



Topical discussions: Design, manufacturing,
post-manufacturing treatment, QA and
assembly

Topic 2: Design, manufacturing, post-manufacturing treatment, QA and assembly

- The includes the conceptual **design and manufacturing** from coils to installation in the tunnel.
- It includes welding, cleaning, leak detection, quality assurance and in-situ installation.
- Support systems, vibration modes, and interfaces with other services are treated here.

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Topical discussions

Discussions have been organized in 3 parts:

- Design.
- Manufacturing, post-manufacturing treatment.
- QA and assembly.

Going through a bullet list of questions.

Design

Write a functional specification with basic parameters from the ET CDR:

- Inner diameter.
- Interaxis distance.
- Free space around vacuum pipe.
- Tunnel cross-section (clear aperture).

Diameter is a critical parameter for the baffle system: from \varnothing 1.2 m to 1 m \rightarrow double the number of baffles.

Design criteria:

- Buckling: Minimum safety coefficient of 3 (linear elastic buckling).
- Strength of the interconnection lip weld under tensile:
 - Maximum force occurring during installation at room temperature.
 - Force given by the tolerances on chamber length and the stiffness of the chamber/bellows:
 - +/- 4 mm considered for the chamber length.
 - 1 bellows every (2)-3 chambers (~ 45 m) for smooth tube solution.

Design

Design criteria:

- Vibrations:
 - No stringent requirement to have first mode(s) outside the higher sensitivity windows (few Hz).
 - Axial vibration is a concern.
 - Ground motion and internal vibration source should be known:
 - Ground motion PSD.
 - Ventilation integration and performance / representative excitation PSD.
 - Baffle max displacement PDS / RMS = possible criterion for further dynamic simulations.

Alignment of baffles:

- Laterally: in the 10 mm range (stochastic) misalignment even better.
- Axially: no stringent requirement.

Sag/straightness of the chamber is not an issue as long as overlapping of the baffles is ensured.

Thermal insulation:

- Maximum 40 °C in the tunnel if operator presence.
- Insulation is problematic for leak detection & time consuming.

Manufacturing

Welding technology:

- Basic principle: the less welds, the better.
- Longitudinal/helicoidal choice is more a matter of expertise/tooling availability of the manufacturer.

Reinforced tubes:

- Local weld of the reinforcement stiffener might be an issue. Non penetrant weld to be considered.

Corrugated tubes:

- Better to keep a flat part between corrugation.
- Virgo prototypes have been built based on corrugated solution.
Recovery of supplier(s), procurement documents.

Instrumentation modules:

- Reinforced tube, 3-4 mm thick, to allow the extrusion of the pumping ports.
- Instrumentation and pumping port sizes based on Carlo's presentation.
- Interface for the electrical powering for the bakeout by Joule effect needs several connecting point around the tube.

Manufacturing

Cleaning:

- Not defined yet (material dependant) but not a showstopper for any of the solutions (except very long in-situ manufacturing).
- Cleaning after the manufacturing process.
- Cleaning 1 by 1 .
- Storage to avoid contamination:
 - Dry air and nitrogen?
 - Ideally small over pressure.
 - Compatible with different climatic conditions & transport (temperature and pressure cycles).

Lip weld geometry must allow 3 repairs.

QA and assembly

Installation of vacuum chambers:

- Sequential installation per arm shall be considered (beam pipe installation after all services).
- Installation scenario(i) shall be defined.
 - Transport time \neq installation time.
 - Installation compared to production rate?
 - Installation strategy: from the extremity or middle of the arms or both?
 - Handling tooling to be assessed.
 - Maintain “clean” environment for connection (tent).

Installation of baffles:

- Baffles shall be installed in clean and dust free environment.
- Preferred solution is based on a baffle mechanically fixed to a ring welded in the chamber.
- Some instrumented baffles have to be considered.
- Two types of baffles: coated/non coated. Two types of installations (before/after welding) might have to be considered.

QA and assembly

Weld qualification:

- Mainly visual inspection for present GWD interferometers.
- Continuous inspection to be assessed.
- Leak detection strategy to be defined based on Paul's presentation.

Exceptional, accidental events need to be assessed for safety of personal, materials and availability.



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