TÍTULO *TITLE*	**Feasibility Study** ***Port Tubes & NNBar Frame to Monolith Vessel welding on site***

Contrato Ensa *Ensa Contract*	Proyecto *Project*	Cliente / Nº Pedido *Customer / PO number*
5EC8	ESS MONOLITH PORT TUBES WELDS ON FIELD	ESS Bilbao Exp. 288/19

Documentos de referencia
Reference documents

Expediente 288/19 – Pliego de condiciones técnicas particulares
File 288/19 - Specification of particular technical conditions

CREADO POR *CREATED BY*	REVISADO POR *REVIEWED BY*	APROBADO POR *APPROVED BY*
Servicios / Field Services	Servicios / Field Services	Ingeniero de Proyecto / Project Engineer
M. Pérez	J. Santoveña	P. Ortiz
02/03/21	03/03/21	03/03/21

EVOLUTION OF THE DOCUMENT

Rev.00	First issue
Rev.01	Included received comments. See 5EC8CDS0001 (2020/03/27) See side-marked paragraphs.
Rev.02	Included new boundary conditions. See ESS-3133587 (5EC8CDS0007) Included welding ESS Mock Up' conclusions. 5EC8INF001. See side-marked paragraphs.
Rev.03	Included received comments (5EC8CDS0009) See side-marked paragraphs.

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1. OBJECT

The aim of this technical report is to expose the feasibility study for the welding on site of components of the Monolith Port Blocks to the Vessel. The content will be:

- Definition of welding book (PQR, WPS, Welder qualification and welding map)
- Definition of chosen weld edge preparation, filler material and welding process.
- Definition of chosen backing gas method
- Definition of tolerances pre- and post-welding
- Definition of chosen NDT techniques
- Definition of optimal installation sequence
- Definition of mock-up

2. INTRODUCTION

The scope of the works is under the contract 5EC8 and is focused in the welding of the 39 Port Tubes, the NNBar Frame and the Connection Pipe to the Monolith Vessel, works to be carried out on site at ESS' facilities in Lund, Sweden.

The supply of most of components (Port Tubes and NNBar) is also under the scope of Ensa, covered in the contract 3EB8, from where some recommendations and requirements have been taken into account. Monolith Vessel and Connection Pipe supply is out of the scope of Ensa.

Present study has been done considering the dimensional restrictions showed in the 3D model with reference "ESS-3147046 - Information for welding and Installation of PT and NN-Bar - 1.0 (A) – Preliminary" received from ESS.Works on site consist of:

- Welding area preparation (installation of protections, checking and maintenance of cleanliness, preparation of welding tooling and backing gas). See sections §5 and §6.
- Welding of 39 Port Tubes + 1 NNBar Frame + 1 Connection Pipe. See sections §7 and §10.
- Non-destructive testing of the welds. See section §9.
- Dimensional control after welding.

Out of the scope of Ensa are:

- Assembly of the equipment according to pre-welding needs. See annex E.
- Supply of welding gas.
- Scaffolding
- Power / Air / Cooling water supply

- Any other mean not covered by this works analysis.

3. REQUIREMENTS TO BE MET

Works must fulfill the next standards:

- Construction code: EN 13445
- Legal requirements: Directive 2014/68/EU (PED)
- Mechanical classification: Classification MQC4
- Welding procedures: EN ISO 15614-1
- Welds acceptance criteria: EN ISO 5817 (Class B)
- Welders qualification: EN ISO 9606-4/ EN ISO 14732
- Visual testing (VT): EN ISO 17637/ EN ISO 23277
- Dye penetrant test (PT): EN ISO 3452-1/ EN ISO 5817 (Level B)
- Radiographic Test (RT): EN ISO 17636-1 (Class B) / EN ISO 10675-1 (Level 1) / EN ISO 19232-3 (Class A)

(Deleted in rev.02)And the next contractual general drawings:

- ESS-0241944.3 rev.09 - PORT TUBE STANDARD
- ESS-0321251.3 rev.08 - NNBAR TUBE

Note: NNBar's installation drawing is still pending issuance.

4. DEFINITION OF WELDING BOOK

Welding Book is the document that encompasses all the information to better understand the intended performance of welding works. Within this document it is included:

- Procedure Qualification Report, PQR. Annex A.
- Welding Procedure Specification, WPS. Annex C.
- Welding Map, WM (drawing with welds location, geometry and tests). Annex D.
- Welders Performance Qualification Report, WPQR.

Welding Book is usually a “live document” that may evolve during the project (i.e. new welders' qualifications).

5. WELD JOINT, FILLER MATERIAL & PROCESS DEFINITION

5.1. Preliminary considerations.

Facing the welding of the components to the vessel, and considering the applicable contractual requirements, the recommendations and the requirements for the fabrication of the components, special attention has been taken on the next variables:

- **Environmental conditions**: Local temperature and humidity must be considered in order to have no undesired defects during welding operations. Welds will be performed inside an open building; therefore, the workstation has to mitigate the impact of wind, rain, etc.
  Both, temperature and humidity, affect also to the welding process and impacts among others on the selection of the filler material, mainly on its storage and maintenance conditions.
- **Welding accessibility**: In case of Port Tubes the accessibility for welding is quite narrow, see Annex E for main dimensions. That is a point to take into account in the selection of the torch and the design of the weld edge preparation.
- **Cleanliness**: It is highly important to maintain a proper cleaning as the protection of the inner part of the components plays a very important role. For this topic, a dedicated tooling will be used. See section §8.1.
- **Tolerances and distortions**: Due to the narrow tolerances required in position and shape for each individual component after the works, it is necessary to reduce as much as possible the heat input transmitted to the components.
  Although the welding sequence has to be thoroughly studied in order to meet the global tolerances for the whole vessel. This topic is analyzed in deep in section §10.
- **Floating equipment**: Monolith vessel, Port Tubes and NNBar are not anchored to the ground. Therefore, translation of the components can be produced due to the forces involved in the welding process.

5.2. Selected parameters.

Taking previous considerations, the selected parameters have been:

- **GTAW (TIG)** as a preferred welding process, mainly because it is one of the cleanest processes (less spatters and welding defects than most of processes) and reduces the necessity of grinding the surface of the welds.
- **Uncovered G 19 12 3L (316L / 1.4404) rod as filler material.** This selection is inherent to the GTAW welding method. Rods as filler material allow to reach the whole geometry of the weld and the fact that it is not covered make the storage of the filler material easier. See Annex F for filler material's certificate.
- The less quantity of weld layers, less heat will be transmitted to the component and the easier it will be to maintain tolerances.

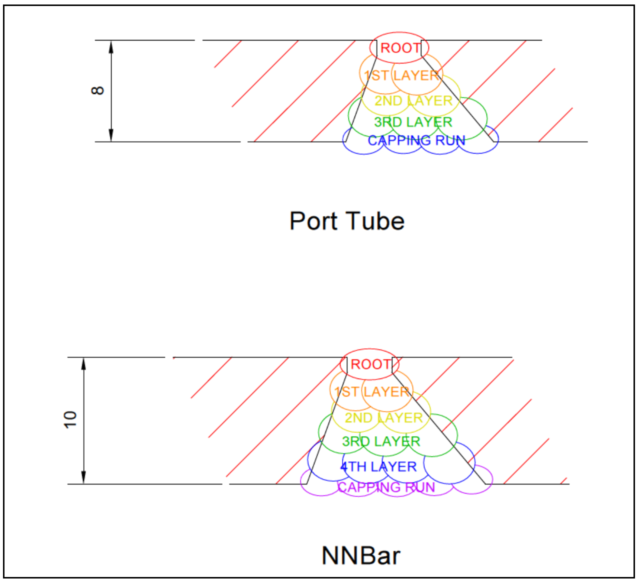


Fig. 1 & 2 - Welding layers

- **Low temperature** must be considered in the Welding Procedure Specification (**WPS**) also. Standard lowest temperature use to be about 15 to 20ºC, but in Lund could descend below 0ºC; therefore, temperature range in WPS must be wider than usual. Moreover, local heating devices (i.e. air heaters) should be available on site.
- At least one **reparation cycle** must be considered in the documentation.
- The design of the bevels must allow to have a good access to the welder that should have the best possible visual control of the work, that is why an **asymmetric weld edge preparation** has been chosen. See Annex E for Pre/post welding drawing.

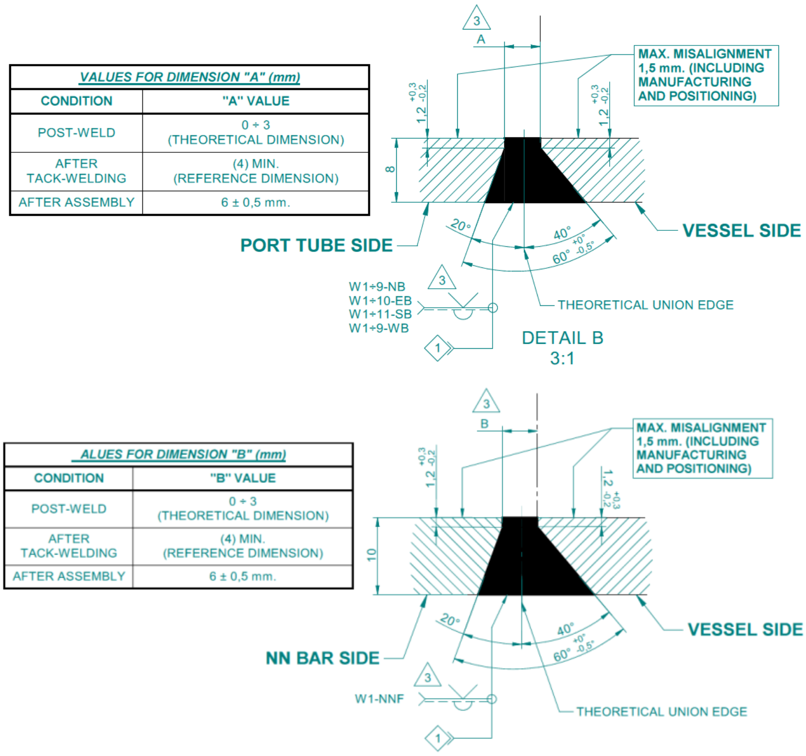


Fig. 3 & 4 - Weld edge preparations

- **Argon** as protective gas. Argon is the preferred gas for ESS' Vacuum Section. This gas has a high purity level (reduces the introduction of non-desired particles) and at the same time Argon is used to protect the molten pool of metal against elements in the Atmosphere including Oxygen, Nitrogen, and Hydrogen. These elements cause reactions with the liquid weld pool, such as porosity and increased weld spatter. Argon also plays an important role in maintaining Arc stability, which leads to increased weld penetration, better filler wire transfer, and better weld appearance.

  Argon supply is under the scope of ESS and shall meet the composition Ar 99,99% (Class I1 acc. to ISO 14175).
- **Backing pass by the outside** where achievable for a better performance of NDTs.

  After the ESS' Mock Up welding and facing the NDT to be performed on the welds by the outside, it was decided to include in the welding documentation (welding table 5EC8WT201) the possibility of performing a capping back run by the outside. The welding table is already reviewed:

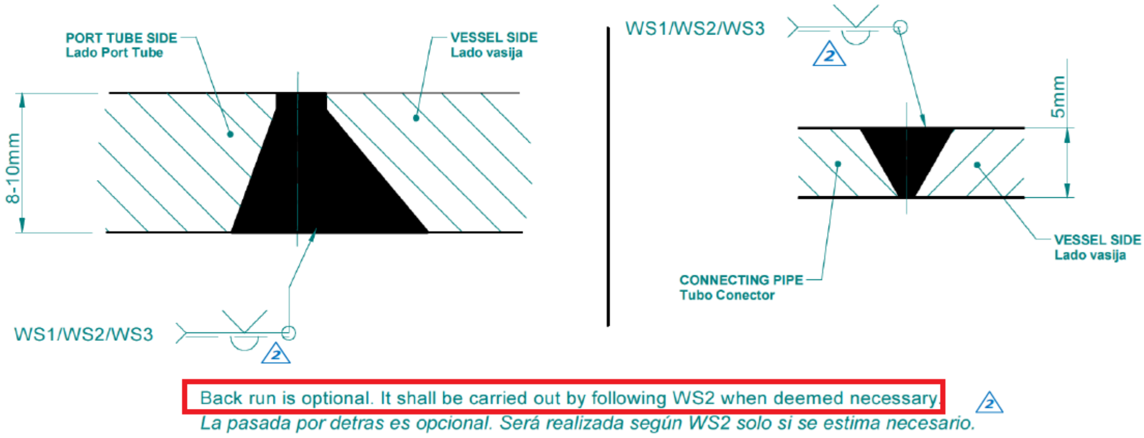


Fig. 5 – Optional back run.

6. DEFINITION OF BACKING GAS METHOD

6.1. Connection pipe:

Connection Pipe weld can be considered as a common pipe weld. The shielding gas must be confined by the inner part of the pipe while welding by the outer side.

Gas containment can be reached by common pipe-welding solutions such as weld purge plugs, shown in fig 6.1.

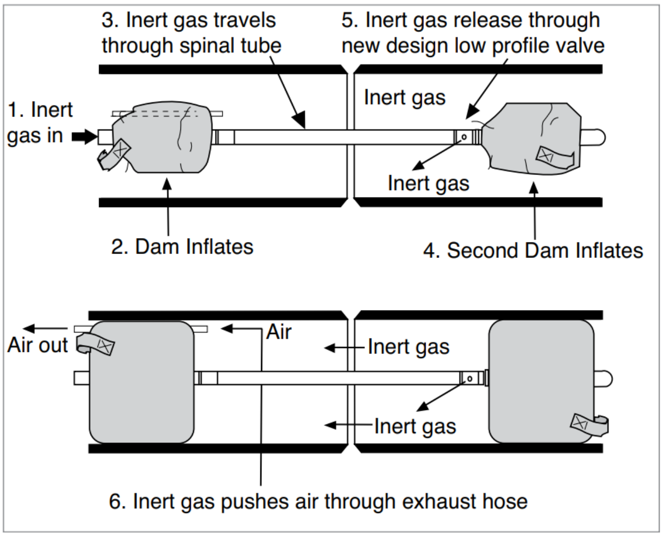


Fig. 6.1 – Weld purge plugs – Source: Huntingdon Fusion Techniques – HFT (https://www.lgtechniek.be/fileman/Uploads/Documents/Huntingdon/HFT.pdf)

6.2. Port Tubes and NNBar:

For the **tack welding stage** two devices has been issued, figs 6.2.1 to 6.2.5. They also can be used for small repairs (20-40mm).

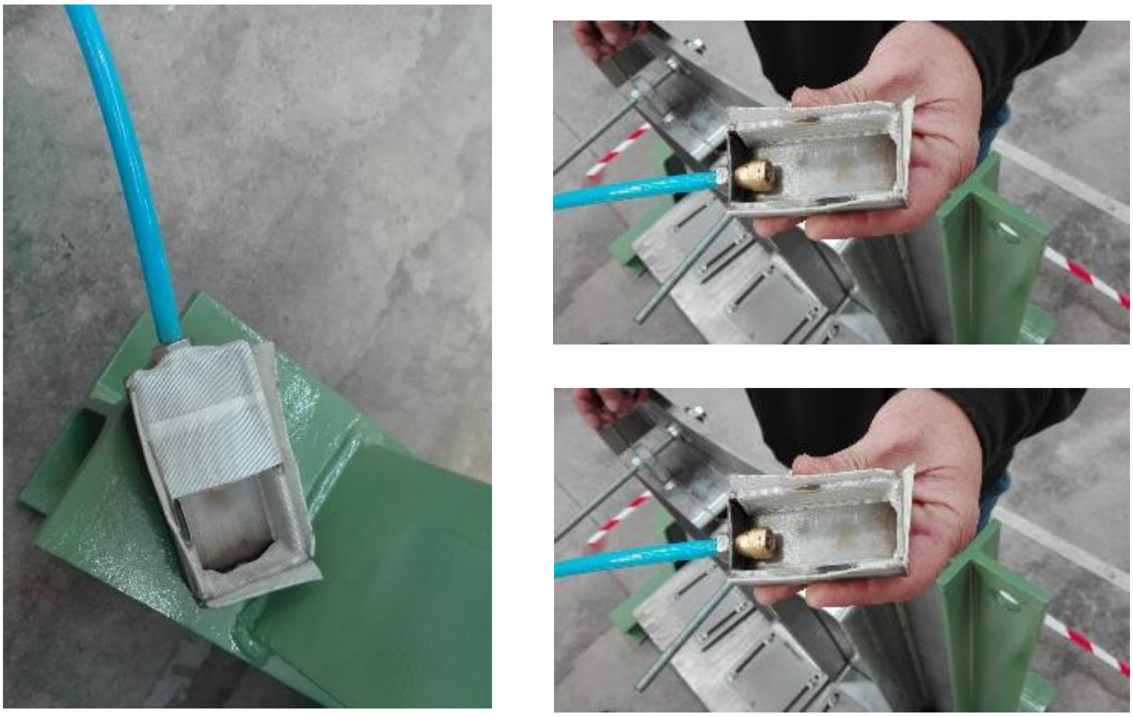


Fig. 6.2.1, 6.2.2 & 6.2.3 – Short tack device

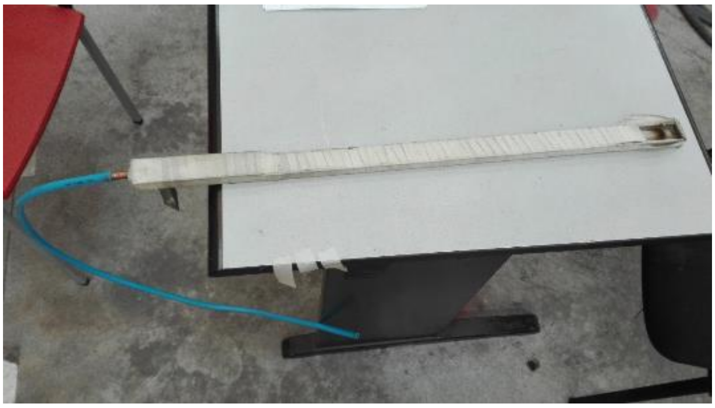


Fig. 6.2.4 & 6.2.5 – Long tack device

Facing the **root and the first pass** stages, the welds can be splitted in different areas:

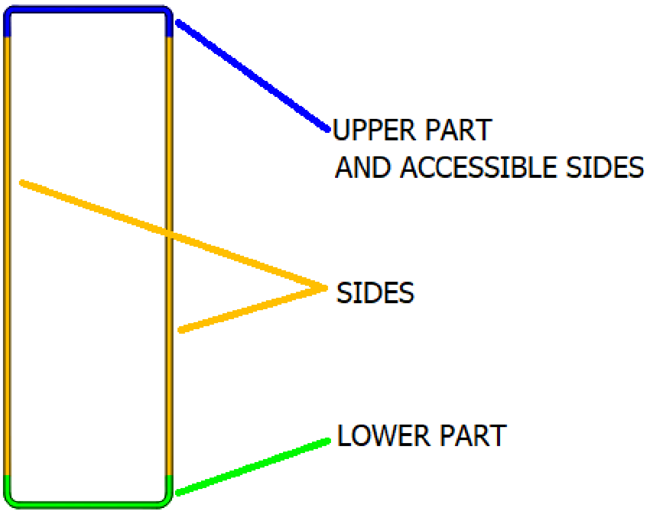


Fig. 6.2.6 – Weld areas

A) UPPER PART & DIRECT ACCESSIBLE SIDES

These areas are fully accessible. The system will be local (just need to install on the root side) and completely removable. Common means:

- Fiberglass tape
- Ceramic weld backing
- Welding glasses

Fig. 6.2.7 – Welding glasses on ESS' Mock Up

B) SIDES – NO DIRECT ACCESS

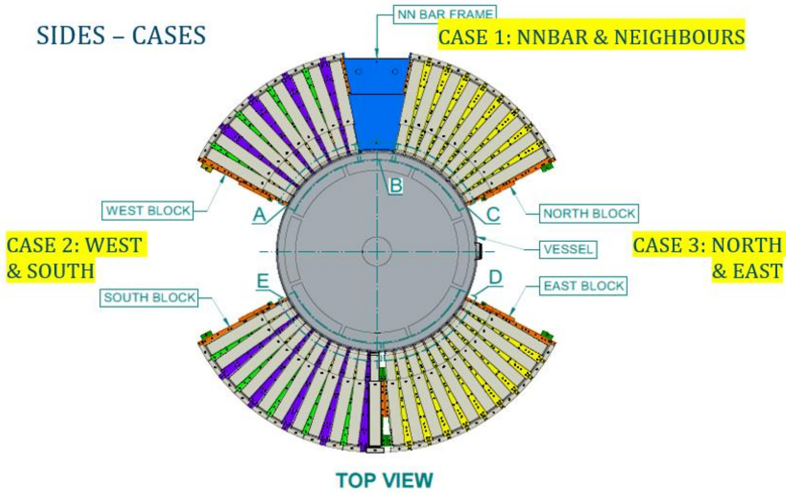


Fig. 6.2.8 – Side weld cases

Welds between two equipment. Adopted solution will be to confine the shielding gas by using modular enclosures. Completely removable.

- Fiberglass tape
- Welding glasses
- 1.4404 Stainless steel plates
- Rubber (NBR, EPDM, …) gaskets
- Inflatable hoses

Fig. 6.2.9, 6.2.10 & 6.2.11 – Example of modular enclosure on Ensa's Mock Up

C) LOWER PART

No accessible areas. Adopted solution will be to confine the shielding gas by enclosing volumes near the welds. Some permanent parts will remain, materials will be agreed between parts.

- Fiberglass tape
- Rubber foam (NBR, EPDM, …)
- Inflatable hoses

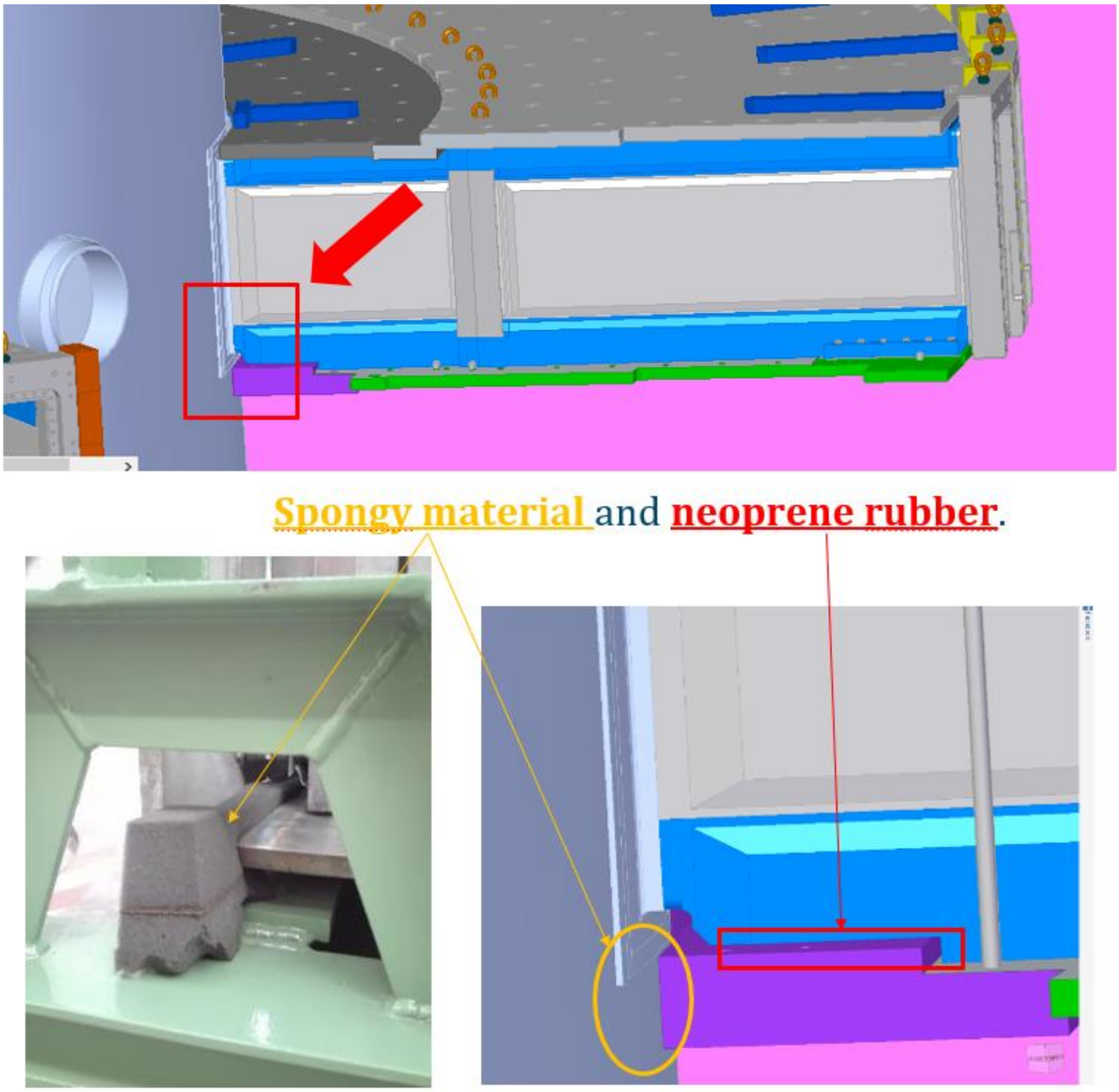


Fig. 6.2.12 & 6.2.13 – Volume enclosure example

Forecasted remaining materials will be made of:

- Fiberglass tape (Annexe G)
- Rubber foam (Annexe I)

7. DEFINITION OF TOLERANCES PRE AND POST WELDING

In this section are analyzed the required design tolerances that appear in design drawings ESS-2024596.2 Rev1.0 (Preliminary status).

7.1. Shape Tolerance (profile of the surface):

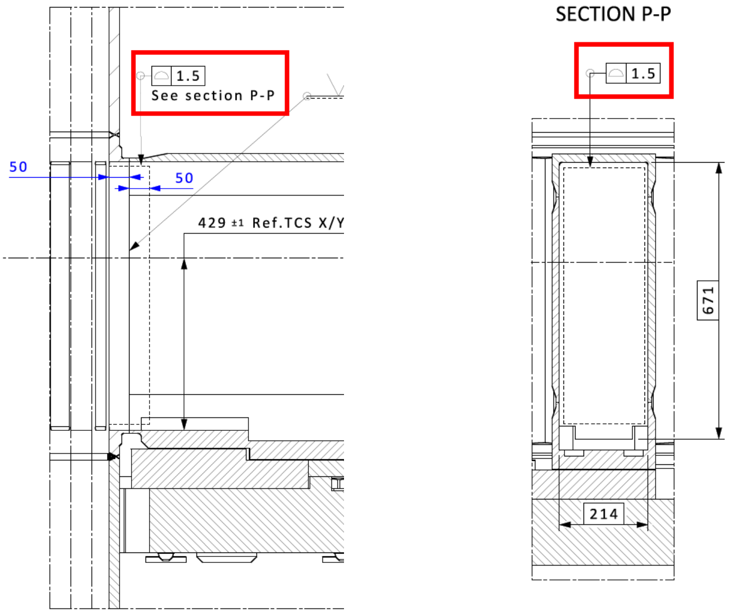


Fig. 7 & 8 - Shape tolerance

As this requirement exists for fabrication, this part of the Port Tube is machined at the very end of the fabrication and counting on that the weld edge preparation of the vessel will meet the requirement, no problems are expected to meet the request.

7.2. Radial Position Tolerance:

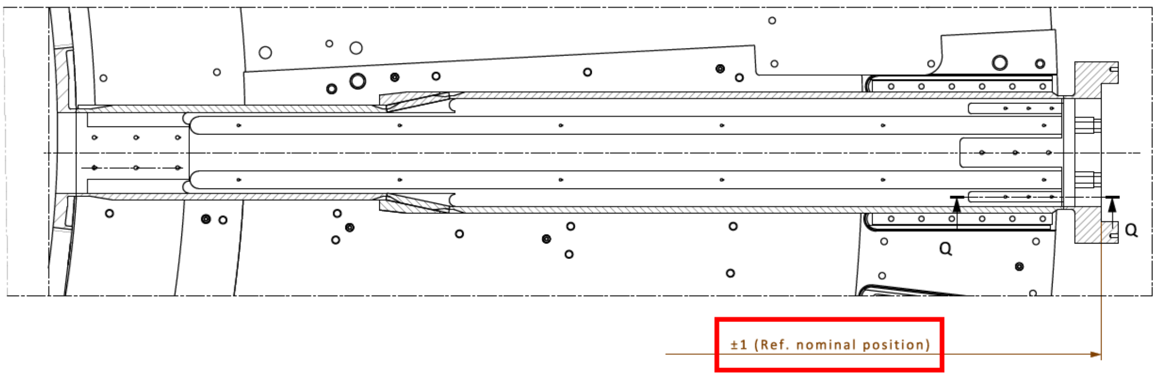


Fig. 9.1 - Radial tolerance

Equipment are not anchored to the ground (§5.1) and this tolerance is directly affected by the shrinkage effect of the welding activities. Differences between shrinkage and distortion of parts must be considered, see doc. 5EC8INF001, section §3.4 for further information.

After welding ESS Mock Up, expected evolution of the GAP between both weld edges can be seen in the next sketch.

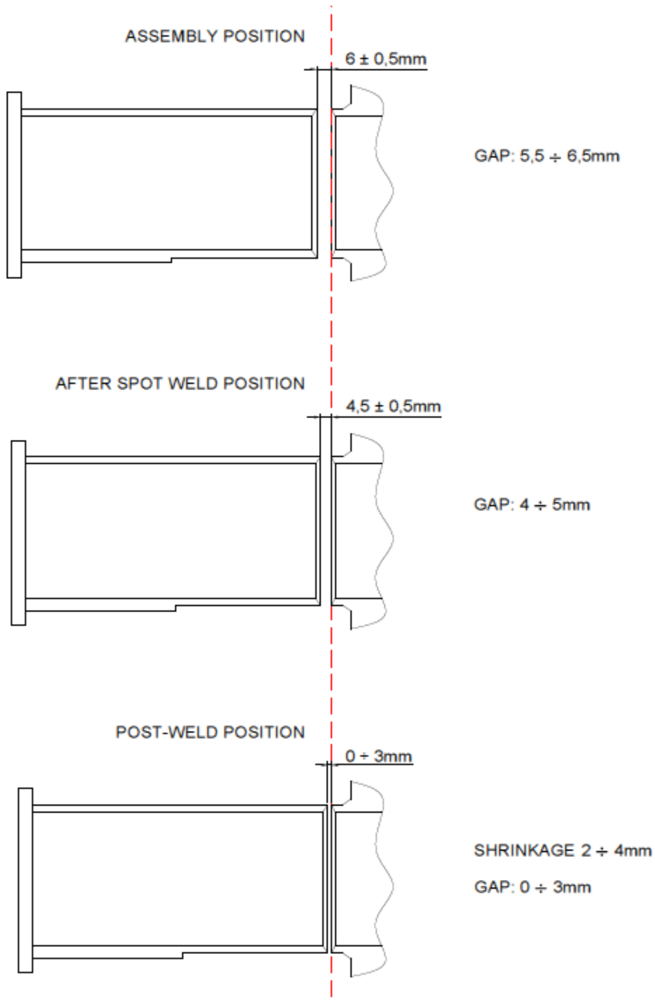


Fig. 9.2 – GAP evolution

Therefore, Ensa will focus on this tolerance during welding activities but cannot ensure compliance with this tolerance of ±1mm, since expected final GAP is between 0÷3mm.

7.3. Tangential Position Tolerance:

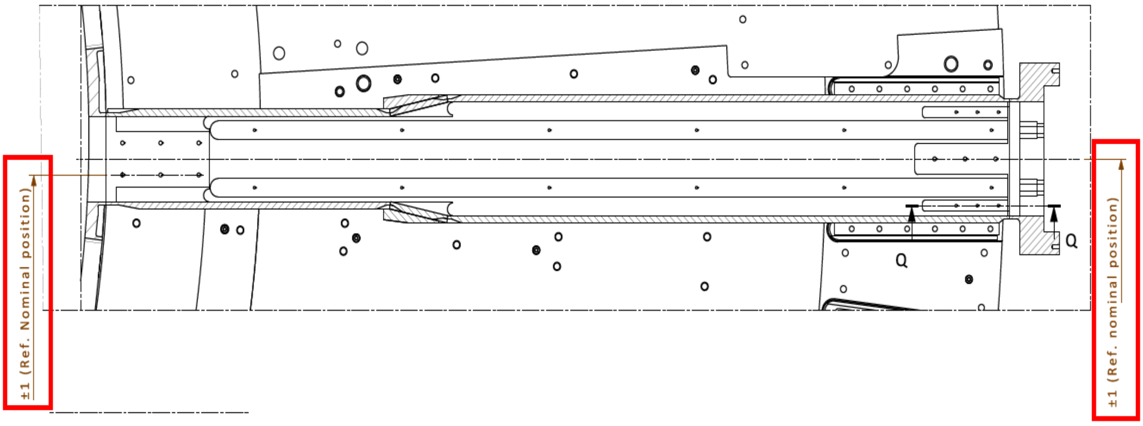


Fig. 10 - Tangential tolerance

These tolerances can be met by properly fixing the components to the bottom plates. As there is only one circumferential weld per component, the final position is determined by the positioning of the component before welding operations. No deviation in the marked direction is expected after welding works., only in the radial direction, section §7.2

Special care has to be considered in the configuration of the joining between Port Tube and Pot Block Bottom Plate. This configuration has been designed to assume possible dilations and contractions of the component during operation but facing the installation could be a problem because it makes hard to perfectly fix the Port Tube to the Port Block Bottom Plate. (Deleted in Rev.01)

7.4. Height Position Tolerance:

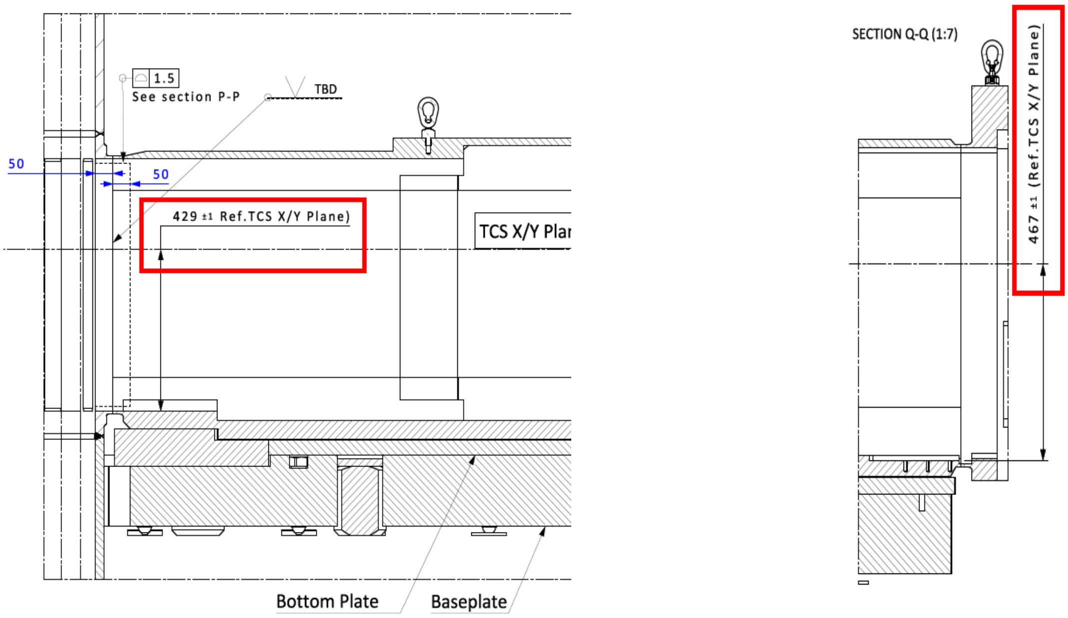


Fig. 11 - Height position

These dimensions, in the same case as per section §7.3, are determined by the positioning of the component before welding operations. No deviations in Z axis is expected after welding works.

7.5. Other considerations for installation and expected results:

A proper positioning before welding must be done. Forecasted vessel positioning tolerances are given in the next sketches:

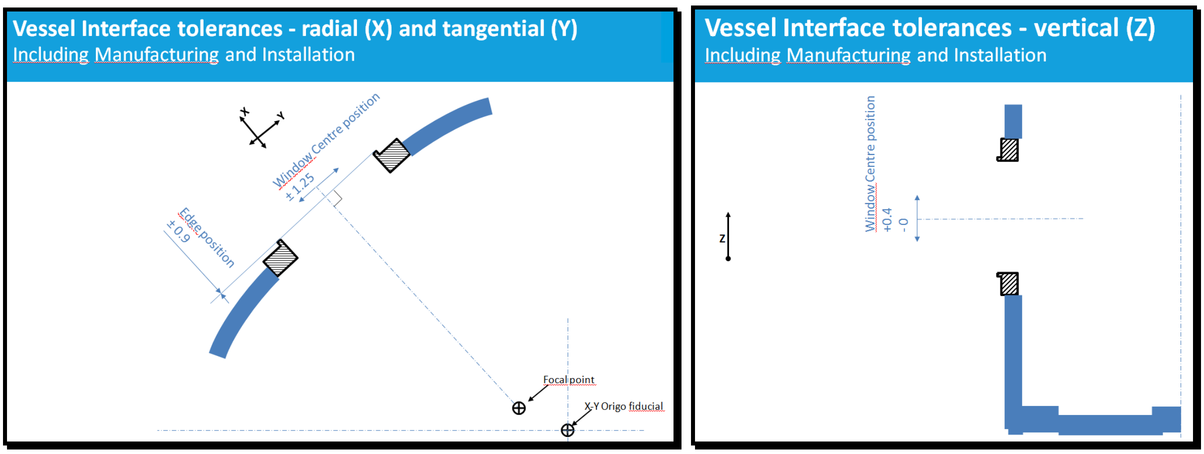


Fig. 12.1 & 12.2 - Vessel interface tolerances

From an ideal dimension of each weld edge perspective, the alignment of the component towards the vessel should focus on starting with the upper corners since they are more critical to weld, because of the smallest radius and welding in PF position. But in practice it is expected that there will be a small deviation of measurement between the weld edges (always within the allowed tolerance). In this case, the difference in size should be distributed and, in any case, the requirement of maximum misalignment marked in the dwg of Annex E (1.5mm max.) and Fig. 3 & 4 shall be met.

The use of shims under the component will help to fix the Z axis position. It shall be taken into account the posterior removal of the shims.

Requested gap (space between weld edges) for welding is at least 4mm. See figure 9.2.

The next step will be to tack weld the component to the vessel and, after re-checking the correct position, to fully weld the component.

Forecasted individual weld sequence for each component is as shown in figures 13.1 and 13.2. If necessary, the sequence and number of tack welds/sectors may be varied at the discretion of the person in charge of the works, and communicated to ESS, in order to ensure that the welding works guarantee a proper performance of the welds.

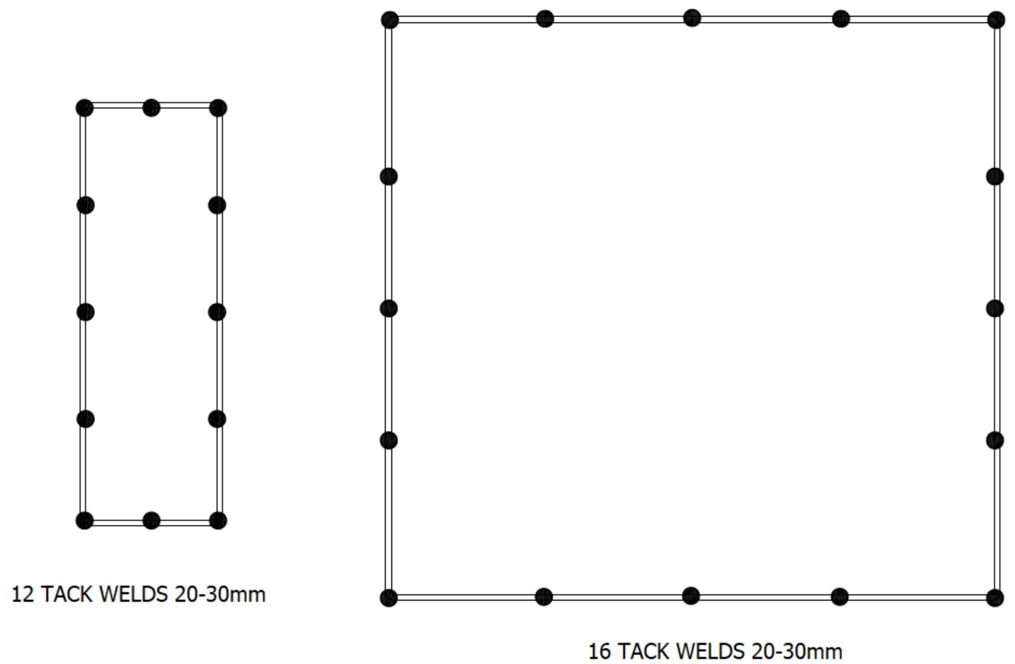


Fig. 13.1 – Tack welds. Sequence and dimensions.

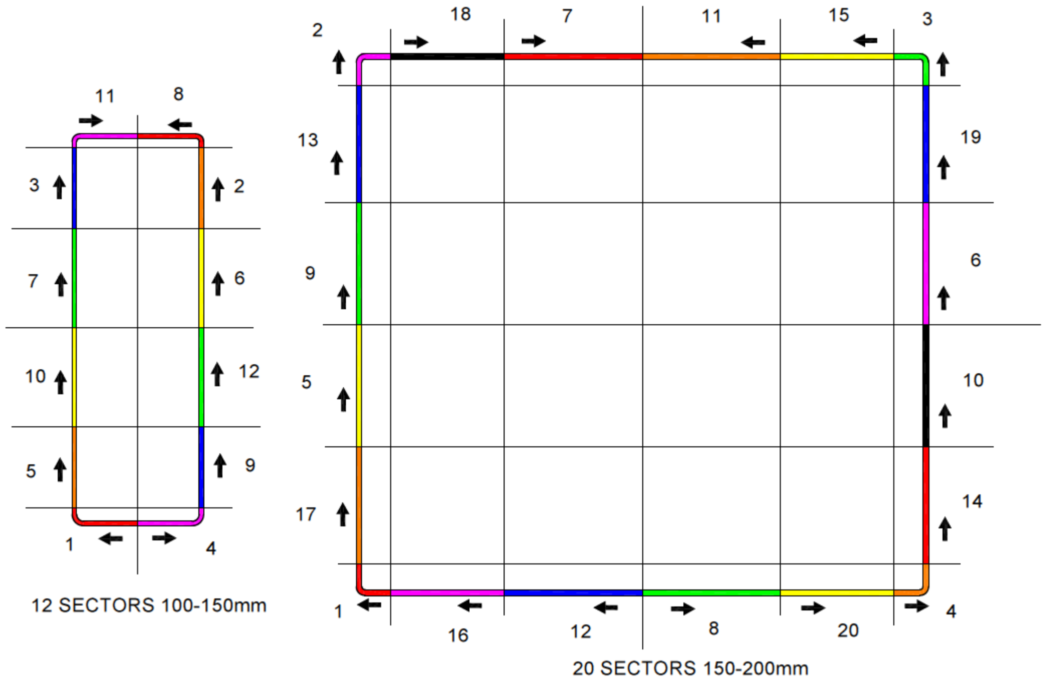


Fig. 13.2 – Sectors. Sequence and dimensions.

Low thickness of the weld will help to reduce distortions in the welding section. Based in previous experiences Ensa considers that expected local deformation in welding section is that the vertical welds will move away from the position before welding (sides will become wider) but required shape tolerance compared to the status before welding can be met (section §7.1)

For the final checking of the inner shape, a "go gauge" will be used in the weld area. Also, the maximum dimensions must be measured.

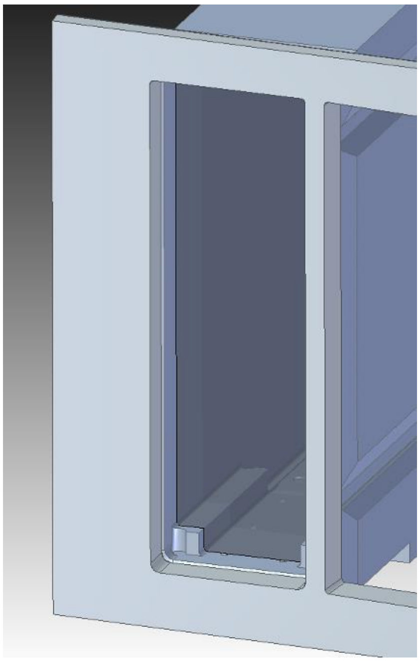
Analyzing obtained values of shrinkage in ESS Mock Up, due to the effect of the weld, Ensa considers that the estimated shrinkage value, will be in a range of 2 - 4mm. Given shrinkage value must be taken as a reference but not as a target value because shrinkage depends on many variables such as welder, welding tooling, heat input, environmental conditional, ..., that has low repeatability.

8. OPERATIONS RELATED WITH WELDING

8.1. Cleanliness during welding.

The tooling for maintaining the cleanliness consist in a foam-body-shield that will be manually placed into the component from the extreme to be weld to the vessel and settled as close as possible to the edge but keeping in mind not to obstruct welding operations.

This “shield“ will maintain the components free of dust, chemical products and any other potential contamination agent.



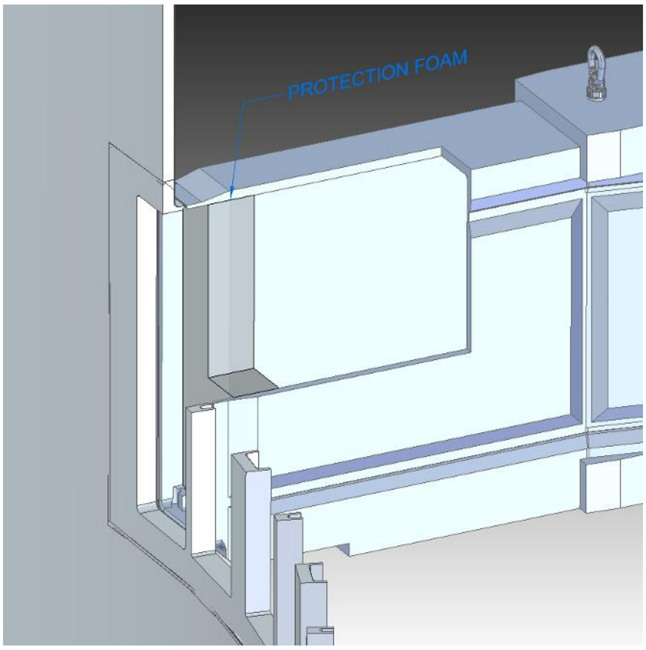


Fig. 14 & 15 - Shield concept

Foam-body will be covered with a protective sheath in order to not to be damaged by spatters of chips during the works. Gap all around the shield must be sealed with tape in order to avoid the entrance of any undesired particle inside the components.

8.2. Grinding operations

Grinding is a common and needed process for a proper examination and acceptable superficial quality of the welds. Despite GTAW (TIG) process is very clean and reduce the appearance of spatters, it is expected the necessity of grinding during and after welding in order to have a smooth transition between weld and base material and avoid areas that could obstruct the examination and generate a misinterpretation. Acceptance criteria for welds are given in EN ISO 5817, §Table 1.

Furthermore, in case of any repair is needed, grinding is unavoidable.

Considering the high level of cleanliness required in vacuum side of the components, it has been studied the way of impact as less as possible this requirement.

Firstly, the use of the “shield” described in section §8.1

Secondly to grind the welds by (nuclear industry) common means until the last surface finish pass, that should be soft ground according to the same soft grinding means referred in the Port Tubes instruction (deleted in rev.03) for the inner surface by following the next instructions that have been studied in the way of impact as less as possible this requirement. Similar instructions are already agreed for the fabrication of the components, and what are shown below:

- Manual brushing:

Brushes with 300 series stainless steel spikes and never before used in another material that could contaminate or damage the component's stainless steel material.

- Electrical brushing:

Brushes with 300 series stainless steel spikes and never before used in another material that could contaminate or damage the component's stainless steel material.

Rotation speed must be as low as possible.

See following section §8.3 for limitations.

- Soft grinding:

All interior areas of the equipment must be protected from a handle that does not include inclusions derived from the grinding operation. The treated surface should have a smooth transition appearance without steps.

Preferably to use grain size range not coarser than Nr.120.

Abrasive agent with aluminum base and which only has been used for this type of material.

Rotation speed must be as low as possible.

See following section §8.3 for limitations.

- <u>Coarse grinding (limited use):</u>

Only when soft grinding is not enough.

After this operation, soft grinding must be applied.

Preferably to use grain size range not coarser than Nr.120.

Abrasive agent with aluminum base and which only has been used for this type of material.

Rotation speed must be as low as possible.

See following section §8.3 for limitations.

8.3. Particularities of the application of this instruction

For the INNER final surface this cleaning instruction should be applied only if necessary and following this specific sequence:

1. manual brushing.
2. electrical brushing (at the lowest speed at which work can be done).
3. soft grinding.

And following the specific notes:

a. manual brushing can be applied at all welding surface.

b. electrical brushing can be applied if manual is not able to clean the surface.

c. soft grinding is only approved when the mechanical dimensions are outside of specifications, the use shall be restricted to strictly necessary areas.

8.4. Repair plan

In case of detection of any rejectable indication on welds or base material after performing NDT, the reparation instructions to follow are:

8.4.1. Surficial defects on welds:

- Temporal marking and record (report) of the area.
- To grind the area to be repaired according to methods described in sections §8.2 & §8.3.
- Complete weld thickness if necessary (reparation cycle #1)
- New performance of NDT *SEE NOTE 1

8.4.2. Internal defects on welds:

- Temporal marking and record (report) of the area.
- To grind the area to be repaired according to methods described in sections §8.2 & §8.3

- Complete weld thickness (reparation cycle #1)
- New performance of NDT *SEE NOTE 1

8.4.3. Surficial defects on base material:

- Temporal marking and record (report) of the area.
- To grind the area to be repaired according to methods described in sections §8.2 & §8.3.
- Confirm with ESS if material in this area is thick enough and the way to proceed. Proposal in case of need is to complete thickness with surfacing welding by using the approved welding documentation for the project (reparation cycle #1).
- New performance of NDT *SEE NOTE 1

** NOTE 1: In case of new performance of NDT detects new rejectable defects ENSA will issue a non-conformity report and will send it for ESS's approval in order to agree the way to proceed.*

8.5. Surface alignment

Where there is misalignment at the inner surface between parts of the same nominal thickness the transition across the weld shall be smooth and gradual with a slope of 1 in 4 over the width of the weld. If this taper cannot be accommodated within the weld width it is permissible to either:

a) grind the higher plate surface (considering §8.2), where this will not reduce the joint thickness at any point below the nominal specified plate thickness minus the plate thickness tolerance;

b) build up the lower plate surface with added weld metalOn the outer surface this requirement can be accomplished where accessible.

9. DEFINITION OF NDTs METHODS

In this section it is showed a detailed analysis of the examinations of the welds. Despite it is focused on Port Tube components, same considerations shall be made on NNBar Frame and Connection Pipe components.

9.1. Examinations prior welding:

No special contractual requirements regarding examinations before welding are required. Meeting EN 13445-5, section §6.4.2, a **visual examination** shall be performed to the weld edge preparation of the components before welding operation. These examinations will be carried out on Port Tubes and NNBar Frame components at the very final stage of the fabrication, so there is no need to repeat this operation on site. A verification by the welding operator before welding is enough but must be repeated in case of any issue has been detected during this verification.

In the same case the Vessel and the Connection Pipe should have this test done before the positioning of the components.

Additionally, 100% **dye penetrant test** will be performed on Port Tubes and NNBar Frame components at the very final stage of the fabrication and before shipping, and Ensa recommends performing it on Vessel and Connection Pipe.

9.2. Examinations during and after welding:

Welds and adjacent areas shall have a proper surface finish that allow to carry out a proper examination. That means that grinding operations will be performed on the inner side of components in order to reach the best conditions for the examination. See section §8.2

- During welding:
    - VT and PT after root weld and where achievable. Will be performed as an in-process check.

- After welding:
    - 100% VT by the weld surface side + where achievable by the root weld side***NOTE**.
    - 100% PT by the weld surface side + where achievable by the root weld side.
    - RT inspection to an extent as high as possible, but at least 10% of the welding total length.

***NOTE**: *Additional checking with endoscope will be performed on the root side of the welds.*

9.3. Dye penetrant testing chemicals

Dye penetrant testing consumables for non destructive testing shall comply:

METHOD	BRAND NAME	CLEANER	PENETRANT	REMOVER	DRYING	DEVELOPER
SOLVENT REMOVABLE	CRC	CRICK 110	CRICK 120	CRICK 110	By natural evaporation	CRICK 130

10. DEFINITION OF INSTALLATION SEQUENCE

The Monolith Vessel's shell has a thickness of 25mm, and the thickness increases to 50mm in the windows where the components will be welded. Despite the welding thickness is 5 to 5mm (Connection Pipe) 8 to 8mm (Port Tubes) and 10 to 10mm (NNBar) it must be considered that there are 41 components to weld all around to a stainless steel vessel and the risk of global distortion has to be studied because, amongst others, the equipment are floating (§5.1). In this section the Connection Pipe equipment has not been analyzed since it is not considered a risky operation, can be welded independently from the Port Tubes or NNBar and its geometry and localization do not impact on the rest of equipment.

Considering the Port Tubes and the NNBar, here lays the importance of an alternated welding sequence searching to reduce as much as possible accumulated tensions and heat provided to the components, searching as less distortion in components as possible.

The hardest access weld identified is the NNBar Frame one due to the geometrical restrictions imposed by the North and West carbon steel bottom plates, the NNBar's base plate, the NNBar's Top plate itself and the small distance to the immediate neighbors Port Tubes. That is the main reason to decide not to assembly the neighbors Port Tubes before the NNBar is completely welded and tested.

For the works, 3 welders working simultaneously in 3 different ports have been considered.Based on that, Ensa's proposal is:

A) To tack weld weld NNBar and 33 Port Tubes (all except the 6 neighbors to NNBar, see figure 16)

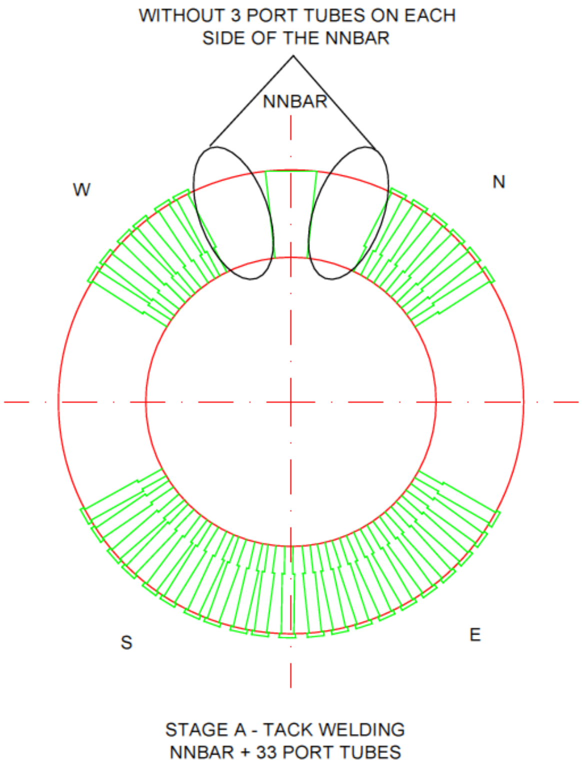


Fig. 16 – Neighbor Port Tubes

To tack weld all these equipment to the vessel helps to keep the whole Vessel fixed since this works as an stiffener.

There is not a preferred order of tack welding the equipment.

The equipment must comply assembly requirements (figs 3 & 4) at the very moment of the tack welding operation, that means that alignment status will be checked just before tack welding, and that, for assembly operations, it must be considered that tack welding operation on one port could affect to the rest of assembled (but not tack welded) ports, therefore in case of decision of assembly several ports before tack welding, it should be expected a light correction of the position of the ports just before tack weld each one.

B) To finish 15 Port Tubes previously tack welded.

In the figure 17 it is shown the proposed sequence. This sequence should be taken as an example, the final sequence should be agreed between Ensa and ESS.

The aim of this sequence is to start welding Port Tubes in a “comfortable” position, therefore, from Port Tube #1 to #15 they are not consecutive, there is at least one Port Tube tack welded between 2 Port Tubes welded. This allows to remove the tack welds of the neighbour Port Tubes in case of need, and gain access for a possible reparation.

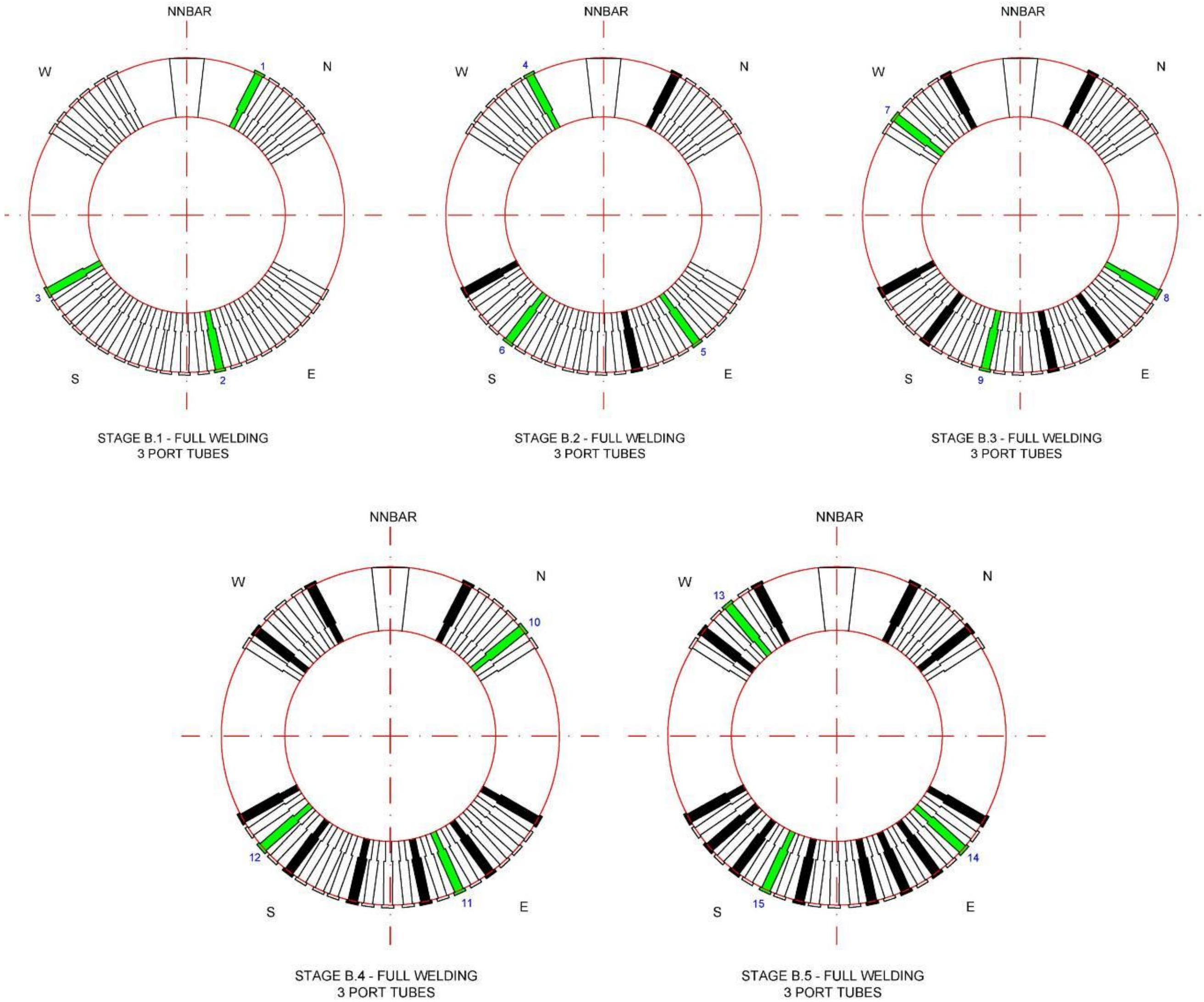


Fig. 17 – Proposed first 15 Port Tubes.

C) To finish NNBar, including NDTs

Once 15 Port Tubes are completely welded a good position on the learning curve will have been reached. Next step is to fully weld NNBar and perform the NDTs to existent welds. Figure 18.

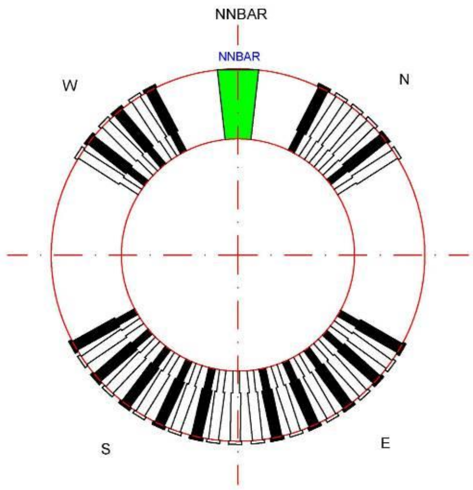


Fig. 18 – Finish NNBar.

D) To tack weld 6 remaining Port Tubes

After successful NDT's results on NNBar, the risk of lack of access for a repair due to closing the space near NNBar is reduced. Figure 19.

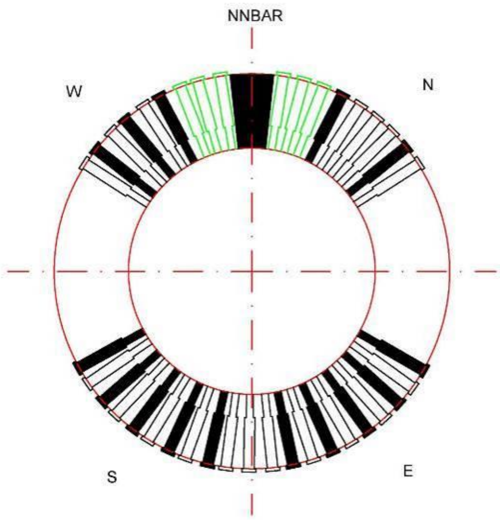


Fig. 19 – Tack weld of remaining 6 Port Tubes.

E) To finish welding all the remaining Port Tubes

In this stage the rest of Port Tubes can be also completely welded. Figure 20.

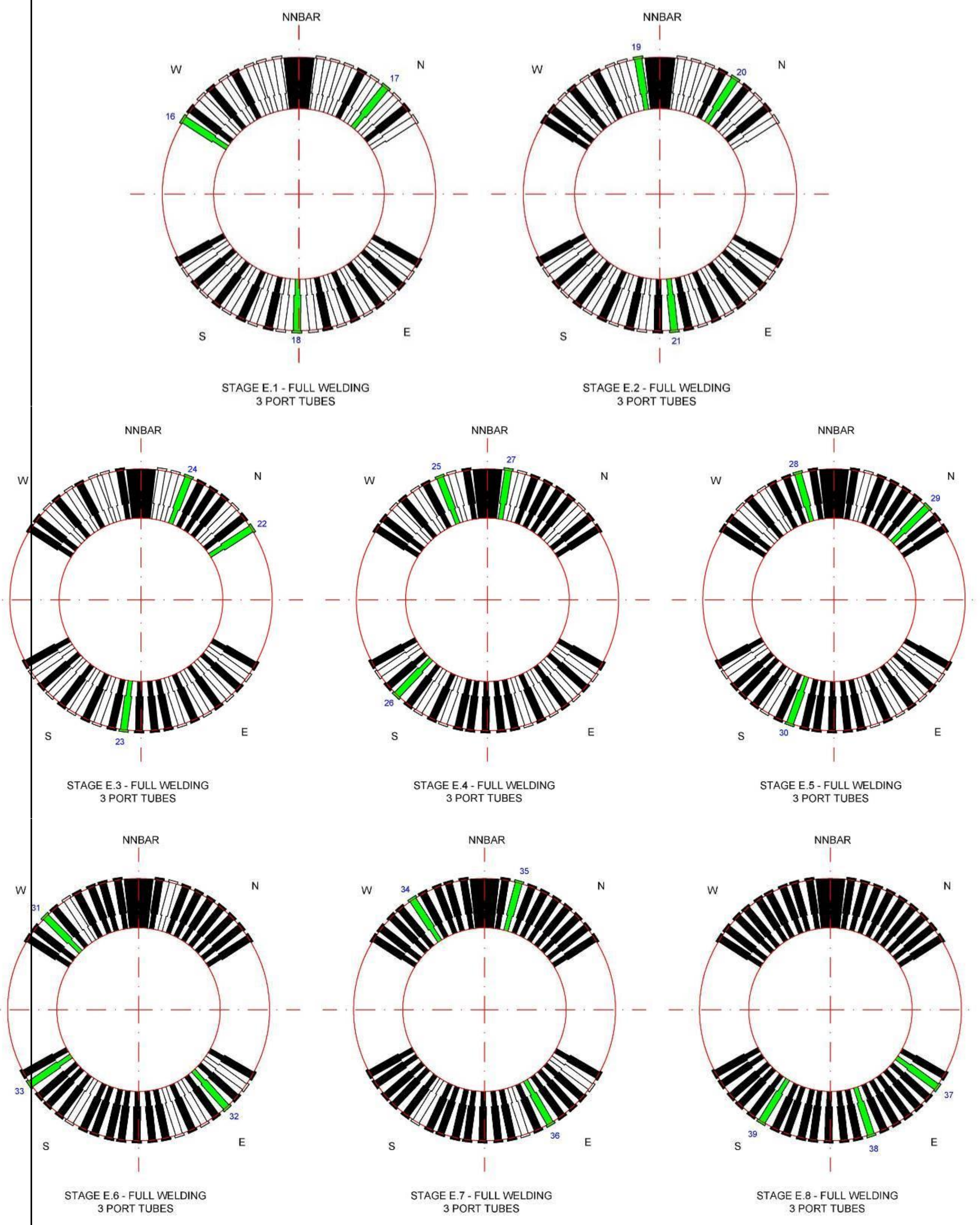


Fig. 20 – Complete weld of remaining Port Tubes.

10.1. Summary

Step	Operation	Ports
A	Tack weld 33 Port Tubes + NNBar	33 PT + NNBar
B	Complete weld of 15 Port Tubes	15 PT
C	Complete weld of NNBar	NNBar
D	Tack weld of remaining 6 Port Tubes	6 PT
E	Complete remaining welds	24 PT

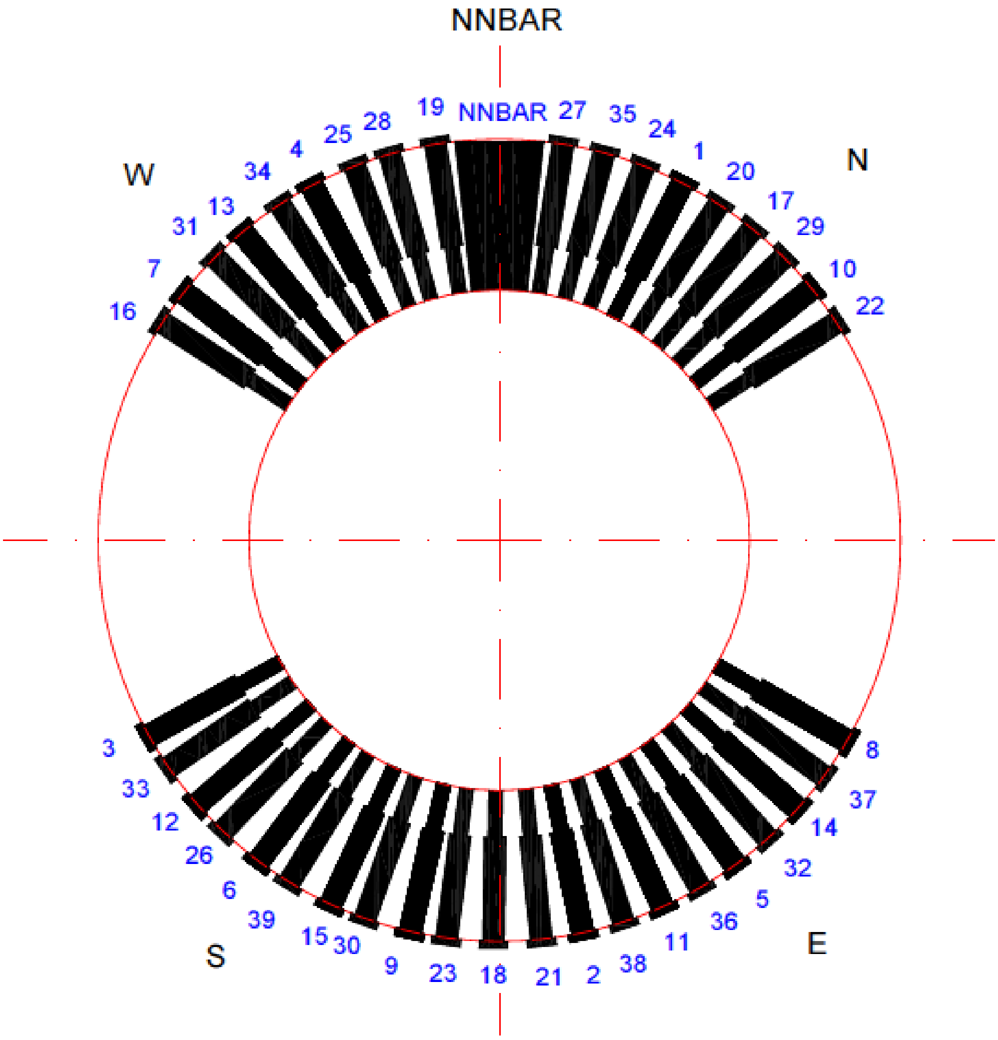


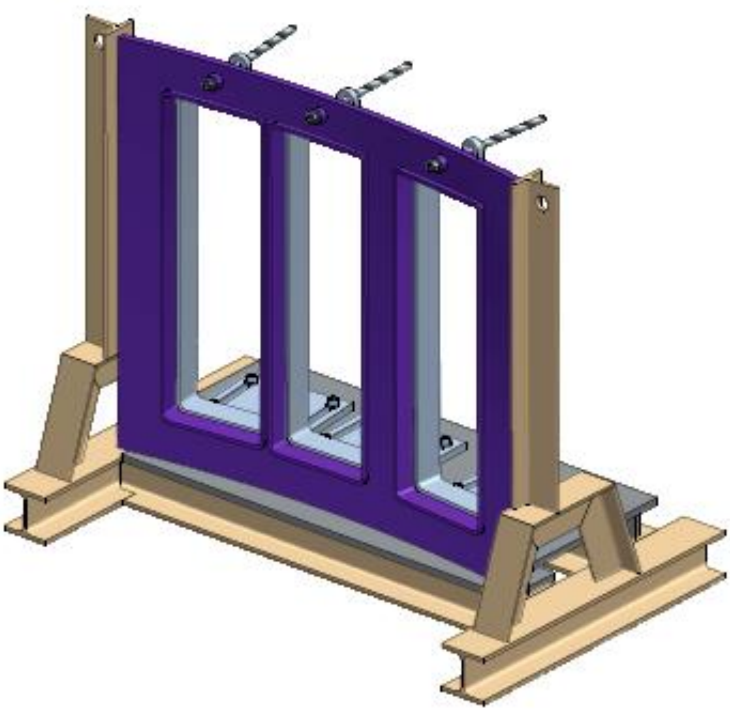
Fig. 21 – Complete weld sequence

11. DEFINITION OF MOCK-UP

Due to the geometrical difficulties of the welding operations Ensa have fabricated a mock-up for:

- Training the backing system assembly.
- Checking the welders accessibility for achieving a good weld quality and a proper realization of the works.
- Checking the correct accessibility for the performance of proposed NDTs.

The mock up is made of standard 1.4404 material and consists in a model that represents 3 Port Tubes "Windows".



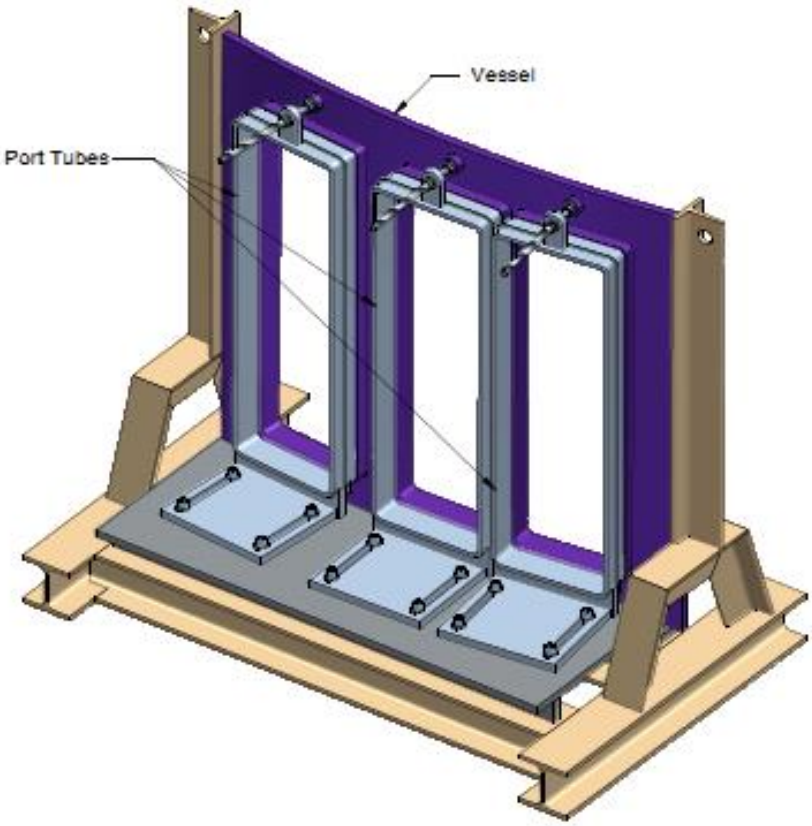


Fig. 23 & 24 - Mock up design

12. CONCLUSIONS

After the study of all the above points the conclusions after Ensa's analysis are:

- Preferably **sequence of assembly** is to tack weld 33 Port Tubes (all the Port Tubes except the neighbors to NNBar) and NNBar Frame. Section §10.1.
- (Deleted in rev.03)
- Regarding **shrinkage**, it is expected to have a reduction in the radial direction of the components (Port Tubes and NNBar Frame) of about 2 to 4mm. Section §7.5
- No **deviations** on tangential or height position are expected provided that the Port Tube component is bolted to the Port Block Bottom Plate and properly fixed. Sections §7.3 & 7.4
- Expected **local deformation** in welding section is that the vertical welds will move away from the position before welding (sides will become wider) but required shape tolerance compared to the status before welding can be met. Section §7.5

- To **grind** welds and adjoining base material surfaces (~50mm wide) is necessary for a proper quality and examination of the works done. Section §8.1
- To perform RT to an extent as high as possible, but **at least 10%** of the welding total length. Section §9.2

ANNEX A - PQR-012-BUTT WELD

PROTOKOLL FRÅN PROCEDURKVALIFICERING (WPQR)
WELDING PROCEDURE QUALIFICATION, TEST CERTIFICATE (WPQR)

ÅF-KONTROLL

SWEDAC ACKREDITERING 4390 EN 45 004 (A)

WPQR-nr/WPQR No.	Referens nr/Reference No.	Uppdragsnr/Comm. No.	Sida/Page
012	ÅFS/575	200111	1(3)

Tillverkare / Manufacturer	**Equipos Nucleares S.A.**
Adress / Address	**Juan Carlos I, 8, 39600 Maliaño (Cantabria) SPAIN**
Provningsstandard / Code/testing standard	**EN ISO 15614-1:2004**
Datum för svetsningen / Date of welding	**2006-09-21**

Kvalificeringens giltighetsområde/ Range of qualification

Svetsmetod / Welding process	**141 (manual)**
Förbandstyp och svetstyp / Type of joint and weld	**BW: ss nb, ss mb, bs, FW** **Branch connections with an angle ≥ 60°**
Grupp(er) och undergrupp(er) för grundmaterial / Parent material group(s) and sub group(s)	**8.1 according to CR/ISO 15608:2000**
Grundmaterialets tjocklek (mm) / Parent Material Thickness (mm)	**BW: 3-22 FW: 5,5 – 13,2**
Svetsgodstjocklek (mm) / Weld Metal Thickness (mm)	**3 – 22**
a-mått (mm) / Throat Thickness (mm)	**No restriction**
Enkelsträng/Flera strängar / Single run/Multi run	**Multi run**
Ytterdiameter rör (mm) / Outside Pipe Diameter (mm)	**≥ 37,5**
Tillsatsmaterial, beteckning / Filler Material Designation	**EN 12072: G 19 12 3L**
Tillsatsmaterial, fabrikat / Filler Material Make	**OK Autrod 16.30**
Tillsatsmaterial, diameter (mm) / Filler Material Size (mm)	**1,2**
Beteckning skyddsgas/pulver / Designation of Shielding Gas/Flux	**EN 439-I1**
Beteckning rotskyddsgas / Designation of backing gas	**EN 439-I1**
Typ av ström och polaritet / Type of Welding Current and Polarity	**DC-**
Sätt för droppövergång / Mode of Metal Transfer	**-**
Sträckenergi / Heat Input	**(Max: 0,6 kJ/mm)**
Svetslägen / Welding positions	**All positions except for PG and J-L045**
Förhöjd arbetstemperatur / Preheat Temperature	**Min +20 °C**
Mellansträngstemperatur / Interpass Temperature	**Max 160 °C**
Väteutdrivning / Post-Heating	**-**
Värmebehandling efter svetsning / Post-Weld Heat Treatment	**-**
Annan upplysning / Other information	**-**

Härmed intygas att provsvetsar bereddes, svetsades och provades med tillfredsställande resultat enligt fordringarna i ovan angiven provningsstandard. / Certified that test welds prepared, welded and tested satisfactorily in accordance with the requirements of the code/testing standard indicated above.

Plats/Place	Utskriftsdatum/Date of issue	Granskare/Examiner
Sundsvall	**2006-11-08**	**Karin Velander**
....	....	Karin Velander

Provningen är utförd av ackrediterat laboratorium. Svetsövervakningen är utförd av examinerad svetskontrollant och granskningen är utförd av ackrediterat kontrollorgan. / The testing is carried out by an accredited laboratory. The welding supervision is performed by an examined weld inspector and the scrutiny is carried out by an accredited inspection body.

PROTOKOLL FRÅN
PROCEDURKVALIFICERING (WPQR)
WELDING PROCEDURE QUALIFICATION,
TEST CERTIFICATE (WPQR)

ÅF-KONTROLL

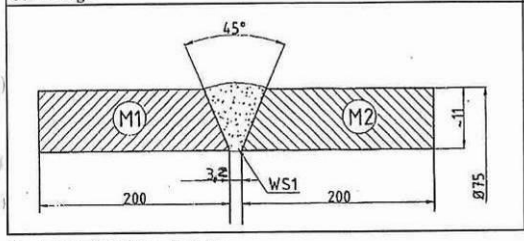
SWEDAC ACKREDITERING
4390
EN 45 004 (A)

WPQR-nr/WPQR No.	Referens nr/Reference No.	Uppdragsnr/Comm. No.	Sida/Page
012	ÅFS/575	200111	2(3)

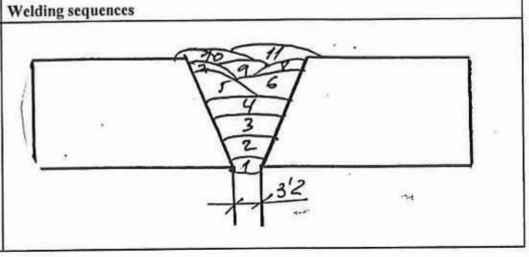
Record of weld test

Location	Cantabria	Method of Preparation and Cleaning	Grinding
Manufacturer's pWPS No	012	Parent Material Specification	ASME SA213 – TP304L
Welder's Name	101295/110270	Material Thickness (mm)	11
Manufacturer	Equipos Nucleares S.A.	Outside Pipe Diameter (mm)	75
Mode of Metal Transfer	-	Welding Position	PA
Joint Type and Weld	BW, ss, nb		

Joint design



Welding sequences



Svetsdata/Welding details

Run	Process	Size of Filler Material (mm)	Current (A)	Voltage (V)	Type of current Polarity	Wire feed speed (m/min)	Travel speed* (mm/min)	Heat input* (kJ/mm) Incl k	Metal transfer
1	141	1.2	60/65	10	DC-	-	50	0,45	-
2	141	1.2	85	10,3	DC-		-	-	
3	141	1.2	110	10,4	DC-		-	-	
4	141	1.2	125	11	DC-		10	0,50	
5-6	141	1.2	140	11	DC-		-	-	
7-9	141	1.2	130	10,6	DC-		-	-	
10-11	141	1.2	130	10,5	DC-		-	-	

Filler Material Designation and Make		EN 12072: G 19 12 3L OK Autrod 16.30	Weaving (max. width of run)	string
Any Special Baking or Drying		-	Oscillation: amp. freq. dwell time	-
Gas/Flux	shielding	Ar 99,99%	Pulse welding details	-
	backing	Ar 99,99%	Distance contact tube/work piece	-
Gas Flow Rate	shielding	10-11 l/min	Nozzle diameter	Gas cup size: 16 mm
	backing	5-9 l/min	Plasma welding details	-
Tungsten Electrode Type/Size		EN 26848 WL20 Ø2.4 2% Th.	Torch angle	-
Details of Back Gouging/Backing		NA	Post-Weld Heat Treatment	-
Preheat Temperature		+20 °C	Time, Temperature, Method	-
Interpass Temperature		Max 160 °C	Heating and Cooling Rates*	-
Post-Heating		-	Other information*	incl k= thermal efficiency factor 141: 0,6

Tillverkare/Manufacturer Namn, datum, signatur Name, date and signature	Equipos Nucleares S.A. Rafael Cardoso	Granskare/Examiner Namn, datum, signatur Name, date and signature	ÅF-Kontroll AB Karin Velander 2006-11-08 Karin Velander

WPQR rev. 0

PROTOKOLL FRÅN PROCEDURKVALIFICERING (WPQR)
WELDING PROCEDURE QUALIFICATION, TEST CERTIFICATE (WPQR)

ÅF-KONTROLL

SWEDAC ACKREDITERING 4390 EN 45 004 (A)

WPQR-nr/WPQR No.	Referens nr/Reference No	Uppdragsnr/Comm. No.	Sida/Page
012	ÅFS/575	200111	3(3)

Provningsresultat/Test results

Visuell inspektion Visual examination	Enligt krav /Acceptable	**Radiografisk provning*** Radiography*	Enligt krav /Acceptable
Penetrant, magnetpulverprovning* Penetrant, magnetic particle test*	Enligt krav /Acceptable	**Ultraljudprovning*** Ultrasonic*	-

Dragprovning/Tensile Tests: EN 895 **Temperatur/Temperature: +20 °C**

Typ nr/Type No	Rp0,2 N/mm²	Rm N/mm²	A %	Z %	Brottställe Fracture location	Anmärkning Remarks
Fordran Requirement		Min 485				
T1, T2	-	597, 605			Base metal/Base metal	

Bockprovning/Bend Tests: EN 910 **Dorndiameter/Former Diameter: 40 mm**

Typ nummer/Type No.	Bockningsvinkel/Bend angle	Förlängning*/Elongation*	Resultat/Results
FB-1	180°		Enligt krav /Acceptable
RB-1	180°		Enligt krav /Acceptable
FB-2	180°		Enligt krav /Acceptable
RB-2	180°		Enligt krav /Acceptable

Slagprovning*/ Impact Test*: NA **Typ/ Type:** **Storlek/ Size:** **Fordran/ Requirement:**

Anv. läge/riktning Notch locations/directions	Temperatur °C Temperature °C	Värden Values 1	2	3	Medelvärde Average	Anmärkning Remarks

Hårdhetsprovning*/Hardness Test*: NA

		Mätpunkternas lägen (skiss) * Location of measurements (sketch)*
Typ/Provkraft Type/Load		
Grundmaterial Parent material		
HAZ HAZ		
Svetsgods Weld metal		
Anmärkningar Remarks		

Makroundersökning/Macro examination: ☒ Enligt krav /Acceptable

Mikroundersökning/Micro examination: ☐

Proven utförda enligt fordringarna angivna i Test carried out in acc. with the requirements of	EN ISO 15614-1:2004
Laboratorierapport, referensnummer Laboratory report, reference No.	WR 3281, PT 4924, RT 8099, PM 11805, EM-6244
Provningsresultat Test results	Enligt krav /Acceptable
Proven utförda i närvaro av Test carried out in presence of	ÅF-Kontroll AB, Thomas Carlström

Granskarens namn, datum, signatur Examiner name, date and signature	ÅF-Kontroll AB, 2006-11-08, Karin Velander Karin Velander

* Om så erfordras/If required

WPQR rev. 0

ANNEX B – (DELETED IN REV.01)

ANNEX C - WPS-5EC8WT201

ensa

ESPECIFICACION DEL PROCEDIMIENTO DE SOLDADURA (WPS)
WELDING PROCEDURE SPECIFICATION (WPS)

WPS NO. **5EC8WT201**
PAG Nº / SHEET 1 / 3
REV. No. 02

EN ISO 15609-1

PQRs
WPQR-012 WPQR-010

PROYECTO / PROJECT	CLIENTE / CLIENT	COMPONENTE / COMPONENT	CONTRATO / CONTRACT	APLICACION / APPLICATION
ESS MONOLITH PORT TUBES WELDS ON FIELD	ESS BILBAO	NEUTRON PORT TUBE	5EC8	MANUFACTURE

WPS No. 5EC8WT201 — REV. No. 02 — DATE 25-1-2021

PROCESO/s DE SOLDADURA / WELDING PROCESS: 141 (EN ISO 4063)

TIPO (S) / TYPE (S):
- [X] MANUAL / MANUAL
- [ ] PARCIALMENTE MECANIZADO / PARTIALLY MECHANISED
- [ ] AUTOMATICO / AUTOMATIC

OBJETO / SUBJECT

SOLDADURA ENTRE MATERIALES GR.8.1 MEDIANTE PROCESO 141 MANUAL
WELDS BETWEEN GR.8.1 BASE METALS BY MEANS OF 141 MANUAL PROCESS

JUNTA/ ASSEMBLY

DISEÑO DE LA JUNTA / JOINT DESIGN: SEE SKETCH IN PAGE 3 & NOTE 5 / Ver sketch y nota 5

RESPALDO / BACKING: [X] SI / YES — [X] NO / NO

MATERIAL DEL RESPALDO / BACKING MATERIAL: BASE METAL OR WELD DEPOSIT (SEE NOTE 6) / Material base o soldadura (ver nota 6

METODO DE ELIMINACION DEL RESPALDO / BACKING ELIMINATION METHOD: [ ] SI / YES — [X] NO / NO
- [ ] AMOLADO / GRINDING
- [ ] MECANIZADO / MACHINNING

PREPARACIÓN DE LA JUNTA, LIMPIEZA INICIAL Y ENTREPASADAS / METHOD OF GROOVE PREPARATION INITIAL AND INTERPASS CLEANING
- [X] CEPILLADO / BRUSHING
- [X] AMOLADO / GRINDING
- [X] OTROS (MECANIZADO) / OTHER (MACHINING)

METAL BASE / BASE METAL

AGRUPAMIENTO Y ESPEC. DE MATERIAL BASE (s/ ISO/TR 15608) / BASE MATERIAL SPEC. & GROUPING (acc. to ISO/TR 15608 / 2000): Gr. 8.1 a/to Gr. 8.1

RANGO DE ESPESOR / THICKNESS RANGE
- MATERIAL BASE / BASE METAL: BW : 3-22 mm; FW : ≥ 5 mm
- DEPOSITO / WELD METAL: BW : 3--22mm; FW : no restriction / sin restricción

DIAMETRO / DIAMETER: (Ø>500 mm) ó/or (Ø>150 mm PA/PC Rotating / rotando)

MATERIAL DE APORTE / FILLER METAL

MAT. DE APORTE / FILLER METAL: [X] SI / YES — [ ] NO / NO

CLASIFICACION, FABRICANTE, NONBRE COMERCIAL... / CLASSIFICATION, MANUFACTURER, TRADE NAME...: EN 12072 / EN ISO 14343: G/W 19 12 3L (Note 4 / Nota 4)

FLUX CLAS., NOMBRE COMERCIAL... / FLUX (CLASSIF.TRADE NAME...): N. App.

FORMA DEL PRODUCTO DEL HILO (SOLIDO,TUBULAR...) / FILLER WIRE PRODUCT FORM (SOLID FLUX CORED....)
- [X] SOLIDO / SOLID
- [ ] TUBULAR / FLUX CORED
- [ ] METAL CORED / METAL CORED

POSICION / POSITION (EN ISO 6947)

POSICION DE SOLDADURA / WELDING POSITION: All except PG & J-L045 / Todas excepto PG & J-L045

PROGRESION DE SOLDADURA / WELDING PROGRESSION: PF [X] ASCEND. / UPWARD — [ ] DESCEND. / DOWNWARD

OTROS / OTHER: N. App.

PRECALENTAMIENTO / PREHEATING

TEMP. DE PRECALENTAMIENTO / PREHEATING TEMPERATURE: Sin / Without — Nota 2 / Note 2

TEMP. ENTRE PASADAS / INTERPASS TEMPERATURE: 140ºC max.

POST CALENTAMIENTO / POSTHEATING HYDROGEN BAKE: N. App.

TRATAMIENTO TERMICO / HEAT TREATMENT

RANGO DE TEMPERATURA / TEMPERATURE RANGE: N. App.

DURACION / TIME RANGE: N. App.

OTROS / OTHERS: N. App.

WPS NO. 5EC8WT201

ESPECIFICACION DEL PROCEDIMIENTO DE SOLDADURA (WPS)
WELDING PROCEDURE SPECIFICATION (WPS)

PAG Nº / SHEET 2 / 3
REV. No. 02

EN ISO 15609-1

VARIABLES GENERALES PARA LOS DIFERENTES PROCESOS / GENERAL VARIABLES FOR THE DIFFERENT PROCESSES

- OSCILLACION / OSCILLATION: [X] SI / YES [X] NO / NO
- ANCHURA / WIDTH: max. 10 mm
- FRECUENCIA / FREQUENCY: N. App
- DISTANCIA AL TUBO DE CONTACTO / CONTACT TUBE TO WORK (For 12 process only / solo para proceso 12): N. App
- TAMAÑO DE LA BOQUILLA DE GAS / GUS CUP SIZE: 5-20 mm
- TIPO Y TAMAÑO DEL TUNGSTENO / TUNGSTEN ELECTRODE SIZE AND TYPE: EN ISO 6848 WCe20, WLa15, WLa20; [Ø2.4, 3.2, 4mm] Note 3 / Nota 3
- PASADA MULTIPLE O UNICA / SINGLE OR MULTIPLE PASS: [X] MULT. / MULT [ ] SINGLE / SIMPLE
- ELECTRODO/s MULTIPLE O UNICO / MULTIPLE OR SINGLE ELECTRODE(S): [X] UNICO / SINGLE [ ] MULTIPLE / MULTIPLE
- OTROS / OTHERS

GAS / GAS (EN ISO 14175)

- COMPOSICION Y CLAS. DEL GAS DE PROTECCION / SHIELDING GAS CLASS AND COMPOSITION: I1 (Ar 99,99%)
- COMPOSICION Y CLAS. DEL GAS DE RESPALDO / GAS BACKING CLASS AND COMPOSITION: I1 (Ar 99,99%)
- CAUDAL / FLOW RATE:
  - PROTECION / SHIELDING: 7-20 l/min
  - RESPALDO / BACKING: 5 mini l/min
- OTROS / OTHERS

GAS BACKING IS NOT MANDATORY FOR TEMPORARY ATTACHMENTS WHICH REMAINING THICKNESS IS 5mm MINIM.
El gas de respaldo no es mandatorio para attachments temporales cuyo espesor remanente sea de 5mm minim.

DETALLE DE PARAMETROS Y CARACTERISTICAS ELECTRICAS / DETAIL OF WELDING PARAMETERS AND ELECTRICAL CHARACTERISTICS

- CORRIENTE / CURRENT: [ ] AC [X] DC
- POLARIDAD / POLARITY: [ ] EP [X] EN
- CORRIENTE PULSADA (Si es aplicbale) / PULSED CURRENT (If applicable): [ ] SI / YES [X] NO / NO
- APORTE TERMICO CUALIFICADO / QUALIFIED HEAT INPUT (EN ISO 1011-1): N.App. kJ/mm

MODO DE TRANSFERENCIA PARA PROCESOS 131,135,136 & 137 / TRANSFER MODE FOR 131,135,136 Y 137 PROCESSES
[ ] SPRAY / SPRAY. [ ] GLOBULAR / GLOBULAR [ ] PULSADO / PULSATING [ ] CORTO CIRCUITO / SHORT CIRCUITING

SECUENCIA DE SOLDADURA / WELD SEQUENCE	PROCESO DE SOLDADURA / WELDING PROCESS	MATERIAL DE APORTE / FILLER METAL	TAMAÑO / SIZE OF FILLER (mm)	AMPERAJE (RANGO) / AMPERAGE (RANGE) (Amps.)	VOLTAJE (RANGO) / VOLTAGE (RANGE) (Volts.)	VELOCIDAD (RANGE) / TRAVEL SPEED (RANGE) (mm/min.)	APORTE TÉRMICO / HEAT INPUT (Kj/mm)	CUALIFICACIÓN DE SOLDADOR / WELDER QUALIFICATION
WS0 (tack/punteo)	141	W/G 19 12 3L	Ø0,8; Ø0,9 Ø1,0; Ø1,2 Ø1,4; Ø1,6 Ø1,8; Ø2,0; Ø2,4	50-130	8-12 info.	--	-	I-001 / I-006
WS1 (root/raíz)	141	W/G 19 12 3L	Ø0,8; Ø0,9 Ø1,0; Ø1,2 Ø1,4; Ø1,6 Ø1,8; Ø2,0; Ø2,4	50-130	8-12 info.	45 min, info	-	I-001 / I-006
WS2 2 (relleno/filling) (back run)	141	W/G 19 12 3L	Ø0,8; Ø0,9 Ø1,0; Ø1,2 Ø1,4; Ø1,6 Ø1,8; Ø2,0; Ø2,4	70-160	8-15 info.	70 min. info	-	I-001 / I-006

ESPECIFICACION DEL PROCEDIMIENTO DE SOLDADURA (WPS)
WELDING PROCEDURE SPECIFICATION (WPS)

WPS NO. 5EC8WT201
PAG Nº / SHEET 3 / 3
REV. No. 02

EN ISO 15609-1

NOTAS / NOTES — **INFORMACION ADICIONAL / ADDITIONAL INFORMATION**

1) *THE SKETCH IS ONLY FOR INFORMATION. FOR ACTUAL MEASURES SEE THE CORRESPONDING DRAWINGS.*
Los dibujos en esta WPS son para información. Para medidas reales, ver el plano aplicable.

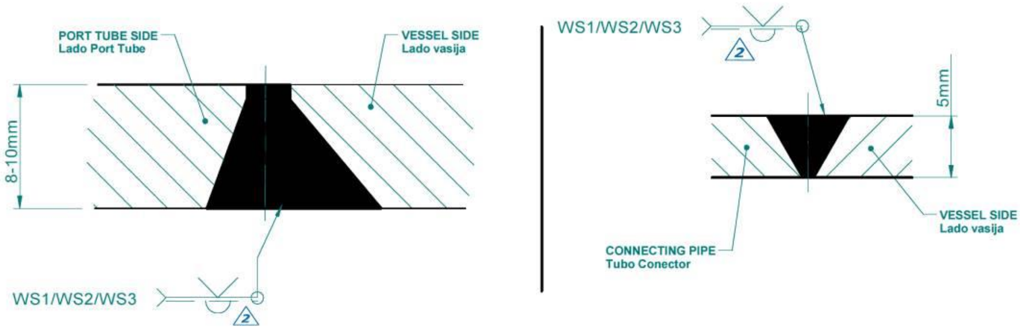
2) *IT IS FORBIDDEN TO WELD IF THE ROOM TEMPERATURE IS BELOW -10ºC. THE PART MUST BE KEPT AT A TEMPERATURE OF AT LEAST 5ºC AND COOLING AFTER WELDING SHALL BE SUFFICIENTLY SLOW TO AVOID CRCKING.*
Está prohibido soldar si la temperatura ambiente está por debajo de -10ºC. La pieza se ha de mantener al menos a 5ºC y el enfriamiento tras la soldadura será suficientemente lento como para evitar agrietamiento.

3) *OR ANY TUNGSTEN ACCORDING TO EN ISO 6848.*
Ó cualquier otro tungsteno según EN ISO 6848.

4) *FOR DRYING AND STORAGE OF FILLER METAL SEE GP 10.8 OR APPLICABLE DOCUMENT IF WELDING IS NOT CARRIED OUT AT ENSA´s FACILITIES*
Para secado y almacenaje de material de aporte ver GP 10.8 o documento aplicable si la soldadura no se realiza en las instalaciones de ENSA:

5) *THIS WPS IS EQUALLY VALID FOR WELDING OF WELDING TEMPORARY ATTACHMENTS (E.G. TOOLING) , WITHIN THE QUALIFIED RANGES. THE MAY BE WELDED BY MEANS OF FILLET WELD, BUTT WELD OR T JOINT.*
Esta wps es igualmente valida para la soldadura de attachments temporales (p.ej utillajes), dentro de los rangos cualificados. Podrán ser realizadas mediante soldadura fillet, a tope o en T.

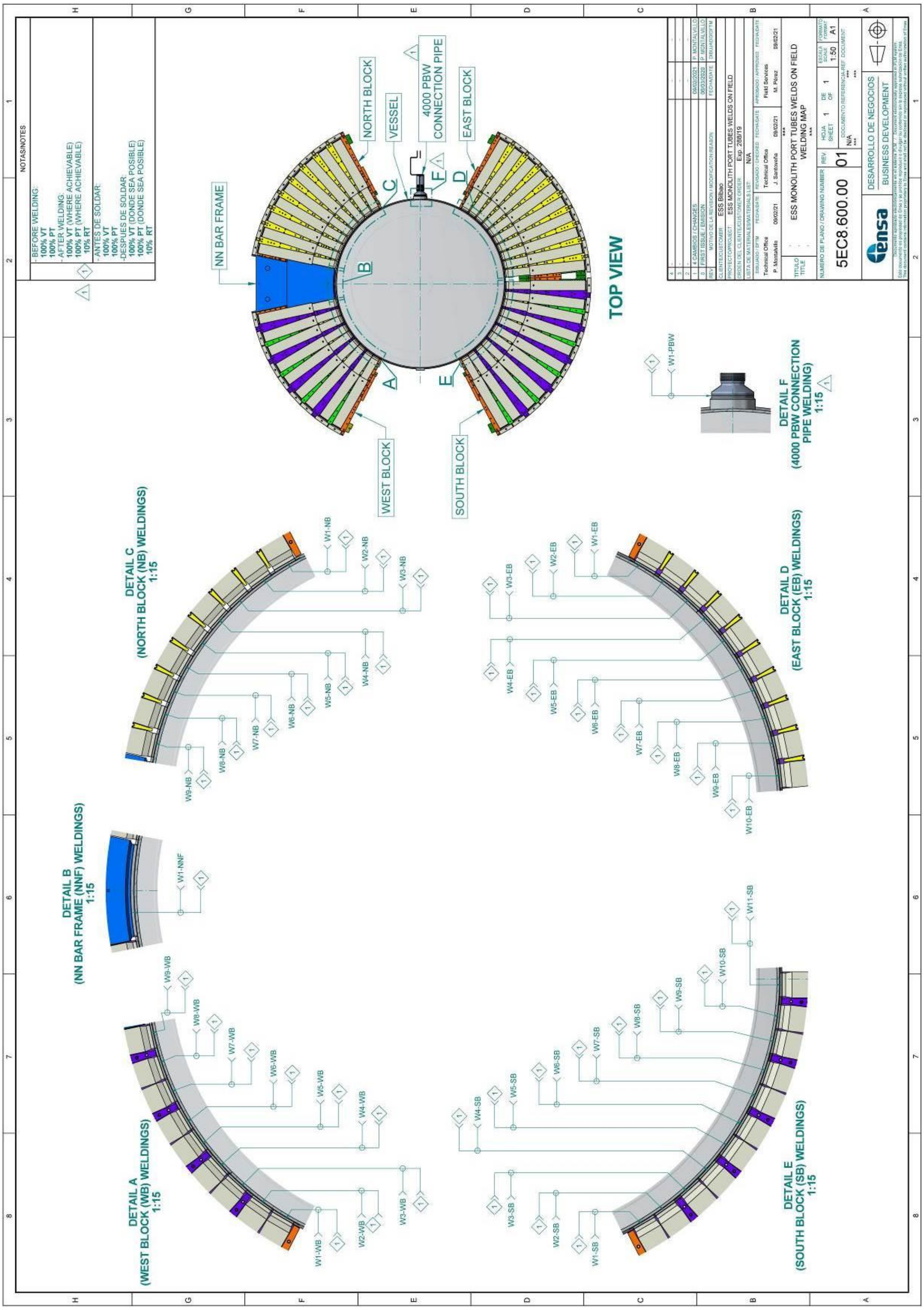
6) *WELDER QUALIFICATION I-001 IS REQUIRED FOR BUTT WELD ONLY. I-006 IS REQUIRED FOR FILLET WELD.*
La cualificacion de soldadores I-001 se requiere para soldadura a tope. La cualificacion I-006 se requiere para soldadura fillet.



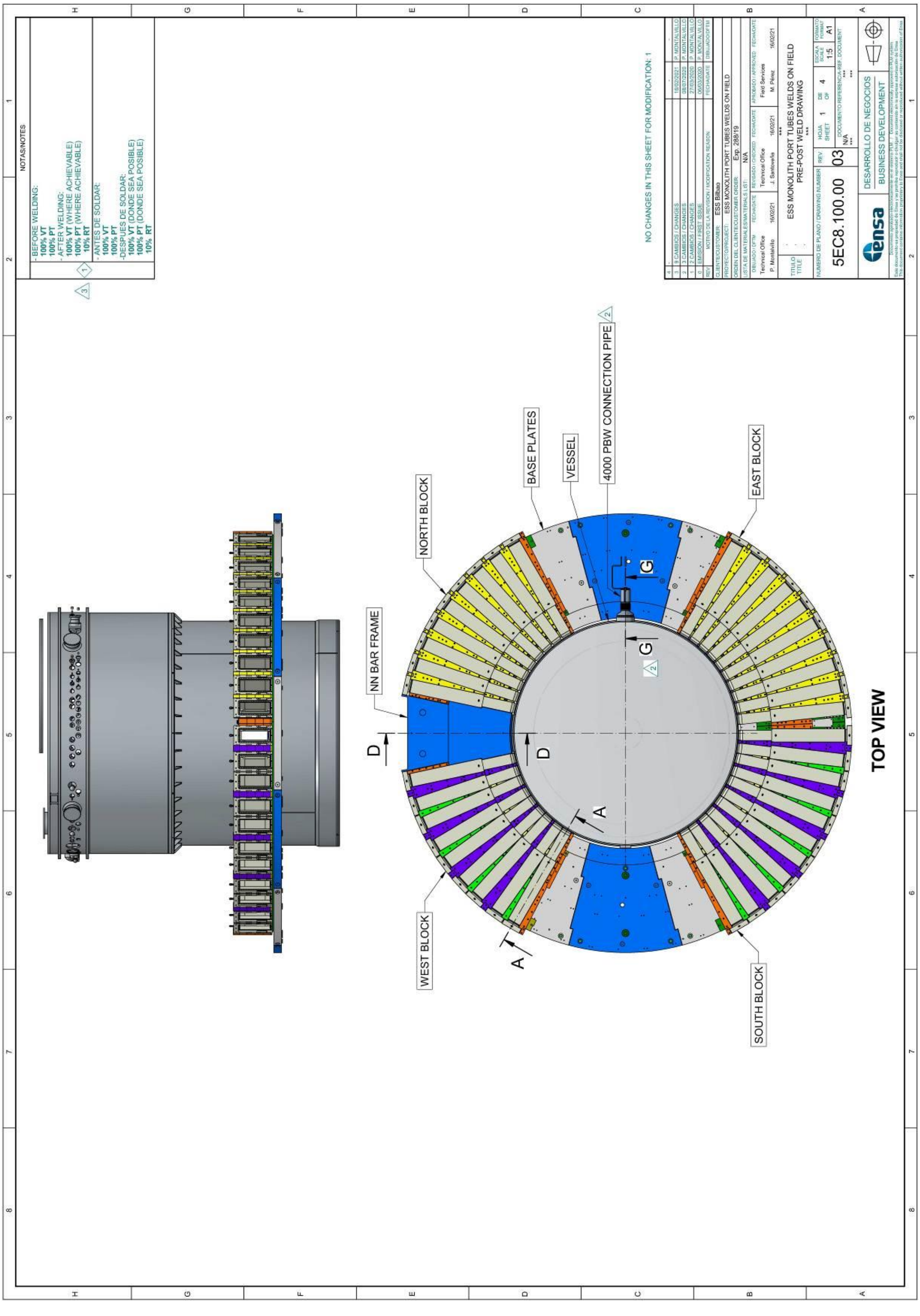
Back run is optional. It shall be carried out by following WS2 when deemed necessary. 2
La pasada por detras es opcional. Será realizada según WS2 solo si se estima necesario.

	DATE DATE	***SUBJECT*** OBJETO	***PREPARED*** PREPARADO	***APPROVED*** APROBADO	***EXTERNAL APPROVALS*** APROBACCIÓN EXTERNA
00	*06/03/2020*	*FIRST ISSUE*			
01	*12/6/2020*	Connecting pipe weld added			
02	*25-2-2021*	Optional back run added	ÁNGEL TOMÁS PEÑA DE LA RIVA 2021.01.25 16:53:42 +02'00'	DAVID SOLANA MARTINEZ	

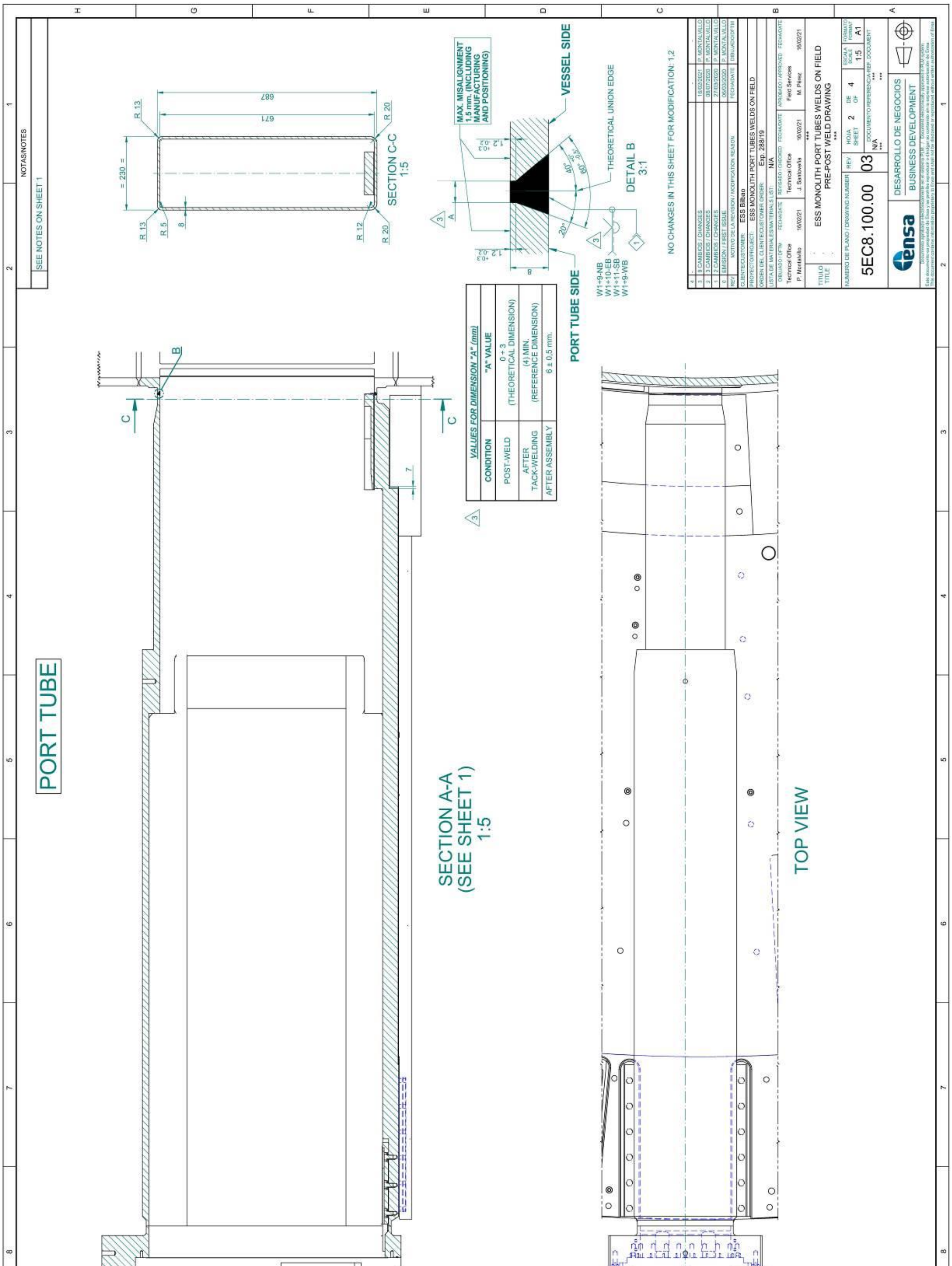
ANNEX D - WELDING MAP

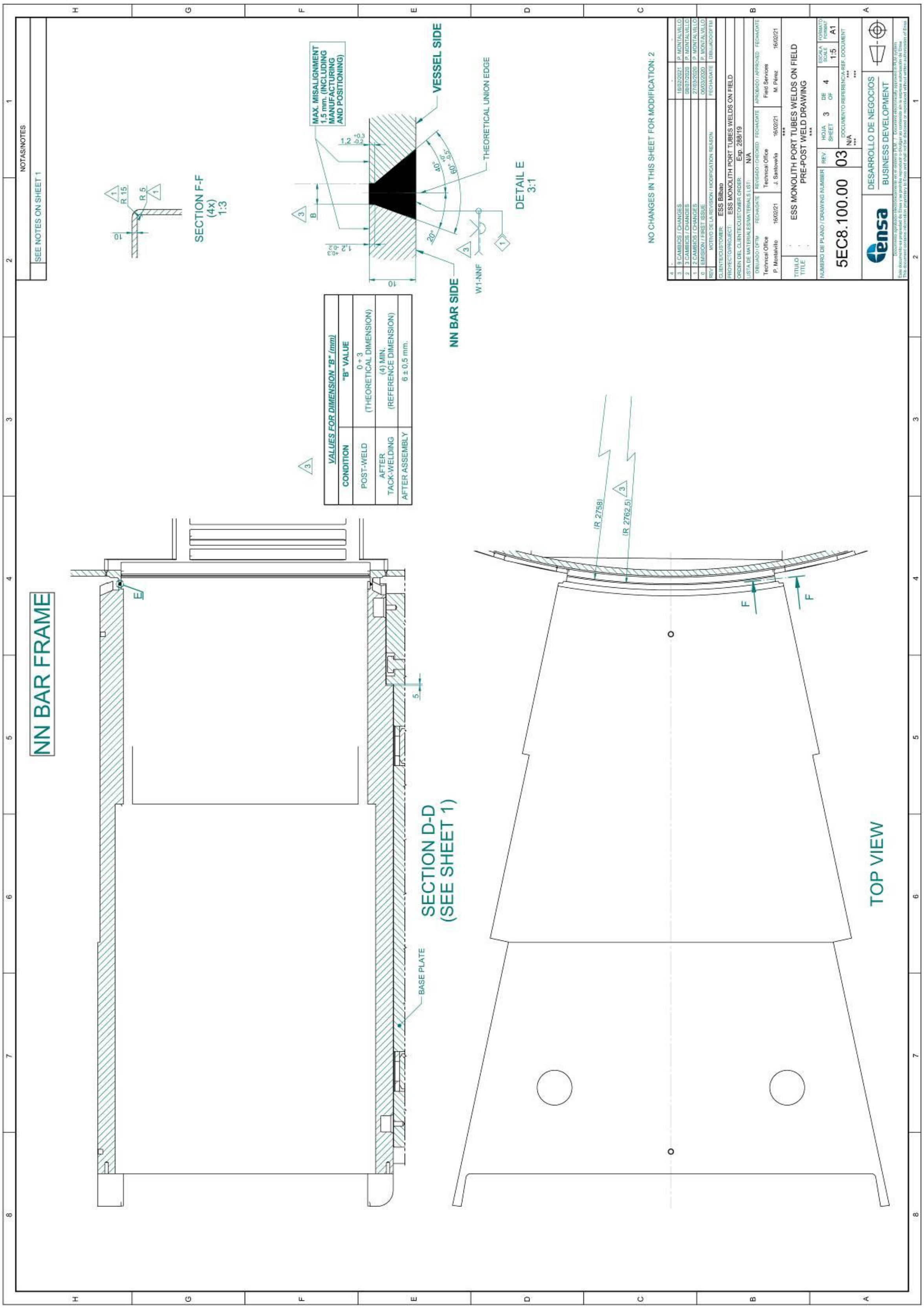

TOP VIEW
NORTH BLOCK
VESSEL
4000 PBW CONNECTION PIPE
EAST BLOCK
NN BAR FRAME
WEST BLOCK
SOUTH BLOCK
DETAIL F (4000 PBW CONNECTION PIPE WELDING) 1:15
DETAIL C (NORTH BLOCK (NB) WELDINGS) 1:15
DETAIL D (EAST BLOCK (EB) WELDINGS) 1:15
DETAIL B (NN BAR FRAME (NNF) WELDINGS) 1:15
DETAIL A (WEST BLOCK (WB) WELDINGS) 1:15
DETAIL E (SOUTH BLOCK (SB) WELDINGS) 1:15
NOTAS/NOTES
- BEFORE WELDING: 100% VT 100% PT
- AFTER WELDING: 100% VT (WHERE ACHIEVABLE) 100% PT (WHERE ACHIEVABLE) 10% RT
- ANTES DE SOLDAR: 100% VT 100% PT
- DESPUES DE SOLDAR: 100% VT (DONDE SEA POSIBLE) 100% PT (DONDE SEA POSIBLE) 10% RT
ESS MONOLITH PORT TUBES WELDS ON FIELD WELDING MAP
5EC8.600.00
01
DESARROLLO DE NEGOCIOS
BUSINESS DEVELOPMENT

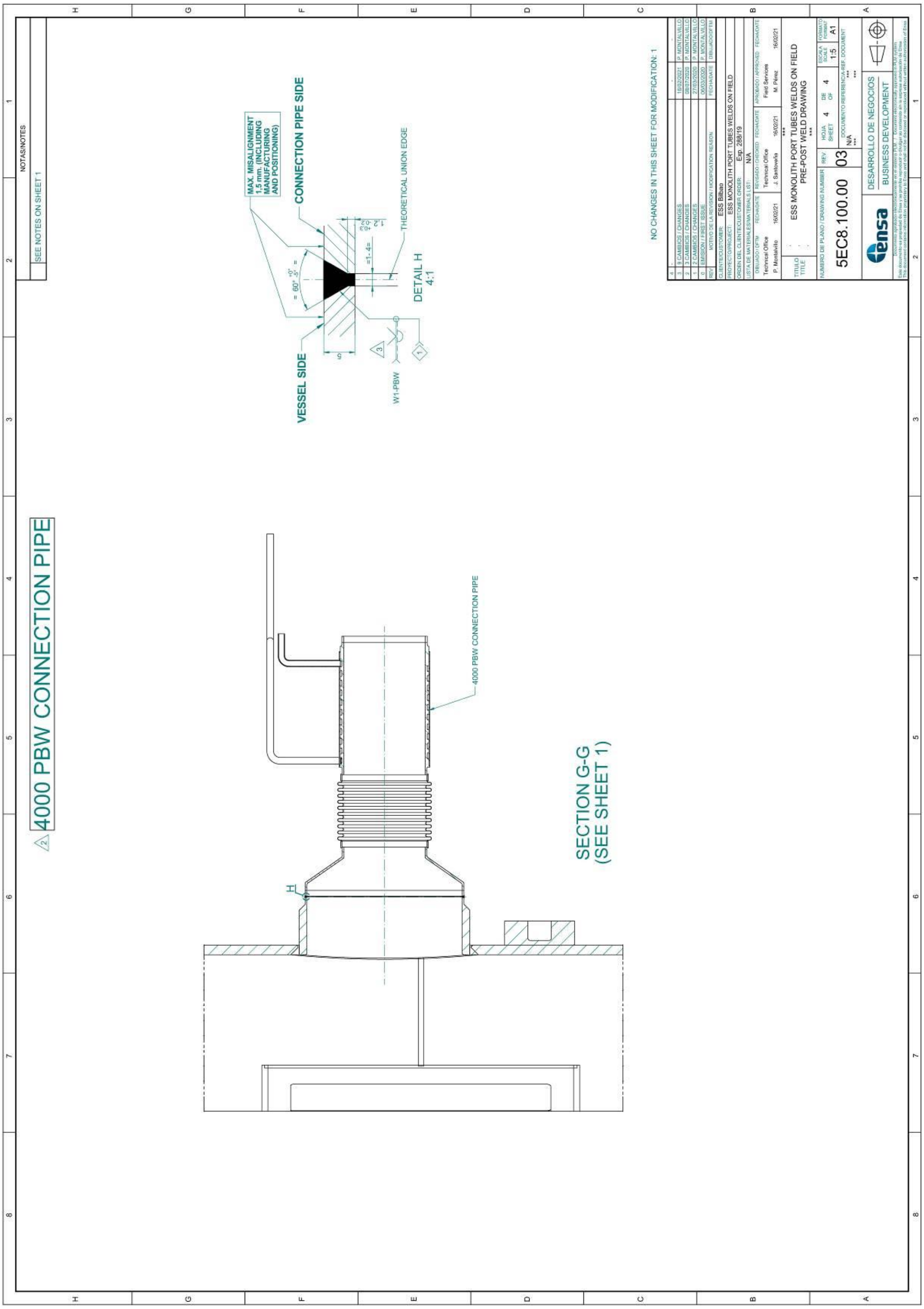
ANNEX E - PRE/POST WELDING DWG 5EC8.100.00



NOTAS/NOTES
- BEFORE WELDING:
100% VT
100% PT
- AFTER WELDING:
100% VT (WHERE ACHIEVABLE)
100% PT (WHERE ACHIEVABLE)
10% RT
- ANTES DE SOLDAR:
100% VT
100% PT
-DESPUES DE SOLDAR:
100% VT (DONDE SEA POSIBLE)
100% PT (DONDE SEA POSIBLE)
10% RT
NO CHANGES IN THIS SHEET FOR MODIFICATION: 1
ESS MONOLITH PORT TUBES WELDS ON FIELD
PRE-POST WELD DRAWING
5EC8.100.00
DESARROLLO DE NEGOCIOS
BUSINESS DEVELOPMENT
BASE PLATES
VESSEL
4000 PBW CONNECTION PIPE
EAST BLOCK
NORTH BLOCK
NN BAR FRAME
WEST BLOCK
SOUTH BLOCK
TOP VIEW


PORT TUBE
SECTION A-A
(SEE SHEET 1)
1:5
TOP VIEW
SECTION C-C
1:5
DETAIL B
3:1
VESSEL SIDE
PORT TUBE SIDE
THEORETICAL UNION EDGE
MAX. MISALIGNMENT 1,5 mm. (INCLUDING MANUFACTURING AND POSITIONING)
VALUES FOR DIMENSION "A" (mm)
NO CHANGES IN THIS SHEET FOR MODIFICATION: 1.2
SEE NOTES ON SHEET 1
ESS MONOLITH PORT TUBES WELDS ON FIELD PRE-POST WELD DRAWING
5EC8.100.00
DESARROLLO DE NEGOCIOS
BUSINESS DEVELOPMENT


NOTAS/NOTES
SEE NOTES ON SHEET 1
NN BAR FRAME
SECTION F-F
(4x)
1:3
MAX. MISALIGNMENT
1,5 mm. (INCLUDING
MANUFACTURING
AND POSITIONING)
VESSEL SIDE
THEORETICAL UNION EDGE
NN BAR SIDE
DETAIL E
3:1
NO CHANGES IN THIS SHEET FOR MODIFICATION: 2
VALUES FOR DIMENSION "B" (mm)
CONDITION
"B" VALUE
POST-WELD
0 + 3
(THEORETICAL DIMENSION)
AFTER TACK-WELDING
(4) MIN.
(REFERENCE DIMENSION)
AFTER ASSEMBLY
6 ± 0,5 mm.
SECTION D-D
(SEE SHEET 1)
BASE PLATE
TOP VIEW
ESS MONOLITH PORT TUBES WELDS ON FIELD
PRE-POST WELD DRAWING
5EC8.100.00
03
DESARROLLO DE NEGOCIOS
BUSINESS DEVELOPMENT


4000 PBW CONNECTION PIPE
SEE NOTES ON SHEET 1
NOTAS/NOTES
SECTION G-G
(SEE SHEET 1)
4000 PBW CONNECTION PIPE
DETAIL H
4:1
VESSEL SIDE
CONNECTION PIPE SIDE
MAX. MISALIGNMENT 1.5 mm. (INCLUDING MANUFACTURING AND POSITIONING)
THEORETICAL UNION EDGE
W1-PBW
NO CHANGES IN THIS SHEET FOR MODIFICATION: 1
ESS MONOLITH PORT TUBES WELDS ON FIELD
PRE-POST WELD DRAWING
5EC8.100.00
03
DESARROLLO DE NEGOCIOS
BUSINESS DEVELOPMENT

ANNEX F - FILLER MATERIAL

CARBO WELDING GROUP

SAIND

AUTOVIA SEVILLA UTRERA KM. 8,300-
APARTADO DE CORREOS 32
41089-MONTEQUINTO – SEVILLA – ESPAÑA
Teléfono 95 412 42 24 - Fax 954 412 40 69
Atención al cliente: 902 19 73 02
E-mail : info@carbo-saind.com
http://www.carbo-saind.com

CLIENTE Customer: EQUIPOS NUCLEARES, S.A.
AVDA. JUAN CARLOS I, 8
39600-MALIAÑO
CANTABRIA

SU REF.-: Your order: P.O. 1MF/904

CERTIFICADO DE CALIDAD

INSPECCION CERTIFICATE
EN 10204-3.1B

DESIGNACIÓN Designation	DIÁMETRO Diameter	N. FABRICACIÓN Batch no.	Fecha Date	NORMA Specification / Classification	N.CERTIFICADO Certificate No.
CARBOTIG 316 L	1.6/1000	0004562	16/03/2007	ASME SEC. II Parte C: SFA 5.9 ER 316L 1998 E 2000 A AWS: A 5.9 ER 316L EN 12072	C206352702-07

ANÁLISIS QUIMICO (%) / Chemical analisis

ELEMENTOS Elements	C	Mn	Si	P	S	Cu	Cr	Mo	Ni	V	Al	B
REQUISITOS Requirement	–	–	–	–	–	–	–	–	–	–	–	–
METAL DEPOSITADO	0.010	1.550	0.490	0.015	0.008	0.110	18.350	2.530	12.200		–	–

ELEMENTOS Elements	Ti	Fe	Mg	Co	N	Nb
REQUISITOS Elements	–	–	–	–	–	–
METAL DEPOSITADO	–	–	–	0.040	–	–

	PROPIEDADES MECANICAS Mechanical properties			RESILIENCIA Impact Test		FIRMEZA Soundness	CONDICIONES DE SOLDADURA Welding Condition				Tratamiento de calor despues de la soldadura
	LIM.ELASTIC Yield strenght (N/mm^2)	RESIS.TRACC Tensile strenght (N/mm^2)	ALARGAMIEN Elongationt (%)	TEMPERATURA Temperature °C	ENERGÍA ABSOR. Charpy J (Kgf-m)		Tipo de corriente Type	Amperaje Amperage	Arco Voltaje	Gas	°C Hr
RESULTADOS Test Result	–	–	–	–	–	–	–	–	–	–	

Prueba soldadura en Fillet Fillet Weld	Prueba de Dureza (HRC) Hardness Test	Humedad (%) Moisture	OBSERVACIONES : Remarks
–	–	–	Ferrigehalt 8%

SECCIÓN CONTROL DE CALIDAD
Quality Assurance Department

WITNESSED ☐ REVIEWED ☑
DATE 16/03/07
E.N.S.A.
Equipos Nucleares, S.A.

Certificado ISO 9001 por BVQi

ANNEX G - TAPE

3M™ Glass Cloth Electrical Tape 69 with Silicone Pressure-Sensitive Adhesive

Data Sheet **May 2014**

Description

3M™ Glass Cloth Electrical Tape 69 is a white glass cloth tape with a high-temperature thermosetting silicone pressure-sensitive adhesive. It is designed for use in 600-volt dry location applications motors, and transformers with and without varnish coating. Key attributes like high mechanical strength and resistance to high temperatures provide excellent performance. The thermosetting adhesive provides an increased bond once applied in areas of high ambient temperatures. The thermosetting adhesive provides elevated temperature performance up to Class N 392°F (200° C) temperature rating.

This tape provides insulation and solvent-resistant protection for use as coil cover, anchor, banding and core, layer and crossover insulation. This tape features a non-corrosive adhesive. It is conformable, printable and flame retardant.

Agency Approvals, Self Certifications, MIL Specs

Meets Requirements of:

- Military Specification No. Mil-I-19166C
- UL Recognized Component listing for 200° C (Guide OANZ2, File E17385)
- CSA Accepted Component 180° C, File LR93411

RoHS
2011/65/EU

"**RoHS** 2011/65/EU" means that the product or part does not contain any of the substances in excess of the maximum concentration values ("MCVs") in EU RoHS Directive 2011/65/EU. The MCVs are by weight in homogeneous materials. This information represents 3M's knowledge and belief, which may be based in whole or in part on information provided by third party suppliers to 3M.

3M™ Glass Cloth Electrical Tape 69

Applications

- Insulating electric and induction-type furnace power supply leads
- Securing high-temperature, non-PSA insulation (such as asbestos and glass) in high-temperature areas
- Securing Scotch® Fire Retardant Electric Arc Proofing Tape 77
- Splicing wire SF and SFF rated 302° F (150° C), 356° F (180° C)
- Reinsulating and repairing coils on mining machines
- Splicing silicone-covered glass wire where splices require more abrasion resistance and mechanical strength than can be provided by silicone tapes Insulating Class "H" dry-type transformer leads
- Insulating splices made on SA type wire in heat treat areas
- Especially suited to high-temperature applications
- Used in a variety of coil/transformer and motor applications, including an outer wrap for bobbin wound coils, banding arbor wound coils, lead pad hold down, end turn and lead anchor and connection.

Typical Properties

Data is not for specifications. Values are typical and should not be considered minimum or maximum. Properties measured at room temperature 73° F (~23° C) unless otherwise stated.

Physical

Property (Test Method) (ASTM D1000 unless noted)	Typical Value US units (metric)
Color	white
Adhesive	silicone
Backing Thickness	5.0 mils (0,125 mm)
Total Thickness	7.0 mils (0,177 mm)
Elongation (% at break)	5%
Operating Temperature	200° C
Adhesion to Steel	40 oz/in (4.4 N/10 mm)
UL 510 Flame Retardant	Yes

Electrical

Property (Test Method) (ASTM D1000 unless noted)	Typical Value US units (metric)
Dielectric Breakdown	3000 V
Breaking Strength	180 lbs/in (314 N/10 mm)`
Insulation Resistance	4.8×10^4 megohms
CTI Material Group	1
Electrolytic Corrosion Factor 3M Test Method	0.9

3M™ Glass Cloth Electrical Tape 69

Specifications

3M™ Glass Cloth Electrical Tape 69 is a glass cloth electrical tape with a silicone thermosetting adhesive. The tape shall be white and 7 mils (0,177 mm) thick. The tape shall be coated on one side with pressure-sensitive adhesive which shall not require heat, moisture, or other preparation prior to or subsequent to application. The adhesive coating shall be smooth and uniform, and be free of lumps and bare spots. There shall be no separator between adjacent layers of the roll. The tape shall be UL Recognized under UL Standard 510. The tape shall perform at a temperature of 392° F (200° C) without loss of physical or electrical properties.

Engineering/ Architecture

All splices for 600-volt wire rated at 266° F (130° C) shall be insulated with a minimum of two half-lapped layers of Scotch® Glass Cloth Electrical Tape 69.

Shelf Life & Storage

This product has a 5-year shelf life from date of manufacture when stored in a humidity controlled storage (50°F/10°C to 80°F/27°C and <75% relative humidity).

Availability

3M™ Glass Cloth Electrical Tape 69 is available in standard and custom lengths and widths. Standard length is 36 yards.

For availability, please contact your local distributor. Names and addresses are available from 3M.com/electrical [Where to Buy], or call 1-800-676-8381 or 1-800-245-3573.

Important Notice

All statements, technical information, and recommendations related to 3M's products are based on information believed to be reliable, but the accuracy or completeness is not guaranteed. Before using this product, you must evaluate it and determine if it is suitable for your intended application. You assume all risks and liability associated with such use. Any statements related to the product which are not contained in 3M's current publications, or any contrary statements contained on your purchase order shall have no force or effect unless expressly agreed upon, in writing, by an authorized officer of 3M.

Warranty; Limited Remedy; Limited Liability

This product will be free from defects in material and manufacture at the time of purchase. **3M MAKES NO OTHER WARRANTIES INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.** If this product is defective within the warranty period stated above, your exclusive remedy shall be, at 3M's option, to replace or repair the 3M product or refund the purchase price of the 3M product. **Except where prohibited by law, 3M will not be liable for any indirect, special, incidental or consequential loss or damage arising from this 3M product, regardless of the legal theory asserted.**

3M

Electrical Markets Division
6801 River Place Blvd.
Austin, TX 78726-9000
800 676 8381 or 800 245 3573
FAX: 800 828 9329 or 800 245 0329
www.3M.com/electrical/oem

78-8111-0896-4 Rev D

ANNEX H - (DELETED IN REV.02)

ANNEX I – RUBBER FOAM

Ficha Técnica / Technical Datasheet 03.17_v01

Caucho celular EPDM D130

Soft Cellular Rubber

Aislamiento y Estanqueidad Erica, S.L.
C/ Marruecos 160
08019 BARCELONA Spain
Tel.+34 932 663 649 Fax +34 932 663 529
www.erica.es erica@erica.es

D130 es caucho de Etileno Propileno (EPDM) microporoso sin piel, de baja densidad, hermético y estanco de celda cerrada, para usos como junta de estanqueidad y mecánicos de baja exigencia.
D130 is a low density cellular Ethylene Propilene (EPDM) rubber without skin, airtight and watertight closed cell, used for sealing gaskets and used for low mechanical requirements.

Propiedades básicas / basic propierties	**Unidad** / unit	**Valor** / value	**Test method**
Composición / composition	EPDM caucho de Etileno Propileno / EPDM ethylene propylene Rubber		
Color estándar / standard colour		Negro / black	
Densidad / density	Kg/m^3	110-150	ISO 845-88
Dureza / hardness	Shore 00	30 ±15	
Compresion 25% Def./strain	kPa	20-65	ASTM D 1056
Resistencia a la tracción / tensile strength	kPa	>400	ISO 1798-97
Alargamiento / elongation to failure	%	>150	ISO 1798-97
Deform. remanente 50% / 50% Comp.Set	%	25	ASTM D 1056
Deform.lineal 168hr 70°C / linear deformation	%	<5	ASTM D 1056
Resistencia al desgarro / tear strength	kN/mt	>0.5	ISO 34-1 (B-a) 94
Absorción de agua / water absorption	%	4	ASTM D 1056
Campo de temperaturas / temperature range	°C	-40 / +80	
Temp. máx. puntas / max. temperature peaks	°C	+100	
Resistencia al fuego / flame resistant		-	FMVSS 302
Ozone Resist. 200 pphm, 48 hrs. a 30°C		Sin grietas / no cracks	
Fuel B Resist. ASTM 168hr 23°C	%	-	

Formato / *format*

- Espesores / thickness : 1.5 a 50mm / 1.5 to 50mm
- Placas / sheets : 2000X1000mm
- Burletes : 5x2 a 100x50mm. Se presentan en rollos , la longitud del rollo varian según la medida / Strips: 5x2mm to 100x50mm. Meters per roll vary according to the size of the profile

Disponibilidad bajo consulta / *availability on request*

- Caras autoadhesivas / Pressure sensitive adhesive backing
- Piezas troqueladas / Punched gaskets

CFC & HCFC FREE

Sin CFC y HCFC, cumple según 2000/53/CE sobre metales pesados / CFC and HCFC compliant 2000/53/EC on heavy metals.