirements

Refer to [1] SDD-Req Target wheel, drive and shaft systems.

4.2 Code requirements

- Standard components that are subjected to CE mark requirements shall comply with relevant standard. A Document of Compliance signed by Notified Body shall be part of delivery for components manufactured according to Pressure Equipment Directive.

4.2.1 Structural, load bearing parts

Parts in class N2Rx

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RC 3200	No	No	Yes	Yes
Section 3 Article RC 3300	No	No	Yes	Yes
Section 3 Article RC 3700	No	No	Yes	Yes
Section 3 Article RC 3800	No	No	Yes	Yes

Review

Parts in Class N3Rx

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RD 3200	No	No	Yes	Yes
Section 3 Article RD 3300	No	No	Yes	Yes
Section 3 Article RD 3700	No	No	Yes	Yes
Section 3 Article RD 3800	No	No	Yes	Yes

4.2.2 Drive mechanisms

Parts in class N3Rx

Relevant section and article of RCC-MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RK 3000, where applicable	2006/42/EG Machinery Directive	No	Yes	No

Review

4.3 Other requirements

4.3.1 For Fabrication

All mechanical work has to be performed in a professional workmanship and due care shall be exercised. The following shall be taken into consideration:

- Corners, edges and transitions must be smooth
- The number of welds shall be minimized
- Welds shall be located such as to consider accessibility during welding (taking preheating into account) and minimization of weld residual stresses. Further on, they shall be carried out in a way that they can be cleaned and decontaminated easily
- Lifting lugs and other components that are necessary for transportation or lifting of equipment, shall comply with SS-EN 13155

4.4 For Maintenance and Service Inspection

Mechanical components must be designed in such a way that it should be easy to perform maintenance, inspection and decontamination. Parts intended for continuous maintenance and repairs must be designed so that they are easily removable and fixable.

Review

5. MATERIAL REQUIREMENTS

5.1 Material procurement

Before the procurement of materials starts, a Material Procurement Specification Document must be produced. This document is subjected for review and ESS approval before the procurement is started.

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
Section 3 Article RM 330-0 Reference Procurement Specifications Austenitic stainless steels, According to RM 332-5 for forgings, RM 333-2 for plates.	Cobalt purity class 2 according to Article RB 2400 for parts subject to significant irradiation. Required Plate surface condition for vacuum specified in [5].	No	Yes	No

5.2 Steel material selection

Material chosen for Target Wheel, Drive and shaft is X2CrNiMo17-12-2 in solution annealed condition with delivery condition specified in RCC-MRx Section 3 RM 330-0.

5.2.1 Testing

Testing must fulfill relevant reference procurement specification.

5.2.2 Material certificate

Material certificate must fulfill relevant reference procurement specification.

5.3 Polymers/ seals material selection

Polymers and elastomers shall fulfill requirements in [5] and [7] .

Review

5.4 Lubricants

Manufacturer shall submit a list of lubricants with Safety Data Sheets and Technical specification (MSDS and PDS) to ESS for review.

6. MANUFACTURING OPERATIONS

The manufacture of mechanical components can only commence after conclusion of review and approval of the documents necessary for manufacturing. For the list of required documents, see section 2.

6.1 Welding requirements

The manufacturer shall be qualified acc. to SS-EN ISO 3834-2: Comprehensive Quality Requirements.

Review

6.1.1 Acceptance of filler materials

Relevant section of RCC- MRx	ESS Eric additional requirements	Specification RCC MRx article
Article RS 2000	No	Reference data sheets according to RS 2700.

6.1.2 Welding procedure qualification

Relevant section of RCC-MRx	ESS Eric additional requirements	Specification RCC MRx article
Article RS 3000	No	-

6.1.3 Qualification of welders and weld operators

Relevant section of RCC-MRx	ESS Eric additional requirements	Specification RCC MRx article
Article RS 4000	No	-

6.1.4 Qualification of filler materials

Relevant section of RCC- MRx	ESS Eric additional requirements	Specification RCC MRx article
Article RS 5000 Qualification of filler materials	No	Applicable for: Powdered fluxes Flux-cored wires Covered electrodes

6.1.5 Technical qualification of production workshop

Relevant section of RCC-MRx	ESS Eric additional requirements	Specification RCC MRx article
Article RS 6000	No	-

Review

6.1.6 Production welds including Non- destructive testing

Relevant section of RCC- MRx	ESS Eric additional requirements	Specification RCC MRx article
Article RS 7000	100 % volumetric testing of all pressure- or load- bearing welds 100 % visual inspection of all root passes from back side, with boroscope if not accessible. Also see [5] Chapter 4.3. Welds should be left in as-welded condition- compare Table RB3683.1d.	Non- destructive testing according to article RS 7720.

6.2 Forming

Relevant section of RCC-MRx	ESS Eric additional requirements	Specification RCC MRx article
Article RF 4130	No	-

6.3 Heat treatment

Relevant section of RCC-MRx	ESS Eric additional requirements	Specification RCC MRx article
Article RF 8000	No	-

6.4 Surface finish

Requirements according to RCC- MRx are replaced by requirements in the Monolith Vessel Vacuum Rules [5].

Relevant section of RCC-MRx	ESS Eric additional requirements	Specification RCC MRx article
N/A	[5] Chapter 3.5.4	-

Review

6.5 Machining

Requirements according to RCC- MRx are replaced by requirements in the Monolith Vessel Vacuum Rules [5].

Relevant section of RCC-MRx	ESS Eric additional requirements	Specification RCC MRx article
N/A	[5]	-

6.6 Cleaning

Requirements according to RCC- MRx are replaced by requirements in the Monolith Vessel Vacuum Rules [5].

Relevant section of RCC- MRx	ESS Eric additional requirements	Specification RCC MRx article
N/A	[5] Suppliers cleaning instruction shall comprise cleanliness including final assembly, packing and Factory Acceptance Test.	-

6.7 Identification and marking

Relevant section of RCC-MRx	ESS Eric additional requirements	Specification RCC MRx article
Article RB 1300, RF 2000	No	-

Review

7. INSPECTIONS AND TESTING

7.1 Required surveillance and review level

The Inspection Plan Documents defines the requirements for manufacturer qualification, material procurement, fabrication, inspection and testing.

The required surveillance and review level by third party are specified in Table 1.

Third- party involvement in inspections	
Quality assurance requirements for welding	AIB
Qualification of welding procedures	AIB
Qualification of welders and weld operators	AIB
General arrangement drawings / Detailed drawings	AIB
Calculation reports	AIB
Inspection Plan documents	AIB
Weld inspection and traceability	AIB
Visual tests and dimensional inspections of welds	AIB
Penetrant tests of welds	AL
Volumetric testing of welds (X-ray or Ultrasound)	AL
Extent of additional NDT inspections (if applicable)	AL
Dimensional inspection	AIB
Marking of components and material identification (if applicable)	AIB
Helium leak testing	AIB
Hydraulic test	AIB
End of manufacturing report	AIB
End of Installation Report	AIB
Certificate of Compliance (Operational readiness)	AIB

AIB: Accredited Inspection Body
AL: Accredited Laboratory

Table 1 - Inspections and involvement of third-party

7.2 Inspection of welding

Required inspection before/ during/ after welding according to 2.5.9 in this document.

Review

7.3 Non-Destructive Testing (NDT)

7.3.1 Ultrasonic examination

Relevant section of RCC-MRx	ESS Eric additional requirements	Specification RCC MRx article
Article RMC 2000	No	-

7.3.2 Radiographic examination

Relevant section of RCC-MRx	ESS Eric additional requirements	Specification RCC MRx article
Article RMC 3000	No	-

7.3.3 Liquid penetrant examination

Relevant section of RCC-MRx	ESS Eric additional requirements	Specification RCC MRx article
Article RMC 4000	No	-

7.3.4 Visual examination and metrology

Relevant section of RCC-MRx	ESS Eric additional requirements	Specification RCC MRx article
Article RMC 7000	No	-

7.3.5 Helium Leak testing

Requirements according to RCC- MRx are replaced by requirements in the Monolith Vessel Vacuum Rules [5].

Relevant section of RCC-MRx	ESS Eric additional requirements	Specification RCC MRx article
N/A	[5]	-

7.3.6 Hydrostatic testing

Relevant section of RCC- MRx	ESS Eric additional requirements	Specification RCC MRx article
RC 5000	After hydrostatic testing component must be baked to get rid of all water before helium test.	-

Review

7.4 Factory Acceptance Test

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
No	See below. Requirements to be validated in the Factory Acceptance Test will be specified in the Requirement Validation Plan	No	Yes	No

The FAT shall demonstrate that the component and all related auxiliary systems fulfill the required and specified properties in the Equipment Specification, this document and the System Description Requirements document [1]

The manufacturer is responsible to prepare a detailed test procedure and to demonstrate that the component meets the requirements and validation strategy specified in the Validation Plan[12].

7.5 Packing, transportation and storage

The supplier shall provide a Packing Instruction which must comply with the requirements of ESS generic document [10] and the ESS Monolith Vacuum Rules [5].

7.6 Site Acceptance Test

Relevant section and article of RCC- MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
No	See below. Requirements to be validated in the Site Acceptance Test will be specified in the Requirement Validation Plan[12]	No	Yes	No

The SAT shall demonstrate that the component and all related auxiliary systems fulfill the required and specified properties in the Equipment Specification, this document and the System Description Requirements document [1].

The manufacturer is responsible to prepare a detailed test procedure and to demonstrate that the component meets the requirements and validation strategy specified in the Validation Plan[12].

After installation, SAT shall demonstrate that the component and all related auxiliary systems are installed properly at site and interfaces with other systems and peripherals in its working environment. SAT could also be a part of the incoming inspection in order to ensure that no damage has occur during the transportation.

7.7 ESS personnel training

ESS operators shall receive proper training of the equipment. This shall be specified in the contract for each component.

8. CRITERIA FOR OPERATIONAL READINESS

Relevant section and article of RCC-MRx	ESS Eric additional requirements	SSM additional requirements Chapter	Specification to be reviewed and approved by ESS Eric	Specification to be reviewed and approved by AIB
No	Operational test witnessed by representatives from AIB according to SSM requirements.	Chapter 5.D.12 specifies operational test to make sure that safety related components are functional and that the component is not exposed to harmful vibrations or other loads which have not been part of the design.	Yes	No

Review

9. REFERENCES

[1] ESS-0020435 SDD-req Target wheel, drive and shaft

[2] Swedish Radiation Safety Authority, Document no.: 15-36 Specific Requirements for the ESS-Facility in Lund, 2015-07-01

[4] ESS-0016468 Guideline- Identification and ranking criteria for ESS Safety Functions and Safety Important Components

[5] ESS-0057844 Monolith Vessel Vacuum Rules

[6] RCC-MRx 2012 Edition, Design and construction rules for mechanical components of nuclear installations

[7] ESS-0023781 Elastomer seals for the Target Wheel, Drive and Shaft

[8] ESS-0000385 ESS Glossary

[9] ESS-0033258 Classification terminology and principles

[10] ESS-0025721 STD Packing, Transportation and Storage

[11] ESS-0007476 ESS Technical Design Report

[12] ESS-00027392 Target Systems WP2 Validation Plan

Review