

Requirement analysis using critical thinking

Functional & operational requirement

Date	19 September2022
Team ID	PNT2022TMID43270
Project name	Signs with smart connectivity for better road safety
Maximum Mark	2 Marks

Best Practices in Mission-Assured, Mission-Critical, and Safety-Critical Systems

Requirements

Requirements group under three primary headings: Operations, Functions, and Performance.

Operational Requirements

Operational requirements pertain to the scenarios within which the product will operate.

Operational requirements usually cover the following concerns:

- Mission profiles

- Infrastructure needed

- Logistics and maintenance

- Responsible party for generating the requirements

- Environment

- Shock

- Vibration

- Corrosion

- Humidity

- Temperature range

- Radiation

Functional Requirements

Functional requirements pertain to the physical plant and situations within which the product will reside. Functional requirements usually cover the following concerns:

- Interfaces (ICDs)—Human, mechanical, electrical, software, special (e.g., optics)

- Mechanical—Size, shape, weight, volume, density

- Electrical—Power sources, distribution

- Responsible party for generating the requirements

Performance Requirements

Performance requirements pertain to the metrics and parameters that describe the product's capability. Performance requirements usually cover the following concerns:

- Responsible party for generating the requirements

- Sensor parameters

Measurand

Speed of transduction—samples per second

Span

Full-scale output

Linearity—%, SNR

Threshold

Resolution—ENOB

Accuracy—SNR

Precision

Sensitivity—%

Hysteresis

Specificity

Noise—SNR, % budget

Stability

- Data throughput

Bytes or samples per second

Data transmission protocol

Data storage

Control

•
Operation

Electrical—Power consumption, efficiency, signal integrity

Mechanical—Strength, motion required

Structural—Capability to withstand environments in mission profiles

Optical

•
Calibration

•
Dependability

Reliability

Maintainability

Testability

Fault tolerance

Longevity

•
Power consumption

•
Dissipation and cooling

•
Electromagnetic compatibility (EMC)

Conducted susceptibility

Radiated susceptibility

Conducted interference

Radiated interference

Design of vacuum system and support structure for plasma facing components of SST1 Tokamak

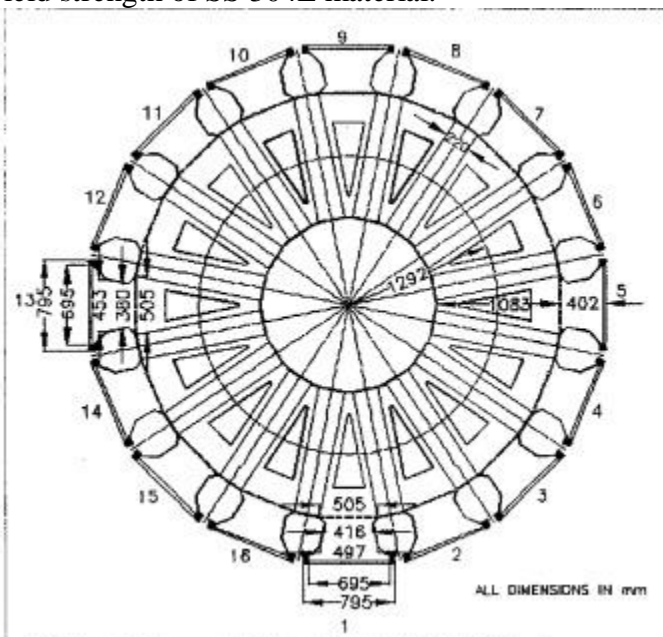
2.1 Vacuum vessel

The design and operational requirements are (a) vessel should be UHV compatible, (b) vessel temperature will be 475 K during baking and 425 K during wall conditioning, (c) vessel and radial ports must have enough space for human entry inside the vessel and (d) vessel L/R time constant should be as large as possible to shield the superconducting coils from time varying magnetic field generated due to plasma movement. The estimated L/R time constant of only vacuum vessel is 7×10^{-3} s. The vessel should be modular to remove and insert the vessel module if required for repair of a coil or vessel. This demands the insitu UHV welding of vessel modules. Vessel is made up of sixteen wedge shaped sectors which are joined together by sixteen

interconnecting rings to form a complete torus. Each wedge sector contains two vertical ports and one radial port.

The material of vessel is SS 304L. The volume of the vessel upto port openings is 16 m^3 and the surface area exposed to UHV is 68 m^2 . Figure 2 shows the top view of the vessel. The wall thickness of vessel is 10 mm and that of port is 6 mm. The inlet pressure and temperature of nitrogen gas to maintain the vessel at 475 K will be 5 bar and 550 K respectively with $287 \text{ W/m}^2\text{K}$ heat transfer coefficient between gas and the tube wall. It may not be possible to carry out GDC between plasma discharges due to superconducting toroidal magnetic field coils.

For this ECR plasma wall conditioning is planned. The stresses developed on the vessel wall due to internal and external pressure of 850 torr are calculated using pressure vessel design codes [1]. The estimated collapsing pressure is about 10 bar with 10 mm wall thickness. Also, the calculated average maximum stress with 10 mm wall thickness is about 18 times less than the yield strength of SS 304L material.



Industry IoT use cases for workforce distribution and automation



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