



MANUFACTURING REPORT



MANUFACTURER : Hoefnagel & Meijn B.V.
MANUFACTURER ORDER No. : 10.345
CLIENT : Nikhef Instituut
CLIENT ORDER No. : 43090
PURCHASER : -
PURCHASE ORDER No. : -
NoBo : Lloyd's Register
NoBo ORDER No. : 8087127
NAME : **CO2 ACCUMULATOR**
ITEM No. : F-260
DRAWING No. : 40030-ME-00074

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- 3) ---- Hazard analysis
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- 7) ---- Material certificates
- 8) ---- Welding key
- 9) ---- Welding documents
- 10) ---- N.D.E. report and sketch
- 11) ---- Qualification of N.D.E. personnel
- 12) ---- Out of roundness certificate
- 13) ---- Hydraulic pressure test and/or pneumatic leaktest certificate
- 14) ---- Copy of nameplate
- 15) ---- Design appraisal document (D.A.D.)
- 16) ---- Drawings and other documents

kiwa
gecertificeerd



HOEFNAGEL & MEIJN B.V. , ZAANDAM-HOLLAND

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NEN-EN-ISO 9001:2000

oktober 2010



HOEFNAGEL & MEIJN B.V. PRODUCT INSPECTION PLAN



Manufacturer : Hoefnagel & Meijn B.V.
Manufacturer Order No. : 10.345
Category : III
Module : G
Used code : CODAP 2000
NoBo : Lloyd's Register
NoBo Order No. : 8087127

Name : CO2 ACCUMULATOR
Item No. : F-260
Client : Nikhef Instituut
Client Order No. : 43090
Purchaser : -
Purchase Order No. : -

| APPL. | STEP | DESCRIPTION INSPECTION PIONT | PROCEDURE / NORM | VERIFYING DOCUMENTS | H&M | NoBo | CLIENT |
|----------------|------|-----------------------------------|---------------------|------------------------|-----|---------------------|--------|
| X | 1 | Drawing and partlist | PP 21 | 40030-ME-00074 | H | H | H |
| X | 2 | Hazard analysis | PED | HA-10.345-01 | H | H | H |
| X | 3 | User manual | 89/392/EEC | MAN-10.345-01 | H | H | H |
| X | 4 | Strength calculation | Used code | 40030-ME-00041 | H | H | H |
| X | 5 | Inspection received material | PP 31 | - | W | NA | NA |
| X | 6 | List of certified material | Used code | C-10.345-01 | R | R | RI |
| X | 7 | Material certificates | EN 10204 | Certificates | R | RI | RI |
| X | 8 | Re-marking material | OP 42 | Certificates | H | RI | RI |
| | 9 | Welding Proc. Spec. (WPS) | NEN-EN | - | NA | NA | NA |
| X | 10 | Proc. Qualification Rec. (PQR) | EN-ISO 15614-1 | W-10.345-01 | R | RI | RI |
| X | 11 | Welders Perf. Qualification (WPQ) | EN 287-1 | W-10.345-01 | R | RI | RI |
| | 12 | Heat treatment | Used code / Drawing | - | NA | NA | NA |
| H = HOLD POINT | | R = REVIEW | | RI = RANDOM INSPECTION | | W = WITNESS | |
| | | | | | | NA = NOT APPLICABLE | |



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| APPL. | STEP | DESCRIPTION INSPECTION POINT | PROCEDURE / NORM | VERIFYING DOCUMENTS | | | H&M | NoBo | CLIENT |
|----------------|------|-----------------------------------|-------------------------|------------------------|----|----|---------------------|------|--------|
| X | 13 | N.D.E.: Radiographic examination | RTD procedure | N.D.E. Report | RI | RI | RI | RI | RI |
| | 14 | N.D.E.: Other | RTD procedure | - | NA | NA | NA | NA | NA |
| X | 15 | Qualification of N.D.E. personnel | PED | RTD Document | H | RI | RI | RI | RI |
| X | 16 | Gasket surfaces & thread | Drawing | - | RI | RI | RI | RI | RI |
| X | 17 | Internal inspection | Used code | - | H | RI | RI | RI | RI |
| X | 18 | External inspection | Used code | - | R | RI | RI | RI | RI |
| X | 19 | Dimensions | Drawing | Drawing | RI | RI | RI | RI | RI |
| X | 20 | Hydraulic pressure test | PP 42 / PED | PL-10.345-01 | H | RI | RI | RI | RI |
| | 21 | Pneumatic leaktest | PP 43 | - | NA | NA | NA | NA | NA |
| X | 22 | Nameplate data | PED | Copy of nameplate | R | RI | RI | RI | RI |
| X | 23 | Surface treatment | PP 45 / Spec. Client | - | R | RI | RI | RI | RI |
| X | 24 | Manufacturing report | Product inspection plan | - | R | RI | RI | RI | RI |
| H = HOLD POINT | | | R = REVIEW | RI = RANDOM INSPECTION | | | W = WITNESS | | |
| | | | | | | | NA = NOT APPLICABLE | | |



DECLARATION OF CONFORMITY



according to Directive 97/23/EC

for a pressure vessel

The manufacturer

Hoefnagel & Meijn B.V.

herewith declares, that the pressure equipment

| | | | | |
|--------------------------------------|---|-----------------|--------|------|
| Name | : | CO2 ACCUMULATOR | | |
| Item No. | : | F-260 | | |
| | | Shell | Coil | |
| Max allowable pressure (PS) | : | 6/110 | 1/16 | Bar |
| Allowable min./max. temperature (TS) | : | -50/35 | -47/35 | °C |
| Test pressure (PT) | : | 157 | 23 | Bar |
| Test fluid | : | Water | Water | |
| Volume (V) | : | 27,3 | 1 | Ltr. |
| Year of manufacturing | : | 2010 | | |

corresponds to the Pressure Equipment Directive 97/23/EC

| | | |
|--|---|------------|
| Safety hazard category | : | III |
| Applied conformity assessment procedure | : | G |
| Applied standards and technical specifications | : | CODAP 2000 |
| Other applied EC-Directives | : | 2006/42/EG |

Engaged notified bodies

| | | |
|---|---|--|
| Surveillance of the QS-System | : | Kiwa N.V. |
| Examination / inspections / test during manufacturing | : | Lloyd's Register Notified Body 0038 |
| Notified Body order no. | : | 8087127 |


| | | |
|--------------------|---|------------------|
| Client | : | Nikhef Instituut |
| Client order no. | : | 43090 |
| Purchaser | : | - |
| Purchase order no. | : | - |

| | | |
|------------------------|---|------------------------|
| Issued by | : | Hoefnagel & Meijn B.V. |
| Manufacturer order no. | : | 10.345 |
| Name | : | B. van Westerop |
| Position | : | Engineer |
| Place | : | Zaandam |
| Date of Issue | : | 01 september 2010 |

Reference :
Revision :

RESULTAAT VAN DE GEVAREN ANALYSE

RESULT OF THE HAZARD ANALYSIS

| | | | |
|--|--|---|--|
| Boundaries of the hazard/risk analyse against the proper (legal) background 8): Accumulator CERN AA0766 | | Date: second of Augustus 2010 Manufacturer: Nikhef | Signature:  |
| | | On behalf of manufacturer: Ad de Snaijer | |

Toelichting op de noten, zie laatste blad

| Nr. | Soort gevaar | Van toepassing <i>Relevant</i> | Risico- bepaling door <i>Risk estimation by</i> | Indien noodzakelijk: risico-reductie door <i>If applicable: risk reduction by</i> | | | | | Risico- evaluatie | Toelichting |
|-----|--|-----------------------------------|---|--|--|--|---|---|----------------------|--|
| No. | <i>Type of hazard</i> | 2) | 3) | Ontwerp/design | | | Gebruik / Use | | 4) | <i>Explications</i> |
| | 1) | | | Constructieve maatregelen <i>Construction</i> | Controle productieproce- s <i>Control of production process</i> | Beveiliging (systemen) <i>Safeguarding (Systems)</i> | Aanvullende maatregelen <i>Additional precautions</i> | Waarschuwing over resterend risico <i>Warning against remaining risk</i> | | |
| 1 | Internal pressure - normal operating conditions - regeneration conditions - thermal liquid expansion - exothermal reactions/run away | Y | M | -calculations -FEM analysis | -Certified welders -NDO Applus (former RTD) | -Certified proportional relief valve set at 110 bar | 7) | | A | |
| 2 | External pressure - vacuum - normal operating conditions - regeneration conditions - condensing steam/vapour due to cooling down | N | | | | | | | | |
| 3 | Ambient temperature | Y | M | Choice of material | Material certification | Relief valve | Monitoring room temperature | | A | Rise in Temperature increases Pressure |

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| Nr. | Soort gevaar | Van toepassing Relevant | Risico-bepaling door Risk estimation by | Indien noodzakelijk: risico-reductie door If applicable: risk reduction by | | | | | Risico-evaluatie Risk evaluation | Toelichting Explications |
|-----|---|-------------------------|---|---|---|---|--|---|----------------------------------|--------------------------|
| No. | Type of hazard | 2) | 3) | Ontwerp/design | | | Gebruik / Use | | 4) | |
| | 1) | | | Constructieve maatregelen Construction | Controle productieprocesses Control of production process | Beveiliging (systemen) Safeguarding (Systems) | Aanvullende maatregelen Additional precautions | Waarschuwing over resterend risico Warning against remaining risk | | |
| 4 | Temperature - margin between operating and design temperature to small - regeneration conditions - exothermal reactions - to small response time of temperature sensors | Y | M | Over dimensioning in strength | | Relief valve | Monitor temperature in the lab T<35 Celsius | | A | |
| 5 | Temperature changes - temperature gradient | Y | M | Heather+ thermocouple | CE Watlow heater | + clixon in power supply | | | A | |
| 6 | Creep | N | | | | | | | | |
| 7 | External fire (pool, jet) | Y | M | | | Discharge through relief valve | Fire alarm | | A | |
| 8 | Static head of the content under operating and test conditions | N | | | | | | | | |
| 9 | Dynamic liquid pressure (waterhammer) - Condensation of gaseous fluids | N | | | | | | | | |
| 10 | Mass of content under operating and test conditions | Y | M | | | | Ventilation/ discharge line | | A | |
| 11 | Traffic loadings/geotechnical loadings(underground pressure equipment) | N | | | | | | | | |
| 12 | Wind loading - mounting outside | N | | | | | | | | |

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| Nr. | Soort gevaar | Van toepassing Relevant | Risico-bepaling door Risk estimation by | Indien noodzakelijk: risico-reductie door If applicable: risk reduction by | | | | | Risico-evaluatie Risk evaluation | Toelichting Explications |
|-----|--|-------------------------|---|---|---|---|--|---|----------------------------------|--------------------------|
| No. | Type of hazard | 2) | 3) | Ontwerp/design | | | Gebruik / Use | | 4) | |
| | 1) | | | Constructieve maatregelen Construction | Controle productieprocesses Control of production process | Beveiliging (systemen) Safeguarding (Systems) | Aanvullende maatregelen Additional precautions | Waarschuwing over resterend risico Warning against remaining risk | | |
| 13 | Snow and ice loads - location (outside) - due to process | N | | | | | | | | |
| 14 | Earthquake loading | N | | | | | | | | |
| 15 | Forces and moments from supporting structures | N | | | | | | | | |
| 16 | Forces and moments from piping connections (nozzle loads) | Y | M | Sufficient support & length tubing | | Mounting panel | | | A | |
| 17 | Corrosion - Internal - External - Condensation in piping for gaseous fluids | N | | | | | | | | |
| 18 | Chemical attack of the materials by the process fluid | N | | | | | | | | |
| 19 | Erosion/wear - pipelines (high velocity of fluid, turbulence, vortices) - solids (e.g. coal) | N | | | | | | | | |
| 20 | Fatigue - pressure fluctuations (range) - vibration of pipelines - mixtures - pumps | N | | | | | | | | Less than 5000 cycles |

RESULTAAT VAN DE GEVAREN ANALYSE

RESULT OF THE HAZARD ANALYSIS

| Nr. No. | Soort gevaar Type of hazard 1) | Van toepassing Relevant 2) | Risiko- bepaling door Risk estimation by 3) | Indien noodzakelijk: risico-reductie door If applicable: risk reduction by 5) | | | | | Risiko- evaluatie Risk evaluation 4) | Toelichting Explications |
|----------------|--|---|---|---|---|--|---|---|--|---------------------------------|
| | | | | Ontwerp/design | | Beveiliging (systemen) Safeguarding (Systems) 6) | Aanvullende maatregelen Additional precautions 7) | Gebruik / Use Waarschuwing over resterend risico Warning against remaining risk | | |
| | | | | Constructieve maatregelen Construction | Controle productieproce- s Control of production process | | | | | |
| 21 | Excessive loadings due to excessive free movement (pipelines) | N | | | | | | | | |
| 22 | Excessive forces/moment on flanges; connections; bellows; hoses (pipelines) | N | | | | | | | | |
| 23 | Decomposition of unstable fluids | N | | | | | | | | |
| 24 | Consequences due to deposits - loss of fluid (level) - corrosion - overheating | N | | | | | | | | |
| 25 | Instability during transport or movement | N | | | | | | | | |
| 26 | Danger due to internal pressure in relation to opening and closing of pressure equipment | N | | | | | | | | |
| 27 | Danger due to the type of fluid in relation to opening and closing of the pressure equipment | N | | | | | | | | |
| 28 | Surface temperature, related to the intended use | Y | M | Isolation | | | | | | |
| 29 | Adversely effects of opening (for inspection) | N | | | | | | Warning signs | Instruction of personnel | A |
| | | | | | | | | | | |

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| Nr. No. | Soort gevaar Type of hazard 1) | Van toepassing Relevant 2) | Risiko- bepaling door Risk estimation by 3) | Indien noodzakelijk: risico-reductie door If applicable: risk reduction by 5) | | | | Risiko- evaluatie Risk evaluation 4) | Toelichting Explications |
|------------|--|-------------------------------------|---|---|---|--|--|--|-----------------------------|
| | | | | Constructieve maatregelen Construction | Ontwerp/design Controle productieproce- s Control of production process | Beveiliging (systemen) Safeguarding (Systems) 6) | Gebruik / Use Aanvullende maatregelen Additional precautions 7) | | |
| 30 | Uncontrolled chemical reactions, due to insufficient ventilation | N | | | | | Waarschuwing over resterend risico Warning against remaining risk | | |
| 31 | Danger related to cleaning, inspecting and maintenance - ventilation - product remains | N | | | | | | | |
| 32 | Overfilling | Y | M | | | Relief valve | Use a scale to measure the amount of gas put in the accumulator | A | |
| 33 | Overpressure due to overfilling (filling ratio and vapour pressure at reference temperature) | Y | M | | | Relief valve | | A | |
| 34 | Instability of the pressure equipment during filling and emptying | N | | | | | | | |
| 35 | Uncontrolled release of the pressurized fluid | N | | | | | | | |
| 36 | Unsafe connection and disconnection | Y | M | | | | Inspection of faces and seals | A | |
| 37 | Dangerous accumulation of ignitable mixtures of combustible substances and air (boilers) | N | | | | | | | |

Reference :
Revision :

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RESULT OF THE HAZARD ANALYSIS

| Nr. | Soort gevaar | Van toepassing Relevant | Risico- bepaling door Risk estimation by | Indien noodzakelijk: risico-reductie door If applicable: risk reduction by | | | | | Risico- evaluatie Risk evaluation | Toelichting Explications |
|------|---|----------------------------|---|---|---|--|---|--|--|-----------------------------|
| No. | Type of hazard | 2) | 3) | 5) | | | | | 4) | |
| | 1) | | | Ontwerp/design | | | Gebruik / Use | | | |
| | | | | Constructieve maatregelen Construction | Controle productieproce- s Control of production process | Beveiliging (systemen) Safeguarding (Systems) | Aanvullende maatregelen Additional precautions | Waarschuwing over resterend risico Warning against remaining risk | | |
| 38 | Flame blowback (boilers) | N | | | | | Additional precautions 7) | | | |
| 39 | Discharge of static electricity | N | | | | | | | | |
| 40 | Dangers due to release of fluids (location and type of fluid): - safety devices - leakages - flange gaskets (type) - glad gaskets - due to forces/moments on flange connections | Y | M | The use of Swagelok VCR couplings | | | | Use new seals | A | |
| 41 | Consequences of dropping the pressure vessel (related to intended use) | N | | | | | | | | |
| 42 | Negative effects of the test fluid | N | | | | | | | | |
| 43 | Failure of joints, due to expected use | N | | | | | | | | |
| 44 | | | | | | | | | | |
| 45 | | | | | | | | | | |
| Nrs. | Combinaties van gevaren | | | | | | | | | |
| No.s | Combination of hazards | | | | | | | | | |

Reference :
Revision :

RESULTAAT VAN DE GEVAREN ANALYSE

RESULT OF THE HAZARD ANALYSIS

| Nr. | Soort gevaar <i>Type of hazard</i> 1) | Van toepassing <i>Relevant</i> 2) | Risico- bepaling door <i>Risk estimation by</i> 3) | Indien noodzakelijk: risico-reductie door <i>If applicable: risk reduction by</i> 5) | | | | | Risico- evaluatie <i>Risk evaluation</i> 4) | Toelichting <i>Explications</i> |
|-----|---|--|---|--|--|--|---|---|--|------------------------------------|
| No. | | | | Ontwerp/design | | | Gebruik / Use | | | |
| | | | | Constructieve maatregelen <i>Construction</i> | Controle productieproce- s <i>Control of production process</i> | Beveiliging (systemen) <i>Safeguarding (Systems)</i> 6) | Aanvullende maatregelen <i>Additional precautions</i> 7) | Waarschuwing over resterend risico <i>Warning against remaining risk</i> | | |
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RESULT OF THE HAZARD ANALYSIS

- 1) Binnen het beoogde gebruik en het redelijkerwijs te voorziene misbruik / overschrijding van de ontwerpondercondities van de drukapparatuur. Identificatie van de gevaren
Within the scope of the intended use and reasonable foreseeable misuse or operation outside the design conditions. Hazard identification
Bij het definiëren van het gevaar dient onderscheid gemaakt te worden tussen de oorzaken en de gevaren die daar het gevolg van zijn. (b.v. uitval van hulpenergie kan bezwijken t.g.v. drukoverschrijding tot gevolg hebben.
When defining the hazards, there has to be a clear distinction between the causes and the hazards that can result from them. (example: auxiliary power failure can lead to collapse due to excessive pressure)
- 2) Beantwoorden met / answer with: Y/N.
Bepalen of een gevaar van toepassing is kan door een logische redenatie, al dan niet ondersteund door analyse technieken als HAZOP, FMEA
Analysing the possibility of the hazard can be done by logical reasoning, when necessary supported by analyse techniques as HAZOP and FMEA
- 3) Beantwoorden met / answer with:
M = fabrikant/manufacturer;
EC = ingenieurbureau / engineering company;
US = specificatie van de gebruiker / user specification
In the framework of the PED, the manufacturer has to bear the main responsibility and has to be supplied with the relevant information in order to establish the hazard identification and risk assessment. Exception to this principle shall be clearly indicated
- 4) Beantwoorden met / answer with: A (Acceptabel, if a tolerable risk is achieved); NA (Not Acceptable, if a tolerable risk is NOT achieved)
De risicoreductie dient uitgevoerd te zijn tegen het principe ALARP (as low as reasonable possible)
The risk reduction shall be carried out against the ALARP principle
- 5) Beantwoorden met / answer with:
+ = Risico tot acceptabel niveau teruggebracht door de betreffende maatregel
Risk reduction to acceptable level with only the counter measure
P = Risico tot acceptabel niveau teruggebracht door een combinatie met andere maatregelen (meerdere P's op de betreffende regel)
Risk reduction to acceptable level with a combination with other precautions (more than one P on the applicable row)
- 6) Indien een instrumentele beveiliging is aangebracht, tevens een referentie opgeven naar een kwantitatieve risicoanalyse
If safeguarding is realised by instrumentation (e.g. SRMCR), a reference shall be made to a quantitative risk analysis
Zo nodig dienen aanwijzingen voor installatie en beveiliging opgenomen te worden in de handleiding bij het drukapparaat
If necessary directions for installation and safeguarding shall be part of the operation manual
- 7) Deze maatregelen dienen opgenomen te worden in de handleiding
These counter measures shall be part of the operation manual
- 8) Gaarne aangeven welke drukvaten; installatieleidingen; onder druk staande c.q. veiligheidsappendages tot de aangevraagde drukapparatuur behoren
Please indicated which vessels, piping, pressure accessories are included in the pressure equipment that is applied for.



MANUAL FOR PRESSURE VESSELS



IMPORTANT:

THIS IS A PRESSURE VESSEL. DISREGARDING THESE INSTRUCTIONS MAY ENDANGER THE SECURITY OF THE GOODS AND SAFETY OF PERSONS.

To preserve the quality of your products from the time of delivery and throughout their use in the best possible safety conditions, we advise carefully reading this manual and strictly follow its recommendations.

Description

Manufacturer's number : 10.345
Identification number : F-260
State of content : Gas
Fluid group : 2
Safety hazard category : III
Conformity assessment procedure : G
Design code : CODAP 2000

The vessel is in compliance with the European Pressure Equipment Directive 97/23/ CE.

For all relevant information refer to the following documents:

- Drawing / Part list : 40030-ME-00074
- Hazard analysis : HA-10.345-01
- Strength calculation : 40030-ME-00041
- Product inspection plan : P-10.345-01

Instructions

These instructions are to be taken into account during the entire lifetime of the vessel, installation, prior to use and during use. This concerns handling, storage, installation, connection, putting into service, usage, maintenance, dismantling.

During the entire lifetime observe and comply with the standardising and prescribed requirements in force in the country of use of the equipment.

CE conformity is valid only when the vessel is operated within the conditions stated in these instructions. If a certain case is not met by these instructions, the manufacturer needs to be consulted.

The user shall provide his employees with an appropriate instructions and/or training on basis of these instructions prior to installation and use of the vessel.

Handling

The vessel needs to be handled with care to avoid impacts able to locally warp or destroy the capacity.

For transport and handling, it is recommended to keep in place the protective elements of the flanges and/or other end pieces of the manufacturer.

During transport, the vessels need to be secured to a pallet or an element adapted to avoid impacts or shocks.

The vessel needs to be hoisted only on its lifting lugs. If not present, a rope around the body and/or flanged nozzles shall be used.

Installation

During installation and before putting into service, visually check that the vessel has not suffered damage, mainly concerning those portions used for connection (nozzles).

It is prohibited to add parts to the pressure containing parts of the vessel by means of weld, piercing or any operation creating a material removal, or compromise the mechanical strength otherwise.

The vessel must not be subjected to miscellaneous external loads: earthquakes - wind - snow - ice - support reactions - pipe work. The vessel is not specifically designed to resist the action of flames. Subsequently no fire certification can be affixed. The vessel cannot be subjected to flames.

Use

Ascertain that the vessel does not exceed the design conditions (e.g. pressure/temperature rating, fluid properties). The vessel must be protected against exceeding the design conditions on basis of user's own Risk Analysis, in conformity with the guidelines of the Pressure Equipment Directive 97/23/CE.

The actual pressure needs to be clearly displayed in the direct neighborhood of the vessel.

Ascertain that the vessel has not deteriorated (corrosion - abrasion - erosion - other forms of degradation, both internal and external) via a loss of thickness below the required minimum.

Carry out periodical checks according to current statutory requirements in the country of use of the equipment and to properly guarantee that the minimum mechanical strength and/or wall thickness is assured at all time.

In addition regularly check that the vessel does not show any sign of deterioration: distortion - crack - leak.

Maintenance - dismantling

Prior to any maintenance or dismantling operation concerning the vessel, drain the pressure circuits and make sure there is no residual pressure inside the vessel.

When replacing parts, the user, in order to retain the "CE" certification, must use original spare parts and take action in accordance with the instructions of the manufacturer. In cases not covered by the manual, the user needs to ask the manufacturer for instructions concerning intervention.

Marking

Marking is made on a stainless steel plate mounted on the vessel as per Pressure Equipment Directive.

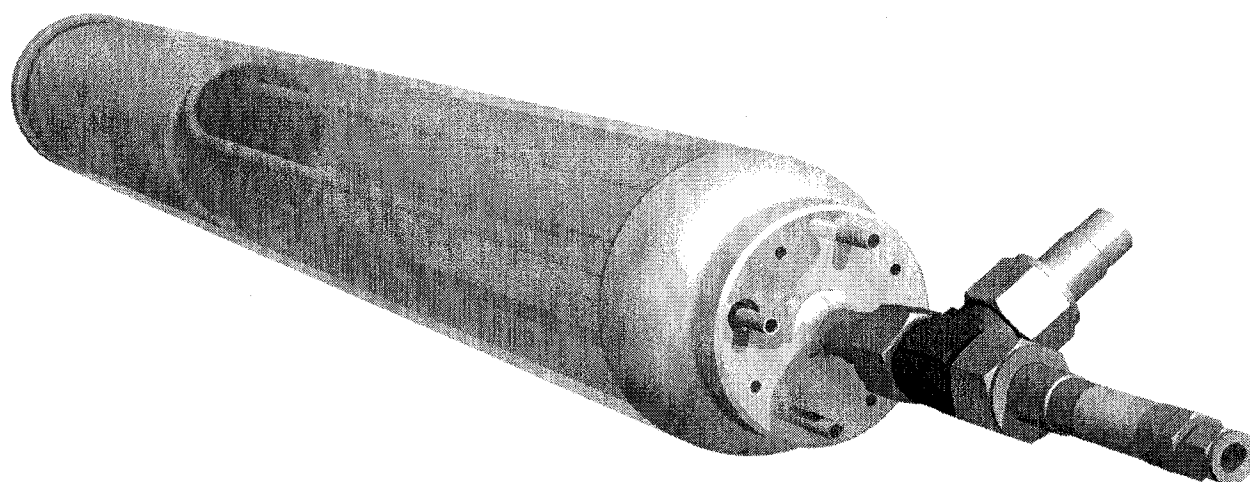
The user must not modify the marking carried out on the original nameplate in case of additional marking (special indications, re-test during inspections...). This must be carried out on a separate plate, i.e. not on the original nameplate.

The markings on the stainless steel plates shall be carried out by etching or stamping (indelible markings).



Safety Analysis CO₂ Accumulator CERN

| | | | |
|---|-------------------------------|-------------------------------------|----------------------|
| Nikhef number: 40030-ME-00041 | Item number: AA0766 | Date: 5/21/2010 | Page: 1 of 22 |
| | | Status: In Work | Revision: A.0 |
| Project: R&D CO2 Cooling | | | |
| Department: Mechanical Engineering | | Top folder: Accumulator, CO2 | |



Abstract:

The scope of this document is to provide the notified body LRQA with the necessary information for an EC unit verification (module G). The finalized document will also serve as a reference for the safety of the CO₂ accumulator used at CERN. The safety requirements are put forward by the Safety Commission (SC) at CERN. The system has to comply with the Pressure Equipment Directive (PED) 97/23/CE. The French construction code for pressure apparatus CODAP (Code De Construction des Appareils a Pression) is used to verify the stresses.

| | | |
|----------------------------------|---------------------------------------|---------------------|
| <i>Created by:</i> M.J. Kraan | <i>Checked by:</i> A.D. de Snaijer | <i>Approved by:</i> |
|----------------------------------|---------------------------------------|---------------------|

Distribution list:



HISTORY OF CHANGES

| <i>Rev. No.</i> | <i>Date</i> | <i>Pages</i> | <i>Description of changes</i> |
|-----------------|-------------|--------------|-------------------------------|
| | | | |

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1. GENERAL DESCRIPTION

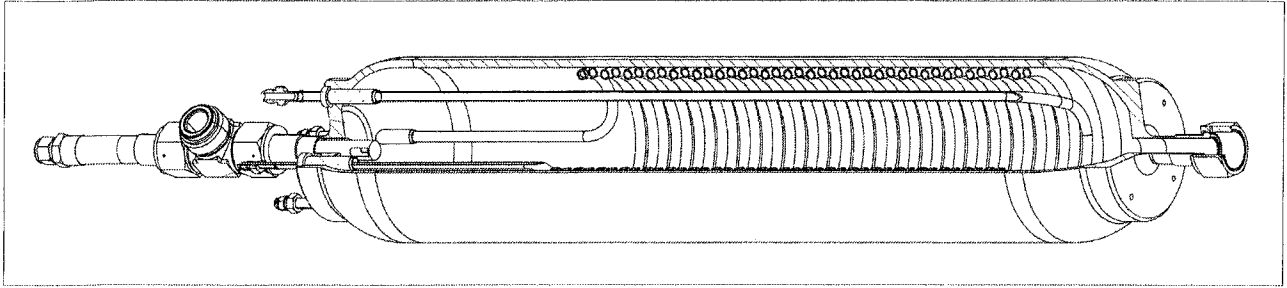


Figure 1, Crossing of the accumulator pressure vessel with two cooling coils inside (length is not to scale).

Figure 1 shows the crossing of the accumulator. The accumulator will be used in a mechanically pumped CO₂ loop which can cool a detector by evaporating low quality CO₂.

The accumulator will be part of the CO₂ test stand located at CERN (*Laboratoire européen pour la physique des particules*) Geneve, Suisse, Site de Meyrin, batiment 158.

1.1 Description of the CO₂ test stand

The CO₂ cooling test stand is designed to cool cooling channel with evaporating CO₂ at a given pressure. Figure 2 shows the schematic of the test stand.

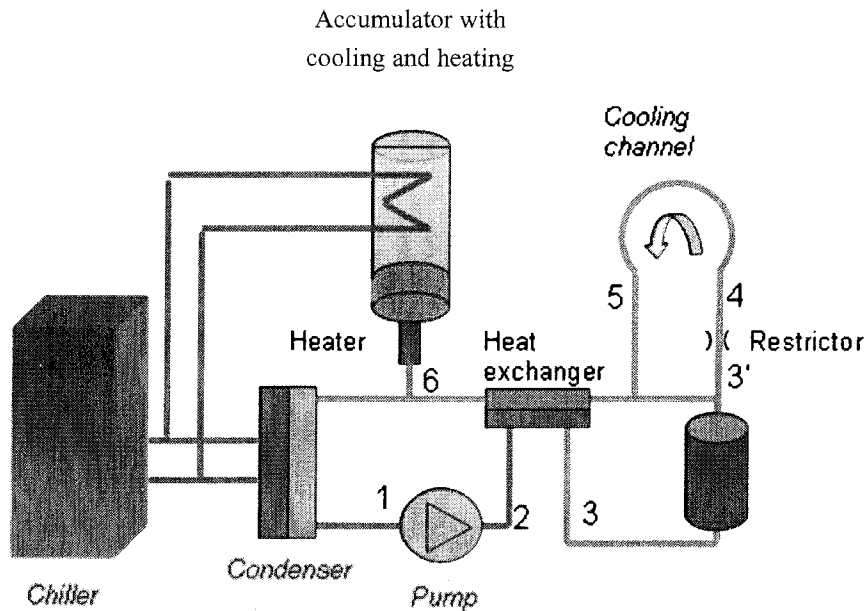


FIGURE 2 SIMPLIFIED SCHEMATICS OF THE CO₂ TEST STAND

The main elements are:

- A chiller which provides cooling power to the condenser and the accumulator. It sub-cools outlet of the condenser down to -25°C to ensure liquid pump proper operation. In second branch by cooling down the fluid inside accumulator it sets the evaporation pressure.
- The experiment structure which has to be cooled down and temperature controlled.
- 2-phase accumulator with cooling and heating element controlling evaporation temperature.
- Liquid membrane pump to ensure CO₂ circulation
- Condenser
- Heat exchanger
- Heater to set up desired vapor quality before cooling channel

Cooling cycle in the pressure-enthalpy diagram is presented on figure 3, only the pressures and the absorbed energy changes.

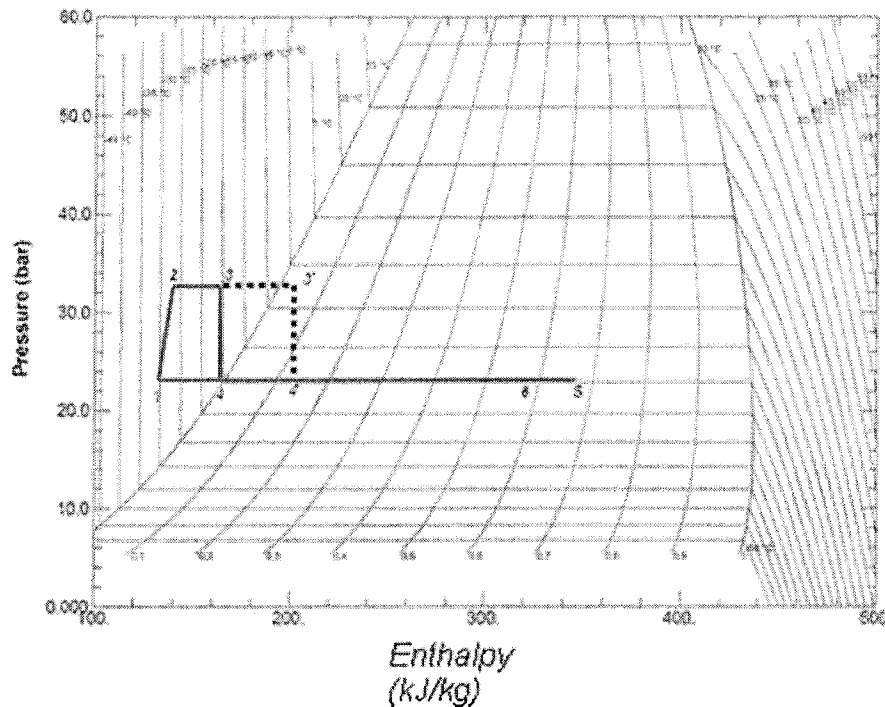


FIGURE 3 TEST STAND OPERATION IN THE P-H DIAGRAM OF CO₂

The state points 4, 5, 6 and 1 are at the same pressure (horizontal line in the P-H diagram). This pressure is controlled by the accumulator which is mounted at the inlet of the condenser. When state points (4-5) are located in the 2-phase region (isotherms run horizontally) the evaporation temperature is controlled directly by accumulator. The liquid pump increases pressure towards point 2. Some enthalpy is also added due to the applied work and energy losses of the pump. Therefore point 2 is diagonally right to the point 1. The cold liquid from the pump need to be adjusted to the desired enthalpy before it can be injected into the experiment. Heater provides the energy to come to point 3'. The expansion from point 3' to point 4' is adiabatic, this means that the enthalpy stays the same (there is no interaction with the environment) and only the pressure is reduced.

Thus for controlling the inlet condition of the cooling channel three parameters have to be set:

- 1) the evaporation temperature by setting the appropriate saturation pressure in the accumulator
- 2) the vapor quality by controlling the heater (between point 3 and 3' (Fig.3))
- 3) mass flow by setting it up on the pump

The sub cooling accomplished by chiller must be sufficient to ensure that CO₂ is well within the liquid area. When point 3 (Fig.3) is in the liquid area the enthalpy can be derived from the measurement of pressure and temperature.

1.2 Accumulator control

The accumulator controls the pressure of itself and indirectly the pressure of state point 4, 5, 6 and 1 (Fig.3). The cooling channel and condenser temperature are derived from this pressure as they encounter normally a two-phase flow. When the loop is operated in single phase flow, the temperature is not depending on the pressure anymore. The accumulator always contains a liquid and vapor mixture. A heating action is increasing the pressure; a cooling action is decreasing the pressure.

The process diagram is given in appendix I

1.3 Operating conditions

The load of the system is determined by the pressure of CO₂ which is related to the temperature. The system is operated at temperatures between +30 and -50 degrees Celsius. Typical pressure in the CO₂ system is 10-75 bar. For the shutdown of the test stand all of the liquid in the cooling loop needs to be stored inside the accumulator. The pressure in the accumulator with all the liquid stored can reach 110 bar at 35 °C. This is the maximum allowable pressure at the max. allowable temperature.

The accumulator is protected by means of a certified class IV proportional relief valve set at 110 bar to be mounted on top of the accumulator (see appendix II).

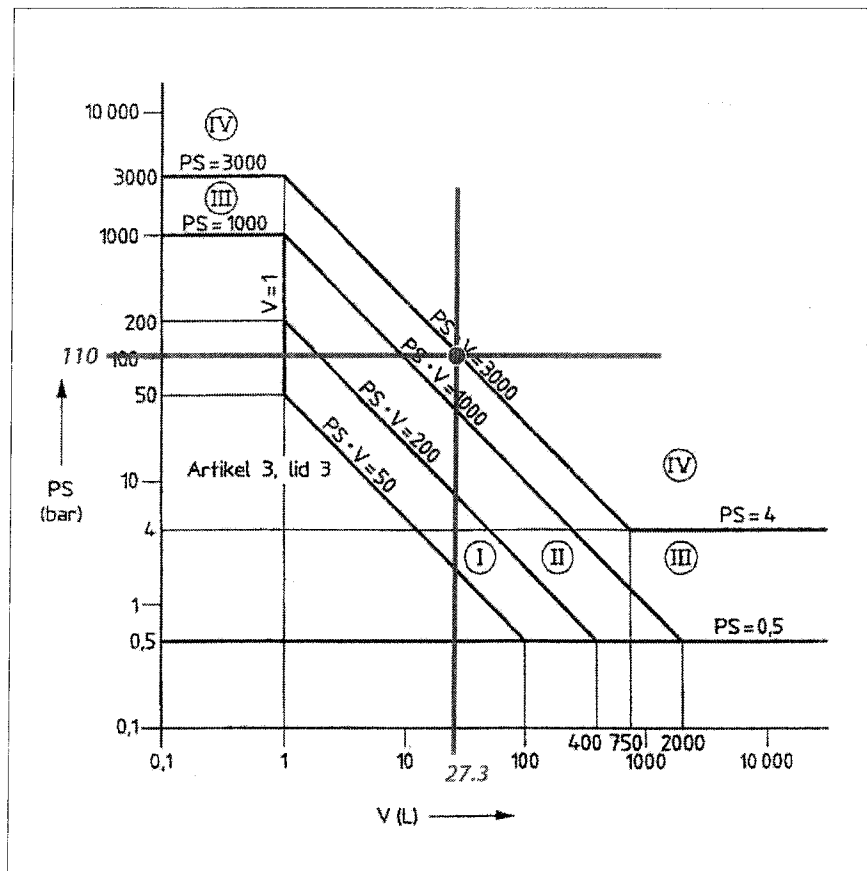
2. DEFINING PED CATEGORY AND MODULE

The Pressure Equipment Directive (97/23/EC) was adopted by the European Parliament and the European Council in May 1997. The PED lays down requirements for the design and manufacture of pressure equipment and assemblies with a maximum allowable pressure greater than 0.5 bar gauge (1.5 bar absolute).

Pressure equipment: Pressure vessel
Media: Carbon dioxide (CO₂)
Group: Non dangerous media
Phase: Gas
Vessel volume: $V = Volume_{vessel} - Volume_{coil} = 28.72 - 1.46 = 27.26 \text{ Liter}$
Design Pressure: $PS = 110 \text{ bar}$

$$PS \cdot V = 2998.6 [\text{bar} \cdot \text{l}]$$

Table 1. Defining the PED category for non dangerous gasses. The red lines indicate the accumulator properties.



Following Table 1, the accumulator vessel must be classified in *category III*

The following modules are available: B1+D, B1+F, B+E, B+C1, H

Since the $PS \cdot V$ is very close to 3000, a conformity assessment is requested to follow module G (EC unit verification) in consult with the notified body LRQA.

Table 2, The contents of the Module G (EC unit verification)

| Module | Description |
|--------|---|
| G | <p>1. This module describes the procedure whereby the manufacturer ensures and declares that <u>pressure equipment</u> which has been issued with the certificate referred to in section 4.1 satisfies the requirements of the Directive which apply to it. The manufacturer must affix the <u>CE</u> marking to the pressure equipment and draw up a declaration of conformity.</p> <p>2. The manufacturer must apply to a notified body of his choice for unit verification.</p> <p>The application must contain:</p> <ul style="list-style-type: none"> the name and address of the manufacturer and the location of the pressure equipment, a written declaration to the effect that a similar application has not been lodged with another notified body, technical documentation. <p>3. The technical documentation must enable the conformity of the pressure equipment with the requirements of the Directive which apply to it to be assessed and the design, manufacture and operation of the pressure equipment to be understood.</p> <p>The technical documentation must contain:</p> <ul style="list-style-type: none"> a general description of the pressure equipment, conceptual design and manufacturing drawings and diagrams of components, sub-assemblies, circuits, etc. descriptions and explanations necessary for an understanding of the said drawings and diagrams and the operation of the pressure equipment, a list of the standards referred to in <u>Article 5</u>, applied in full or in part, and descriptions of the solutions adopted to meet the essential requirements of the Directive where the standards referred to in Article 5 have not been applied. results of design calculations made, examinations carried out, etc., tests reports, appropriate details relating to the approval of the manufacturing and test procedures and of the qualifications or approvals of the personnel concerned in accordance with sections 3.1.2 and 3.1.3 of <u>Annex I</u>. <p>4. The notified body must examine the design and construction of each item of pressure equipment and during manufacture perform appropriate tests as set out in the relevant standard(s) referred to in Article 5 of the Directive, or equivalent examinations and tests, to ensure its conformity</p> |

with the requirements of the Directive which apply to it.

In particular the notified body must:

- examine the technical documentation with respect to the design and the manufacturing procedures,
- assess the materials used where these are not in conformity with the relevant harmonized standards or with a European approval for pressure equipment materials, and check the certificate issued by the material manufacturer in accordance with section 4.3 of Annex I,
- approve the procedures for the permanent joining of parts or check that they have been previously approved in accordance with section 3.1.2 of Annex I,
- verify the qualifications or approvals required under sections 3.1.2 and 3.1.3 of Annex I,
- carry out the final inspection referred to in section 3.2.1 of Annex I, perform or have performed the proof test referred to in section 3.2.2 of Annex I, and examine the safety devices, if applicable.

4.1. The notified body must affix its identification number or have it affixed to the pressure equipment and draw up a certificate of conformity for the tests carried out. This certificate must be kept for a period of ten years.

4.2. The manufacturer, or his authorized representative established within the Community, must ensure that the declaration of conformity and certificate of conformity issued by the notified body can be made available on request.

3. CALCULATIONS (FINITE ELEMENT ANALYSIS)

Finite element analyses are done for the accumulator, reinforced plates and damper to investigate the expected stresses and deformations. The French construction code for pressure apparatus (CODAP) is used to verify the stresses.

Following the chosen *construction class B* and *welding coefficient* $z=0.7$, the stress limits according to CODAP are:

- **Global zones:** $f = f_3 = \frac{R_m}{3.5}$
- **Weld regions:** $f_w = \frac{z \cdot R_m}{3.5}$
- **Peak regions:** $f_p = 1.5 \cdot f_3$
- **Peak/Weld regions:** $f_{pw} = 1.5 \cdot f_w$

Finite element analyses are done with the finite element analysis module of IdeasTM.

Results of the stress analysis are presented in terms of von Mises equivalent stress. In addition the calculated deformations from the stress analysis are presented. The quality of the FEA is verified using the strain energy error norm. A value below 7% is recommended by the IDEASTM software.

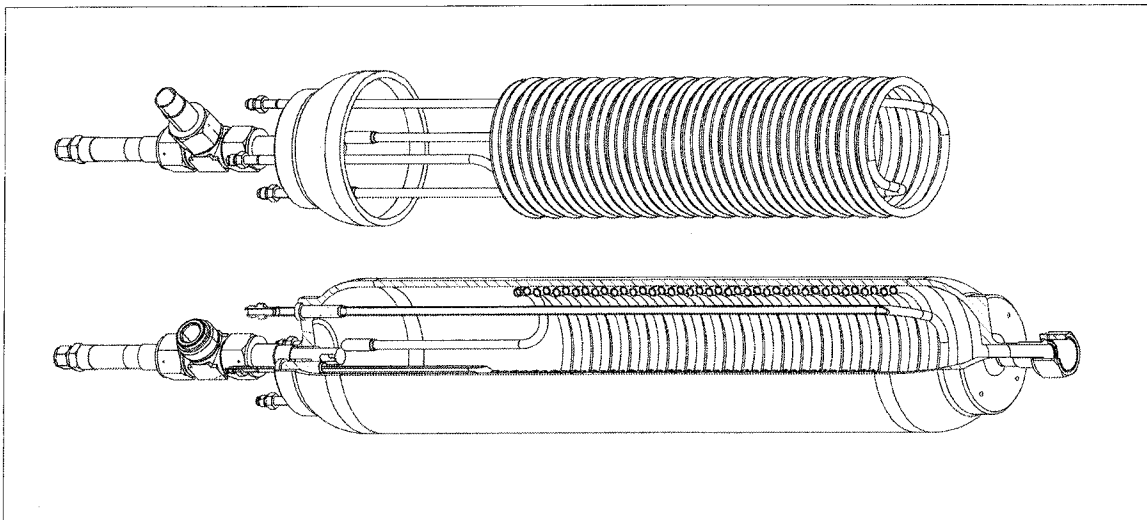


Figure 4, the accumulator pressure vessel with two cooling coils inside (length is not to scale).

The accumulator is a stainless steel pressure vessel with a volume of 28.7 liter. Inside this vessel are two coils welded to the bottom part of the vessel. The accumulator vessel consists of three welded parts together. These welds are at the position where stresses are minimal and are full penetrating preventing a weakening of the structure. The drawing in Appendix III shows detailed engineering information.

3.1 Operational conditions

1/8 of the pressure vessel is modeled, as the vessel is symmetric about YZ and XY, see also Figure 5 - 22.

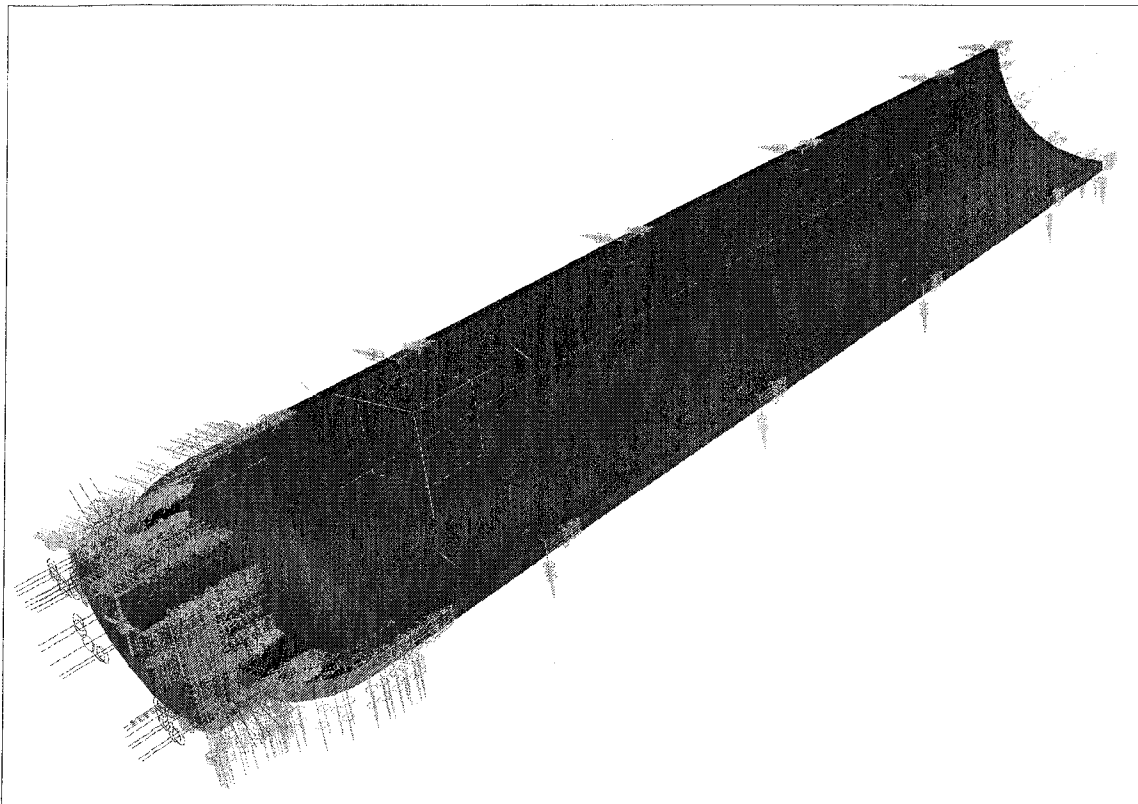


Figure 5. Finite Element Model with symmetry constraints and a pressure load of 110 Bar

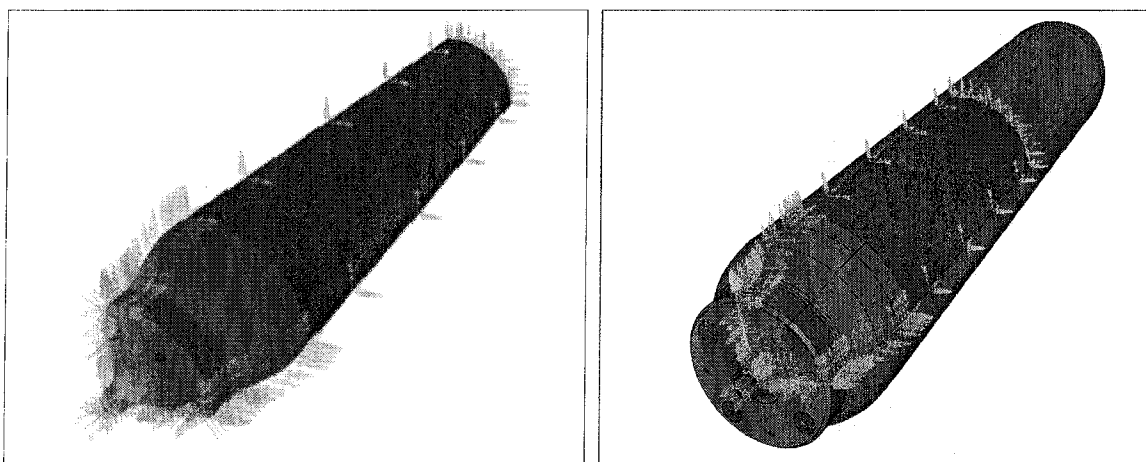


Figure 6. 1/8 part is modeled

The load of the accumulator is 110 Bar (11 MPa). This is determined by the relief valve which opens at 110 Bar. The operational temperature of the accumulator varies between -50...35 degrees Celsius. All the parts of this vessel are connected in such a way that thermal effects have no effect on the

load. Also the support of this vessel is designed in such a way that thermal expansion does not induce stresses in the vessel. All loads are applied without any safety factors. The FEA model is built up from 3D solid parabolic tetrahedron.

3.2 Material

The accumulators are made from AISI 316L TYPE X2CrNiMo17-12-2 (1.4404). The material has been selected based on the corrosion requirements and the welding ability of the material. A summary of the mechanical properties is given in Table 3

Table 3. *Properties AISI 316L (20-25 °C)*

| Tensile strength | R_m [MPa] | min. | 585 |
|-------------------------|----------------------------|-------------|------------|
| Yield strength | R _{p 0.2%} [MPa] | min. | 260 |
| Young's modulus | E [GPa] | min. | 200 |
| Density | ρ [g/cm ³] | | 7.85 |
| Poisons ratio | | | 0.30 |
| Elongation at break | A5 [%] | min. | 40 |
| Brinell hardness | HB | max. | 180 |

The stress limits according to CODAP are:

- Global zones: $f = f_3 = \frac{R_m}{3.5} = \frac{525}{3.5} = 150 \text{ MPa}$
- Weld regions: $f_w = \frac{z \cdot R_m}{3.5} = \frac{0.7 \cdot 525}{3.5} = 105 \text{ MPa}$
- Peak regions: $f_p = 1.5 \cdot f_3 = 1.5 \cdot 150 = 225 \text{ MPa}$
- Peak/Weld regions: $f_{pw} = 1.5 \cdot f_w = 1.5 \cdot 105 = 157 \text{ MPa}$

3.3 Calculation accumulator tube

Design Pressure: $PS = 110 \text{ bar} = 11 \text{ MPa}$

Inside diameter: $D_{in} = 154 \text{ mm}$

Outside diameter: $D_{out} = 168 \text{ mm}$

Wall thickness: $t = 7 \text{ mm}$

The vessel can be considered as thin-walled vessel because the D_{in}/t ratio ($154/7=22$) is higher than 10 (often cited as 20).

$$\text{Radial (Hoop) stress: } \sigma_r = \frac{F}{A} = \frac{PS \cdot D_{in}}{2 \cdot t} = \frac{11 \cdot 154}{2 \cdot 7} = 121 \text{ MPa}$$

$$\text{Axial stress: } \sigma_a = \frac{F}{A} = \frac{PS \cdot D_{in}^2}{D_{out}^2 - D_{in}^2} = \frac{11 \cdot 154^2}{168^2 - 154^2} = 57.8 \text{ MPa}$$

Equivalent stress

$$\sigma_v = \sqrt{\sigma_r^2 + \sigma_a^2} = 134 \text{ MPa}$$

3.4 Stress and deformation analysis

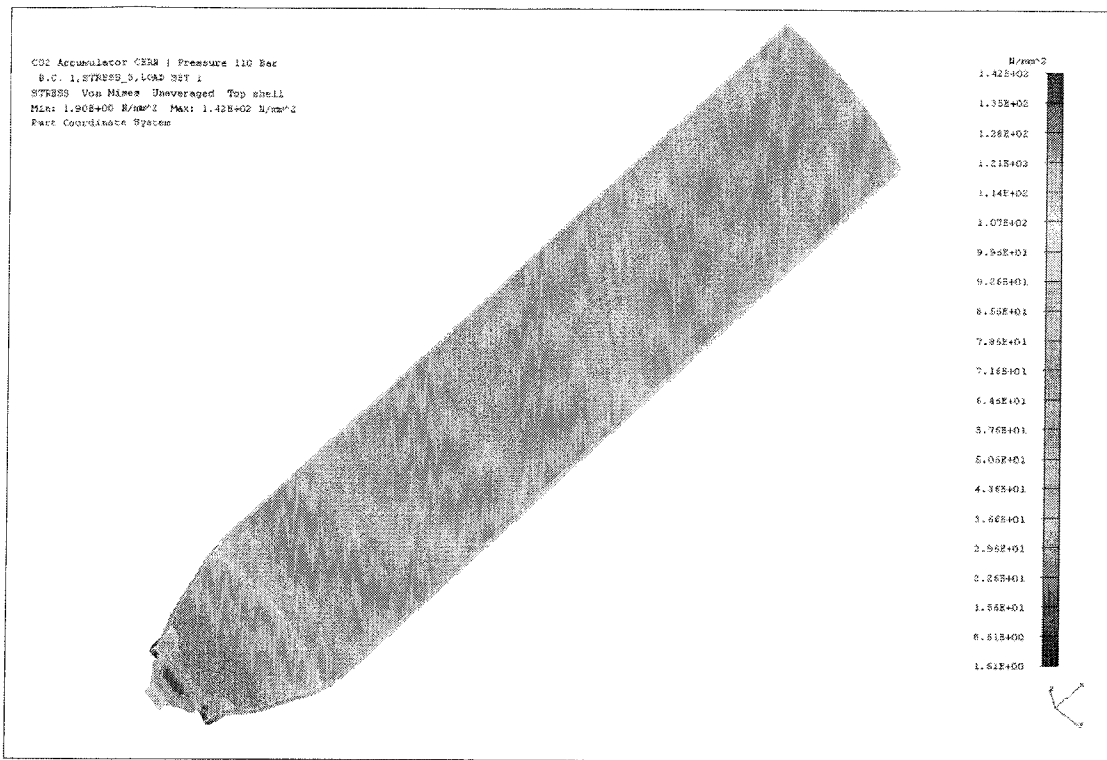


Figure 7. Stress result of the accumulator. Inside view

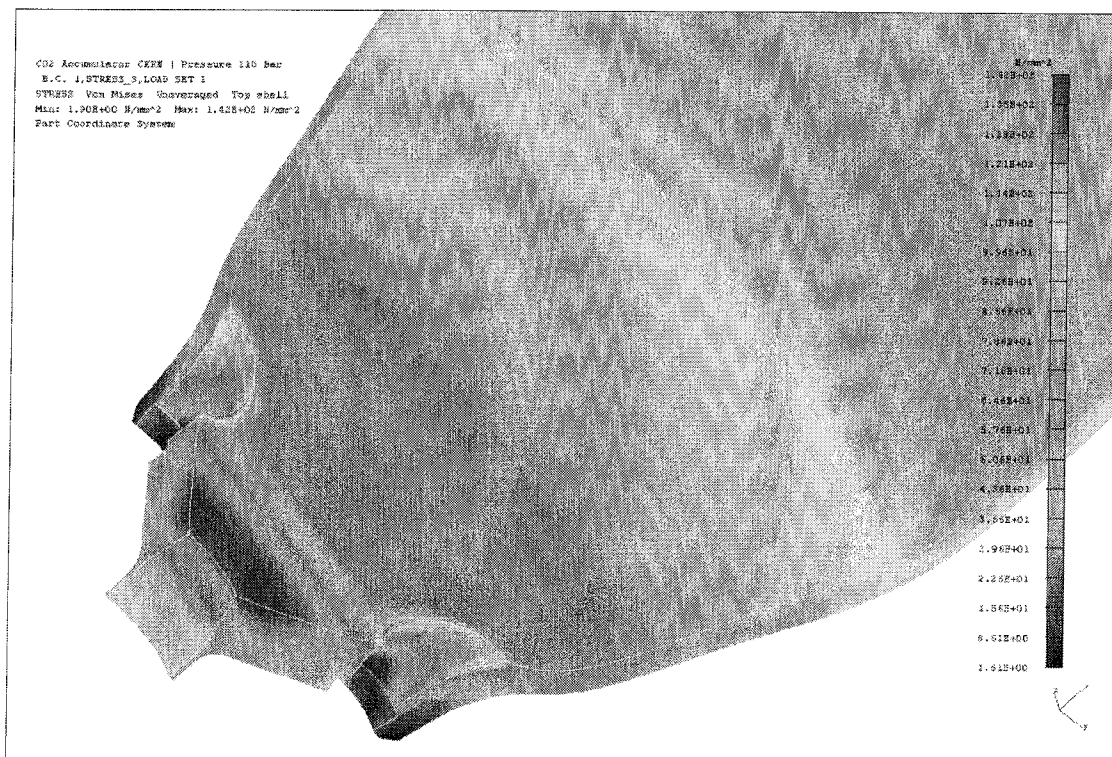


Figure 8. Detail stress inside accumulator

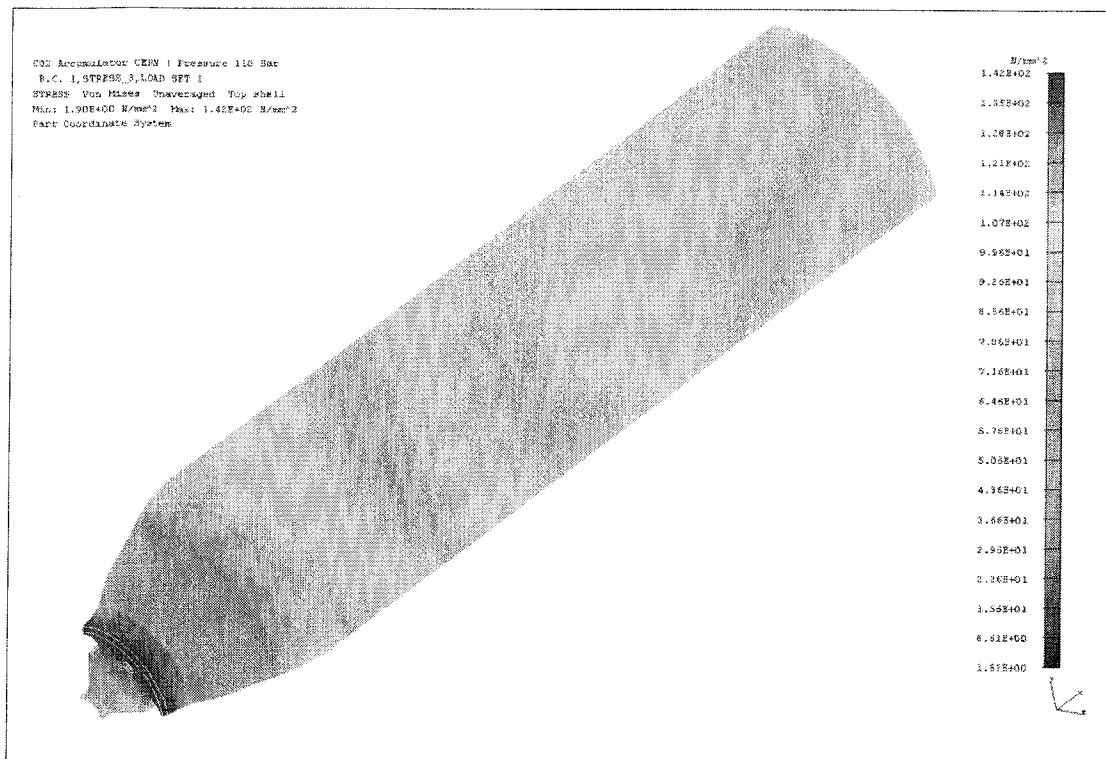


Figure 9. Stress result of the accumulator. Inside view

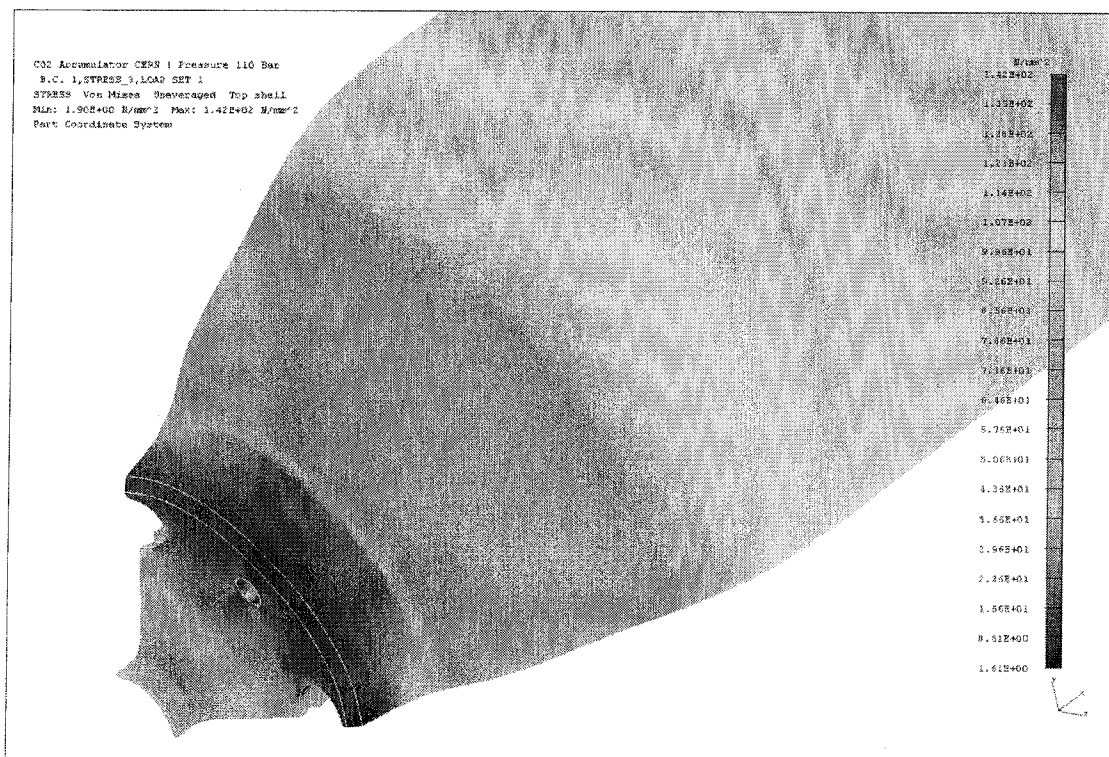


Figure 10. Detail stress outside accumulator

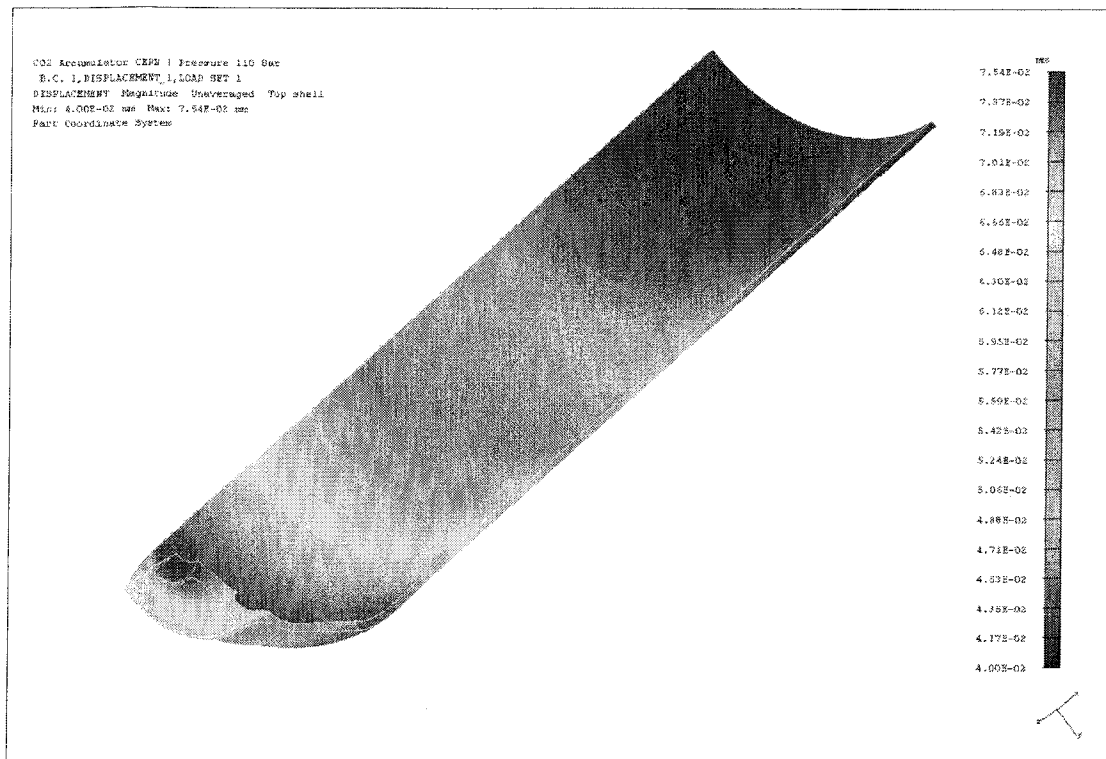


Figure 11. Deformation result of the accumulator. Max = 0.07 mm

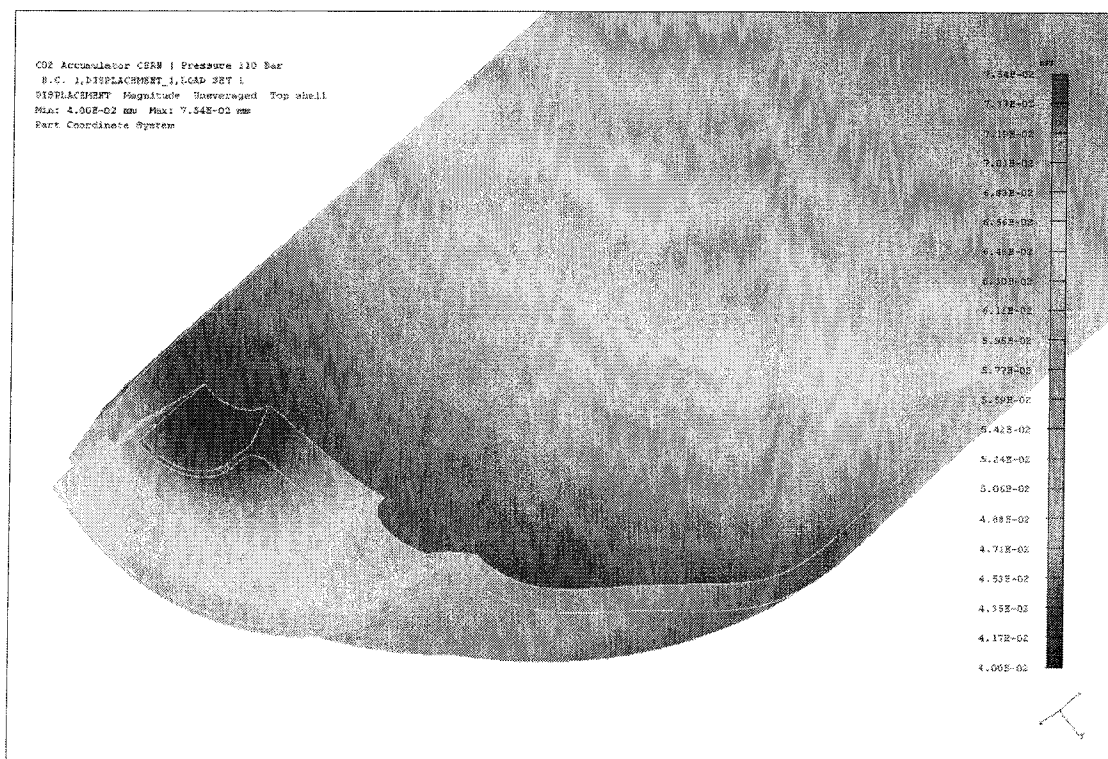


Figure 12. Detail deformation inside accumulator

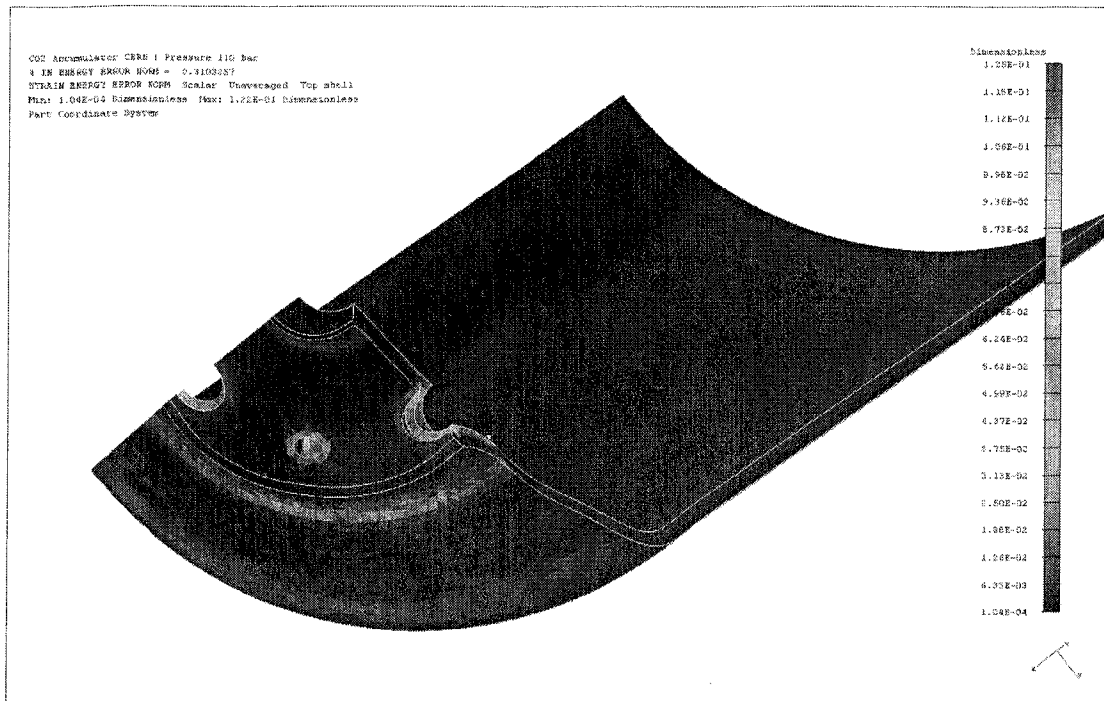


Figure 13. 'Stain energy error norm' of the accumulator (0.3%)

4. ANALYSIS RESULT.

The results are compared with the requirements defined by the CODAP. The limitations of the analysis are presented, and the compliance with the code is verified.

Assuming only the tube, calculation shows that the expected stress (134 MPa) is well below the acceptable values of 150 MPa. Finite element analysis also shows that the general stresses in the accumulator are well below the acceptable value. Stresses in the weld regions (max 90MPa) are below the CODAP limit of 105 MPa. The stress peaks (142 MPa) in the corners of the coil connections are far well below the acceptable peak value of 225 MPa.

The global value for the strain energy error norm in the accumulator is low (0.3 %) and far below the 7% which is recommended by the IDEAS™ software.

5. TESTS, SAFETY AND QUALITY CONTROL

The test, safety and quality control are the steps taken to ensure a safe operation of the system.

5.1 Tests before installation at CERN

The test pressure P_{test} is given by CODAP 95 (E) – 1/36 by the formula:

$$P_{test} = 1.30 \cdot P \frac{f_e}{f_t} = 1.30 \cdot 110 \text{ Bar} \cdot 1 = 143 \text{ Bar}$$

Where:

P = design pressure for a normal condition which is the most severe under pressure

f_e = nominal design stress for a normal operating condition at the temperature of the test

f_t = nominal design stress for a normal operating which is the most severe under pressure at the corresponding design pressure.

Pressure tests on the accumulator at 143bar will be performed by 'Hoefnagel & Meijn B.V'
Industrieterrein Achtersluispolder, Uiterdijk 4, 1505 GW Zaandam

5.2 Tests at CERN

When the accumulator system is complete installed at CERN (connected to transfer line) it will be test for leaks. The system will be filled with N₂ and during a couple of hours the pressure monitored.

5.2.1 Safety valve

To prevent failure of the system, the system will be equipped with a proportional relief valve. The relief valve will open at 110 bar. See appendix II for product data sheets.

5.2.2 Personal safety

Recommended are Oxygen Deficiency detectors at area's, where a potential gas leak could occur this is an area where occasional access is needed during shutdowns for service work. People will be required to take a personal CO₂ meter (C1100 OLDHAM) with them when carrying out work in this area when the cooling system is operational.

Use of special cryogenic equipment (safety goggles and gloves) will be proscribed when intervention and service work on the cooling system is needed.

5.2.3 Heater protections

The heater in the system will be protected by hardware and software. Whenever a limit of 130°C (measured by the thermocouple inside the heater) is exceeded the heater will be switched off. The PLC monitors the heater temperatures of and switch off the heater when the limit is exceeded. The hardware limit is provided by an attached clixon in the electrical supply line of the heater

5.2.4 Pressure protection

The pressure of the accumulator can be increased by external temperature rises or by accidental overheating of the accumulator heater. The pressure is measured, and when a pressure threshold is reached the accumulator heater is switched off.

The CO₂ pumps will have an internal mechanical safety mechanism for overpressure set to 100 bars. However, the PLC will monitor the pressures in different sections of the systems. When the pressure after the pump gets too high (discharge pressure), the pump will be switched off. When the pressure difference over the pump (Δp or pump pressure head) stays below a threshold the pump will also be switched off. To protect the membranes of the CO₂ pumps a membrane alarm is given at a pressure of 10 bars. Whenever this threshold is exceeded the pump concerned stops running.

5.3 Quality control

Tubing

Quality control during manufacturing of all tubing is based on the controlled welding procedure with a Swagelok orbital welding machine. Before each final orbital welding tests with the same tube and material were done to optimize the welding parameters.

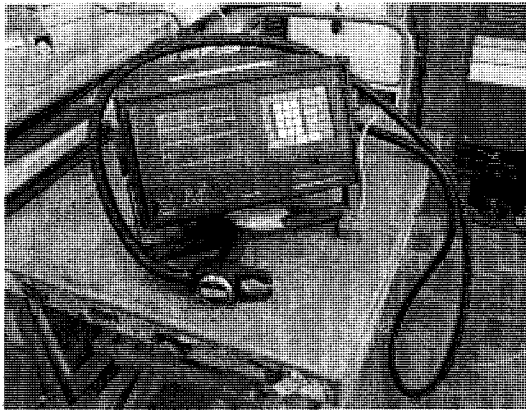


Figure 14. Swagelok orbital welding machine

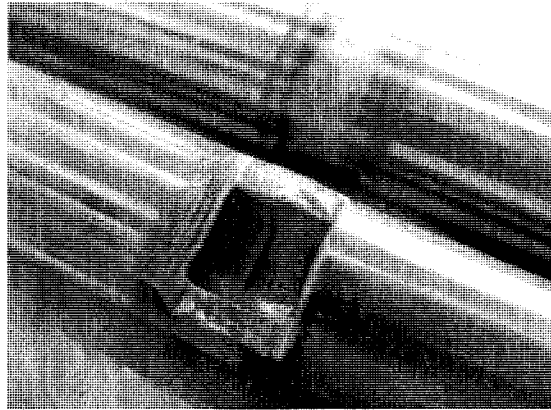


Figure 15. Test weld

Accumulator

The material certificates used in the accumulator is listed in appendix IV

Apart from the circular welds on the cooling spiral made at NIKHEF, the welds of the accumulator will be done by the ISO 9001:2000 certificated firm 'Hoefnagel & Meijn B.V'

Industrieterrein Achtersluispolder, Uiterdijk 4, 1505 GW Zaandam

See appendix ... for the ISO 9001:2000 certificate, the welder qualification and welding procedure approval record.

Visual inspection and radiographic tests will be done by the APPLUS RTD and can be found in appendix... . Certificates and of the APPLUS can be found in appendix ... and ..

6. SUMMARY

Presented is the safety analysis of the accumulator which will be used at CERN. The system must comply with the Pressure Equipment Directive (PED) 97/23/CE. The French construction code for pressure apparatus (CODAP) is used to verify the stresses. The design condition of the system is between +35 and -50 °C and a maximum internal pressure of 110 bar. To prevent failure of the system, the system must be equipped with proportional relief valve set at 110 bar.

The accumulator vessel is classified in PED *category III*. Chosen is to follow the PED modules **G**

The accumulators are made of AISI 316 L. The material is verified upon delivery. The quality of the weldings will be verified by means of visual inspection and radiographic testing. Final pressure test of 145 bar (defined by CODAP 95 (E) – 1/36) has to be performed.

7. APPENDIX I PROCESS DIAGRAM

8. APPENDIX II PROPORTIONAL RELIEF VALVE

9. APPENDIX III WELDING ASSEMBLY

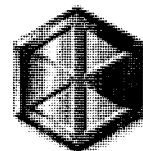
10. APPENDIX IV MATERIAL CERTIFICATES

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| Unsere Abteilung /Our department/Notre département VR-H | Telefon /Telephone/Téléphone 0271/808-2252 | |

Produkt/Product/Produit

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GERICHTET, GESCHAEHLT
1.4401/1.4404 INDUFIL
EN 10272, AD2000-W2/W10, EN 10088-3,
ASTM A 182/276/479, ASME SA 182/479,
NACE MR 0175,
IN ANLEHNUNG AN EN 10222-5, DIN 17440/96

Fertigungsauftr.-Nr./Production lot-No./Lot de fabrication No. :
Lieferschein-Nr./Delivery note/No. de l'avis de livraison :
Schmelzen-Nr./Heat No./No.de coulée : 370270
Stückzahl/Piece No./Nombre des pièces : 3
Gewicht/Weight/Masse : 3106[kg]
Zeichnungs-Nr./Drawing No./No.du dessin :
Format/Shape/Profil : rund / round / rond
Durchm./Breite/Diameter/width/Diamètre/largeur : 180[mm]
Dicke/Thickness/Epaisseur :
Länge/Length/Longueur : 5000 - 6000[mm]

Stückzahl und Gewicht siehe Rechnung. / Quantity and weight see delivery bill/invoice.
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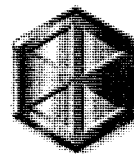
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|---|---|---|---|
| 1541931/7505532/ost | 1212586 / 3 | 315-5401932259 | |

| Schmelzen-Nr. Heat No./No.de coulée | Erschmelzungsart Steelmaking process/Procédé d'élaboration | Sekundärmetallurgie Secondary metallurgy/Metallurgie secondaire |
|--|---|--|
| 370270 | E | VOD |

Chemische Zusammensetzung / Chemical Composition / Composition chimique

| | C | Si | Mn | P | S | Cr | Mo | Ni | Cu | V | Co | Al | N | |
|-------------------|--------|---------|---------|----------|-------|-------|------|-------|------|------|-------|-------|-------|-----|
| Ist/Actual/Actuel | 0.016 | 0.39 | 1.86 | 0.026 | 0.025 | 16.59 | 2.06 | 10.06 | 0.15 | 0.03 | 0.034 | 0.005 | 0.031 | [%] |
| | B | Ti | Nb | Ca | | | | | | | | | | |
| Ist/Actual/Actuel | 0.0039 | < 0.002 | < 0.005 | < 0.0005 | | | | | | | | | | [%] |

Härte/ Hardness/ Dureté

Lieferzustand/Condition as supplied/Etat de livraison
22 HRC

Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

| Probenabm./Specimen dimension/Dimension d'éprouvette | Probenrichtung/Specimen direction/Sens de Prélèvement | Pr.-ent./Specimen location/Point d'prélèv. | Prüftemp./Test temperature/Température d'essai | | | |
|--|---|--|--|--------|----------|-------|
| Zugprobe; 7 mm rd | quer/transverse/traverse | 1/2 Radius,(1/4d) | 23[°C] | | | |
| Proben-Nr./Specimen-No./No.d'éprouvette | Rpo.2 [MPa (N/mm²)] | Rp1.o [MPa (N/mm²)] | Rm [MPa (N/mm²)] | A5 [%] | A2'' [%] | Z [%] |
| 82556-1 | 323 | 368 | 590 | 46.7 | 41.2 | 62 |

Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

| Probenabm./Specimen dimension/Dimension d'éprouvette | Probenrichtung/Specimen direction/Sens de Prélèvement | Pr.-ent./Specimen location/Point d'prélèv. | Prüftemp./Test temperature/Température d'essai | | | |
|--|---|--|--|--------|----------|-------|
| Zugprobe; 7 mm rd | quer/transverse/traverse | 1/2 Radius um 90 Grad versetzt | 23[°C] | | | |
| Proben-Nr./Specimen-No./No.d'éprouvette | Rpo.2 [MPa (N/mm²)] | Rp1.o [MPa (N/mm²)] | Rm [MPa (N/mm²)] | A5 [%] | A2'' [%] | Z [%] |
| 82556-2 | 297 | 343 | 579 | 48.8 | 49.4 | 67 |

Zugversuch/ Tensile test/ Essai de traction

Lieferzustand/Condition as supplied/Etat de livraison

| Probenabm./Specimen dimension/Dimension d'éprouvette | Probenrichtung/Specimen direction/Sens de Prélèvement | Pr.-ent./Specimen location/Point d'prélèv. | Prüftemp./Test temperature/Température d'essai | | | |
|--|---|--|--|--------|----------|-------|
| Zugprobe; 12,5 mm rd | quer/transverse/traverse | 1/3 Radius,max. 50mm u.d. Oberfl.,(1/6d,max. 50mm) | 23[°C] | | | |
| Proben-Nr./Specimen-No./No.d'éprouvette | Rpo.2 [MPa (N/mm²)] | Rp1.o [MPa (N/mm²)] | Rm [MPa (N/mm²)] | A5 [%] | A2'' [%] | Z [%] |
| 82557 | 247 | 279 | 530 | 50.0 | 51.7 | 59 |
| 82556 | 245 | 281 | 534 | 52.5 | 54.3 | 58 |

Schlagbiegeversuch/ Impact test/ Essai de résilience

Lieferzustand/Condition as supplied/Etat de livraison

| Probenform/Type of specimen/Type d'éprouvette | | Probenrichtung/Specimen direction/Sens de Prélèvement | | Prüftemp./Test temperature/Température d'essai | | | |
|---|--|---|--|--|--|---------------------------|--|
| [CHARPY V] | | quer/transverse/traverse | | 23[°C] | | | |
| Proben-Nr./Specimen-No./No.d'éprouvette | | 1. Prfl./Spec./Eprouvette | | 2. Prfl./Spec./Eprouvette | | 3. Prfl./Spec./Eprouvette | |
| 82557 | | 107 [J] | | 110 [J] | | 116 [J] | |
| 82556 | | 110 [J] | | 125 [J] | | 122 [J] | |

Interkristalline Korrosion/ Intergranular corrosion/ Corrosion intercrystalline

GEM. ASTM A 262 PRACTICE E, DIN 50914 / ACC. TO ASTM A 262 PRACTICE E, DIN 50914

US-Prüfung/ Ultrasonic testing/ Contrôle par ultrasons

| |
|--------------------------------------|
| Die Lieferung wurde US-geprüft nach: |
|--------------------------------------|

EN 10228-4 TYP 1A, Tab.4 KL3
ENTSPRICHT AUCH/ALSO CORRESPONDING TO/CORRESPOND AUSSI A/
CORRESPONDE TAMBIEN EN 10308 TYP 1A KL.3, ASTM A 388

Die Lieferung wurde auf Identität geprüft (Optische Emissionsspektrometrie)

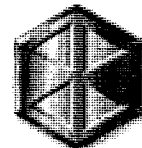
Die Lieferung wurde besichtigt und auf Maß kontrolliert

116

Zertifiziert nach: ISO 9001
ISO / TS 16949
EN 9100
ISO 14001



DEUTSCHE EDELSTAHLWERKE
Providing special steel solutions



D-58452 Witten, D-57012 Siegen, <http://www.dew-steel.com>

Datum/Date: 14.07.10

Seite/Page: 3 / 3

| Zeugnis-Nr. Certificate No./No.de Certificat | Unsere Auftr.-Nr. Our order No./No.de notre Commande | Ihre Auftr.-Nr. vom Your order No. date /No.de votre commande du | Fertigungsauftr.-Nr. Production lot-No./Lot de fabrication No. |
|---|---|---|---|
| 1541931/7505532/ost | 1212586 / 3 | 315-5401932259 | |

Das Material ist frei von Radioaktivität. /The Product is free from radioactive. /Le matériel n'est pas radioactif.
El material es libre de radioactividad.

Das Qualitätsmanagement-System wurde durch LRQA (Kenn-Nr.0525)
gemäß der Richtlinie 97/23/EG Anhang 1, Abschnitt 4.3
(Druckgeräterichtlinie) überprüft (Zertifikats-Nr.: 50072).

It is hereby certified that the quality management system has been
reviewed by LRQA (identification no.0525) according to the
requirements of the Pressure Equipment Directive 97/23/EC Annex 1, 4.3
(guidelines for pressure instruments) (certificate no.: 50072).

Le système d'assurance de qualité est vérifié par la société LRQA (no.
indicatif 0525) selon recommandation 97/23/EG annexe 1,
section 4.3 (Directive pour Appareils soumis a Pression)
(certificate no.: 50072).

El Sistema de Calidad fue examinado por el LRQA (no.de identificación
0525) en conformidad con la directiva 97/23/EG anexo 1, sección 4.3
(para equipos de presión) (certificado no.: 50072).

Erläuterung/ Explanations/ Explications

■ **Erschmelzungsart** / Steelmaking process / Procédé d'élaboration:

E = Elektrostahl / Electric-arc-furnace steel / Acier électrique

■ **Sekundärmetallurgie** / Secondary metallurgy / Metallurgie secondaire:

VOD = Vakuum-Sauerstoff-Entkohlungs-Verfahren / Vacuum-Oxygen-Decarburization / Vacuum-Oxygène-Décarburation

Die Lieferung wurde aus einem bevorrateten, geprüften Abnahmelos entnommen.
Material against this delivery has been taken from a stored and tested inspection lot.
La livraison a été pris d'un lot de réception stocké et éprouvé.

Es wird bestätigt, daß die Lieferung geprüft wurde und den Vereinbarungen bei der Bestellsannahme entspricht.
We hereby certify that the material described above has been tested and complies with the terms of the order.
Nous certifions que la livraison été vérifiée et est conforme aux stipulations de l'acception de la commande.

3710270

3710270

3710270

NOORD-AMSTERDAMSE MACHINEFABRIEK B.V.

1031 HN Amsterdam, Asterweg 16, tel. + 31 (0)20-636 14 48, fax + 31 (0)20-634 16 23

www.nammachinefabriek.nl Email: info@nammachinefabriek.nl

Bank: ABN-AMRO, rek. nr. 46.71.59.416

K.v.K. nr. 34157305, BTW nr. NL 001029964 B01

Packing list

Sent to:

NIKHEF

KRUISLAAN 409

1098 SJ AMSTERDAM

Date 13-10-2010

Our REF. NR 52737

Your REF. NR 00043338

Contactpers. DHR A SNAIJER

Pieces**Back order**

2,000 ACCUMULATOR TOP EN SPHERE BOTTOM

GEHEEL VOLGENS TEKENING 40030-ME-00039 EN 40030-ME-00016
MATERIAAL RVS 316L (1.4404)

MATERIAAL DOORSTEMPELEN CERITFICAATNR. 814TK

CERTIFICATEN OPSTUREN NAAR:

NIKHEF

T.A.V. DHR A. SNAIJER

POSTBUS 41882

1009 DB AMSTERDAM

AFLEVERADRES:

HOEFNAGEL EN MIJNS

UITERDIJK 4

1505 GW ZAANDAM

**Date receipt of the
goods**

Name

Signature

Op al onze aanbiedingen, overeenkomsten en leveringen zijn de algemene verkoop- en leveringsvoorwaarden voor de metaal- en de elektronische industrie van toepassing, welke zijn uitgegeven door de vereniging FME-CWN en gedeponneerd ter griffie van de Arrondissementsrechtbank te Den Haag op 19 oktober 1998 onder nummer 119/1998.

Reclames binnen 8 dagen na ontvangst



SHANGHAI JINCHANG STAINLESS STEEL TUBE MANUFACTURING CO., LTD.

158 Xinyang Road, Shaochang Town, Fengxian District, Shanghai, China
AD WO/TRD100: 01 202 CH/AD-04 0106 9723/EC: 01 202 CH/Q-04 0106

MILL TEST CERTIFICATE

DATE OF ISSUE: 2005.5.15

DIN EN ISO9001:2000 No: 01 100 038935

| | | | | | | | | | | | |
|--|--------------------|--------------------------|-----------------|----------------|----------|-------------|--------------------------|------------------|----------------|-------------|-----------------------------|
| COMMODITY: STAINLESS STEEL SEAMLESS PIPES | | ORDER NO: 12-25 | | | | | | | | | |
| CONDITION: COLD FINISH / SOLUTION TREATED / PICKLED / PLAIN END. | | GRADE: ASTM A312 TP 316L | | | | | | | | | |
| CHEMICAL CONTENTS (WT%) | | HEAT NO: J0405-140 * | | | | | | | | | |
| ELEMENTS | C | Mn | P | S | Si | Ni | Cr | Mo | | | |
| SPECIFICATION | ≤0.030 | ≤2.00 | ≤0.045 | ≤0.030 | ≤1.00 | 10.00-14.00 | 16.00-18.00 | 2.00-3.00 | | | |
| RESULTS (PRODUCT) | 0.021 | 0.64 | 0.030 | 0.001 | 0.36 | 12.19 | 16.52 | 2.08 | | | |
| PHYSICAL PROPERTIES | | | | | | | | | | | |
| Dimensions | TEST No. | Pieces | Quantity (m/kg) | 0.2%TS (Mpa) | TS (Mpa) | EL (%) | EDDY CURRENT TEST (100%) | FLAT FENING TEST | HARDNESS (HRC) | P.M.L. TEST | HYDRO-STATIC TEST (Mpa/min) |
| OD. (mm) 168.28 | Length (m) 6.0-6.2 | 1225 | 4 | 24.48m / 704kg | 240 | 575 | 50 | OK | OK | OK | 8.0/5sec |
| REMARKS: AS PER ASTM A312/ASTM A999 LATEST EDITION & ASME SA312/A SIME SA999 LATEST EDITION WALL THICKNESS TOLERANCE AS PER ASTM A312-04 MELTING PROCESS: EF POSITIVE MATERIAL IDENTIFICATION TEST: SATISFACTORY CORROSION TEST PER ASTM A-262 PRACTICE "E" HARDNESS TEST PER NACE MR-01-75 SOLUTION HEAT TREATMENT: 1920 F x 1.15h/min WATER COOLED TO BELOW 800 F in 3min NO WELD REPAIR WAS PERFORMED FREE FROM MERCURY CONTAMINATION MARKING: JINCHANG / ASTM A312 ASTM A999 TP 316L / 168.28 mm x 7.11 mm H est. No: J0405-140 PROD: C12-26 | | | | | | | | | | | |
| SHANGHAI JINCHANG STAINLESS STEEL TUBE MANUFACTURING CO., LTD. MANAGER OF QUALITY ASSURANCE DEPARTMENT: <i>Zhang Baonan</i> Zhang Baonan | | | | | | | | | | | |

247-365

R20

△
TUV

PMI examination Report

Röntgen Technische Dienst bv



F&A number

1104--050207/012

Report number

03103-2010-39-010

Delftweg 144
Postbus 10065
3004 AB Rotterdam

Tel. (010) 208 82 08
Fax (010) 415 80 22
E-mail rtd@rtd.nl

Client Hoefnagel & Meijn b.v.
Address Uiterdijk 4
Post code and city 1505 GW Zaandam
Country Nederland
Contact Dhr. N. Wester

Client order number 10.345
F-260
Project T.b.v. Nikhef Instituut
Drawing number 40030-ME-00074
Object CO2 Accumulator

Carried out at Hoefnagel & Meijn b.v.
Address Uiterdijk 4
Post code and city 1505 GW Zaandam
Country Nederland
Date 29-9-2010

RTD branch office Barneveld
Telephone number (0342) 42 54 40
Fax (0342) 42 54 49
Contact Mr. T. Cornelissen

Examination proc. DT 21901 Rev. 5

Remarks I.o. met klant meerdere
elementen genoteerd.
Vergeleken met library X-

PMI equipment X-MET3000TX
Number 5555-1200-0531 Reference piece Duplex 2205
Calibration expires 01-12-2010 Result [%] 100%
Standardisation date 29-09-2010 Cal. block Ser 700877

Purpose of examination: Positive Material Identification (PMI)

Items examined: Different parts, in total 3 parts of a CO2 Accumulator with only one measurements of each PART_ID. See results.

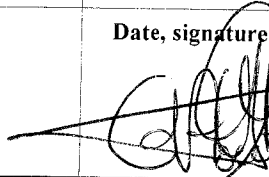

Result: Calibration results:

| Item | Result | Cr% | Std Dev | Ni% | Std Dev | Mo% | Std Dev | Mn% | Std Dev |
|-------------------------|-------------|------|---------|------|---------|------|---------|-----|---------|
| Calibratie (Ser 700877) | Duplex 2205 | 23,4 | 0,2 | 5,7 | 0,1 | 3,21 | 0,04 | 1,1 | 0,1 |
| Reference (316L no. 23) | AISI 316L | 17,2 | 0,2 | 10,3 | 0,2 | 2,35 | 0,04 | 1,7 | 0,1 |

Result: Measurements object:

| Item | Result | Cr% | Std Dev | Ni% | Std Dev | Mo% | Std Dev | Mn% | Std Dev |
|-----------|--------|------|---------|------|---------|------|---------|-----|---------|
| 6" pipe | SS316 | 17,2 | 0,2 | 11,8 | 0,2 | 2,18 | 0,03 | 0,6 | 0,1 |
| Cap left | SS304 | 18,4 | 0,2 | 7,7 | 0,2 | 0,31 | 0,01 | 1,7 | 0,1 |
| Cap right | SS304 | 18,3 | 0,2 | 7,6 | 0,2 | 0,31 | 0,01 | 1,8 | 0,1 |

Opmerking: Resultaat waarden in overeenstemming met library X-MET.

| For client | Name operator | No. | Level | Cert.no. | Report checked for RTD |
|---------------|---|------|-------|----------|---------------------------|
| | a M.G.A. Oude Wesselink | 1035 | II | 473/1238 | Name |
| | b -- | -- | -- | -- | |
| Page 1 | Date, signature and stamp 29-09-2010 | | | | Date, signature and stamp |
| Total pages 2 |  Applus  ND Testing M. Oude Wesselink | | | | |



CERTIFICATE No. A/10-934746 Rev 00
Date 2010-02-01 Page 1/2

INSPECTION CERTIFICATE acc to
EN 10 204 3.1

SWAGelok COMPANY
P.O. BOX 31300
INDEPENDENCE, OH 44131
USA

INSPECTION STAMP
QA-TUBE

Customer References

W27877

230-06760 NEDERLAND

Material description

SEAMLESS STAINLESS COLD FINISHED
INSTRUMENTATION TUBING

Sandvik References

Order No. Subs No. ABSMT Dispatch note
order 27877 44264/54
2010-01-28 ABSMT No. C.Code
300-15945 29

Steel/material Designations

Sandvik AISI
3R60 TP316/TP316L
EN no
1.4436/1.4435

Steel making process

Electric furnace

Technical requirements

ASTM A-213-08 AW, ASME SA-213-ED-07 AD-08 AW, ASTM A-269-08
NACE MR0175/ISO 15156-3:2003
PED 97/23/EC EN 10216-5 TC1
HRB MAX 80

EXTENT OF DELIVERY

| It | Product designation | Heat | Lot | Pieces | Kg | M |
|-------|---------------------|--------|-------|--------|-------|--------|
| 01 | THT-3R60-9.53-0.89 | 047279 | 92425 | 100 | 113.0 | 600.00 |
| | 9.53 X .89 | | | | | |
| | SS-T6-S-035-6ME | | | | | |
| Total | | | | 100 | 113.0 | 600.00 |

KEY TO HEAT

| Heat Code | Heat No. |
|-----------|----------|
| 047279 | 522467 * |

KEY TO LOT

| Lot Code | Lot No. |
|----------|---------|
| 92425 | 348109 |

TEST RESULTS

Chemical composition (weight%)

| Heat | C | Si | Mn | P | S | Cr | Ni | Mo |
|--------|-------|------|------|-------|-------|-------|-------|------|
| 047279 | 0.019 | 0.40 | 1.66 | 0.029 | 0.008 | 17.33 | 13.18 | 2.65 |
| N | | | | | | | | |
| 047279 | 0.044 | | | | | | | |

Chemical composition, product (weight%)

| Lot | C | Si | Mn | P | S | Cr | Ni | Mo |
|-------|-------|------|------|-------|-------|-------|-------|------|
| 92425 | 0.018 | 0.39 | 1.65 | 0.029 | 0.006 | 17.31 | 13.15 | 2.63 |
| N | | | | | | | | |
| 92425 | 0.037 | | | | | | | |

Quality assurance - Per Eriksson/ QA-manager Tube & Pipe

MTC Service / Certificates

AB SANDVIK MATERIALS TECHNOLOGY Reg No. 556234-6832 VAT No. SE663000-060901
SE-81181 SANDVIKEN SWEDEN www.smt.sandvik.com mtc_service.smt@sandvik.com



CERTIFICATE No. A/10-934746 Rev 00

Date 2010-02-01 Page 2/2

Tensile test at room temperature

| Lot | Yield strength | | Tensile strength | Elongation | |
|-------|----------------|-------|------------------|------------|----|
| | MPa | MPa | MPa | % | % |
| | Rp0.2 | Rp1.0 | Rm | A | 4D |
| 92425 | 287 | 316 | 587 | 64 | 58 |
| | 286 | 315 | 587 | 64 | 60 |
| | 279 | 309 | 579 | 65 | 60 |
| | 252 | 280 | 551 | 64 | 60 |

Hardness test

| Lot | Min | Max |
|-------|-----|-----|
| | HRB | HRB |
| 92425 | 68 | 70 |

Following controls/tests have been satisfactorily performed:

- Flattening test.
- Flaring test
- PMI-test.
- Intergranular corrosion test acc to ASTM A-262 PR.E
- Leak test: Eddy current test acc to ASTM A-1016.
- Visual inspection and dimensional control.

Heat Treatment:

Solution annealed and quenched.

Marking:

SANDVIK 3R60 ASTM/ASME A/SA-213AW A-269 EN 10216-5 TC1 TP 316/TP 316L EN 1.4435 COLD SMLS NDE 9.53 X 0.89 MM 3/8" X 20 BWG/SWG HT 522467 SC LOT 348109 DIN 2391 *QA-TUBE*

Approved acc. AD 2000-Merkblatt W0 and certified acc. to Pressure Equipment Directive (97/23/EC) by TUEV NORD GmbH; notified body, reg.no. 0045.

The number of tests are based on the size of the manufacturing lot before cutting to finished lengths.

The delivered products comply with the specifications and requirements of the order.

The material is manufactured according to a Quality system, approved and registered to ISO 9001.

The certificate is produced with EDP and valid without signature.

TEST RESULTS TRANSFERRED FROM CERTIFICATE NO 00038721



Sandvik Steel Canada
435 McCortney Street
Ayrshire, Ontario, Canada K7S 3P3
(613) 623-6501 Fax: (613) 623-7243

CERTIFIED MATERIAL TEST REPORT

CUSTOMER:

SHIP TO:

MILL ORDER:
000214146

CUSTOMER ORDER & Item
42796 05

SPECIFICATION
ASTM A213-99A/A269-98, P&P Z-001 REV 1 12/99
EN 10204 3.1B

MATERIAL

TP316 / TP316L Seamless Stainless Steel Coiled Tube
9.53mm avg/OD x 0.89mm avg/wall

| WORK ORDER/HEAT NO. | No. of Coils | Total Length | Total Weight |
|---------------------|--------------|--------------|--------------|
| 119701 451633 | 6 | 1504.5 | 292.0 |
| 119761 451633 | 1 | 256.0 | 49.0 |

| HEAT ANALYSIS | | | | | Melt Source - Sandvik, Sweden | | | | | Melt Method - Electric Furnace | | | | |
|---------------|------|-----|------|------|-------------------------------|-------|-------|------|------|--------------------------------|------|--|--|--|
| Heat No. | C | Si | Mn | P | S | Cr | Ni | Mo | Co | Cu | N | | | |
| * 451633 | .022 | .38 | 1.56 | .026 | .011 | 16.87 | 12.54 | 2.06 | .082 | .32 | .026 | | | |

| PRODUCT ANALYSIS | | | | | | | | | | | | | | |
|------------------|------|-----|------|------|------|-------|-------|------|------|-----|------|--|--|--|
| 451633 | .023 | .38 | 1.56 | .027 | .010 | 16.79 | 12.53 | 2.05 | .079 | .31 | .025 | | | |

MECHANICAL TESTS


| Work Order | UTS | 0.2% YS | E1 % on 2" | Hardness |
|------------|-----|---------|------------|----------|
| Order | Ksi | Ksi | | HB |
| 119701 | 88 | 38 | 60 | 76, 76 |
| | 88 | 38 | 60 | |
| 119761 | 91 | 42 | 62 | 78, 79 |
| | 93 | 44 | 60 | |

Flare Test - Acceptable
Flattening Test - Acceptable
Corrosion Test as per A-262 Pr. E - Acceptable
Eddy Current Examination - Acceptable
Seamless, Cold Finished, Bright Annealed & Quenched
No weld repair has been performed on this material.
Traceability is through Work Order number line marked on tubes.
Country of origin: Canada
This material has not come in contact with mercury or mercury-containing compounds.
This certification affirms that the contents of the report are correct and accurate and that all test results and operations performed by Sandvik Steel Canada or our subcontractors are in compliance with the material specification. The material is manufactured according to a quality system, approved and registered to ISO 9002, certificate number 002812 which expires September 25, 2001.
This certificate is produced electronically and is valid without signature.

Quality Assurance - Richard Wright, Manager Quality Assurance
Julia Racoskie, Certificates
01.05.01

| | |
|------------------------|---|
| | Best. Nr.: 20010196/Konsi-Lager |
| | Kunde/customer: MERINOX b.v. |
| | Komm.-Nr./orderconfirmation no.: 140458 |
| | Stück/pieces: 7 |
| | Meter/meter: 1760,50 |
| Datum/Date: 2002-11-11 | Unterschrift/signature |

260 mm 1381-1C

| | | | | | |
|---|--|---|--|--|--|
|  DNEPROSPETSstal, YUZHNOYE SHOSSE 81, ZAPOROZHYE 69008, UKRAINE | | Contract No.: 07295 TECHN. PROTOCOL № DCO031-04 SPEC. №3163/240MNL1381 "AD 2000-Merkblatt W0TRD 100/9723/5G(DGRU)" "AD 2000-Merkblatt W2, AD2000-Merkblatt W10 "DIN EN 10088-3, DIN EN 10272, ASTM A 276, ASTM A 479" | | Sheets: 5 QUALITY CERTIFICATE EN 102042.1 Nr. 221475 PLANT ORDER № 8072933163 | |
| PRODUCT DESCRIPTION Rods of corrosion-resistant (stainless) steel hot rolled, peeled. Прутки из коррозионностойких (нержавеющих) сталей горячекатаные, обточенные. STEEL MAKING PROCESS: Electric furnace СПОСОБ ВЫПУСКА: Электропечь Round 20.09 mm L=5.00-6.00m Grade: 1.4401/1.4404/316/316L | | QUANTITY: (number of pcs) 1bund Q-1099 kg Delivery condition Heat-treated (solution annealing 1020-1100° water) С термической обработки (закалка в воде 1020-1100°) | | | |
| ANALYSES, % C Si Mn P S Cr Ni Mo Al Cu V W Ti Co Nb N ₂ Sn B REQUIRED <0.30 <1.00 <2.00 <0.045 <0.015 16.50-18.00 10.00-13.00 2.00-2.50 <1.0 <40 <10 <20 <15 <40 <20 <10 CAST № 93856 * 0.025 .54 1.36 .038 .018 16.80 10.42 2.02 .056 .30 .04 .14 .09 .072 .011 .027 .0014 | | TECHNICAL REQUIREMENTS: Macrostructure - GOOD GRAIN SIZE: 5 to ASTM E 112 Nonmetallic inclusions ASTM E 45 (Method A) thin thick thin thick thin thick 2.0 2.0 1.5 1.5 0.0 0.0 1.0 1.0 ICC-DIN 50914(EN 114, EN ISO 3651-2)-test: O.K. "Anti-mixing test-O.K." "Dimension test and surface defects test is accomplished" | | | |
| MECHANICAL PROPERTIES Yield Strength (N/mm ²) 205 240 306 330 Tensile Strength (N/mm ²) 515-690 578 Elongation A ₅ % L Q 40 50 59 75.5 Impact strength, KV, J L Q 100 206 187 194 | | MECHANICAL PROPERTIES TESTED IN STATE OF DELIVERY US - testing yes Results: SEP 19213/DD-O.K. Radiation free; mercury free. No Weld or Weld repair. | | | |



Manufacturer: ISC DNEPROSPETSstal
 Date: 20.02.09 Signed:
 Zaporozhye
 Made in Ukraine.

TESTING OF TEST SAMPLE

Customer : Hoefnagel & Meijn B.V.
Uiterdijk 4, 1505 GW Zaandam
Order no. customer : 10.404
Project :
Material : AISI 316L
Test sample : Welding connection 4
Condition test sample : As delivered
Certificate no. : SFI0000161A
Order no. : SFI0000161SO
Amsterdam : 2010-10-18

CODE: CUSTOMER

RESULTS OF THE TESTS

| CHEMICAL COMPOSITION | | | [OES] | | | [WT %] | | | |
|----------------------|-------|------|-------|-------|-------|--------|-------|-------|------|
| Specimen no. | C | Si | Mn | P | S | Cr | Mo | Ni | N |
| F0161A | 0.026 | 0.59 | 1.35 | 0.037 | 0.019 | 16.7 | 2.00 | 10.9 | 1) |
| Requirements | max. | max. | max. | max. | max. | 16.0- | 2.00- | 10.0- | max. |
| AISI 316L | 0.030 | 0.75 | 2.00 | 0.045 | 0.030 | 18.0 | 3.00 | 14.0 | 0.10 |

(Key to steel)

Remark: The results are an average of at least 3 measurements.

1) N not determined

CONCLUSIONS/ REMARKS

The results meet the specified requirements

Stork FDO Inoteq B.V.

Verified: W.H. Mooij

Authorised: E. de Rijcke

Departmentmanaging Director





Swagelok Company
29500 Solon Rd
Solon, OH 44139 U.S.A
440.349.5600
440.519.4997 fax

Inspection Certificate EN 10204-3.1 (formerly 3.1B)

| Distributor | Customer | Customer PO# |
|--|---|---------------------|
| Nederland Sales & Service B.V. Coenecoop 770 2741 PW Waddinxveen P.O. Box 93 The Netherlands | Nikhef Science Park 103 1098 XG Amsterdam | 42873 0100390688 |

| No. Part Number | Qty Product ID | Component | Heat Code |
|----------------------|----------------|-----------|-----------|
| 1 6lv-16-vcr-3-16tb7 | 8 R9KBJ1420 | Body | VHL |

Swagelok products referenced above are manufactured from material purchased and certified as being in accordance with the specification(s) listed below.

Information contained in the above customer address column (marked as "Customer") and area marked "Reference" (when applicable) of this certification are for reference purposes only. Swagelok Company makes no stipulations, nor takes responsibility, for the accuracy or reliability of such information.

Swagelok products are manufactured under conditions which are free from mercury. No Mercury bearing components have been used in the products of your order and no Mercury bearing instruments or other equipment have been used in their manufacture, assembly, or testing in such a manner as might cause contamination.

No asbestos or asbestos-containing components are used in Swagelok brand products.

MATERIAL STANDARDS

| Components | Material | Standards |
|-------------------|------------------------------|--|
| Straight Fittings | 316L VAR Stainless Steel Bar | SEMI F20 (with exception of 20% min. elongation) |

Annexes: Material Certificates

The Swagelok® products specified above are certified for use in commercial-grade (non-Nuclear Safety Related) applications and were manufactured in accordance with Swagelok Company's Quality Assurance Manual (latest revision, revision H, dated December 10, 2007). Swagelok Company's Quality System is approved to ISO 9001 (BSI Certificate # FM01729).

Certifications Supervisor
Jonathan Seewald

5

CERTIFICATE OF TESTS ABNAHMEPRUEFZEUGNIS CERTIFICAT DE CONTROLE
APPROVED BY LENNY TABORY 10/28/2009

CERT SERIAL# 000706187


CARPENTER

 Carpenter Technology Corporation
 101 West Bern Street, Reading, Pa. 19601
 Tel: (610) 208-2000 (800) 338-4592

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10/28/09

CUSTOMER/BESTELLER/CLIENT

VHL

SELLER/VERKÄUFER/VENDEUR PAGE 1 OF 4

 SWAGELOK COMPANY
 P.O. BOX 0529
 MEDINA, OH 44258

HIT

| CUSTOMER ORDER NO./BESTELL-NR./N° DE COMMANDE | CARPENTER NOWERKS-NR./N° DE REFERENCE INTERNE | DATE/DATUM/DATE | WEIGHT/GEWICHT/POIDS |
|---|---|-----------------|----------------------|
| K40733 | W56769 | | 1604 |

HEAT NUMBER / SCHMELZE-NR. / N° DE COULEE 556882
PRODUCT DESCRIPTION: VAR 316L-SCO STRAIN HARDENED GROUND
PART NUMBER: 6LV-RB-143750
SPECIFICATION: SWAGELOK SMS-00094 REV J (01/06/09)

 ASTM-A262-02A(2008)
 ASTM-A276-08A (MODIFIED MECH PROPERTIES)
 ASTM-A479-08 (MODIFIED MECH PROPERTIES AND ANNEALING TEMP
 ASTM-A484-08 (MODIFIED ANNEALING TEMPERATURE)
 ASTM-A751-08
 ASTM-E18-08B
 ASTM-E45-05E2
 ASTM-A370-09A
 ASME-SA479 2007 EDITION, 2009B ADD (MODIFIED MECH PROPERTIES)
 ASTM-E112-96(2004)E2
 ASTM-E8-08
 ASTM-E1001-06
 SWAGELOK SOS-00012 REV K (01/15/09)
 SWAGELOK SOS-00020 REV J (08/20/09)
 SWAGELOK SOC-00196 REV E (11/20/08)
 SEMI F20-0706 (HP) GRADE (10/06) MECH PROPS PER SMS-00094

SIZE 1.437500 IN. (36.51 MM) RD BAR
PRIMARY HEAT CHEMISTRY(WT%): (TEST METHOD IS SHOWN IN PARENTHESIS)

| | | | | | |
|---------|---------|---------|---------|---------------|---------|
| C (COM) | MN(XRF) | SI(XRF) | P (XRF) | S (COM) | CR(XRF) |
| 0.023 | 1.20 | 0.67 | 0.011 | 0.006 | 17.69 |
| NI(XRF) | MO(XRF) | CU(XRF) | CO(XRF) | AL(OES) | N (FUS) |
| 13.26 | 2.69 | 0.21 | 0.08 | 0.003 | 0.04 |
| TI(XRF) | NB(XRF) | SE(XRF) | CA(OES) | CR EQV/NI EQV | FN |
| LT .004 | 0.04 | LT .002 | LT .005 | 1.50 | 4.45 |

MELT DATE: 11/04/08
INTERGRANULAR CORROSION TESTED TO ASTM-A262, PRACTICE E - ACCEPTABLE. (OXALIC) (STEP)
ANNEALED MICROSTRUCTURE FREE FROM CONTINUOUS GRAIN BOUNDARY CARBIDE PRECIPITATION (NETWORK). (KALLINGS)
MATERIAL ULTRASONICALLY INSPECTED IMMERSION METHOD - ACCEPTABLE.

CONTINUED ON NEXT PAGE

Diana M. Kissling

CERTIFICATE OF TESTS ABNAHMEPRUEFZEUGNIS CERTIFICAT DE CONTROLE

CERT SERIAL# 000706187


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CUSTOMER / BESTELLER / CLIENT

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SELLER / VERKÄUFER / VENDEUR PAGE 2 OF 4

 SWAGELOK COMPANY
 P.O. BOX 0529
 MEDINA, OH 44258

HIT

| CUSTOMER ORDER NO./BESTELL-NR./N° DE COMMANDE | CARPENTER NO/WERKS-NR/N° DE REFERENCE INTERNE | DATE/DATUM/DATE | WEIGHT/GEWICHT/POIDS |
|---|---|-----------------|----------------------|
| K40733 | W56769 | | 1604 |

HEAT NUMBER / SCHMELZE-NR. / N° DE COULEE 556882

100% COMPARATOR TESTED TO DETECT/SORTOUT HIGH IRON/LOW ALLOY INCLUSIONS.

THIS MATERIAL WAS MANUFACTURED IN ACCORDANCE WITH CARPENTER SPECIALTY ALLOYS OPERATIONS QUALITY PROGRAM MANUAL REVISION 27, DATED 1/08.

DISCS MACROETCH TESTED AND APPROVED

THIS ORDER WAS MANUFACTURED IN ACCORDANCE WITH SPECIALTY ALLOYS OPERATIONS QUALITY PROGRAM MANUAL REVISION 27, DATED 1/08 "AS ACCEPTED BY SWAGELOK COMPANY" IN COMPLIANCE WITH ASME B & P V CODE SECTION III, DIVISION I, SUBSECTION NCA 3800, 2007 EDITION.

NO WELD REPAIR.

CARPENTER TECHNOLOGY COMPLIES TO THE EUROPEAN DIRECTIVE (EU) 2002/95/EC.

THIS HEAT MELTED BY THE ARC/ADD + VAR PROCESSES

MATERIAL IS IN COMPLIANCE WITH ASTM A276 AND ASTM A479 WITH MODIFIED ANNEALING AND MECHANICAL PROPERTIES.

MATERIAL HAS BEEN MANUFACTURED IN ACCORDANCE WITH SEMI F20-0706.

MILL HEAT TREATMENT:

| | |
|---------------|-----------------|
| TYPE | SOLUTION ANNEAL |
| TEMP. | 1832F (1000C) |
| TIME AT TEMP. | .50 HOUR |
| QUENCH | WATER |

HARDNESS AS SHIPPED, HRC - 32

| | |
|-----------------------------------|-------------|
| YIELD STRENGTH, (0.20 %) KSI(MPA) | 102.0(703) |
| TENSILE STRENGTH, KSI(MPA) | 129.0(889) |
| ELONGATION IN 2.00" % | 22.0 |
| REDUCTION OF AREA, % | 73.0 |

GRAIN SIZE PER ASTM E112: 5 (KALLINGS)

CONTINUED ON NEXT PAGE

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CERTIFICATE OF TESTS ABNAHMEPRUEFZEUGNIS CERTIFICAT DE CONTROLE

CERT SERIAL# 000706187


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101 West Bern Street, Reading, Pa. 19601
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CUSTOMER / BESTELLER / CLIENT

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SWAGelok COMPANY
P.O. BOX 0629
MEDINA

OH 44258

HIT

| CUSTOMER ORDER NO./BESTELL-NR./N° DE COMMANDE | CARPENTER N°WORKS-NR/N°DE REFERENCE INTERNE | DATE/DATUM/DATE | WEIGHT/GEWICHT/POIDS |
|---|---|-----------------|----------------------|
| K40733 | W56769 | | 1604 |

HEAT NUMBER / SCHMELZE-NR. / N° DE COULEE 556882

CHEMISTRY CHECK (WT%) AT SIZE 7.125 IN. X 7.125 IN.

| | | | | | | |
|----------|----------------|------------|----------------|----------------|-----------------------|-------------|
| 4A (TOP) | C 0.026 | MN 1.18 | SI 0.68 | P 0.011 | S 0.007 | CR 17.74 |
| 4A (TOP) | NI 13.31 | MO 2.73 | CU 0.21 | CO 0.08 | AL 0.003 | N 0.04 |
| 4A (TOP) | TI LT 0.004 | NB 0.04 | SE LT 0.002 | CA LT 0.005 | CR EQV/NI EQV 1.51 | |

MATERIAL PRODUCED ON THIS ORDER WAS MELTED AND MANUFACTURED IN THE U.S.A.
MATERIAL HAS BEEN MELTED IN USA OR QUALIFYING COUNTRY TO OFARS REQUIRE-
MENTS 252.225-7014 WITH ALTERNATE 1 FOR QUALIFYING COUNTRY 225.872.1.
CARPENTER'S QUALITY MANAGEMENT SYSTEM WAS REGISTERED AS OF NOVEMBER 24, 2007 TO
THE REQUIREMENTS OF ISO 9001:2000 APPROVAL CERTIFICATE 07-0869 BY PERFORMANCE
REVIEW INSTITUTE. CERTIFICATE OF TEST IS PREPARED IN ACCORDANCE WITH PARAGRAPH
3.1 OF EN 10204 (DIN 50049). WE HEREBY CERTIFY THAT THE ABOVE TEST DATA ARE
IN ACCORDANCE WITH THE PURCHASE ORDER AND SPECIFICATION REQUIREMENTS.

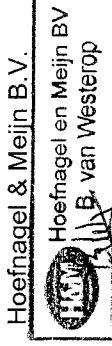
DEANA KISSLING
MET RELEASE/REQUIREMENTS ANALYST
CARPENTER TECHNOLOGY CORPORATION



| | |
|--------------------|--------------------|
| Name | : CO2 ACCUMULATOR |
| Item No. | : F-260 |
| Drawing No. | : 40030-ME-00074 |
| Client | : Nikhef Instituut |
| Client Order No. | : 43090 |
| Purchaser | : - |
| Purchase Order No. | : - |

| PAW (15) = Plasma | SMAW (111) = Elektrode | GMAW (131) = MIG | GMAW (135) = MAG | FCAW (136) = Filled wire | GTAW (141) = TIG |
|-------------------|------------------------|------------------|------------------|--------------------------|------------------|
|-------------------|------------------------|------------------|------------------|--------------------------|------------------|

INSPECTION MANUFACTURER



W-10.345-01

| | | | |
|--------------------------------|--|---|--|
| Client Order no. WPS no. | Hoefnagel & Meijn BV, [NLD] Zaandam 04060 Q4431g | Certificate no. Stork FDO order no. Amsterdam | MKW 04-0066 OMKW 4038 2004-01-28 |
| Code | EN 288-3 and ASME section IX. | | |

TEST RESULTS PROCEDURE QUALIFICATION

| | | |
|---|---|---|
| Test sample / material Test sample marked | 6 x Welded testpipe Ø 21.3 x 3.7 wt mm 910959 - 1.4404 and stamp Stoomwezen. ASME 312 tp 316/316L 141 [GTAW] | Stainless steel ASTM A 312 TP 316L |
| Welding process / -position | | PC [2G] |
| Filler metal / gas | Avesta 316L-Si / SKR-Si [ER316LSi] | Shieldinggas: Argon 99.995% Backinggas : Argon 99.995% |
| Welding joint Heat treatment | V n.a. | |
| NDT: VISUAL INSPECTION RADIOGRAPHIC EX. PENETRANT EXAM. | acceptable [Lloyd's Register Nederland BV] acceptable [RTD report no. 2003-5065-102 / film no. F0066] acceptable [RTD report no. 224-2004-04-006] | |

| TENSILE TEST | Dimensions testpiece | Area | Temp. | Yield str. ReH/Rp0,2 | Tensile str. Rm | Elong. Lo mm | Red | Fracture Character of failure |
|-----------------|-------------------------|-----------------|-------|--------------------------|--------------------------|-----------------|-----|-------------------------------------|
| Type | mm | mm ² | °C | MPa [N/mm ²] | MPa [N/mm ²] | % | % | |
| Requirements | | | | | > 485 | - | - | |
| Transverse - 1 | Full pipe | 222 | RT | - | 508 | - | - | In pipe mat. |
| Transverse - 2 | Full pipe | 222 | RT | - | 501 | - | - | In pipe mat |

| BEND TEST | | mandrel: Ø = 4 x t / angle 180 ° | |
|-----------|---------|----------------------------------|---------|
| type | results | type | results |
| face | good | root | good |
| face | good | root | good |

| | |
|----------------|------------|
| MACRO SPECIMEN | acceptable |
|----------------|------------|

Conclusion/Remarks : Approved

Stork FDO B.V., Materials Testing Department

Verified: H.J.M. van Tol

Authorised: G.V. Tokarenko



Tests witnessed by:
Lloyd's Register Nederland B.V.

Ing. N.J. Huppen
☒ Witnessed / ☐ Reviewed / ☐ Examined

Stw. no. 164410



Welding Procedure Qualification Certificate

(EN ISO 15614-1)

Energy - Downstream, Power and Manufacturing

Manufacturer's Welding Procedure Qualification
Record No.:

WPS Q4431g (d.d. 06-01-2004)

Examining body
Reference No:

LR 0038 / 188613

Manufacturer:

Hoefnagel & Meijn B.V.

Address:

Uiterdijk 4, 1505 GW Zaandam

Welders Name

J. J. Tanger (JT12)

Code/Testing Standard:

EN ISO 15614-1; 2004 / Pressure Equipment Directive 97/23/EG

Date of Welding:

16 January 2004

Range of Qualification

Welding Process(es): 141 (GTAW)
 Type of joint and weld: BW
 Parent material group(s) and sub-group(s): 8.1 -- 8.1 (material test piece ASTM A312 TP316L)
 Parent Material Thickness (mm): 3 -- 7.5 mm
 Weld Metal Thickness (mm): 3 -- 7.5 mm
 Throat Thickness (mm): N.A.
 Single Run/Multi Run: Multi run
 Outside Pipe Diameter (mm): 10,5 -- 43 mm
 Filler Material Designation: Avesta 316L Si/SKR Si
 Filler Material Make: Solid
 Filler Material Size: 2,0 mm
 Designation of Shielding Gas/Flux: 99,99% Ar (EN 14175 I1)
 Designation of Backing Gas: 99,99% Ar (EN 14175 I1)
 Type of Welding Current and Polarity: DC -
 Mode of Metal Transfer: N.A.
 Heat Input: See WPS Q4431g (d.d. 06-01-2004)
 Welding Positions: All, excluded PG & J-L045
 Preheat Temperature: See WPS Q4431g (d.d. 06-01-2004)
 Interpass Temperature: Max. 150 °C
 Post-Heating: N.A.
 Post-Weld Heat Treatment and/or Ageing: N.A.

Other Information

Qualification according to EN 288-3 with identification 164410/CAS688 (d.d. 15-03-2004) has been revised and therefore re-written. Based on examination during welding the test-coupon, followed by destructive and non destructive testing according to Standard/Code the qualification is technically equivalent with EN ISO 15614-1; 2004. See also Lab. Report MKW 04-0066 (d.d. 2004-01-28).

Certified that test welds were prepared, welded and tested satisfactorily in accordance with the requirements of the code/testing standard indicated above.

Location: Zaandam

Date of Issue: 25 April 2008

Surveyor

C.A. Stedelaar



A member of the Lloyd's Register Group

Examining Body LR 0038

| | | | |
|--------------------------------|--|---|---|
| Client Order no. WPS no. | Hoefnagel & Meijn BV, [NLD] Zaandam 04060 Q4431g | Certificate no. Stork FDO order no. Amsterdam | MKW 04-0066A OMKW 4038 2004-01-28 |
| Code | EN 287-1 [2003] and ASME section IX. | | |

WELDER PERFORMANCE QUALIFICATION

| | |
|--------------------|---------------------------------------|
| Test sample marked | 910959 – 1.4404 and stamp Stoomwezen. |
|--------------------|---------------------------------------|

| | |
|---|--|
| Welder name Identification Method of identification Place and date of birth Job knowledge | J.J. Tanger JT12 Passport no. H479971 [NLD] Westzaan // d.o.b. 20-12-1953 n.a. |
|---|--|

| | weld test details | range of approval | |
|--|---|-------------------------|----------------------|
| | | EN 287-1 [2003] | ASME sect. IX |
| Welding process Plate [P] or pipe [T] Joint type | 141 [GTAW] T BW | 141 T BW FW | GTAW P T BW FW |
| Parent metal group[s] Filler metal type / designation | ASTM A312 TP 316L Avesta 316L-Si / SKR-Si [ER316LSi] | 8 – 9.2 – 9.3 - 10 S | P1 up to P11 F6 |
| Shielding gas Backing gas | Argon 99.995% Argon 99.995% | - - | - - |
| Test sample thickness [mm] Pipe outside diameter [mm] | 3.7 21.3 | 3 – 7.4 21.3 – 42.6 | Max. 7.4 ≥21.3 |
| Welding position | PC [2G] | PA PB PC | F H |
| Performance Gouging / backing | ss nb | ss mb nb bs | one- and two side |

| | Number | RESULTS |
|------------------|--------|--|
| Visual ex. | 1 | accepted by Lloyd's RegisterNed. BV] |
| Radiographic ex. | 6 | acceptable [RTD report no. 2003-5065-102 / film no. F0066] |

Conclusion/Remarks: Approved

Stork FDO B.V., Materials Testing Department

Verified: H.J.M. van Tol

Authorised: G.V. Tokarenko



Tests witnessed by:
Lloyd's Register Nederland B.V.
Ing. M.J. Izuppen

☒ Witnessed / ☐ Reviewed / ☐ Examined

Stw. No. 164410



Welder Qualification Test Certificate (EN 287-1:2004)

Energy - Downstream, Power and Manufacturing

Designation: EN 287-1 141 T BW 8.1 S t3,73 D21,3 PC ss nb ml

Welding Procedure
Specification Reference No.

WPS Q4431g (d.d. 06-01-2004)

Examining Body:
Reference No:

LR 0038 / 188613

Welder's Name

J. Tanger

Identification:

JT12

Method of Identification:

H479971 / Passport

Date and place of birth:

20-12-1953 / Westzaan

Photograph
(if required)

Employer:

Hoefnagel & Meijn B.V.

Code/Testing Standard:

EN 287-1; 2004 / Pressure Equipment Directive 97/23/EG

Job knowledge:

Not Tested

| | Test piece | Range of qualification |
|--------------------------------------|---------------------------|------------------------|
| Welding process(es) | 141 (GTAW) | 141 (GTAW) |
| Plate or pipe | T | T P |
| Type of weld | BW | BW FW |
| Material group(s) | 8.1 (ASTM A312 TP316L) | 8, 9.2+9.3, 10 |
| Filler metal type/designation | S (Avesta 316L Si/SKR Si) | S |
| Shielding gas | 99,99% Ar (EN 14175 I1) | Similar |
| Auxiliaries (e.g. backing gas, flux) | 99,99% Ar (EN 14175 I1) | Similar |
| Material thickness (mm) | 3,73 mm | 3 -- 7,5 mm |
| Pipe outside diameter (mm) | 21,3 mm | 21,3 -- 43 mm |
| Welding positions | PC | PA, PB, PC |
| Weld details | ss, nb, ml | ss, bs, nb, mb, sl, ml |

Additional information is available on attached sheet and/or welding procedure specification No.

WPS Q4431g (d.d. 06-01-2004)

| Type of qualification test | Performed and acceptable | Not tested |
|----------------------------------|--------------------------|------------|
| Visual testing | X | |
| Radiographic testing | X | |
| Ultrasonic testing | | X |
| Magnetic particle/penetrant test | | X |
| Macroscopic examination | | X |
| Fracture test | | X |
| Bend test | | X |
| Notch tensile test | | X |

Surveyor

C.A. Stedelaar

A member of the Lloyd's Register Group

Date of welding: 16 January 2004

Date of Issue: 25 april 2008 (see page 2)

Location: Zaandam

Validity of qualification until: 25 April 2010




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Verlenging volgens EN 287-1 (uitg. 05-2004) van:

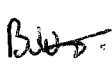

Naam : J.J. tanger

Kenmerk : JT12

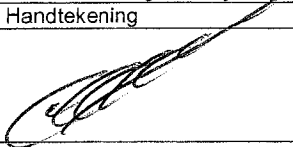
WPS : Q4431g

| Datum uitgave kwalificatie | Verlenging geldig tot | Handtekening | Functie of titel |
|----------------------------|-----------------------|--|--|
| Januari 2004 | Januari 2006 |  | Lloyd's Register Nederland B.V. C.A. Stedelaar Groningen Office <input type="checkbox"/> Witnessed <input checked="" type="checkbox"/> Reviewed <input type="checkbox"/> Examined |





Bevestiging van de geldigheid door de werkgever/lascoördinator voor de 3 tijdsperiodes van 6 maanden (zie ook par. 9.2)

| Datum verlenging | Rapportage ¹⁾ | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|--------------------------|-----------------------|---|------------------|
| Juli 2004 | 3007 06-04 | Januari 2005 |  | ENGINEER |
| Januari 2005 | 1501 12-05 | Juli 2005 |  | ENGINEER |
| Juli 2005 | 1501 09-05 | Januari 2006 |  | ENGINEER |

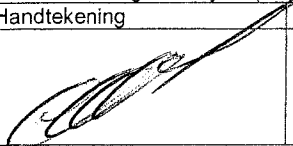
Verlenging van de kwalificatie door de beoordelaar/keuringsinstantie voor de volgende 2 jaar (zie ook par. 9.3)

| Datum verlenging | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|-----------------------|--|--|
| Januari 2006 | Januari 2008 |  | Lloyd's Register Nederland B.V. C.A. Stedelaar Groningen Office <input type="checkbox"/> Witnessed <input checked="" type="checkbox"/> Reviewed <input type="checkbox"/> Examined |

Bevestiging van de geldigheid door de werkgever/lascoördinator voor de 3 tijdsperiodes van 6 maanden (zie ook par. 9.2)

| Datum verlenging | Rapportage ¹⁾ | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|--------------------------|-----------------------|--|------------------|
| Januari 2006 | 1501 08-05 | Juli 2006 |  | ENGINEER |
| Juli 2006 | 3007 03-06 | Januari 2007 |  | ENGINEER |
| Januari 2007 | 4794/1 11-06 | Juli 2007 |  | ENGINEER |
| Juli 2007 | 9393/18 05-07 | Januari 2008 |  | ENGINEER |

Verlenging van de kwalificatie door de beoordelaar/keuringsinstantie voor de volgende 2 jaar (zie ook par. 9.3)

| Datum verlenging | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|-----------------------|--|--|
| Januari 2008 | Januari 2010 |  | Lloyd's Register Nederland B.V. C.A. Stedelaar Groningen Office <input type="checkbox"/> Witnessed <input checked="" type="checkbox"/> Reviewed <input type="checkbox"/> Examined |

1) Rapportage dient tevens te voldoen aan de voorwaarde van bijlage D van EN 287-1 (uitg. 05-2004)



Verlenging volgens EN 287-1 (uitg. 05-2004) van:

Naam : J.J. tanger

Kenmerk : JT12

WPS : Q4431g

Bevestiging van de geldigheid door de werkgever/lascoördinator voor de 3 tijdsperiodes van 6 maanden (zie ook par. 9.2)

| Datum verlenging | Rapportage ¹⁾ | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|--------------------------|-----------------------|--------------|------------------|
| Januari 2008 | 9393/33 08-'07 | Juli 2008 | | ENGINEER |
| Juli 2008 | 20587/13 09-'08 | Januari 2009 | | ENGINEER |
| Januari 2009 | 20587/048 10-'08 | Juli 2009 | | ENGINEER |
| Juli 2009 | 32458/018 03-'09 | Januari 2010 | | ENGINEER |

Verlenging van de kwalificatie door de beoordelaar/keuringsinstantie voor de volgende 2 jaar (zie ook par. 9.3)

| Datum verlenging | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|-----------------------|--------------|--|
| Januari 2010 | Januari 2012 | | Lloyd's Register Nederland B.V. C.A. Stedelaar Groningen Office <input type="checkbox"/> Witnessed <input checked="" type="checkbox"/> Reviewed <input type="checkbox"/> Examined |

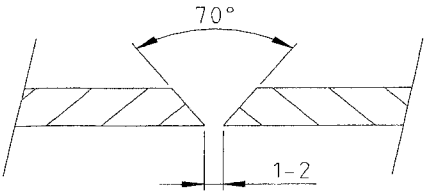
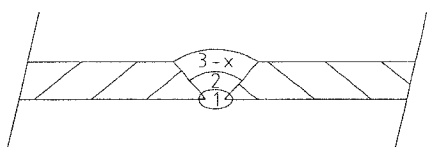


Bevestiging van de geldigheid door de werkgever/lascoördinator voor de 3 tijdsperiodes van 6 maanden (zie ook par. 9.2)

| Datum verlenging | Rapportage ¹⁾ | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|---------------------------|-----------------------|--------------|------------------|
| Januari 2010 | 725-2009-31-001 07-'09 | Juli 2010 | | ENGINEER |
| Juli 2010 | 725-2010-21-003 05-'10 | Januari 2011 | | ENGINEER |
| Januari 2011 | | Juli 2011 | | |
| Juli 2011 | | Januari 2012 | | |

Verlenging van de kwalificatie door de beoordelaar/keuringsinstantie voor de volgende 2 jaar (zie ook par. 9.3)

| Datum verlenging | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|-----------------------|--------------|------------------|
| Januari 2012 | Januari 2014 | | |

1) Rapportage dient tevens te voldoen aan de voorwaarde van bijlage D van EN 287-1 (uitg. 05-2004)

| | | | | | | | | | | | | | | | |
|---|------|---|-------------|--|--------------------------------|---|---|--|---|--|---------------------------------|---|---------------------------|---------|--|
| ASMETHODE-BESCHRIJVING | | | | | | | | | | | | | | | |
| (Welding procedure specification) | | | | | | | | | | | | | | | |
| Basis materiaal (Base material) | | 1 | A312 TP316L | | | | | Afmeting/Dikte (Dimension/Thickness) | | ø21,3x3,73 | | | | | |
| Basis materiaal (Base material) | | 2 | A312 TP316L | | | | | Afmeting/Dikte (Dimension/Thickness) | | ø21,3x3,73 | | | | | |
| Uitvoering volgens (Performed acc. to) | | EN 288-3 / ASME IX | | | | | Geldig voor pijpdiameter (Diameter range qualified) | | 21,3-42,6mm / >=21,3mm | | | | | | |
| Materiaalgroep (Material group) | | 1 | | 2 | | | Geldig voor materiaaldikte (Thickness range qualified) | | 3,0-7,4mm / max.7,4mm | | | | | | |
| Lasproces (Welding proces) | | Hechtlas (Tack weld) | | Grondlaag (Root pass) | | | Vullagen (Filling passes) | | Tegenlas (Back weld) | | Oplassen (Overlay weld) | | | | |
| | | HL 141 / GTAW | | GL 141 / GTAW | | | VL 141 / GTAW | | TL --- | | OL --- | | | | |
|  | | | | | | | | | |  | | | | | |
| Lasnaadvorm (Weld edge preparation) | | | | | | | | | | Lasvolgorde (Sequence of passes) | | | | | |
| Laag | LP | Laastoevoegmateriaal | Dia | Klasse (Class) | | ASME IX | | Laspositie | Stroom (Current) | | | Voltage | Lassnelheid [mm/min] | | |
| (Pass) | (Wp) | (Welding filler material) | (Dia) | SFA | AWS | F No. | A No. | (Welding position) | =/- dc/ac | +/- | Amperage | [V] | (Rate of travel [mm/min]) | | |
| 0 | HL | 316L-Si/SKR-Si *) | 2,0 | 5,90 | ER316LSi | 6 | 8 | PC / 2G | = | --- | 90-110 | 24 | --- | | |
| 1 | GL | 316L-Si/SKR-Si *) | 2,0 | 5,90 | ER316LSi | 6 | 8 | PC / 2G | = | --- | 90-110 | 24 | 100 | | |
| 2-x | VL | 316L-Si/SKR-Si *) | 2,0 | 5,90 | ER316LSi | 6 | 8 | PC / 2G | = | --- | 90-110 | 24 | 100 | | |
| *) Avesta Polarit | | | | | | | | | | | | | | | |
| Bewerken laskanten (Preparation edges) | | Branden - Hakken - Mach. bewerk. - Slijpen (Cutting - Chipping - Machining - Grinding) | | | Beschermgas (Shielding gas) | | Argon 99,995% | | | | | l/min | 15-20 | | |
| Bewerking tegenlas (Preparation backwelding) | | --- | | | Lasgas (Welding gas) | | --- | | | | | l/min | --- | | |
| Warmtebehandeling (Heat treatment) | | Voorverwarmen (Preheating) | | | Beschermgas (Backing gas) | | Argon 99,995% | | | | | l/min | 8-12 | | |
| | | Nee/Yes | | Ja/Yes | | Temp. tijdens lassen (Interpass temp.) | | --- | | | Nawarm temp. (Soaking Temp.) | | --- | | |
| | | | | °C | | Isolatie (Insulation) | | --- | | | Nawarm tijd (Soaking time) | | --- | | |
| Gloeien (Post weld heat treatment) | | | Nee (No) | | Ja (Yes) | | °C | | Lasmethode - kwalificatie nr. (Procedure Qualification Record no.) | | | MKW 04-0066 | | | |
| Onderzoek (Inspection) | | RT | | --- | | UT | | --- | | MT/PT | | Overige (Others) | | Visual | |
| Opgesteld (Prepared) | | B. van Westerop | | | | | Datum (Date) | | 10-04-08 | | | Wijziging (Revision) | | 0 | |
| Goedgekeurd QA-H&M (Approved QA-dep.) | | | | Goedgekeurd klant (Approved customer) | | | | Goedgekeurd keuringsinstantie (Approved inspection authority) | | | | | | | |
|  | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | HOEFNAGEL & MEIJN B.V. ZAANDAM-HOLLAND | | WPS Nr. | |
| | | | | | | | | | | | | INDUSTRIETERREIN ACHTERSLUISPOLDER UITERDIJK 4, 1505 GW ZAANDAM | | Q4431g | |

| | | | |
|--|---|---|--|
| Client Order no. WPS no. Code | Hoefnagel & Meijn BV, [NLD] Zaandam 04060 Q4431h EN 288-3 and ASME section IX. | Certificate no. Stork FDO order no. Amsterdam | MKW 04-0067 OMKW 4038 2004-01-28 |
|--|---|---|--|

TEST RESULTS PROCEDURE QUALIFICATION

| | | |
|---|---|---|
| Test sample / material Test sample marked | Welded testpipe Ø 114.3 x 8.56 wt mm 1.4404 LPN | Stainless steel ASTM 312 TP 316L |
| Welding process / -position | 141 [GTAW] and 136 [FCAW] | PA [1G] |
| Filler metal / gas | 141: Avesta 316L-Si / SKR-Si [ER316LSi] 136: Avesta FCW-316L-TO-4 | 141: Shieldinggas: Argon 99.995% 136: Shieldinggas: 80% Argon + 20% CO ₂ 141: Backinggas : Argon 99.995% |
| Welding joint | V | |
| Heat treatment | n.a. | |
| NDT: VISUAL INSPECTION RADIOGRAPHIC EX. PENETRANT EXAM. | acceptable [Lloyd's Register Nederland BV] acceptable [RTD report no. 2003-5065-103 / film no. F0067] acceptable [RTD report no. 224-2004-04-006] | |

| TENSILE TEST | Dimensions testpiece | Area | Temp. | Yield str. ReH/Rp0,2 | Tensile str. Rm | Elong. Lo mm | Red | Fracture Character of failure |
|-----------------|-------------------------|-----------------|-------|--------------------------|--------------------------|-----------------|-----|-------------------------------------|
| Type | mm | mm ² | °C | MPa [N/mm ²] | MPa [N/mm ²] | % | % | |
| Requirements | | | | | ≥ 485 | - | - | |
| Transverse - 1 | 12.03 x 8.3 | 99.9 | RT | - | 530 | - | - | In pipe mat. |
| Transverse - 2 | 11.96 x 8.3 | 99.3 | RT | - | 549 | - | - | In pipe mat. |

| BEND TEST | mandrel: Ø = 4 x t / angle 180 ° | | | IMPACT TEST | Charpy - V | temp. °C | - 60 |
|-----------|----------------------------------|------|---------|-------------------|---------------------|----------------------|------|
| type | results | type | results | Dimensions mm | 10 x 7.5 x 55 | Area mm ² | 60 |
| face | good | root | good | Location of notch | Joules | | Av. |
| face | good | root | good | Requirements | min. 21 / single 15 | | 21 |
| | | | | Weld centre | 121 - 104 - 104 | | 110 |
| | | | | H.a.z. | 184 - 189 - 184 | | 186 |

| | |
|----------------|------------|
| MACRO SPECIMEN | acceptable |
|----------------|------------|

Conclusion/Remarks : Approved

Stork FDO B.V., Materials Testing Department

Verified: H.J.M. van Tol

Authorised: G.V. Tokarenko



Tests witnessed by:
Lloyd's Register Nederland B.V.

Ing. N.J. Happen
☐ Witnessed ☐ Reviewed ☐ Examined
Stw. no. 164410





Welding Procedure Qualification Certificate (EN ISO 15614-1) Energy - Downstream, Power and Manufacturing

Manufacturer's Welding Procedure Qualification
Record No.:

WPS Q4431h (d.d. 06-01-2004)

Examining body
Reference No:

LR 0038 / 188613

Manufacturer:

Hoefnagel & Meijn B.V.

Address:

Uiterdijk 4, 1505 GW Zaandam

Welders Name

J. J. Tanger (JT12)

Code/Testing Standard:

EN ISO 15614-1; 2004 / Pressure Equipment Directive 97/23/EG

Date of Welding:

16 January 2004

Range of Qualification

| | |
|--|---|
| Welding Process(es): | 141 (GTAW) / 136 (FCAW) |
| Type of joint and weld: | BW |
| Parent material group(s) and sub-group(s): | 8.1 -- 8.1 (material test piece ASTM A312 TP316L) |
| Parent Material Thickness (mm): | 3 -- 17.0 mm |
| Weld Metal Thickness (mm): | 3 -- 17.0 mm |
| Throat Thickness (mm) | N.A. |
| Single Run/Multi Run | Multi run |
| Outside Pipe Diameter (mm): | ≥57 mm |
| Filler Material Designation: | Avesta 316L Si/SKR Si / Avesta FCW 316L TO-4 |
| Filler Material Make: | Solid / Fluxcored |
| Filler Material Size: | 2,0 mm / 1,2 mm |
| Designation of Shielding Gas/Flux: | 99,99% Ar (EN 14175 I1) / 80% Ar 20% CO2 (EN 14175 M21) |
| Designation of Backing Gas: | 99,99% Ar (EN 14175 I1) |
| Type of Welding Current and Polarity: | DC - / DC - |
| Mode of Metal Transfer: | N.A. / Spray and globular transfer |
| Heat Input: | See WPS Q4431h (d.d. 06-01-2004) |
| Welding Positions: | All, excluded PG & J-L045 |
| Preheat Temperature: | See WPS Q4431h (d.d. 06-01-2004) |
| Interpass Temperature: | Max. 150 °C |
| Post-Heating: | N.A. |
| Post-Weld Heat Treatment and/or Ageing: | N.A. |

Other Information

Qualification according to EN 288-3 with identification 164410/CAS689 (d.d. 15-03-2004) has been revised and therefore re-written. Based on examination during welding the test-coupon, followed by destructive and non destructive testing according to Standard/Code the qualification is technically equivalent with EN ISO 15614-1; 2004. See also Lab. Report MKW 04-0067 (d.d. 2004-01-28).

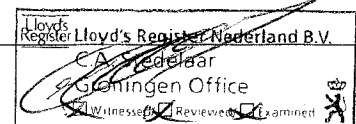
Certified that test welds were prepared, welded and tested satisfactorily in accordance with the requirements of the code/testing standard indicated above.

Location: **Zaandam**

Date of Issue: **25 April 2008**

Surveyor

C.A. Stedelaar



A member of the Lloyd's Register Group

Examining Body **LR 0038**

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| | | | |
|--------------------------------|--|---|---|
| Client Order no. WPS no. | Hoefnagel & Meijn BV, [NLD] Zaandam 04060 Q4431h | Certificate no. Stork FDO order no. Amsterdam | MKW 04-0067A OMKW 4038 2004-01-28 |
| Code | EN 287-1 [2003] and ASME section IX. | | |

WELDER PERFORMANCE QUALIFICATION

| | |
|---|--|
| Test sample marked | 1.4404 LPN |
| Welder name Identification Method of identification Place and date of birth Job knowledge | J.J. Tanger JT12 Passport no. H479971 [NLD] Westzaan // d.o.b. 20-12-1953 n.a. |

| | | weld test details | range of approval | |
|---------------------------------|------------|------------------------------------|--------------------|-------------------|
| | | | EN 287-1 [2003] | ASME sect. IX |
| Welding process | root fill. | 141 [GTAW] 136 [FCAW] | 141 136 | GTAW FCAW |
| Plate [P] or pipe [T] | | T | P T | P T |
| Joint type | | BW | BW FW | BW FW |
| Parent metal group[s] | | ASTM A312 TP 316L | 8 – 9.2 – 9.3 - 10 | P1 up to P11 |
| Filler metal type / designation | 141 | Avesta 316L-Si / SKR-Si [ER316LSi] | S | F6 |
| | 136 | Avesta FCW-316L-TO-4 | S M | F6 |
| Shielding gas | 141 | Argon 99.995% | - | - |
| | 136 | 80% Argon + 20% CO ₂ | - | - |
| Backing gas | 141 | Argon 99.995% | - | - |
| Test sample thickness [mm] | | 8.56 | 3 – 17.12 | Max. 17.12 |
| Pipe outside diameter [mm] | | 114.3 | ≥ 57.15 | ≥73 |
| Welding position | | PA [1G] | PA PB | F |
| Performance | | ss | ss mb nb | one- and two side |
| Gouging / backing | | nb | bs | |

| | Number | RESULTS |
|-----------------------------|--------|--|
| Visual ex. | 1 | accepted by Lloyd's Register (Ned. BV) |
| Radiographic ex. | 7 | acceptable [RTD report no. 2003-5065-103 / film no. F0067] |
| Bend test | 1 | acceptable |
| face | 1 | acceptable |
| root | | |
| Mandrel Ø 4xt / angle 180 ° | | |

Conclusion/Remarks: Approved

Stork FDO B.V., Materials Testing Department

Verified: H.J.M. van Tol

Authorised: G.V. Tokarenko



Tests witnessed by:
Lloyd's Register Nederland B.V.

Ing. N.J. Huppen

☒ Witnessed / ☐ Reviewed / ☐ Examined

Stw. no. 164410



Welder Qualification Test Certificate (EN 287-1:2004)

Energy - Downstream, Power and Manufacturing

Designation: EN 287-1 141/136 T BW 8.1 S/R t8,56 D114,3 PA ss nb ml

Welding Procedure
Specification Reference No.

WPS Q4431h (d.d. 06-01-2004)

Examining Body:
Reference No:

LR 0038 / 188613

Welder's Name

J. Tanger

Identification:

JT12

Method of Identification:

H47997.1 / Passport

Date and place of birth:

20-12-1953 / Westzaan

Employer:

Hoefnagel & Meijn B.V.

Code/Testing Standard:

EN 287-1; 2004 / Pressure Equipment Directive 97/23/EG

Job knowledge:

Not Tested

Photograph
(if required)

| | | |
|--------------------------------------|--|-------------------------|
| | Test piece | Range of qualification |
| Welding process(es) | 141 / 136 (GTAW / FCAW) | 141 / 136 (GTAW / FCAW) |
| Plate or pipe | T | T P |
| Type of weld | BW | BW FW |
| Material group(s) | 8.1 (ASTM A312 TP316L) | 8, 9.2+9.3, 10 |
| Filler metal type/designation | S / R (Avesta 316L Si/SKR Si / FCW-316L-TO-4) | S / R,P,V,W,Y,Z |
| Shielding gas | 99,99% Ar/80% Ar 20% CO ₂ (EN 14175 I1/M21) | Similar |
| Auxiliaries (e.g. backing gas, flux) | 99,99% Ar (EN 14175 I1) | Similar |
| Material thickness (mm) | 8,56 mm | 3 -- 17,0 mm |
| Pipe outside diameter (mm) | 114,3 mm | ≥57 mm |
| Welding positions | PA | PA, PB |
| Weld details | ss, nb, ml | ss, bs, nb, mb, sl, ml |

Additional information is available on attached sheet and/or welding procedure specification No.

WPS Q4431h (d.d. 06-01-2004)

| Type of qualification test | Performed and acceptable | Not tested |
|----------------------------------|--------------------------|------------|
| Visual testing | X | |
| Radiographic testing | X | |
| Ultrasonic testing | | X |
| Magnetic particle/penetrant test | | X |
| Macroscopic examination | | X |
| Fracture test | | X |
| Bend test | | X |
| Notch tensile test | | X |

Surveyor

C.A. Stedelaar

A member of the Lloyd's Register Group

Date of welding: 16 January 2004

Date of Issue: 25 april 2008 (see page 2)

Location: Zaandam

Validity of qualification until: 25 April 2010



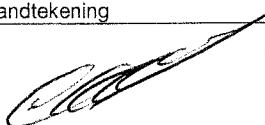
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Verlenging volgens EN 287-1 (uitg. 05-2004) van:

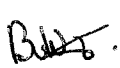


Naam : J.J. tanger

Kenmerk : JT12

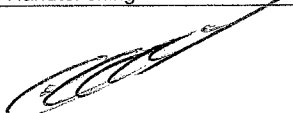
WPS : Q4431h

| Datum uitgave kwalificatie | Verlenging geldig tot | Handtekening | Functie of titel |
|----------------------------|-----------------------|--|--|
| Januari 2004 | Januari 2006 |  | Lloyd's Register Nederland B.V. C.A. Stedelaar Groningen Office <input type="checkbox"/> Witnessed <input checked="" type="checkbox"/> Reviewed <input type="checkbox"/> Examined |





Bevestiging van de geldigheid door de werkgever/lascoördinator voor de 3 tijdsperiodes van 6 maanden (zie ook par. 9.2)

| Datum verlenging | Rapportage ¹⁾ | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|--------------------------|-----------------------|---|------------------|
| Juli 2004 | 1501 05-'04 | Januari 2005 |  | ENGINEER |
| Januari 2005 | 1501 10-'04 | Juli 2005 |  | ENGINEER |
| Juli 2005 | 1501 02-'05 | Januari 2006 |  | ENGINEER |

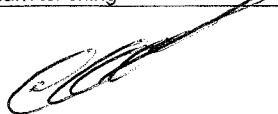
Verlenging van de kwalificatie door de beoordelaar/keuringsinstantie voor de volgende 2 jaar (zie ook par. 9.3)

| Datum verlenging | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|-----------------------|--|--|
| Januari 2006 | Januari 2008 |  | Lloyd's Register Nederland B.V. C.A. Stedelaar Groningen Office <input type="checkbox"/> Witnessed <input checked="" type="checkbox"/> Reviewed <input type="checkbox"/> Examined |

Bevestiging van de geldigheid door de werkgever/lascoördinator voor de 3 tijdsperiodes van 6 maanden (zie ook par. 9.2)

| Datum verlenging | Rapportage ¹⁾ | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|---------------------------|-----------------------|--|------------------|
| Januari 2006 | 276-2005-36-003 09-'05 | Juli 2006 |  | ENGINEER |
| Juli 2006 | 1501 04-'06 | Januari 2007 |  | ENGINEER |
| Januari 2007 | 1501 09-'06 | Juli 2007 |  | ENGINEER |
| Juli 2007 | 9343/2 02-'07 | Januari 2008 |  | ENGINEER |

Verlenging van de kwalificatie door de beoordelaar/keuringsinstantie voor de volgende 2 jaar (zie ook par. 9.3)

| Datum verlenging | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|-----------------------|--|--|
| Januari 2008 | Januari 2010 |  | Lloyd's Register Nederland B.V. C.A. Stedelaar Groningen Office <input type="checkbox"/> Witnessed <input checked="" type="checkbox"/> Reviewed <input type="checkbox"/> Examined |

1) Rapportage dient tevens te voldoen aan de voorwaarde van bijlage D van EN 287-1 (uitg. 05-2004)

Verlenging volgens EN 287-1 (uitg. 05-2004) van:

Naam : J.J. tanger

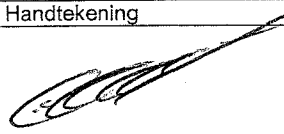
Kenmerk : JT12

WPS : Q4431h

Bevestiging van de geldigheid door de werkgever/lascoördinator voor de 3 tijdsperiodes van 6 maanden (zie ook par. 9.2)

| Datum verlenging | Rapportage ¹⁾ | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|--------------------------|-----------------------|--------------|------------------|
| Januari 2008 | 9343/43 10-'07 | Juli 2008 | BW | ENGINEER |
| Juli 2008 | 10587/15 05-'08 | Januari 2009 | BW | ENGINEER |
| Januari 2009 | 031681/004 12-'08 | Juli 2009 | BW | ENGINEER |
| Juli 2009 | 32458 06-'09 | Januari 2010 | BW | ENGINEER |

Verlenging van de kwalificatie door de beoordelaar/keuringsinstantie voor de volgende 2 jaar (zie ook par. 9.3)

| Datum verlenging | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|-----------------------|--|--|
| Januari 2010 | Januari 2012 |  | Lloyd's Register Nederland B.V. C.A. Stedelaar Groningen Office <input type="checkbox"/> Witnessed <input checked="" type="checkbox"/> Reviewed <input type="checkbox"/> Examined |

Bevestiging van de geldigheid door de werkgever/lascoördinator voor de 3 tijdsperiodes van 6 maanden (zie ook par. 9.2)

| Datum verlenging | Rapportage ¹⁾ | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|---------------------------|-----------------------|--------------|------------------|
| Januari 2010 | 725-2009-43-001 10-'09 | Juli 2010 | BW | ENGINEER |
| Juli 2010 | 725-2010-21-003 05-'10 | Januari 2011 | BW | ENGINEER |
| Januari 2011 | | Juli 2011 | | |
| Juli 2011 | | Januari 2012 | | |

Verlenging van de kwalificatie door de beoordelaar/keuringsinstantie voor de volgende 2 jaar (zie ook par. 9.3)

| Datum verlenging | Verlenging geldig tot | Handtekening | Functie of titel |
|------------------|-----------------------|--------------|------------------|
| Januari 2012 | Januari 2014 | | |

1) Rapportage dient tevens te voldoen aan de voorwaarde van bijlage D van EN 287-1 (uitg. 05-2004)

ASME

SMETHODE-BESCHRIJVING

(Welding procedure specification)

| | | | | | | | | | | | | | | | |
|---|------------|---|--------------------|--|---|---|-------------|--|---|-------------------------|---------|---|-------------|-------------------------|--------|
| Basis materiaal (Basematerial) | | 1 | A312 TP316L | | Afmeting/Dikte (Dimension/Thickness) | | ø114,3x8,56 | | | | | | | | |
| Basis materiaal (Basematerial) | | 2 | A312 TP316L | | Afmeting/Dikte (Dimension/Thickness) | | ø114,3x8,56 | | | | | | | | |
| Uitvoering volgens (Performed acc. to) | | | EN 288-3 / ASME IX | | | Geldig voor pijpdiameter (Diameter range qualified) | | >=57,2-mm / >=73mm | | | | | | | |
| Materiaalgroep (Material group) | | 1 | | 2 | | Geldig voor materiaaldikte (Thickness range qualified) | | 3,0-17,1mm / max.17,1mm | | | | | | | |
| Lasproces (Welding proces) | | Hechtlas (Tack weld) | | Grondlaag (Root pass) | | Vullagen (Filling passes) | | Tegenlas (Back weld) | | Oplassen (Overlay weld) | | | | | |
| | | HL 141 / GTAW | | GL 141 / GTAW | | VL 136 / FCAW | | TL --- | | OL --- | | | | | |
| | | | | | | | | | | | | | | | |
| Lasnaadvorm (Weld edge preparation) | | | | | | Lasvolgorde (Sequence of passes) | | | | | | | | | |
| Laslaag (Pass) | LP (Wp) | Laastoevoegmateriaal (Welding filler material) | Dia (Dia) | Klasse (Class) | | ASME IX | | Laspositie (Welding position) | Stroom (Current) | | Voltage | Lassnelheid [mm/min] (Rate of travel [mm/min]) | | | |
| | | | | SFA | AWS | F No. | A No. | | =/~ dc/ac | +/- Amperage | [V] | | | | |
| 0 | HL | 316L-Si/SKR-Si *) | 2,0 | 5,90 | ER316LSi | 6 | 8 | PA / 1G | = | --- | 100-120 | 24 | --- | | |
| 1 | GL | 316L-Si/SKR-Si *) | 2,0 | 5,90 | ER316LSi | 6 | 8 | PA / 1G | = | --- | 100-120 | 24 | 150 | | |
| 2-x | VL | FCW-316L-TO-4 *) | 1,2 | 5,20 | ER316LSi | 6 | 8 | PA / 1G | = | --- | 200-240 | 30 | 200 | | |
| *) Avesta Polarit | | | | | | | | | | | | | | | |
| Bewerken laskanten (Preparation edges) | | Branden - Hakken - Mach. bewerk. - Slijpen (Cutting - Chipping - Machining - Grinding) | | Beschermgas (Shielding gas) | | Argon 99,995% | | | | l/min | | 15-20 | | | |
| Bewerking tegenlas (Preparation backwelding) | | --- | | Lasgas (Welding gas) | | Argon 20% Co2 80% | | | | l/min | | 20-25 | | | |
| Warmtebehandeling (Heat treatment) | | Voorverwarmen (Preheating) | | Beschermgas (Backing gas) | | Argon 99,995% | | | | l/min | | 8-12 | | | |
| | | Nee/Yes | | Ja/Yes | | Temp. tijdens lassen (Interpass temp.) | | | | --- | | Nawarm temp. (Soaking Temp.) | --- | | |
| | | | | °C | | Isolatie (Insulation) | | | | --- | | Nawarm tijd (Soaking time) | --- | | |
| Gloeien (Post weld heat treatment) | | | Nee (No) | | Ja (Yes) | | °C | | Lasmethode - kwalificatie nr. (Procedure Qualification Record no.) | | | | MKW 04-0067 | | |
| Onderzoek (Inspection) | | RT | | --- | | UT | | --- | | MT/PT | | --- | | Overige (Others) | Visual |
| Opgesteld (Prepared) | | | | | | B. van Westerop | | | | Datum (Date) | | 10-04-08 | | Wijziging (Revision) | 0 |
| Goedgekeurd QA-H&M (Approved QA-dep.) | | | | Goedgekeurd klant (Approved customer) | | | | Goedgekeurd keuringsinstantie (Approved inspection authority) | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | HOEFNAGEL & MEIJN B.V. ZAANDAM-HOLLAND | | WPS Nr. | |
| | | | | | | | | | | | | INDUSTRIETERREIN ACHTERSLUISPOLDER UITERDIJK 4, 1505 GW ZAANDAM | | Q4431h | |

| | |
|---------------------|-----------|
| Volume Coil | = 1,46 l |
| Volume Vessel | = 28,72 l |
| Netto Volume Vessel | = 27,26 l |

X-10.395-01

| Bill of Material | Quantity | Part Number | Definition | Material | Revision |
|------------------|----------|-------------|-------------------------|-----------|----------|
| | 1 | AA00684 | Accumulator Top | AISI 316L | A.3 |
| | 1 | AA10446 | Pipe, Accumulator Body | AISI 316L | A.2 |
| | 1 | AA07688 | Cooling Spiral | AISI 316L | A.2 |
| | 4 | AA07689 | Welding connection 4 | AISI 316L | A.0 |
| | 2 | AA07811 | 6LV 16 VCR 3 16TB7 | AISI 316L | A.0 |
| | 1 | AA06661 | Sphere bottom | AISI 316L | A.3 |
| | 2 | AA10444 | VCR Nut 1" Female | AISI 316L | A.0 |

[illegible]

Notes:
1) Design / Production Parameters According: CODAP

- 2) Pressure Test At 143 bar
- 3) All Material (AISI 316L) With Certificate EN 10204/3.1.8
- 4) Tubbing of Coil A in/out and Coil B in/out Are orbital welded

Onderzoeksrapport radiografie

RTD sectie Midden Nederland RTD rapportnr 725-2010-41-027
Telefoonnummer 0251220838 RTD ordernr 52202
Fax 0251210405 F&A-nummer 1104-003
Cont. pers. RTD Dhr. van Kuilenburg Onderzoeksdatum 13-10-2010

Klant Hoefnagel & Meijn BV Uitgevoerd bij Applus RTD
Adres Uiterdijk 4 Adres Gooiland 21
Postcode en plaats 1505 GW Zaandam Postcode en plaats 1948 RC Beverwijk
Land Nederland Land Nederland
Contactpersoon Hr. N. Wester. Aannemer Hoefnagel & Meijn.
Ordernr. klant 10-404 Project ---
Aanvraagnr. --- Tekeningnummer ---
Rapportnr. klant Object 4 lasverbindingen.

Opmerkingen

| Filmmr. | Film afm. [cm x cm] | Afwijking type / locatie Na [cm] | A/Na | drd/zw. | Lasser | Las vorm | Las Geometrie [mm x mm] | Door [mA. str. d. min] | f [mm] | b [mm] | Opn techn. |
|---------|---------------------|----------------------------------|------|---------|--------|----------|-------------------------|------------------------|--------|--------|-------------|
| F254 | 1 6x12 | | A | 16/2.6 | | V | Ø 9.53 x 0.89 | 150 | 1 | 2 | 560 9.53 12 |
| | 2 | | A | 16/2.6 | | | | | | | |
| | 3 | | A | 16/2.6 | | | | | | | |
| F255 | 1 6x12 | | A | 16/2.6 | | V | Ø 9.53 x 0.89 | 150 | 1 | 2 | 560 9.53 12 |
| | 2 | | A | 16/2.6 | | | | | | | |
| | 3 | | A | 16/2.6 | | | | | | | |
| F256 | 1 6x12 | | A | 16/2.6 | | V | Ø 9.53 x 0.89 | 150 | 1 | 2 | 560 9.53 12 |
| | 2 | | A | 16/2.6 | | | | | | | |
| | 3 | | A | 16/2.6 | | | | | | | |
| F257 | 1 6x12 | | A | 16/2.6 | | V | Ø 9.53 x 0.89 | 150 | 1 | 2 | 560 9.53 12 |
| | 2 | | A | 16/2.6 | | | | | | | |
| | 3 | | A | 16/2.6 | | | | | | | |

| Films en rapportage | | | Operators | | | Filmkeuring | | | Rapport gecontroleerd | | |
|---------------------|----|--------------|-----------|----------|--------------|-------------|----------|------------------|-----------------------|------|----------|
| Aantal films | 12 | Naam Level 2 | 0448 | Klijn J. | Naam Level 2 | 0448 | Klijn J. | Cert. nr. 433347 | Naam Level 2 | 0448 | Klijn J. |
| Pagina 1 | | | | | | | | | | | |
| Totaal pag. 1 | | | | | | | | | | | |

Cert. nr. 433347
Applus RTD
ND Testing
J. Klijn

Cert. nr. 433347
Applus RTD
Filmkeuring
J. Klijn

Naam Level 2
0448
Klijn J.
Cert. nr. 433347
Applus RTD
ND Testing
J. Klijn

20/10/10

Radiographic Examination report

| | | | |
|--------------------------|--------------------|-------------------------|------------------|
| RTD branch office | Beverwijk. | RTD report no | 1793-2010-42-019 |
| Telephone number | 025120838 | RTD order no | 52202 |
| Fax | 0251210405 | F&A-number | 0-004 |
| Contact | Dhr T Cornelissen. | Examination date | 20-10-2010 |

**Delftweg 144
Postbus 10065
3004 AB Rotterdam**



Röntgen Technische Dienst bv

Client Hoefnagel & Meijn BV

Uiterdijk 4

Post code and city 1505 GW Zaandam

Country
Nederland

Contact Mr. N Wester.

Order no 10404

Request no

Report no client

Carried out at **ApplusRD** Thisinst.

Address Gooiland 21

Post code and city 1948 RC Beverwijk.

Country
Nederland.Contractor
Hoefnagel & Meijn.

Project 10404

Drawing no.

| Object | Weld. |
|--------|-------|
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Exam. standard Codap 2005 Div. I

Exam. procedure

Accept. standard Codap 2005 Div. 1

Accept. procedure

R

Material S.St.316

Weld metal
S St 316

Weld method GTAW 141

| Heat treated | Yes | No |
|--------------|--------------------------|-------------------------------------|
| | <input type="checkbox"/> | <input checked="" type="checkbox"/> |

| Film type | D4 |
|-----------|-----|
| 1 | 1 |
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| 100 | 100 |

Screens (f/b)

10 FE EN

Pct. exam. 100

1797 Focal spot

Röntgen 280 kV

100

5

Remarks

[illegible]

| Films and reporting | Operators | | Filminterpretation | | Report checked for RfD |
|---------------------|--|-------|---|--|--|
| Film quantity 1 | Name 0448 Klijn J. | Name | Name 0448 Klijn J. | | |
| Page 1 | Level 2 Cert. no 473/347 | Level | Level 2 Cert. no 473/347 | | |
| Total pages 1 | <p>Applus RfD</p> <p>ND Testing</p> <p>J. Klijn</p> | | <p>Applus RfD</p> <p>Filminterpreter</p> <p>J. Klijn</p> | | <p>Report checked for RfD</p> <p>Name</p> <p>Applus RfD</p> <p>Lloyd's Register Nederland B.V.</p> <p>N. Huppen</p> <p>Groningen Office</p> <p><input type="checkbox"/> Middelste Noord <input type="checkbox"/> Kampen</p> <p>28/10/12</p> |

Certificaten

| | | | | | | | |
|--------------------|-----------------|--------------------|------------|-----------------------------------|-------------------|--|--|
| Werknemer | | Naam van werknemer | | | | | |
| EM.001.0040 | | Beers, Michael | | | | | |
| Certificaat | Certificaattype | Beginndatum | Einddatum | Omschrijving | Registratienummer | | |
| MT2e-EN | T&O | 01/04/2009 | 01/04/2015 | Magnetic Particle Testing Level 2 | LRQA 473/088 | | |
| MT2i-SNT | T&O | 04/04/2008 | 04/04/2013 | Magnetic Particle Testing Level 2 | EM.001.0040 | | |
| PT2e-EN | T&O | 01/12/2005 | 01/12/2010 | Liquid Penetrant Testing Level 2 | LRQA 473/88 | | |
| PT2i-SNT | T&O | 22/12/2009 | 22/12/2014 | Liquid Penetrant Testing Level 2 | EM.001.0040 | | |
| RT2e-EN | T&O | 01/03/2009 | 01/03/2014 | Radiographic Testing Level 2 | LRQA 473/088 | | |
| RT2i-SNT | T&O | 15/06/2008 | 15/06/2013 | Radiographic Testing Level 2 | EM.001.0040 | | |
| UT1i-SNT | T&O | 28/07/2009 | 28/07/2012 | Ultrasonic Testing Level 1 | EM.001.0040 | | |
| Vision Examination | | 26/03/2010 | 26/03/2011 | Vision requirements | EM.001.0040 | | |
| Werknemer | | Naam van werknemer | | | | | |
| EM.001.0070 | | Blais, Geatan | | | | | |
| Certificaat | Certificaattype | Beginndatum | Einddatum | Omschrijving | Registratienummer | | |
| MT2e-EN | T&O | 01/08/2009 | 01/08/2014 | Magnetic Particle Testing Level 2 | LRQA 473/360 | | |
| MT2i-SNT | T&O | 02/08/2010 | 02/08/2015 | Magnetic Particle Testing Level 2 | EM.001.0070 | | |
| PT2e-EN | T&O | 01/06/2010 | 01/06/2015 | Liquid Penetrant Testing Level 2 | verlenging | | |
| PT2i-SNT | T&O | 29/06/2008 | 29/06/2013 | Liquid Penetrant Testing Level 2 | EM.001.0070 | | |
| RT2e-EN | T&O | 01/02/2007 | 01/02/2012 | Radiographic Testing Level 2 | LRQA 473/360 | | |
| RT2i-SNT | T&O | 28/03/2008 | 28/03/2011 | Radiographic Testing Level 2 | EM.001.0070 | | |
| UT2e-EN | T&O | 01/01/2010 | 01/01/2015 | Ultrasonic Testing Level 2 | LRQA 473/360 | | |
| UT2i-SNT | T&O | 19/12/2007 | 19/12/2010 | Ultrasonic Testing Level 2 | EM.001.0070 | | |
| Vision Examination | | 17/02/2010 | 17/02/2011 | Vision requirements | | | |
| Werknemer | | Naam van werknemer | | | | | |
| EM.001.0086 | | Bosch, Dennis | | | | | |
| Certificaat | Certificaattype | Beginndatum | Einddatum | Omschrijving | Registratienummer | | |
| MT2e-EN | T&O | 01/05/2009 | 01/05/2014 | Magnetic Particle Testing Level 2 | LRQA 473/1139 | | |
| MT2i-SNT | T&O | 06/05/2009 | 06/05/2012 | Magnetic Particle Testing Level 2 | EM.001.0086 | | |
| RT2e-EN | T&O | 01/12/2008 | 01/12/2013 | Radiographic Testing Level 2 | LRQA 473/1139 | | |
| RT2i-SNT | T&O | 12/12/2008 | 12/12/2013 | Radiographic Testing Level 2 | EM.001.0086 | | |
| Vision Examination | | 21/09/2009 | 21/09/2010 | Vision requirements | | | |
| Werknemer | | Naam van werknemer | | | | | |
| EM.001.0103 | | Borstrok, Bert | | | | | |
| Certificaat | Certificaattype | Beginndatum | Einddatum | Omschrijving | Registratienummer | | |
| FL-2 | T&O FL | 10/05/2009 | 10/05/2012 | FL Level 2 | EM.001.0103 | | |
| MT3e-EN | T&O | 01/06/2009 | 01/06/2014 | Magnetic Particle Testing Level 3 | LRQA 473/538 | | |
| MT3i-SNT | T&O | 04/05/2009 | 04/05/2012 | Magnetic Particle Testing Level 3 | EM.001.0103 | | |
| PT3e-EN | T&O | 01/12/2009 | 01/12/2014 | Liquid Penetrant Testing Level 3 | LRQA 473/538 | | |
| PT3i-SNT | T&O | 04/05/2009 | 04/05/2012 | Liquid Penetrant Testing Level 3 | EM.001.0103 | | |
| RT3e-EN | T&O | 01/06/2009 | 01/06/2014 | Radiographic Testing Level 3 | LRQA 473/538 | | |
| RT3i-SNT | T&O | 04/05/2009 | 04/05/2012 | Radiographic Testing Level 3 | EM.001.0103 | | |
| UT3e-EN | T&O | 01/10/2009 | 01/10/2014 | Ultrasonic Testing Level 3 | LRQA 473/538 | | |
| UT3i-SNT | T&O | 04/05/2009 | 04/05/2012 | Ultrasonic Testing Level 3 | EM.001.0103 | | |
| Vision Examination | | 06/01/2010 | 06/01/2011 | Vision requirements | EM.001.0103 | | |
| Werknemer | | Naam van werknemer | | | | | |
| EM.001.0143 | | Diemeer, Frank | | | | | |

Certificaten

| Certificaat | Certificaattype | Beginndatum | Einddatum | Omschrijving | Registratienummer |
|--------------------|-----------------------|-------------|------------|-----------------------------------|-------------------|
| MT2e-EN | T&O | 01/03/2010 | 01/03/2015 | Magnetic Particle Testing Level 2 | LRQA 473/1061 |
| MT2i-SNT | T&O | 08/03/2010 | 08/03/2015 | Magnetic Particle Testing Level 2 | EM.001.0143 |
| PT2e-EN | T&O | 01/02/2009 | 01/02/2014 | Liquid Penetrant Testing Level 2 | LRQA 473/1061 |
| PT2i-SNT | T&O | 16/02/2009 | 16/02/2014 | Liquid Penetrant Testing Level 2 | EM.001.0143 |
| RT2e-EN | T&O | 01/06/2008 | 01/06/2013 | Radiographic Testing Level 2 | LRQA 473/1061 |
| RT2i-SNT | T&O | 13/06/2008 | 13/06/2011 | Radiographic Testing Level 2 | EM.001.0143 |
| UT1e-EN | T&O | 01/01/2009 | 01/01/2014 | Ultrasonic Testing Level 1 | LRQA 473/1061 |
| UT1i-SNT | T&O | 07/01/2009 | 07/01/2014 | Ultrasonic Testing Level 1 | EM.001.0143 |
| Vision Examination | HRM | 08/03/2010 | 08/03/2011 | Vision requirements | |
| Werknemer | | | | | |
| Naam van werknemer | | | | | |
| EM.001.0159 | Colaris, Henk | | | | |
| Certificaat | Certificaattype | Beginndatum | Einddatum | Omschrijving | Registratienummer |
| MT2e-EN | T&O | 01/07/2008 | 01/07/2013 | Magnetic Particle Testing Level 2 | LRQA 473/47 |
| MT2i-SNT | T&O | 21/06/2009 | 21/06/2012 | Magnetic Particle Testing Level 2 | EM.001.0159 |
| PT2e-EN | T&O | 01/09/2007 | 01/09/2012 | Liquid Penetrant Testing Level 2 | LRQA 473/047 |
| PT2i-SNT | T&O | 22/02/2009 | 22/02/2014 | Liquid Penetrant Testing Level 2 | EM.001.0159 |
| RT2e-EN | T&O | 01/09/2008 | 01/09/2013 | Radiographic Testing Level 2 | LRQA 473/47 |
| RT2i-SNT | T&O | 03/11/2009 | 03/11/2014 | Radiographic Testing Level 2 | EM.001.0159 |
| Vision Examination | HRM | 11/03/2009 | 11/03/2010 | Vision requirements | |
| Werknemer | | | | | |
| Naam van werknemer | | | | | |
| EM.001.0276 | Grapendaal, Jan | | | | |
| Certificaat | Certificaattype | Beginndatum | Einddatum | Omschrijving | Registratienummer |
| MT2e-EN | T&O | 01/12/2007 | 01/12/2012 | Magnetic Particle Testing Level 2 | LRQA 473/308 |
| MT2i-SNT | T&O | 12/12/2009 | 12/12/2014 | Magnetic Particle Testing Level 2 | EM.001.0276 |
| PT1i-SNT | T&O PT | 22/03/2009 | 22/03/2014 | Liquid Penetrant Testing Level 1 | EM.001.0276 |
| RT2e-EN | T&O | 01/12/2007 | 01/12/2012 | Radiographic Testing Level 2 | LRQA 473/308 |
| RT2i-SNT | T&O | 15/03/2009 | 15/03/2014 | Radiographic Testing Level 2 | EM.001.0276 |
| Vision Examination | HRM | 26/04/2010 | 26/04/2011 | Vision requirements | |
| Werknemer | | | | | |
| Naam van werknemer | | | | | |
| EM.001.0350 | Ortiz Hylkema, Dennis | | | | |
| Certificaat | Certificaattype | Beginndatum | Einddatum | Omschrijving | Registratienummer |
| MT2e-EN | T&O | 01/11/2008 | 01/11/2013 | Magnetic Particle Testing Level 2 | LRQA 473/1079 |
| MT2i-SNT | T&O | 18/11/2008 | 18/11/2011 | Magnetic Particle Testing Level 2 | EM.001.0350 |
| PT1e-EN | T&O | 01/03/2008 | 01/03/2013 | Liquid Penetrant Testing Level 1 | LRQA 473/1079 |
| PT2e-EN | T&O | 01/02/2009 | 01/02/2014 | Liquid Penetrant Testing Level 2 | LRQA 473/1079 |
| PT2i-SNT | T&O | 23/02/2009 | 23/02/2012 | Liquid Penetrant Testing Level 2 | EM.001.0350 |
| RT2e-EN | T&O | 01/12/2008 | 01/12/2013 | Radiographic Testing Level 2 | LRQA 473/1079 |
| RT2i-SNT | T&O | 02/12/2008 | 02/12/2013 | Radiographic Testing Level 2 | EM.001.0350 |
| UT1e-EN | T&O | 01/05/2008 | 01/05/2013 | Ultrasonic Testing Level 1 | LRQA 473/1079 |
| UT1i-SNT | T&O | 08/05/2008 | 08/05/2011 | Ultrasonic Testing Level 1 | EM.001.0350 |
| UT2e-EN | T&O | 01/06/2009 | 01/06/2014 | Ultrasonic Testing Level 2 | LRQA 473/1079 |
| UT2i-SNT | T&O | 03/09/2009 | 03/09/2014 | Ultrasonic Testing Level 2 | EM.001.0350 |
| Vision Examination | HRM | 21/09/2009 | 21/09/2010 | Vision requirements | |
| Werknemer | | | | | |
| Naam van werknemer | | | | | |
| EM.001.0372 | Hoy, Andy | | | | |

Certificaten

| Certificaat | Certificaatype | Beginndatum | Einddatum | Omschrijving | Registratienummer | |
|-------------|--------------------|-------------|------------|---------------------|-----------------------------------|---------------|
| Werknemer | Vision Examination | MT2e-EN | 01/05/2005 | 01/05/2010 | Magnetic Particle Testing Level 2 | LRQA 473/71 |
| | | MT2i-SNT | 14/06/2009 | 14/06/2014 | Magnetic Particle Testing Level 2 | EM.001.0372 |
| | | PT2e-EN | 01/05/2010 | 01/03/2015 | Liquid Penetrant Testing Level 2 | LRQA 473/071 |
| | | PT2i-SNT | 14/06/2009 | 14/06/2014 | Liquid Penetrant Testing Level 2 | EM.001.0372 |
| | | RT2e-EN | 01/06/2007 | 01/06/2012 | Radiographic Testing Level 2 | LRQA 473/071 |
| | | RT2i-SNT | 09/07/2008 | 09/07/2013 | Radiographic Testing Level 2 | EM.001.0372 |
| | | UT2e-EN | 01/10/2007 | 01/10/2012 | Ultrasonic Testing Level 2 | LRQA 473/071 |
| | | UT2i-SNT | 11/10/2008 | 11/10/2013 | Ultrasonic Testing Level 2 | EM.001.0372 |
| Werknemer | Naam van werknemer | 17/02/2010 | 17/02/2011 | Vision requirements | | |
| EM.001.0392 | Janssen, Stefan | | | | | |
| Certificaat | Certificaatype | Beginndatum | Einddatum | Omschrijving | Registratienummer | |
| Werknemer | Vision Examination | MT2e-EN | 01/07/2006 | 01/07/2011 | Magnetic Particle Testing Level 2 | LRQA 473/688 |
| | | MT2i-SNT | 04/07/2009 | 04/07/2014 | Magnetic Particle Testing Level 2 | EM.001.0392 |
| | | PT2e-EN | 01/10/2006 | 01/10/2011 | Liquid Penetrant Testing Level 2 | LRQA 473/688 |
| | | PT2i-SNT | 20/10/2009 | 20/10/2014 | Liquid Penetrant Testing Level 2 | EM.001.0392 |
| | | RT2e-EN | 01/12/2006 | 01/12/2011 | Radiographic Testing Level 2 | LRQA 473/688 |
| | | RT2i-SNT | 11/12/2009 | 11/12/2014 | Radiographic Testing Level 2 | EM.001.0392 |
| | | UT1e-EN | 21/12/2007 | 01/12/2012 | Ultrasonic Testing Level 1 | EM.001.0392 |
| | | UT1e-EN | 06/01/2010 | 06/01/2011 | Vision requirements | LRQA 473/688 |
| Werknemer | Naam van werknemer | | | | | |
| EM.001.0416 | Korte, Patrick de | | | | | |
| Certificaat | Certificaatype | Beginndatum | Einddatum | Omschrijving | Registratienummer | |
| Werknemer | Vision Examination | MT2e-EN | 01/06/2009 | 01/06/2014 | Magnetic Particle Testing Level 2 | LRQA 473/1201 |
| | | PT2e-EN | 24/06/2010 | 01/06/2015 | Liquid Penetrant Testing Level 2 | LRQA 473/1201 |
| | | PT2i-SNT | 24/06/2010 | 24/06/2015 | Liquid Penetrant Testing Level 2 | EM.001.0416 |
| | | RT1e-EN | 01/10/2008 | 01/10/2013 | Radiographic Testing Level 1 | LRQA 473/1201 |
| | | RT2e-EN | 01/05/2009 | 01/05/2014 | Radiographic Testing Level 2 | LRQA 473/1201 |
| | | RT2i-SNT | 20/05/2009 | 20/05/2014 | Radiographic Testing Level 2 | EM.001.0416 |
| | | UT1e-EN | 06/01/2010 | 06/01/2011 | Vision requirements | |
| | | UT1e-EN | | | | |
| Werknemer | Naam van werknemer | | | | | |
| EM.001.0448 | Klijn, Jaap | | | | | |
| Certificaat | Certificaatype | Beginndatum | Einddatum | Omschrijving | Registratienummer | |
| Werknemer | Vision Examination | MT2e-EN | 01/05/2010 | 01/05/2015 | Magnetic Particle Testing Level 2 | LRQA 473/347 |
| | | MT2i-SNT | 20/03/2008 | 20/03/2011 | Magnetic Particle Testing Level 2 | EM.001.0448 |
| | | PT2e-EN | 01/06/2009 | 01/06/2014 | Liquid Penetrant Testing Level 2 | LRQA 473/347 |
| | | PT2i-SNT | 05/06/2009 | 05/06/2014 | Liquid Penetrant Testing Level 2 | EM.001.0448 |
| | | RT2e-EN | 01/06/2009 | 01/06/2014 | Radiographic Testing Level 2 | LRQA 473/347 |
| | | RT2i-SNT | 07/04/2010 | 07/04/2015 | Radiographic Testing Level 2 | EM.001.0448 |
| | | UT1e-EN | 17/02/2010 | 17/02/2011 | Vision requirements | |
| | | UT1e-EN | | | | |
| Werknemer | Naam van werknemer | | | | | |
| EM.001.0457 | Koenders, Chiel | | | | | |
| Certificaat | Certificaatype | Beginndatum | Einddatum | Omschrijving | Registratienummer | |
| Werknemer | Vision Examination | MT2e-EN | 01/05/2010 | 01/05/2015 | Magnetic Particle Testing Level 2 | LRQA 473/118 |
| | | MT2i-SNT | 13/05/2008 | 13/05/2013 | Magnetic Particle Testing Level 2 | EM.001.0457 |
| | | PT2e-EN | 01/05/2010 | 01/05/2015 | Liquid Penetrant Testing Level 2 | LRQA 473/118 |

| Certificaat | Certificaattype | Begindatum | Einddatum | Omschrijving | Registratienummer |
|--------------------|-------------------|------------|------------|-----------------------------------|-------------------|
| PT2i-SNT | T&O | 26/05/2008 | 26/05/2013 | Liquid Penetrant Testing Level 2 | EM.001.0457 |
| RT2e-EN | T&O | 01/03/2006 | 01/03/2011 | Radiographic Testing Level 2 | LRQA 473/118 |
| RT2i-SNT | T&O | 17/03/2009 | 17/03/2014 | Radiographic Testing Level 2 | EM.001.0457 |
| UT2e-EN | T&O | 01/03/2007 | 01/03/2012 | Ultrasonic Testing Level 2 | LRQA 473/118 |
| UT2i-SNT | T&O | 28/03/2010 | 28/03/2015 | Ultrasonic Testing Level 2 | EM.001.0457 |
| Vision Examination | HRM | 06/01/2010 | 06/01/2011 | Vision requirements | |
| Werknemer | | | | | |
| Naam van werknemer | | | | | |
| EM.001.0488 | Kuik, Jan | | | | |
| Certificaat | Certificaattype | Begindatum | Einddatum | Omschrijving | Registratienummer |
| MT2e-EN | T&O | 01/02/2008 | 01/02/2013 | Magnetic Particle Testing Level 2 | LRQA 473/520 |
| MT2i-SNT | T&O | 17/04/2009 | 17/04/2014 | Magnetic Particle Testing Level 2 | EM.001.0488 |
| PT2e-EN | T&O | 01/02/2007 | 01/02/2012 | Liquid Penetrant Testing Level 2 | LRQA 473/520 |
| PT2i-SNT | T&O | 20/03/2008 | 20/03/2011 | Liquid Penetrant Testing Level 2 | EM.001.0488 |
| RT2e-EN | T&O | 01/12/2007 | 01/12/2012 | Radiographic Testing Level 2 | LRQA 473/520 |
| RT2i-SNT | T&O | 06/04/2009 | 06/04/2014 | Radiographic Testing Level 2 | EM.001.0488 |
| UT2e-EN | T&O | 01/09/2007 | 01/09/2012 | Ultrasonic Testing Level 2 | LRQA 473/520 |
| UT2i-SNT | T&O | 18/12/2008 | 18/12/2013 | Ultrasonic Testing Level 2 | EM.001.0488 |
| Vision Examination | HRM | 03/08/2009 | 03/08/2010 | Vision requirements | |
| Werknemer | | | | | |
| Naam van werknemer | | | | | |
| EM.001.0496 | Kuiper, Sjoerd | | | | |
| Certificaat | Certificaattype | Begindatum | Einddatum | Omschrijving | Registratienummer |
| MT1e-EN | T&O | 01/02/2009 | 01/02/2014 | Magnetic Particle Testing Level 1 | LRQA 473/883 |
| MT1i-SNT | T&O | 18/02/2009 | 18/02/2012 | Magnetic Particle Testing Level 1 | EM.001.0496 |
| PT2e-EN | T&O | 01/06/2009 | 01/06/2014 | Liquid Penetrant Testing Level 2 | LRQA 473/883 |
| PT2i-SNT | T&O | 15/06/2009 | 15/06/2014 | Liquid Penetrant Testing Level 2 | EM.001.0496 |
| RT2e-EN | T&O | 01/08/2007 | 01/08/2012 | Radiographic Testing Level 2 | LRQA 473/883 |
| RT2i-SNT | T&O | 13/08/2010 | 13/08/2015 | Radiographic Testing Level 2 | EM.001.0496 |
| UT2e-EN | T&O | 01/02/2010 | 01/02/2015 | Ultrasonic Testing Level 2 | LRQA 473/883 |
| UT2i-SNT | T&O | 22/02/2010 | 22/02/2015 | Ultrasonic Testing Level 2 | EM.001.0496 |
| Vision Examination | HRM | 07/06/2010 | 07/06/2011 | Vision requirements | |
| Werknemer | | | | | |
| Naam van werknemer | | | | | |
| EM.001.0526 | Leeuw, Anthony de | | | | |
| Certificaat | Certificaattype | Begindatum | Einddatum | Omschrijving | Registratienummer |
| MT2e-EN | T&O | 01/03/2010 | 01/03/2015 | Magnetic Particle Testing Level 2 | LRQA 473/1329 |
| MT2i-SNT | T&O | 10/03/2010 | 10/03/2015 | Magnetic Particle Testing Level 2 | EM.001.0526 |
| PT2e-EN | T&O | 07/01/2010 | 01/01/2015 | Liquid Penetrant Testing Level 2 | LRQA 473/1329 |
| PT2i-SNT | T&O | 08/01/2010 | 08/01/2015 | Liquid Penetrant Testing Level 2 | EM.001.0526 |
| RT1e-EN | T&O | 01/07/2009 | 01/07/2014 | Radiographic Testing Level 1 | LRQA 473/1329 |
| RT1i-SNT | T&O | 06/07/2009 | 06/07/2014 | Radiographic Testing Level 1 | EM.001.0526 |
| UT1e-EN | T&O | 01/01/2009 | 01/01/2014 | Ultrasonic Testing Level 1 | LRQA 473/1329 |
| UT1i-SNT | T&O | 07/01/2009 | 07/01/2014 | Ultrasonic Testing Level 1 | EM.001.0526 |
| UT2e-EN | T&O | 01/02/2010 | 01/02/2015 | Ultrasonic Testing Level 2 | LRQA 473/1329 |
| UT2i-SNT | T&O | 22/02/2010 | 22/02/2015 | Ultrasonic Testing Level 2 | EM.001.0526 |
| Vision Examination | HRM | 06/01/2010 | 06/01/2011 | Vision requirements | |
| Werknemer | | | | | |
| Naam van werknemer | | | | | |
| EM.001.0541 | Luiten, Mark | | | | |

| Certificaat | Certificaattype | Beginndatum | Einddatum | Omschrijving | Registratienummer |
|--------------------|--------------------|-------------|------------|-----------------------------------|-------------------|
| RT1i-SNT | T&O | 27/03/2008 | 27/03/2011 | Radiographic Testing Level 1 | EM.001.0541 |
| RT2e-EN | T&O | 01/06/2008 | 01/06/2013 | Radiographic Testing Level 2 | LRQA 473/1150 |
| RT2i-SNT | T&O | 27/02/2009 | 27/02/2014 | Radiographic Testing Level 2 | EM.001.0541 |
| Vision Examination | HRM | 10/08/2009 | 10/08/2010 | Vision requirements | |
| Werknemer | Naam van werknemer | | | | |
| EM.001.0564 | Maessen, Bruno | | | | |
| Certificaat | Certificaattype | Beginndatum | Einddatum | Omschrijving | Registratienummer |
| MT2e-EN | T&O | 03/06/2010 | 01/06/2015 | Magnetic Particle Testing Level 2 | LRQA 473/1148 |
| PT2i-SNT | T&O | 30/03/2010 | 30/03/2015 | Liquid Penetrant Testing Level 2 | EM.001.0564 |
| RT1e-EN | T&O | 01/03/2008 | 01/03/2013 | Radiographic Testing Level 1 | LRQA 473/1148 |
| RT2e-EN | T&O | 01/12/2008 | 01/12/2013 | Radiographic Testing Level 2 | LRQA 473/1148 |
| RT2i-SNT | T&O | 12/12/2008 | 12/12/2013 | Radiographic Testing Level 2 | EM.001.0564 |
| Vision Examination | HRM | 06/01/2010 | 06/01/2011 | Vision requirements | |
| Werknemer | Naam van werknemer | | | | |
| EM.001.0652 | Pennekamp, Wilco | | | | |
| Certificaat | Certificaattype | Beginndatum | Einddatum | Omschrijving | Registratienummer |
| FL-2 | T&O FL | 05/05/2009 | 05/05/2012 | FL Level 2 | EM.001.0652 |
| MT2e-EN | T&O | 01/03/2008 | 01/03/2013 | Magnetic Particle Testing Level 2 | LRQA 473/913 |
| MT2i-SNT | T&O | 11/03/2008 | 11/03/2011 | Magnetic Particle Testing Level 2 | EM.001.0652 |
| PT2e-EN | T&O | 01/07/2008 | 01/07/2013 | Liquid Penetrant Testing Level 2 | LRQA 473/913 |
| PT2i-SNT | T&O | 10/07/2008 | 10/07/2011 | Liquid Penetrant Testing Level 2 | EM.001.0652 |
| RT2e-EN | T&O | 19/12/2007 | 01/12/2012 | Radiographic Testing Level 2 | LRQA 473/913 |
| RT2i-SNT | T&O | 19/12/2007 | 19/12/2010 | Radiographic Testing Level 2 | EM.001.0652 |
| UT1e-EN | T&O | 07/12/2007 | 01/12/2012 | Ultrasonic Testing Level 1 | LRQA 473/913 |
| UT2e-EN | T&O | 01/11/2008 | 01/11/2013 | Ultrasonic Testing Level 2 | LRQA 473/913 |
| UT2i-SNT | T&O | 28/11/2008 | 28/11/2013 | Ultrasonic Testing Level 2 | EM.001.0652 |
| Vision Examination | HRM | 17/02/2010 | 17/02/2011 | Vision requirements | |
| Werknemer | Naam van werknemer | | | | |
| EM.001.0654 | Piening, Frank | | | | |
| Certificaat | Certificaattype | Beginndatum | Einddatum | Omschrijving | Registratienummer |
| MT2e-EN | T&O | 01/02/2009 | 01/02/2014 | Magnetic Particle Testing Level 2 | LRQA 473/1060 |
| MT2i-SNT | T&O | 18/02/2009 | 18/02/2014 | Magnetic Particle Testing Level 2 | EM.001.0654 |
| PT2e-EN | T&O | 01/06/2009 | 01/06/2014 | Liquid Penetrant Testing Level 2 | LRQA 473/1060 |
| PT2i-SNT | T&O | 16/06/2009 | 16/06/2014 | Liquid Penetrant Testing Level 2 | EM.001.0654 |
| RT2e-EN | T&O | 01/03/2009 | 01/03/2014 | Radiographic Testing Level 2 | LRQA 473/1060 |
| RT2i-SNT | T&O | 06/03/2009 | 06/03/2014 | Radiographic Testing Level 2 | EM.001.0654 |
| Vision Examination | HRM | 21/09/2009 | 21/09/2010 | Vision requirements | |
| Werknemer | Naam van werknemer | | | | |
| EM.001.0685 | Reedijk, Ger | | | | |
| Certificaat | Certificaattype | Beginndatum | Einddatum | Omschrijving | Registratienummer |
| MT2e-EN | T&O | 01/01/2010 | 01/01/2015 | Magnetic Particle Testing Level 2 | LRQA 473/300 |
| MT2i-SNT | T&O | 31/01/2010 | 31/01/2015 | Magnetic Particle Testing Level 2 | EM.001.0685 |
| PT2e-EN | T&O | 01/04/2009 | 01/04/2014 | Liquid Penetrant Testing Level 2 | LRQA 473/300 |
| PT2i-SNT | T&O | 09/05/2010 | 09/05/2015 | Liquid Penetrant Testing Level 2 | EM.001.0685 |
| UT2e-EN | T&O | 01/10/2007 | 01/10/2012 | Ultrasonic Testing Level 2 | LRQA 473/300 |
| UT2i-SNT | T&O | 16/10/2008 | 16/10/2013 | Ultrasonic Testing Level 2 | EM.001.0685 |

Certificaten

| Certificaat | | Certificaattype | Begindatum | Einddatum | Omschrijving | Registratienummer |
|--------------------|--|----------------------|------------|------------|-----------------------------------|-------------------|
| Vision Examination | | HRM | 08/03/2010 | 08/03/2011 | Vision requirements | |
| Werknemer | | Naam van werknemer | | | | |
| EM.001.0809 | | Strietman, Kees | | | | |
| Certificaat | | Certificaattype | Begindatum | Einddatum | Omschrijving | Registratienummer |
| MT2e-EN | | T&O | 01/05/2010 | 01/05/2015 | Magnetic Particle Testing Level 2 | LRQA 473/460 |
| MT2i-SNT | | T&O | 20/03/2008 | 20/03/2011 | Magnetic Particle Testing Level 2 | EM.001.0809 |
| PT2e-EN | | T&O | 01/03/2010 | 01/03/2015 | Liquid Penetrant Testing Level 2 | LRQA 473/460 |
| PT2i-SNT | | T&O | 31/01/2008 | 31/01/2011 | Liquid Penetrant Testing Level 2 | EM.001.0809 |
| RT2e-EN | | T&O | 01/09/2005 | 01/09/2010 | Radiographic Testing Level 2 | LRQA 473/460 |
| RT2i-SNT | | T&O | 12/03/2009 | 12/03/2014 | Radiographic Testing Level 2 | EM.001.0809 |
| UT1e-EN | | T&O | 09/12/2009 | 01/12/2014 | Ultrasonic Testing Level 1 | LRQA 473/460 |
| UT1i-SNT | | T&O | 20/01/2009 | 20/01/2014 | Ultrasonic Testing Level 1 | EM.001.0809 |
| Vision Examination | | HRM | 06/01/2010 | 06/01/2011 | Vision requirements | |
| Werknemer | | Naam van werknemer | | | | |
| EM.001.0830 | | Terwindt, Cees | | | | |
| Certificaat | | Certificaattype | Begindatum | Einddatum | Omschrijving | Registratienummer |
| FL-2 | | T&O FL | 05/05/2009 | 05/05/2012 | FL Level 2 | EM.001.0830 |
| MT2e-EN | | T&O | 01/01/2009 | 01/01/2014 | Magnetic Particle Testing Level 2 | LRQA 473/40 |
| MT2i-SNT | | T&O | 14/02/2010 | 14/02/2015 | Magnetic Particle Testing Level 2 | EM.001.0830 |
| PT2e-EN | | T&O | 01/09/2008 | 01/09/2013 | Liquid Penetrant Testing Level 2 | LRQA 473/40 |
| PT2i-SNT | | T&O | 16/12/2009 | 16/12/2014 | Liquid Penetrant Testing Level 2 | EM.001.0830 |
| RT2e-EN | | T&O | 01/12/2008 | 01/12/2013 | Radiographic Testing Level 2 | LRQA 473/40 |
| RT2i-SNT | | T&O | 17/12/2009 | 17/12/2014 | Radiographic Testing Level 2 | EM.001.0830 |
| Vision Examination | | HRM | 05/05/2009 | 05/05/2010 | Vision requirements | |
| Werknemer | | Naam van werknemer | | | | |
| EM.001.0975 | | Woning, Jan | | | | |
| Certificaat | | Certificaattype | Begindatum | Einddatum | Omschrijving | Registratienummer |
| FL-2 | | T&O FL | 07/06/2009 | 07/06/2012 | FL Level 2 | EM.001.0975 |
| MT2e-EN | | T&O | 01/03/2010 | 01/03/2015 | Magnetic Particle Testing Level 2 | LRQA 473/229 |
| MT2i-SNT | | T&O | 16/03/2008 | 16/03/2011 | Magnetic Particle Testing Level 2 | EM.001.0975 |
| PT2e-EN | | T&O | 01/10/2007 | 01/10/2012 | Liquid Penetrant Testing Level 2 | LRQA 473/229 |
| RT2e-EN | | T&O | 01/03/2009 | 01/03/2014 | Radiographic Testing Level 2 | LRQA 473/229 |
| RT2i-SNT | | T&O | 13/03/2009 | 13/03/2014 | Radiographic Testing Level 2 | EM.001.0975 |
| Vision Examination | | HRM | 25/11/2009 | 25/11/2010 | Vision requirements | |
| Werknemer | | Naam van werknemer | | | | |
| EM.001.1035 | | Oude Wesselink, Mark | | | | |
| Certificaat | | Certificaattype | Begindatum | Einddatum | Omschrijving | Registratienummer |
| MT2e-EN | | T&O | 01/03/2010 | 01/03/2015 | Magnetic Particle Testing Level 2 | LRQA 473/1238 |
| MT2i-SNT | | T&O | 11/03/2010 | 11/03/2015 | Magnetic Particle Testing Level 2 | EM.001.1035 |
| RT1e-EN | | T&O | 01/07/2009 | 01/06/2014 | Radiographic Testing Level 1 | LRQA 473/1238 |
| RT1i-SNT | | T&O | 06/07/2009 | 06/07/2014 | Radiographic Testing Level 1 | EM.001.1035 |
| UT2e-EN | | T&O | 01/08/2009 | 01/08/2014 | Ultrasonic Testing Level 2 | LRQA 473/1238 |
| UT2i-SNT | | T&O | 01/10/2009 | 01/10/2014 | Ultrasonic Testing Level 2 | EM.001.1035 |
| Vision Examination | | HRM | 24/09/2009 | 24/09/2010 | Vision requirements | |

Certificaten

| | | | | | | | |
|-------------|--------------------|--------------------|------------|-------------|-----------|------------------------------|-------------------|
| Werknemer | | Naam van werknemer | | | | | |
| EM.001.1125 | | Berkum, Joris van | | | | | |
| Certificaat | | Certificaatype | | Beginndatum | Einddatum | Omschrijving | Registratienummer |
| RT1e-EN | Vision Examination | T&O | 16/03/2010 | 01/03/2015 | | Radiographic Testing Level 1 | LRQA 473/1436 |
| RT1i-SNT | | T&O | 30/03/2010 | 30/03/2015 | | Radiographic Testing Level 1 | EM.001.1125 |
| | | HRM | 17/02/2010 | 17/02/2011 | | Vision requirements | |
| Werknemer | | Naam van werknemer | | | | | |
| EM.009.0212 | | Dijkstra, Kees | | | | | |
| Certificaat | | Certificaatype | | Beginndatum | Einddatum | Omschrijving | Registratienummer |
| RT2i-SNT | Vision Examination | T&O | 15/01/2009 | 15/01/2014 | | Radiographic Testing Level 2 | EM.009.0212 |
| | | HRM | 26/04/2010 | 26/04/2011 | | Vision requirements | |

Registratienummer

LRQA 473/1436

EM.001.1125

Omschrijving

Radiographic Testing Level 1

Radiographic Testing Level 1

Vision requirements

Registratienummer

EM.009.0212

Omschrijving

Radiographic Testing Level 2

Vision requirements



UNROUNDNESS CERTIFICATE



Manufacturer : Hoefnagel & Meijn B.V.
Manufacturer Order No. : 10.345

NoBo : Lloyd's Register
NoBo Order No. : 8087127

Name : **CO2 ACCUMULATOR**

Item No. : F-260

Client : Nikhef Instituut

Client Order No. : 43090

Purchaser : -

Purchase Order No. : -

Diameter vat = **168** mm
Wand dikte = **7** mm
Inwendige diameter = **154** mm

Lengte romp = **1400** mm
Aantal metingen = **33**
Meet afstand = **42** mm

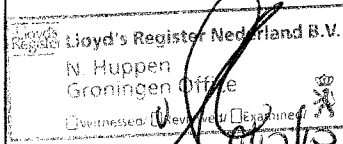
| | | |
|--------------------|-------|----|
| 1. middelijn D1 = | 168,2 | mm |
| 2. middelijn D1 = | 168,7 | mm |
| 3. middelijn D1 = | 168,8 | mm |
| 4. middelijn D1 = | 168,8 | mm |
| 5. middelijn D1 = | 168,8 | mm |
| 6. middelijn D1 = | 168,6 | mm |
| 7. middelijn D1 = | 168,7 | mm |
| 8. middelijn D1 = | 168,7 | mm |
| 9. middelijn D1 = | 168,8 | mm |
| 10. middelijn D1 = | 168,8 | mm |
| 11. middelijn D1 = | 168,9 | mm |
| 12. middelijn D1 = | 168,7 | mm |
| 13. middelijn D1 = | 168,7 | mm |
| 14. middelijn D1 = | 168,8 | mm |
| 15. middelijn D1 = | 168,8 | mm |
| 16. middelijn D1 = | 168,7 | mm |
| 17. middelijn D1 = | 168,8 | mm |
| 18. middelijn D1 = | 168,8 | mm |
| 19. middelijn D1 = | 168,8 | mm |
| 20. middelijn D1 = | 168,8 | mm |
| 21. middelijn D1 = | 168,9 | mm |
| 22. middelijn D1 = | 168,8 | mm |
| 23. middelijn D1 = | 168,8 | mm |
| 24. middelijn D1 = | 168,9 | mm |
| 25. middelijn D1 = | 168,9 | mm |
| 26. middelijn D1 = | 168,9 | mm |
| 27. middelijn D1 = | 168,9 | mm |
| 28. middelijn D1 = | 168,7 | mm |
| 29. middelijn D1 = | 168,7 | mm |
| 30. middelijn D1 = | 168,7 | mm |
| 31. middelijn D1 = | 168,6 | mm |
| 32. middelijn D1 = | 168,6 | mm |
| 33. middelijn D1 = | 168,2 | mm |
| 34. middelijn D1 = | 0,0 | mm |

| | | |
|--------------------|-------|----|
| 1. middelijn D2 = | 167,9 | mm |
| 2. middelijn D2 = | 168,5 | mm |
| 3. middelijn D2 = | 168,6 | mm |
| 4. middelijn D2 = | 168,5 | mm |
| 5. middelijn D2 = | 168,7 | mm |
| 6. middelijn D2 = | 168,6 | mm |
| 7. middelijn D2 = | 168,6 | mm |
| 8. middelijn D2 = | 168,6 | mm |
| 9. middelijn D2 = | 168,7 | mm |
| 10. middelijn D2 = | 168,8 | mm |
| 11. middelijn D2 = | 168,7 | mm |
| 12. middelijn D2 = | 168,7 | mm |
| 13. middelijn D2 = | 168,6 | mm |
| 14. middelijn D2 = | 168,6 | mm |
| 15. middelijn D2 = | 168,6 | mm |
| 16. middelijn D2 = | 168,6 | mm |
| 17. middelijn D2 = | 168,6 | mm |
| 18. middelijn D2 = | 168,7 | mm |
| 19. middelijn D2 = | 168,9 | mm |
| 20. middelijn D2 = | 168,7 | mm |
| 21. middelijn D2 = | 168,9 | mm |
| 22. middelijn D2 = | 168,8 | mm |
| 23. middelijn D2 = | 168,7 | mm |
| 24. middelijn D2 = | 168,7 | mm |
| 25. middelijn D2 = | 168,8 | mm |
| 26. middelijn D2 = | 168,7 | mm |
| 27. middelijn D2 = | 168,8 | mm |
| 28. middelijn D2 = | 168,8 | mm |
| 29. middelijn D2 = | 168,8 | mm |
| 30. middelijn D2 = | 168,9 | mm |
| 31. middelijn D2 = | 168,9 | mm |
| 32. middelijn D2 = | 168,9 | mm |
| 33. middelijn D2 = | 168,4 | mm |
| 34. middelijn D2 = | 0,0 | mm |

DATE:
29 september 2010

INSPECTION NoBo

Lloyd's Register

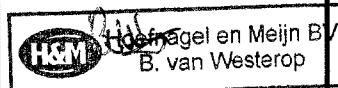


INSPECTION CLIENT

Nikhef Instituut

INSPECT. MANUFACTURER

Hoefnagel & Meijn B.V.





UNROUNDNESS CERTIFICATE



Manufacturer : Hoefnagel & Meijn B.V.
Manufacturer Order No. : 10.345

NoBo : Lloyd's Register
NoBo Order No. : 8087127

Name : **CO2 ACCUMULATOR**

Item No. : F-260

Client : Nikhef Instituut

Client Order No. : 43090

Purchaser : -

Purchase Order No. : -

1.Delta D = 0,30 mm
2.Delta D = 0,20 mm
3.Delta D = 0,20 mm
4.Delta D = 0,30 mm
5.Delta D = 0,10 mm
6.Delta D = 0,00 mm
7.Delta D = 0,10 mm
8.Delta D = 0,10 mm
9.Delta D = 0,10 mm
10.Delta D = 0,00 mm
11.Delta D = 0,20 mm
12.Delta D = 0,00 mm
13.Delta D = 0,10 mm
14.Delta D = 0,20 mm
15.Delta D = 0,20 mm
16.Delta D = 0,10 mm
17.Delta D = 0,20 mm

18.Delta D = 0,10 mm
19.Delta D = -0,10 mm
20.Delta D = 0,10 mm
21.Delta D = 0,00 mm
22.Delta D = 0,00 mm
23.Delta D = 0,10 mm
24.Delta D = 0,20 mm
25.Delta D = 0,10 mm
26.Delta D = 0,20 mm
27.Delta D = 0,10 mm
28.Delta D = -0,10 mm
29.Delta D = -0,10 mm
30.Delta D = -0,20 mm
31.Delta D = -0,30 mm
32.Delta D = -0,30 mm
33.Delta D = -0,20 mm
34.Delta D = 0,00 mm

Voerstraalafwijking

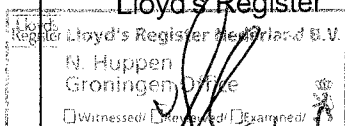
1. Delta r = 0,30
2. Delta r = 0,20
3. Delta r = 0,20
4. Delta r = 0,30
5. Delta r = 0,10
6. Delta r = 0,00
7. Delta r = 0,10
8. Delta r = 0,10
9. Delta r = 0,10
10. Delta r = 0,00
11. Delta r = 0,20
12. Delta r = 0,00
13. Delta r = 0,10
14. Delta r = 0,20
15. Delta r = 0,20
16. Delta r = 0,10
17. Delta r = 0,20

18. Delta r = 0,10
19. Delta r = -0,10
20. Delta r = 0,10
21. Delta r = 0,00
22. Delta r = 0,00
23. Delta r = 0,10
24. Delta r = 0,20
25. Delta r = 0,10
26. Delta r = 0,20
27. Delta r = 0,10
28. Delta r = -0,10
29. Delta r = -0,10
30. Delta r = -0,20
31. Delta r = -0,30
32. Delta r = -0,30
33. Delta r = -0,20
34. Delta r = NVT

DATE:
29 september 2010

INSPECTION NoBo

Lloyd's Register

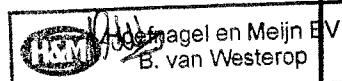


INSPECTION CLIENT

Nikhef Instituut

INSPECT. MANUFACTURER

Hoefnagel & Meijn B.V.





PRESSURE- & LEAKTEST CERTIFICATE



Manufacturer : Hoefnagel & Meijn B.V.
Manufacturer Order No. : 10.345

NoBo : Lloyd's Register
NoBo Order No. : 8087127

Name : **CO2 ACCUMULATOR**

Item No. : F-260

Client : Nikhef Instituut

Client Order No. : 43090

Purchaser : -

Purchase Order No. : -

HYDRAULIC PRESSURE TEST

| | | | |
|---------------|--------|--------|------|
| | VESSEL | COIL 1 | |
| MEDIUM | N.A. | Water | |
| TEST PRESSURE | N.A. | 23 | Barg |
| TEST TIME | N.A. | 1 | Hour |

PNEUMATIC LEAKTEST

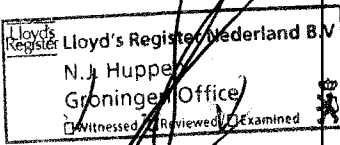
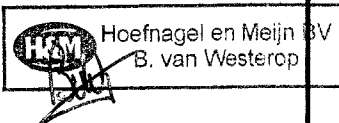
| | | | |
|----------------|--------|--------|------|
| | VESSEL | COIL 1 | |
| MEDIUM | N.A. | N.A. | |
| TEST PRESSURE | N.A. | N.A. | Barg |
| TEST APPARATUS | N.A. | N.A. | |

REMARKS:

Manometer Vessel :

Manometer Coil 1 : 1007-01491

THE ABOVE MENTIONED PRESSURE/LEAKTEST HAS BEEN EXECUTED WITH A POSITIVE RESULT

| | | | |
|---|--|---------------------------------------|--|
| DATE: 22 oktober 2010 | INSPECTION NoBo Lloyd's Register  | INSPECTION CLIENT Nikhef Instituut | INSPECT. MANUFACTURER Hoefnagel & Meijn B.V.  |
| PERFORMED AT: Hoefnagel & Meijn B.V. | | | |

Customer information

Client : Hoefnagel en Meijn B.V.
Contact : Simon van der Mast
Address : Uiterdijk 4
1505 GW ZAANDAM
The Netherlands
Reference client :
Reference Stork : 201006244/8

Instrument information

Make / type : WIKA / EN 837-1
Description : Manometer
Range / nom. size : 0 .. 40 bar
Serial number :
Identification number : 600005
Accuracy :

Date of calibration : 06-07-2010

Used method : M 212-902 Pressure measurement

Environmental conditions : Ambient temperature : $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$
Relative humidity : $45\%\text{rh} \pm 20\%\text{rh}$

Used reference : The measurements have been executed using standards for which the traceability to (inter)national standards can be demonstrated.

83825/6 Digital pressure indicator

Note : Recommended recalibration date : 06-07-2011

Conclusion : There were no deviations ascertained of the specified tolerances. This has been determined without taking into account the measuring uncertainty.

Measure technician
Dirk Bonthuis

Issue date: 06-07-2010



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7553 JD Hengelo (OV)
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Stork Interme B.V.

CALIBRATION CERTIFICATE

1007-01491

| | Reference value | Instrument value | Difference | Tolerance ± | Uncertainty ± | Units | |
|----|--------------------|---------------------|------------|----------------|------------------|-------|-----|
| 1 | 0,00 | 0,00 | 0,00 | 0,40 | 0,23 | bar | 0% |
| 2 | 7,93 | 8,00 | 0,07 | 0,40 | 0,23 | bar | 19% |
| 3 | 15,97 | 16,00 | 0,03 | 0,40 | 0,23 | bar | 7% |
| 4 | 23,87 | 24,00 | 0,13 | 0,40 | 0,23 | bar | 33% |
| 5 | 31,93 | 32,00 | 0,07 | 0,40 | 0,23 | bar | 17% |
| 6 | 40,00 | 40,00 | 0,01 | 0,40 | 0,23 | bar | 1% |
| 7 | 31,88 | 32,00 | 0,13 | 0,40 | 0,23 | bar | 31% |
| 8 | 23,84 | 24,00 | 0,16 | 0,40 | 0,23 | bar | 40% |
| 9 | 15,86 | 16,00 | 0,14 | 0,40 | 0,23 | bar | 34% |
| 10 | 7,88 | 8,00 | 0,12 | 0,40 | 0,23 | bar | 30% |
| 11 | 0,00 | 0,00 | 0,00 | 0,40 | 0,23 | bar | 0% |



PRESSURE- & LEAKTEST CERTIFICATE



Manufacturer : Hoefnagel & Meijn B.V.
Manufacturer Order No. : 10.345

NoBo : Lloyd's Register
NoBo Order No. : 8087127

Name : **CO2 ACCUMULATOR**

Item No. : F-260

Client : Nikhef Instituut

Client Order No. : 43090

Purchaser : -

Purchase Order No. : -

HYDRAULIC PRESSURE TEST

| | | | |
|---------------|--------|--------|------|
| | VESSEL | COIL 2 | |
| MEDIUM | N.A. | Water | |
| TEST PRESSURE | N.A. | 23 | Barg |
| TEST TIME | N.A. | 1 | Hour |

PNEUMATIC LEAKTEST

| | | | |
|----------------|--------|--------|------|
| | VESSEL | COIL 2 | |
| MEDIUM | N.A. | N.A. | |
| TEST PRESSURE | N.A. | N.A. | Barg |
| TEST APPARATUS | N.A. | N.A. | |

REMARKS:

Manometer Vessel :

Manometer Coil 2 : 1003-08031

THE ABOVE MENTIONED PRESSURE/LEAKTEST HAS BEEN EXECUTED WITH A POSITIVE RESULT

| | INSPECTION NoBo | INSPECTION CLIENT | INSPECT. MANUFACTURER |
|---|--|-------------------|--|
| DATE: 22 oktober 2010 | Lloyd's Register | Nikhef Instituut | Hoefnagel & Meijn B.V. |
| PERFORMED AT: Hoefnagel & Meijn B.V. | <small>Lloyd's Register</small> Lloyd's Register Nederland B.V. N.J. Huppen Groningen Office <input checked="" type="checkbox"/> Witnessed <input type="checkbox"/> Reviewed <input type="checkbox"/> Examined | | <small>H&M</small> Hoefnagel en Meijn B.V. B. van Westerop |

Stork Intermees B.V.

CERTIFICATE OF CALIBRATION

1003-08031

Customer information

Client : Hoefnagel en Meijn B.V.
Contact : Dhr. B. van Westerop
Address : Uiterdijk 4
1505 GW ZAANDAM
The Netherlands
Reference client : -
Reference Stork : 201002512/5

Instrument information

Make / type : GOMMER BV / EN 837-1
Description : Test gauge
Range / nom. size : 0 .. 40 bar
Serial number : 122857006
Identification number : 600016
Accuracy : 1 % fs.

Date of calibration : 18-03-2010

Used method : M 212-902 Pressure measurement

Environmental conditions : Ambient temperature : 23°C ± 2°C
Relative humidity : 45%rh ± 20%rh

Used reference : The measurements have been executed using standards for which the traceability to (inter)national standards can be demonstrated.

83825/5 Digital pressure indicator
920601/4 Digital pressure indicator

Note : Recommended recalibration date : 18-03-2011

Conclusion : There were no deviations ascertained of the specified tolerances. This has been determined without taking into account the measuring uncertainty.

Measure technician
Patrick Scholten

Issue date: 18-03-2010



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* c 1 0 0 3 0 8 0 3 1 *

Stork Intermees B.V.

CALIBRATION CERTIFICATE

1003-08031

| | Reference value | Instrument value | Difference | Tolerance ± | Uncertainty ± | Units | |
|----|--------------------|---------------------|------------|----------------|------------------|-------|------|
| 1 | 0,00 | 0,00 | 0,00 | 0,40 | 0,24 | bar g | 0% |
| 2 | 8,12 | 8,00 | -0,12 | 0,40 | 0,24 | bar g | -30% |
| 3 | 16,25 | 16,00 | -0,25 | 0,40 | 0,24 | bar g | -61% |
| 4 | 24,39 | 24,00 | -0,39 | 0,40 | 0,24 | bar g | -98% |
| 5 | 32,38 | 32,00 | -0,38 | 0,40 | 0,24 | bar g | -94% |
| 6 | 40,25 | 40,00 | -0,25 | 0,40 | 0,24 | bar g | -63% |
| 7 | 32,29 | 32,00 | -0,29 | 0,40 | 0,24 | bar g | -72% |
| 8 | 24,35 | 24,00 | -0,35 | 0,40 | 0,24 | bar g | -88% |
| 9 | 16,15 | 16,00 | -0,15 | 0,40 | 0,24 | bar g | -37% |
| 10 | 8,00 | 8,00 | 0,00 | 0,40 | 0,24 | bar g | 0% |
| 11 | 0,00 | 0,00 | 0,00 | 0,40 | 0,24 | bar g | 0% |



PRESSURE- & LEAKTEST CERTIFICATE



Manufacturer : Hoefnagel & Meijn B.V.
Manufacturer Order No. : 10.345

NoBo : Lloyd's Register
NoBo Order No. : 8087127

Name : **CO2 ACCUMULATOR**

Item No. : F-260

Client : Nikhef Instituut

Client Order No. : 43090

Purchaser : -

Purchase Order No. : -

HYDRAULIC PRESSURE TEST

| | | | |
|---------------|--------|------|------|
| | VESSEL | COIL | |
| MEDIUM | Water | N.A. | |
| TEST PRESSURE | 157 | N.A. | Barg |
| TEST TIME | 1 | N.A. | Hour |

PNEUMATIC LEAKTEST

| | | | |
|----------------|--------|------|------|
| | VESSEL | COIL | |
| MEDIUM | N.A. | N.A. | |
| TEST PRESSURE | N.A. | N.A. | Barg |
| TEST APPARATUS | N.A. | N.A. | |

REMARKS:

Manometer Vessel : 1007-01454

Manometer Coil :

THE ABOVE MENTIONED PRESSURE/LEAKTEST HAS BEEN EXECUTED WITH A POSITIVE RESULT

| | | | |
|---|---|---------------------------------------|---|
| DATE: 28 oktober 2010 | INSPECTION NoBo Lloyd's Register | INSPECTION CLIENT Nikhef Instituut | INSPECT. MANUFACTURER Hoefnagel & Meijn B.V. |
| PERFORMED AT: Hoefnagel & Meijn B.V. | | | |

Customer information

Client : Hoefnagel en Meijn B.V.
Contact : Simon van der Mast
Address : Uiterdijk 4
1505 GW ZAANDAM
The Netherlands

Reference client :
Reference Stork : 201006244/2

Instrument information

Make / type : WIKA / EN 837-1
Description : Manometer
Range / nom. size : 0 .. 250 bar
Serial number :
Identification number : 600006
Accuracy :

Date of calibration : 07-07-2010

Used method : M 212-902 Pressure measurement

Environmental conditions : Ambient temperature : $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$
Relative humidity : $45\%\text{rh} \pm 20\%\text{rh}$

Used reference : The measurements have been executed using standards for which the traceability to (inter)national standards can be demonstrated.

4391/2 Drukbalans

Note : Recommended recalibration date : 07-07-2011

Conclusion : There were no deviations ascertained of the specified tolerances. This has been determined without taking into account the measuring uncertainty.

Measure technician
Dirk Bonthuis

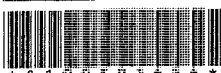
Issue date: 07-07-2010



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7553 JD Hengelo (OV)
The Netherlands
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Telefax + 31 74 240.81.66
E-mail gmo.fdo@stork.com

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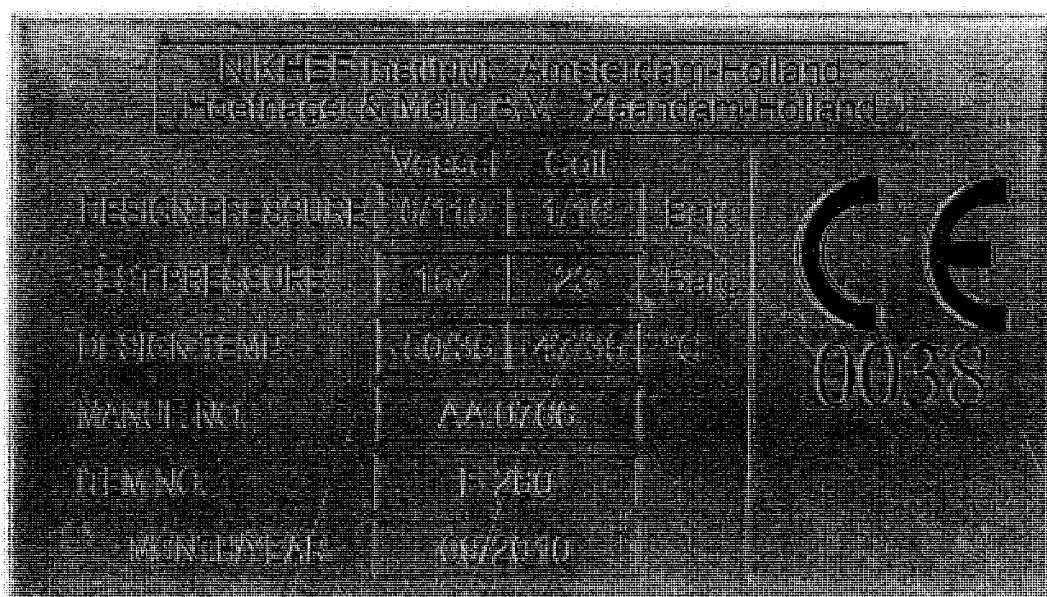


Stork Intermees B.V.

CALIBRATION CERTIFICATE

1007-01454

| | Reference value | Instrument value | Difference | Tolerance ± | Uncertainty ± | Units | |
|----|--------------------|---------------------|------------|----------------|------------------|-------|------|
| 1 | 0,0 | 0 | 0,0 | 2,5 | 1,2 | bar | 0% |
| 2 | 50,0 | 49 | -1,0 | 2,5 | 1,2 | bar | -40% |
| 3 | 100,0 | 99 | -1,0 | 2,5 | 1,2 | bar | -40% |
| 4 | 150,0 | 148 | -2,0 | 2,5 | 1,2 | bar | -80% |
| 5 | 200,0 | 198 | -2,0 | 2,5 | 1,2 | bar | -80% |
| 6 | 250,0 | 249 | -1,0 | 2,5 | 1,2 | bar | -40% |
| 7 | 200,0 | 198 | -2,0 | 2,5 | 1,2 | bar | -80% |
| 8 | 150,0 | 148 | -2,0 | 2,5 | 1,2 | bar | -80% |
| 9 | 100,0 | 99 | -1,0 | 2,5 | 1,2 | bar | -40% |
| 10 | 50,0 | 49 | -1,0 | 2,5 | 1,2 | bar | -40% |
| 11 | 0,0 | 0 | 0,0 | 2,5 | 1,2 | bar | 0% |



HOEFNAGEL & MEIJN B.V. ZAANDAM-HOLLAND

T : +31 (0)75 6166122, F : +31 (0)75 6313840, M : MAIL@HOEFNAGEL-MEIJN.DEMON.NL

N-10.345-01

Visit Report

| | | | |
|-----------------------------------|------------------------------|----------------------|-------------------------------|
| Visit report number: 8087127/2 | Date of visit: 28-10-2010 | Office: ROTTERDAM | Control number: RET0235848 |
|-----------------------------------|------------------------------|----------------------|-------------------------------|

| | | |
|-------------------------|--------------------|--|
| File number: 8087127 | Report issue: 2 | |
|-------------------------|--------------------|--|

| | |
|--------------------------|--|
| Report of visit to: | Hoefnagel & Meijn BV Uiterdijk 4 1505 GW ZAANDAM |
| Applicant: | NIKHEF Instituut Postbus 41882 1009 DB AMSTERDAM |
| Project (if applicable): | |
| Applicant reference: | mail 14-07-2010 CO2 accumulator |
| Applicant order number: | 43090 |

| | | | |
|--|--|---------------|--|
| directive 97/23/EC (PED) specific data: | Conformity assessment procedure: Module G | | |
| Type of pressure equipment (art. 3): Vessel | Serial(fabr.) number(s): AA 0766 | | |
| Description / Type: CO2 accumulator | Year of fabrication: 2010 | | |
| Certificate / Document: | Number: | Issue: | |
| Revised drawing(s) number(s): | Rev. | Recalculate ? | |

| | | | |
|---|-------------------|------|----------|
| Nature and extent of visit: | Document number: | Rev. | Result * |
| All specific comments on the certificate / document are fulfilled | | | |
| Material certificate(s): | C-10.345-01 | 0 | B |
| Welding documentation: | | | |
| Welders Performance Qualification(WPQ): | W-10.345-01 | 0 | B |
| Welding Procedure Qualification Record(WPQR): | W-10.345-01 | 0 | B |
| Post weld heat treatment(PWHT): | | | NA |
| Non destructive testing(NDT): | X-10.345-01 | 0 | B |
| Manufacturers: | | | |
| Test & inspection plan(T&IP): | P-10.345-01 | 0 | B |
| Instructions for use: | MAN 10.345-01 | 0 | B |
| Declaration of conformity: | D-10.345-01 | 0 | B |
| Nameplate & markings: | N-10.345-01 | 0 | B |
| Visual examination: | | | |
| Internal1: | | | B |
| Internal2: | | | |
| External: | | | B |
| Hydrostatic testing witnessed: | PL10.345-01/02/03 | 0 | B |
| Calibration record(s): | 1007-01454 | 0 | B |
| Other: | | | |

All referenced documents and reports shall bear a unique reference to the (Lloyd's Register) file number.

Remarks / Comments overleaf





Visit Report

| | | | |
|-----------------------------------|------------------------------|----------------------|-------------------------------|
| Visit report number: 8087127/2 | Date of visit: 28-10-2010 | Office: ROTTERDAM | Control number: RET0235848 |
|-----------------------------------|------------------------------|----------------------|-------------------------------|

Remarks / Comments:

All activities finished, certificate can be issued:

Yes

| | | |
|---|--|--|
| Name in BLOCK CAPITALS HUPPEN, N.J. Surveyor to Lloyd's Register Nederland B.V. A member of the Lloyd's Register Group | Signature  | <div>Lloyd's Register Nederland B.V. A member of the Lloyd's Register group</div> <div>Nico Huppen</div> <div><input checked="" type="checkbox"/> Witnessed <input checked="" type="checkbox"/> Reviewed <input checked="" type="checkbox"/> Examined</div> <div></div> |
| Distribution: original | Distribution: copies | |

* Inspection Status Key

| | |
|----|--|
| NA | Not Applicable |
| B | Examined and found in accordance with the specification. |
| BM | Examined and amended to be in accordance with the specification, with remarks as stated in the report. |
| BQ | Examined and not found in accordance with the specification; to be re-inspected by Lloyd's Register. |
| R | Rejected, Not acceptable. |

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Design Appraisal Document

Lloyd's Register Nederland B.V.
Plan Appraisal Department
Weena-Zuid 170, 3012 NC Rotterdam
Postal: P.O. Box 701, 3000 AS Rotterdam
Telephone: +31(0)10 2014200
Telefax: +31(0)10 4117580

Date
23/08/2010

Quote this reference on all future communications
235848-8087127

Name : Applicant
Address : NIKHEF Instituut
Place : Science Park 105
Country : 1098 XG AMSTERDAM
: NEDERLAND

Subcontractor
Hoefnagel & Meijn BV
Uiterdijk 4
1505 GW ZAANDAM
NEDERLAND

Client Order no. : 43090
Type of pressure equipment : Vessel
Manufacturing no : AA 0766
Project : R&D CO2 Cooling
Subject : CO2 Accumulator
Item : F-260

The pressure equipment has been examined for compliance with the design requirements of the Pressure Equipment Directive 97/23/EC based on the chosen conformity module:

Module G: Unit Verification

using the following Code(s) and /or Standard(s):

CODAP Edition 2000.

- Based on the result of the risk analysis submitted by the applicant the following applicable load cases have been appraised:

| Load cases: | Applicable | Not applicable | Appraised |
|--|------------|----------------|-----------|
| Internal pressure | X | | Yes |
| External pressure | X | | Yes |
| Temperature | X | | Yes |
| External nozzle loads | | X | No |
| Mechanical loads acting on attachments | | X | No |
| Piping flexibility | | X | No |
| Fatigue (cyclic service) | | X | No |
| Loads due to wind | | X | No |
| Wind induced vibration | | X | No |
| Loads due to earthquake | | X | No |

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2. Design Data

| | | | |
|---------------------------------------|-----------------|--|--|
| Chamber | vessel | | |
| Max./min. allowable Pressure PS [bar] | 110 / 6 | | |
| Max./min. allowable Temperature [°C] | 35 / -50 | | |
| Test pressure [bar] | 157.3 | | |
| Capacity (vessels) [L] | 27,26 | | |
| DN (piping) [mm] | - | | |
| Heated surface [m ²] | - | | |
| Fluid | CO ₂ | | |
| Corrosion allowance [mm] | 0 | | |
| No. of cycles (fatigue) | - | | |
| Lifetime (creep) | - | | |
| Additional Design Data | - | | |

3. PED Data

| | | | |
|---|--------|--|--|
| Chamber | vessel | | |
| Fluid classification (group) according to PED, article 9 | 2 | | |
| Applicable table acc. PED, article.3 par.1 / PED, appendix II | 2 | | |
| Category PED, appendix II | III | (category of the vessel is the highest category of any chamber, article 9.3 PED) | |

4. List of plans, drawings and documents

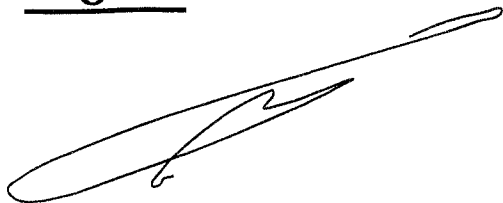
| Plan no. / Line no. | Title | Rev. | Appraisal Status |
|---------------------|------------------------------|------|------------------|
| 40030-ME-00074 | Welding assembly accumulator | A.2 | BM |
| 40030-ME-00016 | Sphere bottom | A.3 | B |
| 40030-ME-00081 | 6LV_16_VCR_3_16TB7 | A.0 | B |
| 40030-ME-00078 | Pipe, accumulator body | A.2 | B |
| 40030-ME-00040 | Welding connection 4 | A.0 | B |
| 40030-ME-00079 | Cooling spiral | A.1 | B |
| 40030-ME-00039 | Accumulator top | A.3 | B |
| 40030-ME-00081_2 | VCR Nut 1" Female | A.0 | RI |

| Calculation / Stress Report no. | Title | Date | Rev. |
|---------------------------------|--|------------|------|
| 40030-ME-00041 | Safety Analysis CO ₂ Accumulator CERN | 21/05/2010 | A.0 |

| Document no. | Title | Date | Rev. |
|--------------|-------------------------------|------------|------|
| AA0766 | Result of the Hazard Analysis | 02/08/2010 | 0 |

5. Specific comments

- 5.1. Operating procedures and personnel for permanent joining of components must be approved by a competent third party, acc. the PED, Appendix I, par. 3.1.2.
- 5.2. Personnel for non-destructive testing of permanent joints must be approved by a recognized third party organization, acc. to the PED, Appendix I, par. 3.1.3.
- 5.3. According the requirements of the PED the hydrotest pressure is given by the formula $1.43 \times P = 157.3$ barg.
- 5.4. Valves and other appurtenances shall be delivered CE-marked, and are no part of the design appraisal.
- 5.5. It is concluded that the materials used in the design are in accordance with the harmonised material standards.



Louis Boone
Senior Surveyor
Lloyd's Register Nederland BV

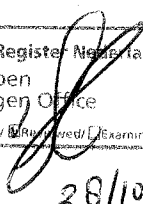
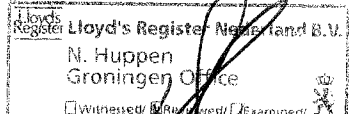
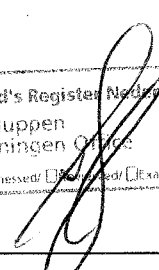
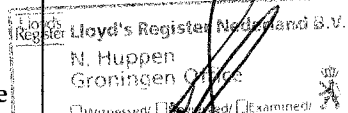
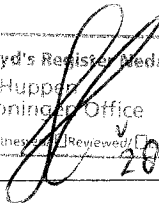
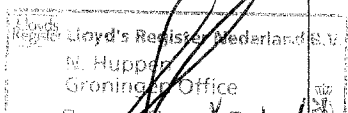
Appraisal Status Key

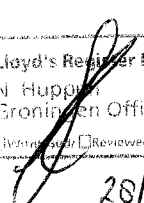
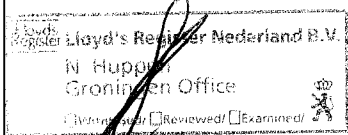
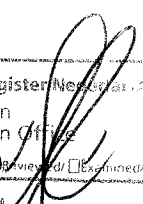

| | |
|----|---|
| B | Examined and found in accordance with Pressure Equipment Directive 97/23/EC |
| BM | Examined and amended to be in accordance with Pressure Equipment Directive 97/23/EC, i.e. with conditions as marked or qualified on the design document |
| BQ | Examined subject to matters identified within the Design Appraisal Document which require resolution; these matters shall be re-appraised by Plan Appraisal, Rotterdam Office |
| R | Rejected, Not acceptable |
| RI | Used for information only |


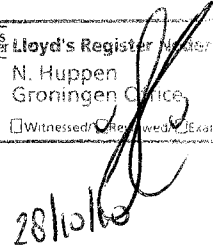


| | |
|--|---|
| <input type="checkbox"/> PED Module B (<i>EC-Type examination</i>) The sample to be examined shall be subject to the following inspections by a Lloyd's Register surveyor. | <p><u>PED module B:</u> to be signed of in this document.</p> <p><u>Modules F and G:</u> To be signed of in this document or in the test & inspection plan, where the requirements as mentioned in this document shall be incorporated.</p> |
| <input type="checkbox"/> PED Module (B1+) F (<i>Product verification</i>) The following aspects must be part of the test & inspection plan of the manufacturer and will be checked during the fabrication and final inspection. Registration number of the design examination (Mod. B1) is: 900.... | |
| <input checked="" type="checkbox"/> PED Module G (<i>EC Unit verification</i>) The following aspects must be part of the test & inspection plan of the manufacturer and will be checked during the fabrication and final inspection. | |

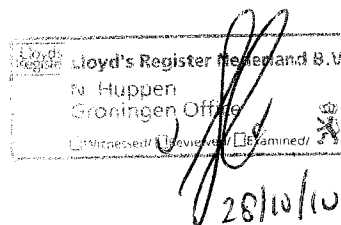
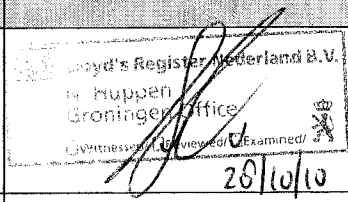
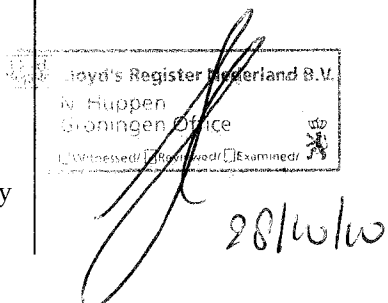
| | |
|----------------|----------|
| Drawing number | Revision |
| 40030-ME-00074 | A2 |

| Description | Date; Signature; Stamp |
|--|---|
| <p align="center">CONSTRUCTION CATEGORY: B WELDED JOINT COEFFICIENT, Z= 0,7 NOMINAL DESIGN STRESS: f3 TYPE OF ACCEPTANCE: r1</p> | |
| <p>I.7.1 Welding procedure approval</p> <p>The welding procedures shall be qualified in accordance with the EN ISO 15614-1 (former EN 288-3).</p> <p>Check of the required welding procedure qualifications of all welds in- and on pressure retaining parts. The applied welding method of each weld has to be indicated.</p> <p>All welding procedure qualifications have to be made and tested with proper involvement of a NoBo or a recognized Third Party Organization.</p> |   <p align="right">28/10/2010</p> |
| <p align="center">A summary list and documents to be included in the fabrication file.</p> | |
| <p>I.7.2 Welder approval</p> <p>The approval operations shall be performed in accordance with the EN 287-1: 2004.</p> <p>Welders' competence must be confirmed for every welder.</p> <p>All welders and welding operators performance qualifications have to be made and tested with proper involvement of a NoBo or a recognized Third Party Organization.</p> |   <p align="right">28/10/2010</p> |
| <p align="center">A summary list and documents to be included in the fabrication file.</p> | |
| <p>I.17 Visual examination of the vessel</p> <p>Internal/external visual inspection – if necessary during fabrication – of:</p> <ul style="list-style-type: none"> entire apparatus including weldconnected parts <p>The examination must be carried out before the pressure test.</p> |   <p align="right">28/10/2010</p> |

| Description | Date; Signature; Stamp |
|--|--|
| I.10.4.2.1 Visual inspection of welds <ul style="list-style-type: none"> all welds must be visually examined. I.10 Non-destructive testing (see Table I.10.4.3.1) <p>Radiographic examination (RT) of the main welds (circumferential butt welds, Annex FA1 type of welds: 1, 2 and 3):</p> <ul style="list-style-type: none"> partial examination (10%) |   28/10/10 |
| Time of examination (see I.10.4.4) : Examination to be performed: <ul style="list-style-type: none"> before the pressure test | |
| NDT reports and certificate to be included in the fabrication file. | |
| An endorsed sketch-outline of the NDT as carried out on the apparatus must be included in the fabrication file. | |
| | |
| I.17.2 and F1.5.4/5 Out of roundness measurements <p>For <u>internal</u> as well as <u>external</u> pressure (see F1.5.4). Ovality, difference between the largest and the smallest diameter at the cross section under consideration. The following requirements apply: Shell: for $e/D \leq 0,01$ maximum allowable ovality: $0,02 \times D$ mm. For sections that include an opening, above value may be increased by a value equal to 2% of the inside diameter of that opening.</p> <p>For <u>internal</u> pressure, see F1.5.5.1. The following requirements apply: Shell: maximum allowable deviation f: 6 mm, the length of the template chord C: $D/6$ mm.</p> <p>Measurement reports to be included in the fabrication file.</p> |   28/10/10 |
| | |
| Part M/Material certificates <p>Type of acceptance: r1.</p> | |

| Description | Date; Signature; Stamp |
|---|---|
| <p>Info:</p> <ul style="list-style-type: none"> - r1-type acceptance: the product shall be subjected to specific testing and supplied with an inspection certificate 3.1 acc. EN 10204. The tests and testing specified in the product standard/specification are supplemented with particular requirements (tests and testing generally optional in the standard); - r2-type acceptance: the product shall be subjected to specific testing and supplied with an inspection certificate 3.1 acc. EN 10204. No tests or testing other than those normally provided for in the relevant standard/specification are required; - r3-type acceptance: the product does not need to be subjected to a specific testing and shall be supplied with a certificate of compliance 2.1 or with a test report 2.2 according to EN 10204. <p>Certificates in accordance with EN 10204: 1991 / 2004 must be submitted for the parts as mentioned on the drawing.</p> <p>The level of the certificates is:</p> <p><i>For the main pressure bearing parts of pressure equipment in category II, III and IV, the level of the certificates is:</i></p> <ul style="list-style-type: none"> • For basic product forms ¹⁾ : 3.1B ²⁾, 3.1C / 3.2 according EN 10204: 1991 : 3.1 ²⁾ / 3.2 according EN 10204: 2004 • For components ³⁾: <ol style="list-style-type: none"> a) Material certificate of the basic product form (see above); b) Documentation of the component ⁴⁾ (if applicable): <ul style="list-style-type: none"> - Welding Procedure Qualification Records - Welders Qualifications - NDT personnel qualifications - NDT reports - Destructive examination reports - Forming- / heat treatment-, etc. reports <p><i>For the main pressure bearing parts of pressure equipment in category I, pressure parts other than main pressure bearing parts in categories I, II, III and IV and attachments to pressure bearing parts in categories II, III and IV, the level of the certificates is:</i></p> <p>Test report Type 2.2</p> <p><i>For all other parts, the level of the certificates is:</i></p> <p>Certificate of compliance Type 2.1</p> | <div data-bbox="1063 1160 1420 1288">  <p>Lloyd's Register N. Huppen Groningen Office <input type="checkbox"/> Witnessed <input type="checkbox"/> Reviewed <input checked="" type="checkbox"/> Examined</p> </div> <p>28/10/06</p>  |



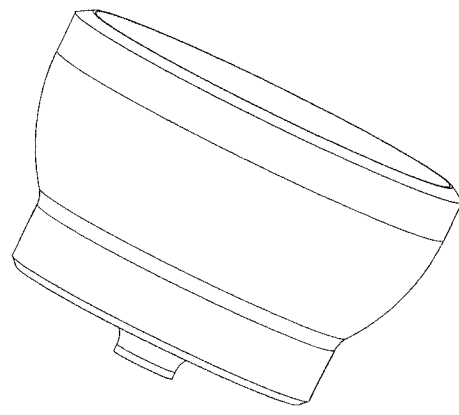
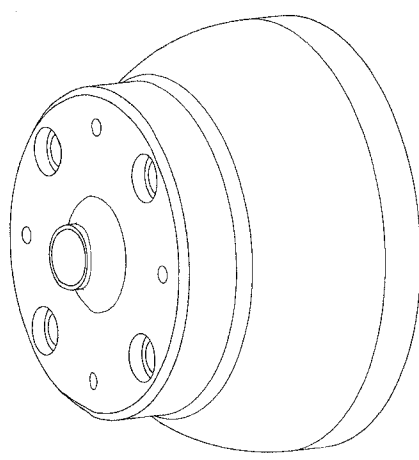
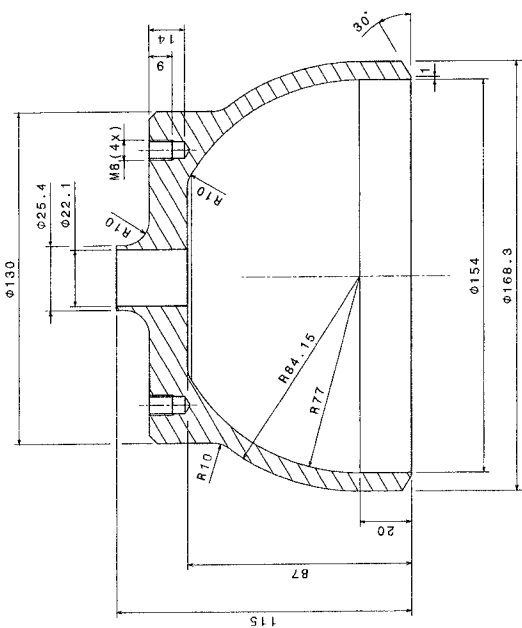
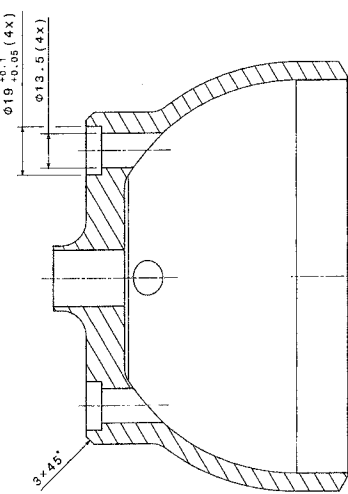
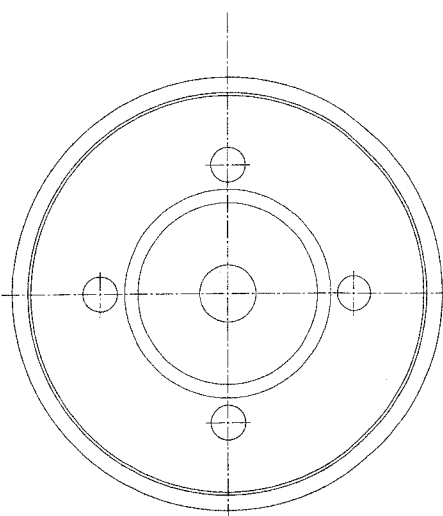
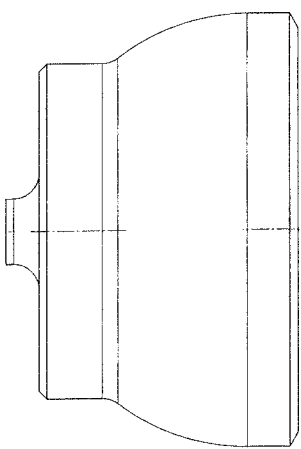
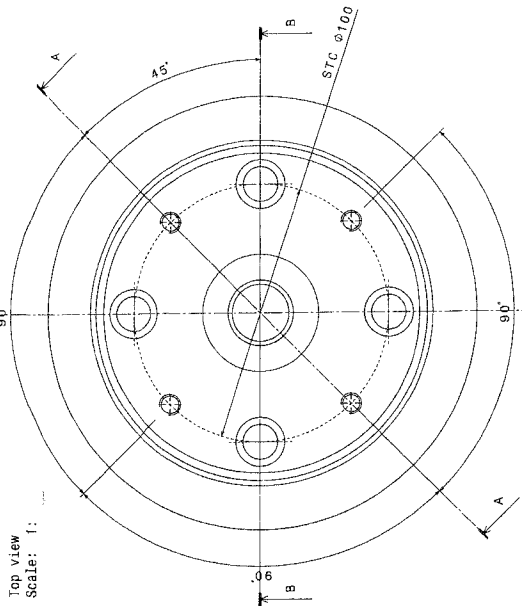
| Description | Date; Signature; Stamp |
|---|---|
| <p>Notes:</p> <p>1) e.g. plate, coil, bar, forging, seamless tube, welded pipe from coil with an automatic welding process, casting</p> <p>2) 3.1B according EN 10204: 1991 / 3.1 according EN 10204: 2004 indicates the issue of a certificate 3.1B according EN 10204: 1991 / 3.1 according EN 10204: 2004 by a manufacturer having an ISO 9001:2000 quality system, certified by a competent body within the European Economical Area and having undergone a specific assessment for the applied materials</p> <p>3) fabricated from basic product forms, e.g. welded pipe from plate, welded fitting, (welded) caps, flanges from plate</p> <p>4) The mentioned information may be included in a 3.1B, 3.1C or 3.2 certificate according EN 10204: 1991 / 3.1 or 3.2 certificate according EN 10204: 2004 in which the information is covered by a statement on the certificate, without the need to supply the underlying documentation, however the information shall be accessible in case further investigation is required</p> | |
| <p>A summary of the materials used-quality-numbers-manufacturer-part identification must be included in the fabrication file.</p> | |
| <p>I.13 Strength Test</p> <p>Once the required assessment and inspection have been completed successfully, the apparatus shall be subject to a pressure test. The standard test shall be hydrostatic pressure testing (water) at the test pressure as mentioned below.</p> <ul style="list-style-type: none"> The test pressure is 157.3 bar. <p>A test report and an inspection and strength test certificate shall be included in the fabrication file.</p> |  |
| <p>I.16 Marking or labelling</p> <ul style="list-style-type: none"> The manufacturer's nameplate shall be permanently attached in accordance with I.16 and shall include all the information as specified therein. |  |
| <p>A copy of the name plate shall be included in the fabrication file</p> | |
| <p>I.17 Final examination of the vessel</p> <p>The following requirements are applicable. A final-examination certificate shall be included in the fabrication file.</p> <ul style="list-style-type: none"> The equipment shall be examined for conformance with the approved construction drawings. The marking on the equipment, on the manufacturer's nameplate shall correspond to the documents included in the vessel file. General examination of the finishing. Possible damage and any necessary repairs shall be noted. |  |



| Description | Date; Signature; Stamp |
|---|------------------------|
| <ul style="list-style-type: none"> Once the inspection has been successfully completed, the nameplate itself, at least one of the rivets or nameplate attachment-weld and the nameplate-holder attachment-weld shall be endorsed (hard stamped) with the official approval mark of the Authorised Inspection Body. | |
| | |

End of this document





Floyd, Registered Medical & Health Care
 Practitioner License
 Plan Approval, Production Office

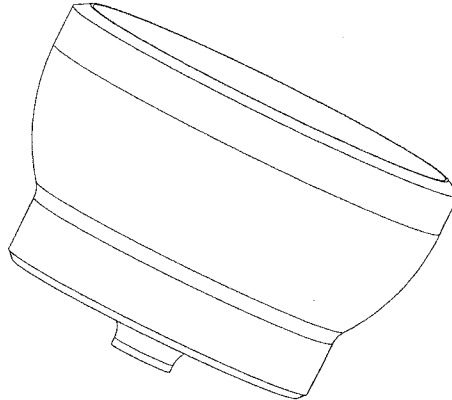
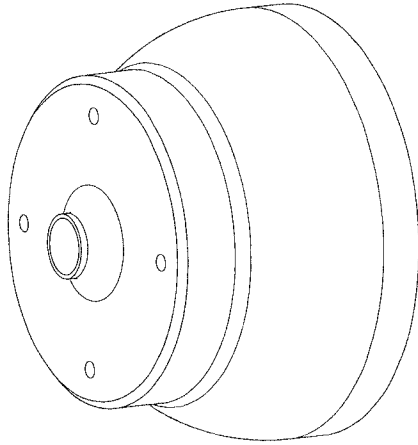
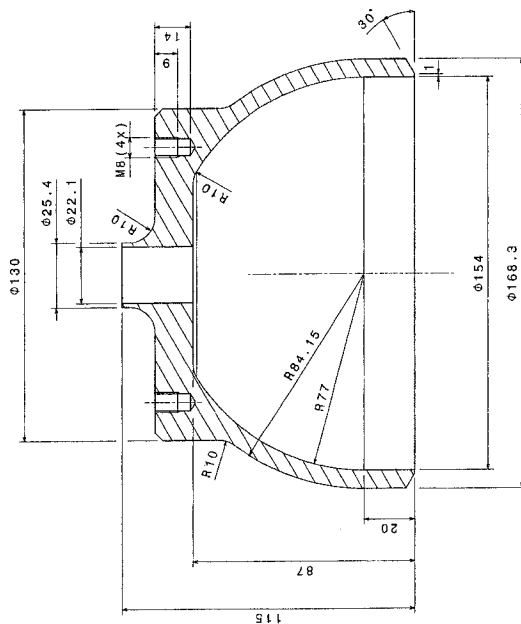
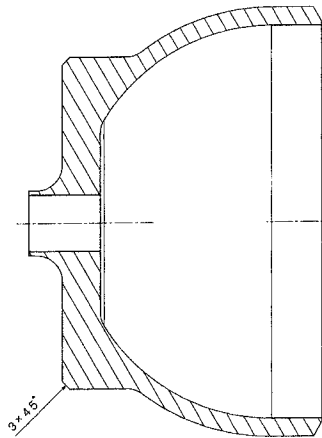
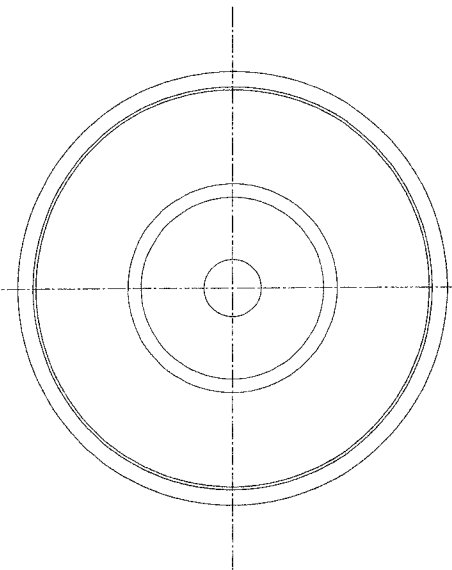
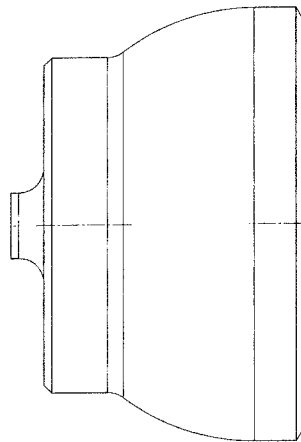
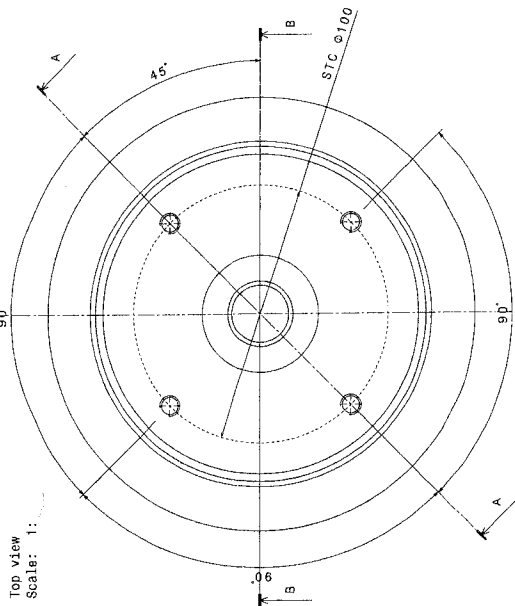
EXAMINED

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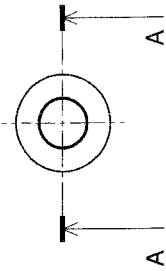
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Date: 23.08.2010 Initials: **WB**

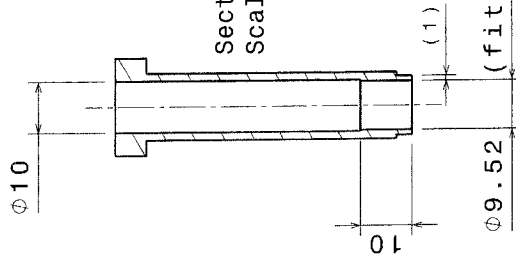
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 accordance with the provisions of the Act and it is therefore valid without any signature.



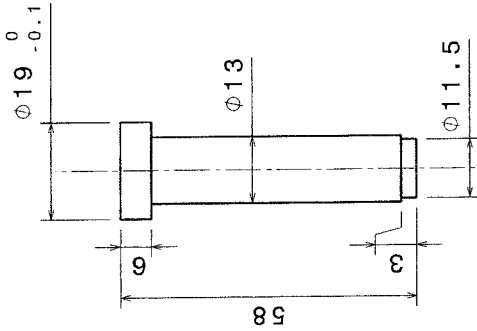
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|--|--|
| Lloyd's Register Numbered RV: <i>a number of the Lloyd's Register group</i> | Lloyd's Register Numbered Register |
| Lloyd's Register Numbered RV: <i>a number of the Lloyd's Register group</i> | Lloyd's Register Numbered Register |



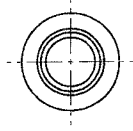
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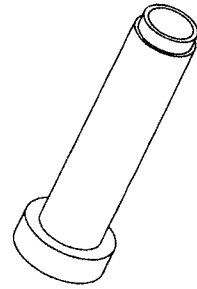
Section view A-A
Scale: 1:1



Front view
Scale: 1:1



Bottom view
Scale: 1:1



Isometric view
Scale: 1:1

Lloyd's Register Nederland B.V.
A member of the Lloyd's Register group

Plan Approved, Rotterdam Office

EXAMINED

This plan has been examined and given the status as shown in the Design Appraisal Document (DAD) number below

DAD Number:

8087127

Date:

23.08.2010

Initials:

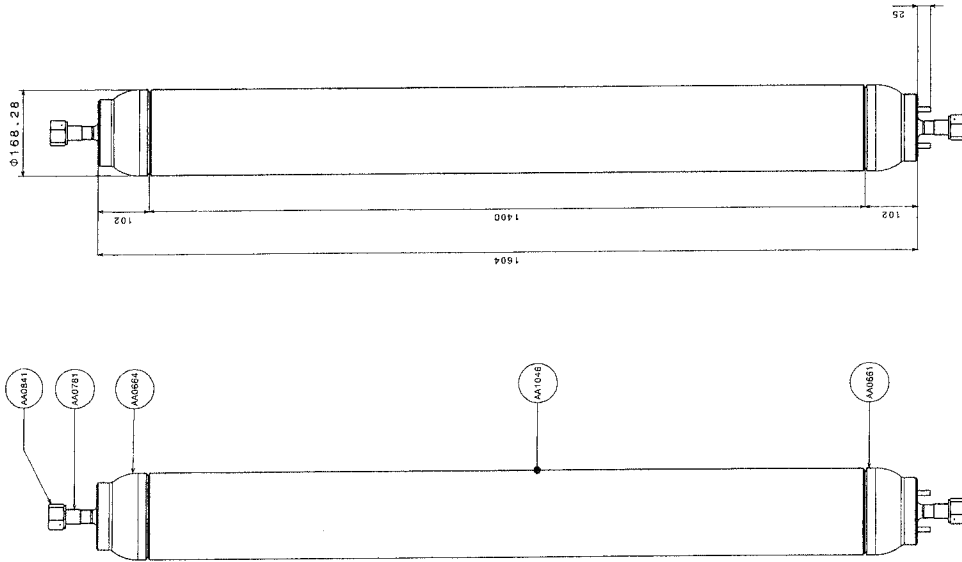
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Lloyd's Register

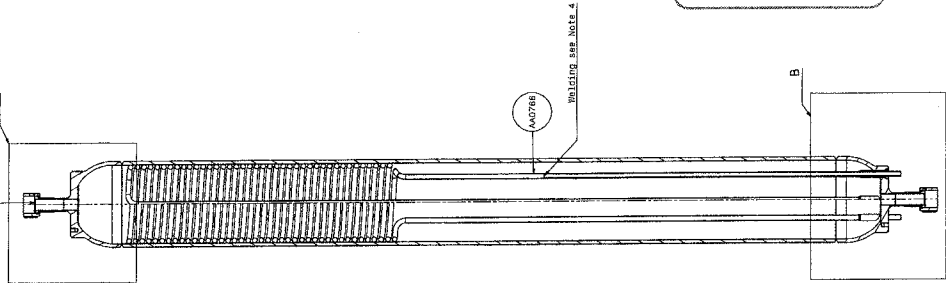
This document has been processed electronically and it is therefore valid without any signature.

| | | |
|--|---------------------|-------------------------------|
| General tolerances unless otherwise stated according to : ISO-2768-mK-E Geometrical tolerances unless otherwise stated according to : ISO-8015-E Surface tolerances unless otherwise stated according to : ISO-15002 | Material: AISI 316L | Revision: A.0 |
| Project: R&D CO2 Cooling | Date: 10/05/2010 | Engineer: A. de Snaijer |
| Top folder: Accumulator, CO2 | Units: mm | Size: A3 |
| Name: | Checked: | Status: In Work |
| Welding connection 4 | Item number: AA0769 | Nikhef number: 40030-ME-00040 |
| National Institute for Subatomic Physics Science Park 105, 1098XG Amsterdam | | |
| This drawing may not be used for commercial purposes without written authorisation. | | |

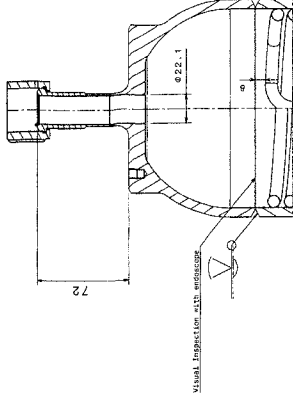
Maximum Allowable PS 110 bar



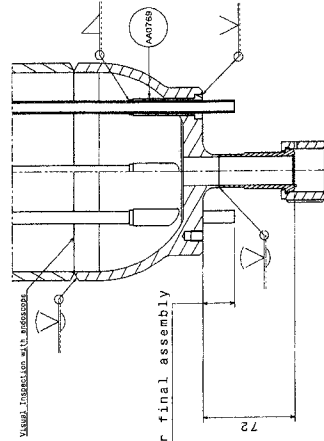
Front view
Scale: 1:5



Section view D-D
Scale: 1:5



Detail C
Scale: 1:2



Detail B
Scale: 1:2

25 Length needed for final assembly

Welding Assembly
Accumulator

EXAMINED

This plan has been examined and shown the details as shown in the design. Applicable document (GAD) number below.

Date: 23.08.2016 Initial: WS

8087127

Loops Register

This document has been processed electronically and it is for the sole use of the client and its representatives.

Bill of Material: AA0766

| Quantity | Part Number | Definition | Material | Revision |
|----------|-------------|------------------------|-----------|----------|
| 1 | AA0664 | Accumulator top | AISI 316L | A.3 |
| 1 | AA1046 | Pipe, Accumulator Body | AISI 316L | A.2 |
| 1 | AA0768 | Cooling Spiral | AISI 316L | A.2 |
| 4 | AA0789 | Welding connection | AISI 316L | A.0 |
| 2 | AA0781 | SLV 16 VCR 3 16TR7 | AISI 316L | A.0 |
| 1 | AA0661 | Sphere bottom | AISI 316L | A.3 |
| 2 | AA1044 | VCR Nut 1" | AISI 316L | A.0 |

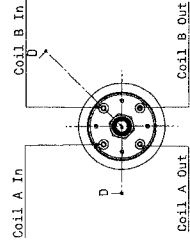
Welding Assembly
Accumulator

AA0766

In Work

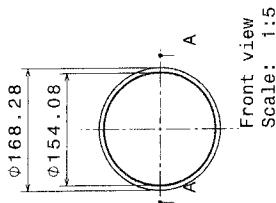
40030-ME-00074

- Notes:
- 1) Design / Production Parameters According: CODAP
 - 2) Pressure Test At 149 bar
 - 3) All Material (AISI 316L) With Certificate EN 10204/3.1.B
 - 4) Tubing of Coil A In/out and Coil B In/out Are orbital welded

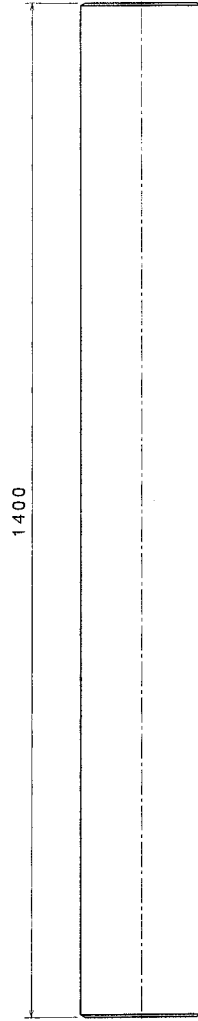


Auxiliary view A
Scale: 1:5

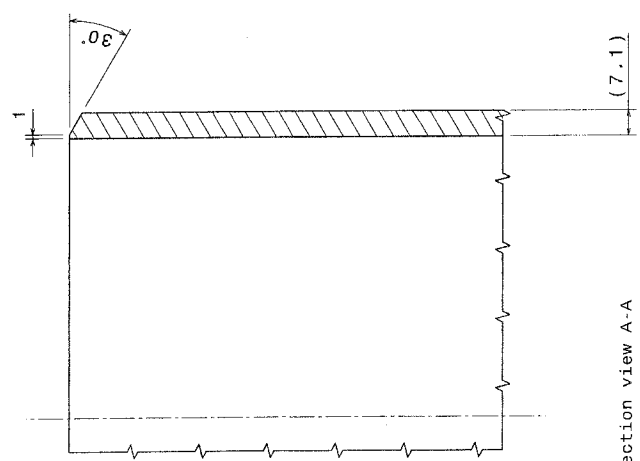
Volume Coil = 1,46 l
Volume Vessel = 28,72 l
Netto Volume Vessel = 27,26 l



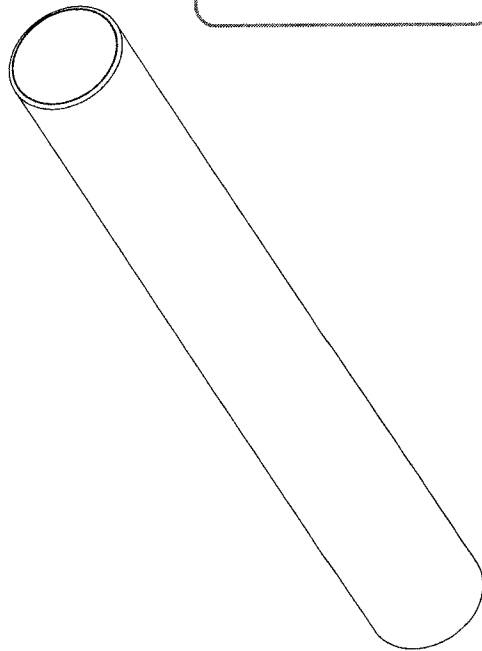
Front view
Scale: 1:5



Front view
Scale: 1:5



Section view A-A
Scale: 1:1



Isometric view
Scale: 1:5

Lloyd's Register Nederland B.V.
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Plan Appraisal, Rotterdam Office

EXAMINED

This plan has been examined and given the status as shown in the Design Appraisal Document (DAD) number below

DAD Number:
8087127

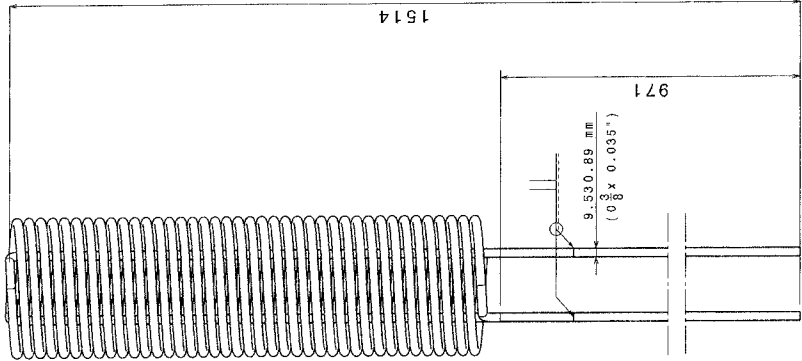
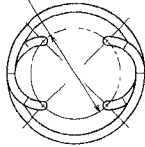
Date: 23.08.2010 Initials: **WB**

Lloyd's Register

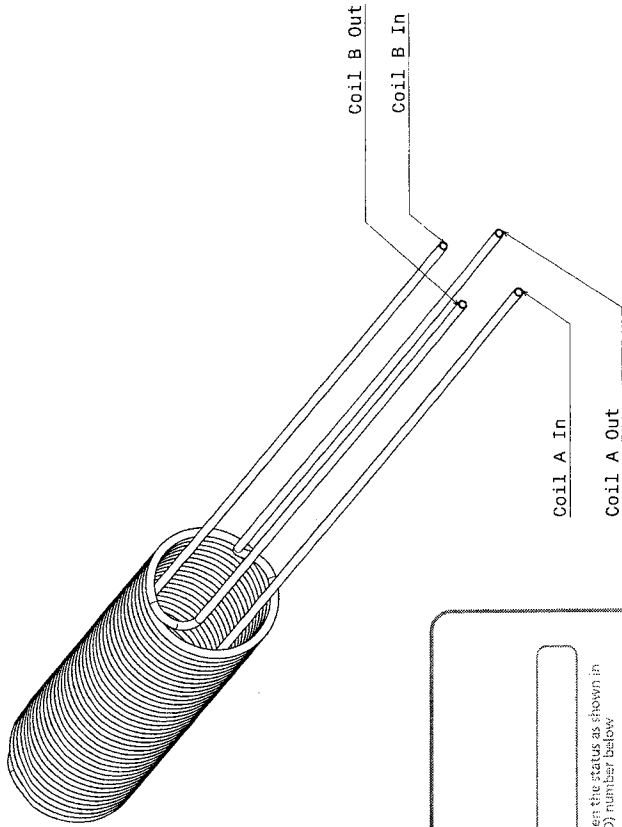
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| | | | |
|---|------------------|-------------------------------|-----------------|
| General information unless otherwise stated according to ISO 9001 and ISO 14001 standards unless otherwise stated according to ISO 9001 and ISO 14001 standards | | Material: AISI 316L | |
| Project: R&D CO2 Cooling | Date: 06/09/2010 | Revisie: A.2 | |
| Top folder: Accumulator, C02 | Size: A2 | Signer: A. de Smit | |
| Name: | | Checked: | |
| Pipe, Accumulator Body | | Item number: AA0766 | Status: In Work |
| National Institute for Subatomic Physics | | Number number: 40030-ME-00078 | |
| This drawing may not be used for commercial purposes without written authorization. | | | |

Ø 100



1514



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Plan Appraisal Rotterdam Office

EXAMINED

This plan has been examined and given the status as shown in the Design Appraisal Document (DAD) number below

DAD Number:

8087127

Date:

23.05.2010

Initials:

WB

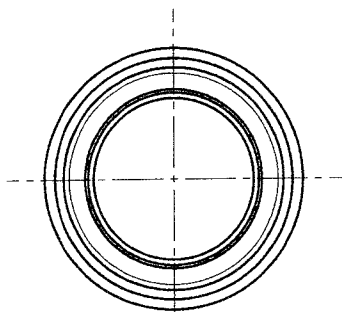
Lloyd's Register

This document has been processed electronically and it is therefore valid without any signature.

Note:

- 1) See For Manufacturing Jig Drawing No. TVK 36
- 2) Coil Tube Length 11 Meter

| | | |
|---|------------------------------|---|
| General tolerances unless otherwise stated according to ISO 2768-MS | | Material: AISI 316L |
| Surface finish: Ra 1.6 | Units: mm | Size: A2 |
| Thread: ISO 228-1 | Size: A2 | Engineer: G.J. Mul |
| Project: R&D C02 Cooling | Top folder: Accumulator, C02 | Checked: |
| Name: | | Item number: AA0768 |
| Cooling Spiral | | Status: In Work |
| National Institute for Subatomic Physics | | Witkief number: 40030-ME-00079 |
| NINEF | | THIS DRAWING MAY NOT BE USED FOR COMMERCIAL PURPOSES WITHOUT WRITTEN AUTHORIZATION. |



Front view
Scale: 1:1

Lloyd's Register Nederland B.V.
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Plan Appraisal, Rotterdam Office

EXAMINED

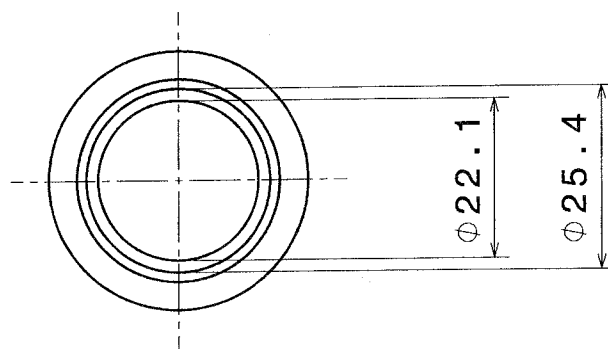
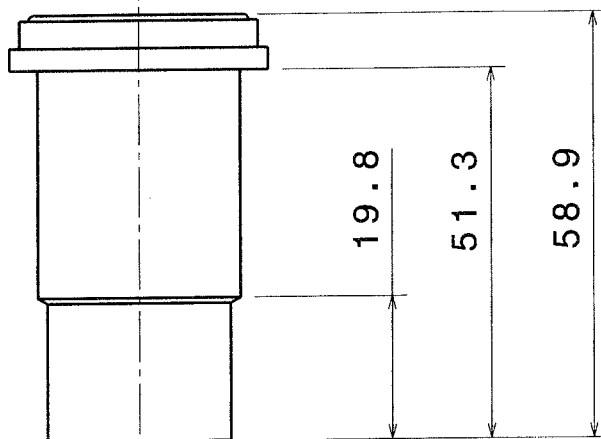
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DAD Number:
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Date: 23.08.2010 Initials: WB

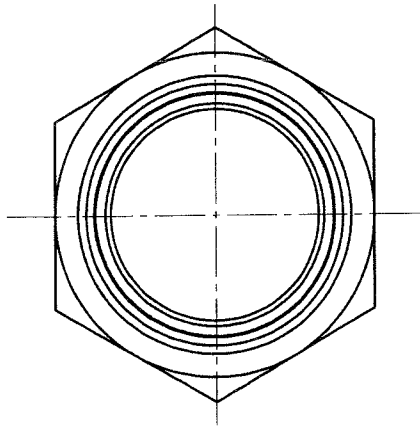
Lloyds Register

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Front view
Scale: 1:1

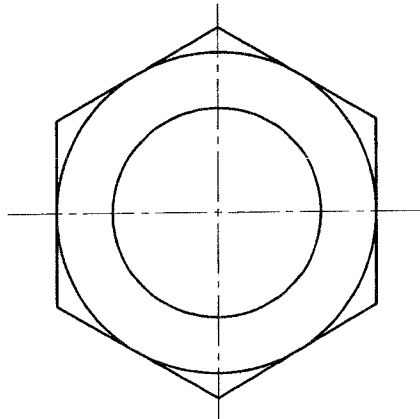
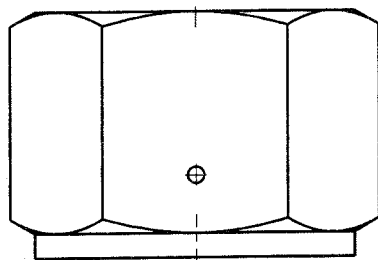
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|--|--|-----------|-------------------------|-------------------------------|-----------------|
| General tolerances unless otherwise stated according to :ISO-2768-mK-E Geometrical tolerances unless otherwise stated according to:ISO-8015-E Roughness unless otherwise stated according to :ISO-1302 | | | | Material: AISI 316L | |
| Project: R&D C02 Cooling | | Units: mm | Date: 06/08/2010 | Revision: A.0 | |
| Top folder: Accumulator, C02 | | Size: A4 | Engineer: A. de Snaijer | | |
| Name: | | Checked: | | | |
| 6LV_16_VCR_3_16TB7 | | | | Item number: AA0781 | Status: In Work |
| NIKHEF National Institute for Subatomic Physics Science Park 105, 1098XG Amsterdam | | | | Nikhef number: 40030-ME-00081 | |
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Register



General tolerances unless otherwise stated according to :ISO-2768-mK-E
Geometrical tolerances unless otherwise stated according to:ISO-8015-E
Roughness unless otherwise stated according to :ISO-1302



Material: AISI 316

Project: R&D CO2 Cooling

Units: mm

Date: 04/08/2010

Revision: A.0

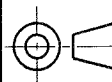
Top folder: Accumulator, co2

Size: A4

Engineer: A. de Snaijer

Name:

VCR Nut 1" Female



Checked:

Item number:
AA1044

Status:
In Work

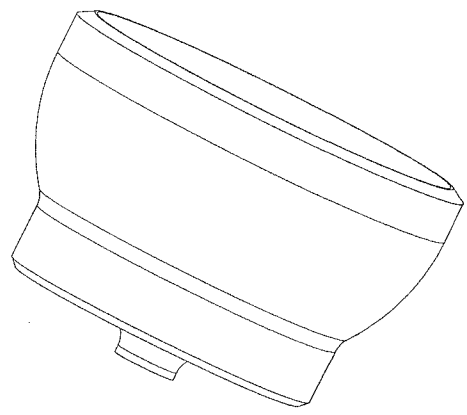
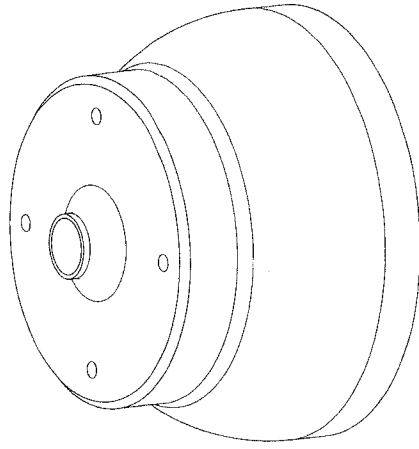
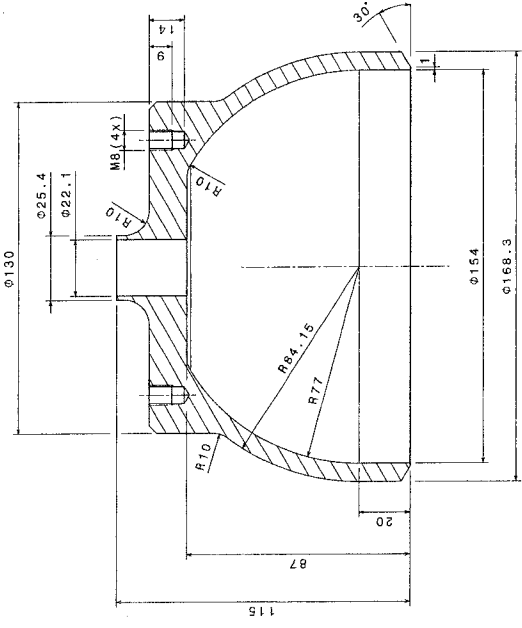
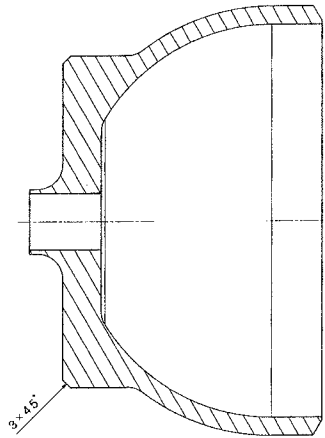
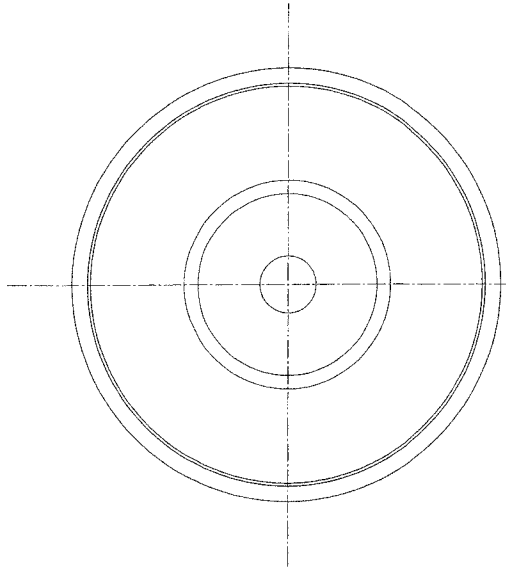
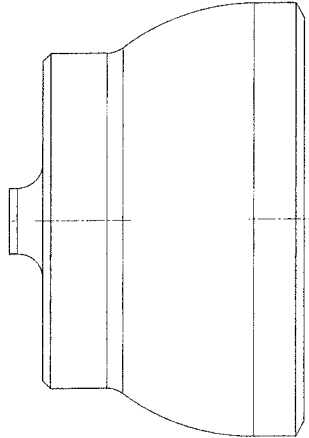
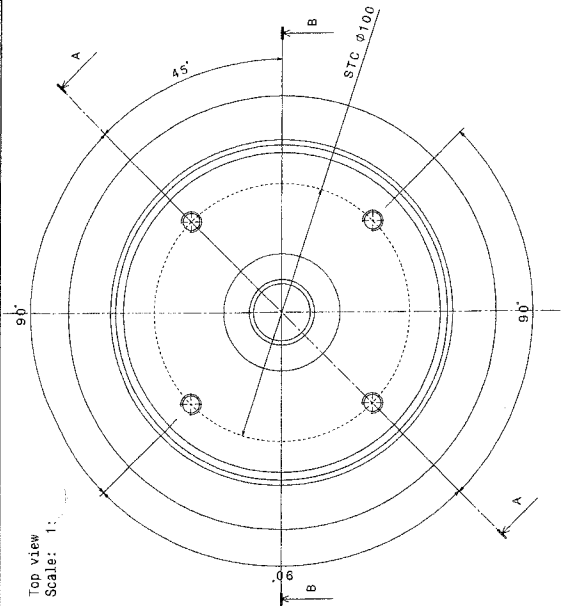



National Institute for
Subatomic Physics
Science Park 105, 1098XG Amsterdam

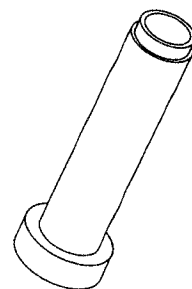
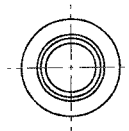
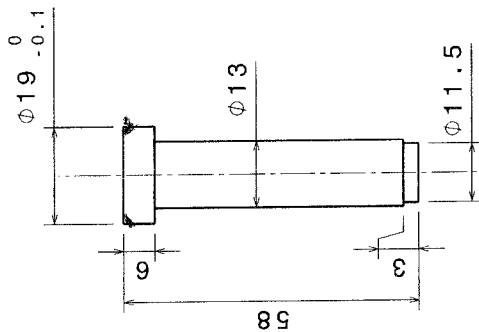
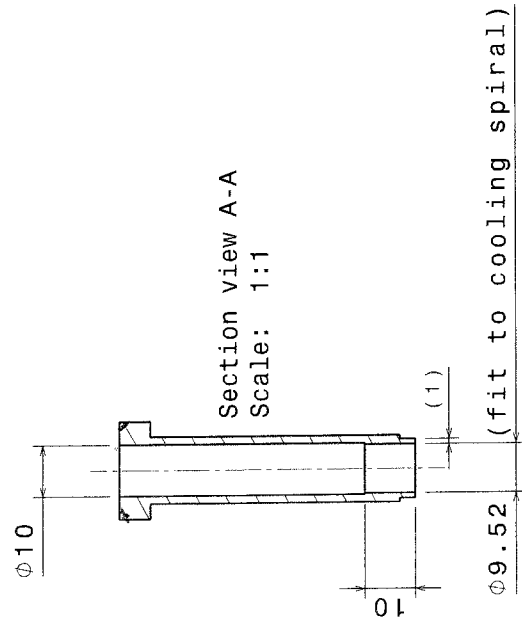
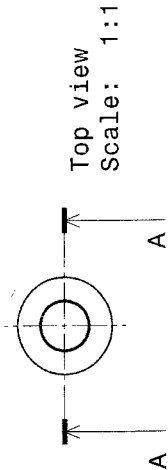


Nikhef number:
40030-ME-00081_2

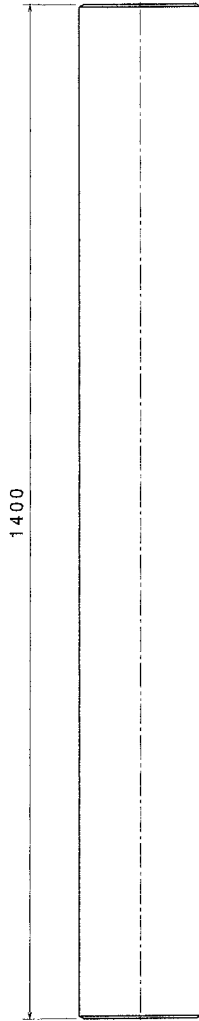
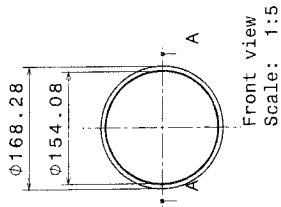
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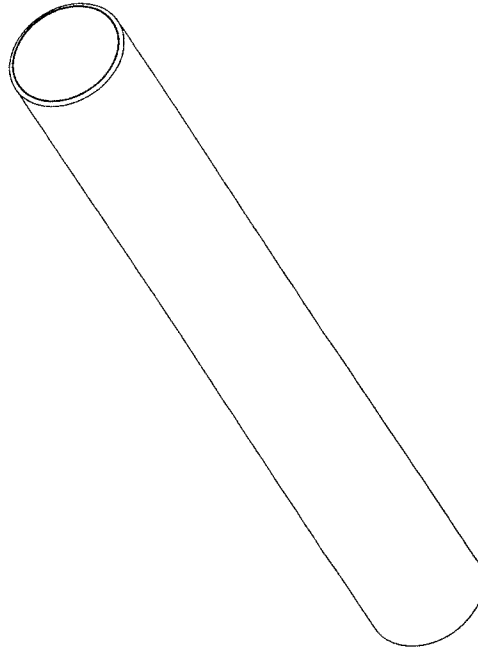
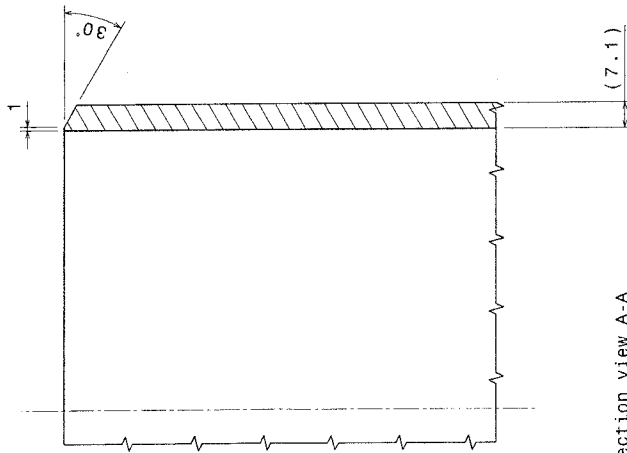
| | | | | | | | | | | | | | |
|--|--|---|--|-----------------|--|--|--|---|--|--|--|-----------|--|
|  NINDEF NATIONAL INSTITUTE FOR DEFENSE EDUCATION | | Project: IBM QCP COOLING IBM Folder-Accumulator, COE | | Accumulator top | | Name: _____ Title: _____ Date: _____ | | Drawing Number: 40030- ME. 00039 Rev: _____ Date: _____ | | Part: 04/02/02 Pos: A-3 Author: _____ Date: _____ Title: _____ | | AISC 313L | |
|--|--|---|--|-----------------|--|--|--|---|--|--|--|-----------|--|



| | | | | | |
|---|--|----------------------|-------------------------|---|---------------|
| General tolerances unless otherwise stated according to : ISO 2768-mK-E Geometrical tolerances unless otherwise stated according to : ISO 8015-E Surface finish unless otherwise stated according to : ISO 1302 | | Material: AISI 316L | Units: mm | Date: 10/05/2010 | Revision: A.0 |
| Project: R&D CO2 Cooling | | Size: A3 | Engineer: A. de Snaijer | Status: In Work | |
| Top folder: Accumulator, CO2 | | Item number: AA0769 | | Nikhef number: 40030-ME-00040 | |
| Name: | | Welding connection 4 | | This drawing may not be used for commercial purposes without written authorisation. | |
| National Institute for Subatomic Physics Science Park 105, 1098XG Amsterdam | | Nikhef | | | |

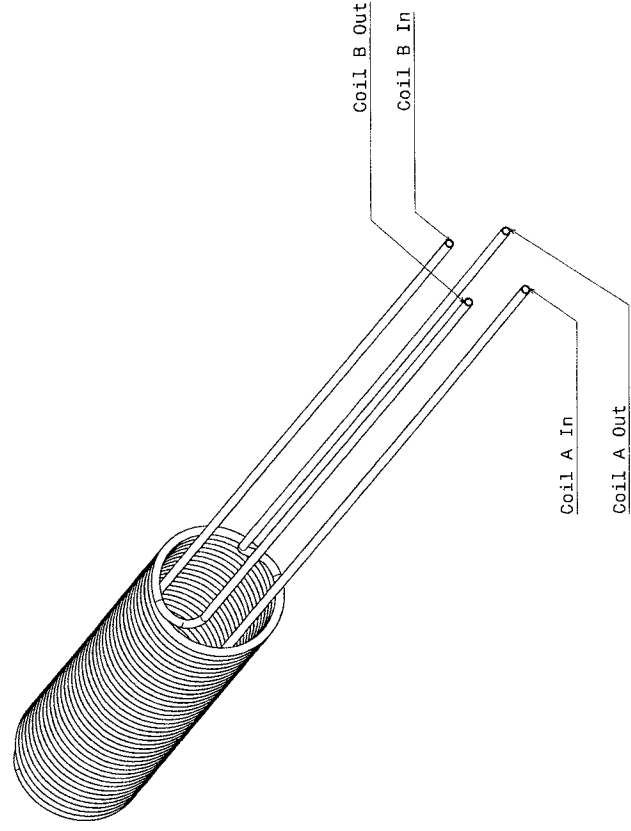
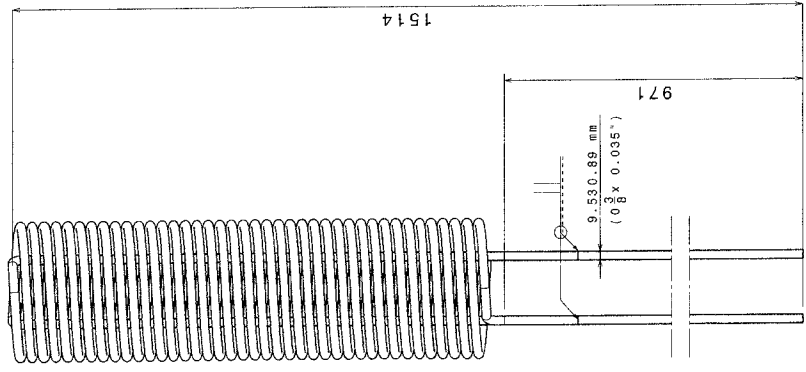
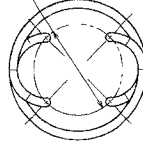


Front view
Scale: 1:5




| | | |
|--|-----------|------------------------------|
| General information and standards according to ISO 15926-2 Nomenclature and standards according to ISO 15926-1 Nomenclature standards according to ISO 15926-3 | | Material: AISI 316L |
| Project: R&D CO2 Cooling | Unit: ME | Date: 06/08/2010 |
| Top folder: Accumulator, CO2 | Sheet: A2 | Version: A.2 |
| Name: Pipe, Accumulator Body | | Engineer: A. de Stalier |
| Item number: AA0766 | | Status: In Work |
| Number: 40030-ME-00078 | | Other number: 40030-ME-00078 |

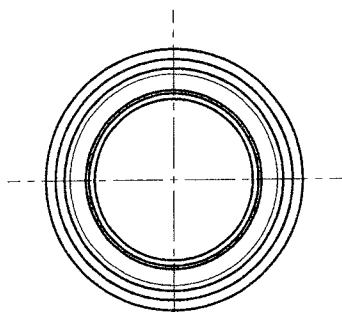
Φ100



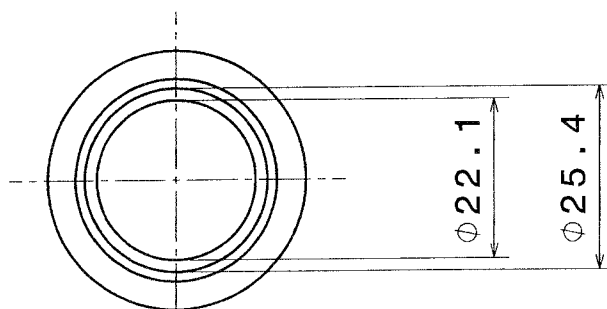
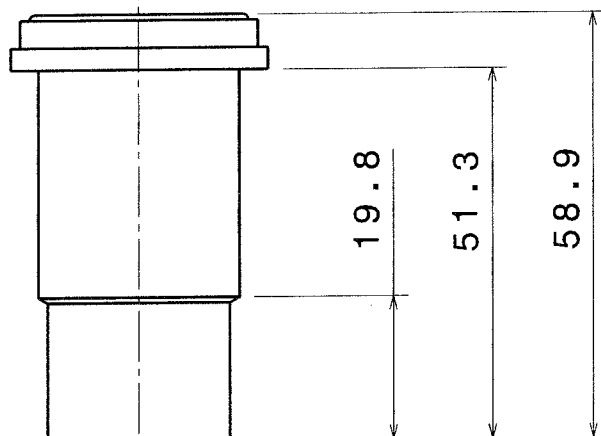
Note:

- 1) See For Manufacturing Jig Drawing No. TVK 36
- 2) Coil Tube Length 11 Meter

| | | | |
|--|--|--|---------------------|
|  | | National Institute for Subatomic Physics Nieuwehof 100, 3720 ZG, Utrecht, The Netherlands | |
| Name: Cooling Spiral | | Item number: AA0768 | Status: In Work |
| Project: R&D CO2 Cooling | | Size: A2 | Material: AISI 316L |
| Top folder: Accumulator, CO2 | | Engineer: G.J. MUL | Date: 06/08/2010 |
| General information unless otherwise stated according to ISO 2768-mS and dimensional tolerances unless otherwise stated according to ISO 8015-4 Surface finish unless otherwise stated according to ISO 1302 | | Drawing No. TVK 36 Drawing Date: 06/08/2010 Drawing Scale: 1:1 Drawing Title: Cooling Spiral Drawing Author: G.J. MUL Drawing Checker: G.J. MUL Drawing Project: R&D CO2 Cooling Drawing Top folder: Accumulator, CO2 Drawing Name: Cooling Spiral | |
| This drawing may not be used for commercial purposes without written authorization. | | | |

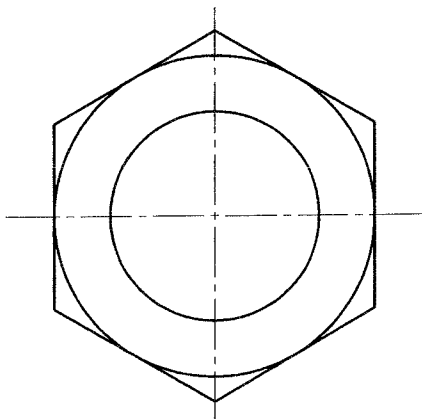
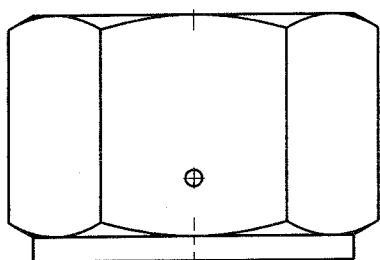
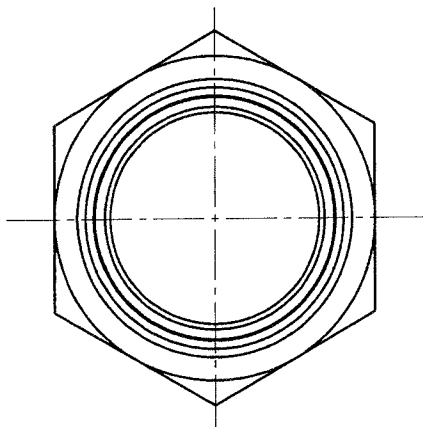


Front view
Scale: 1:1



Front view
Scale: 1:1

| | | | | |
|--|--|---|--|---------------|
| General tolerances unless otherwise stated according to :ISO-2768-mK-E Geometrical tolerances unless otherwise stated according to:ISO-8015-E Roughness unless otherwise stated according to :ISO-1302 | | | Material: AISI 316L | |
| Project: R&D C02 Cooling Top folder: Accumulator, C02 | | Units: mm Size: A4 | Date: 06/08/2010 Engineer: A. de Snaijer | Revision: A.0 |
| Name: 6LV_16_VCR_3_16TB7 | | | Checked: Item number: AA0781 Status: In Work | |
| National Institute for Subatomic Physics Science Park 105, 1098XG Amsterdam | | Nikhef number: 40030-ME-00081 | | |
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General tolerances unless otherwise stated according to :ISO-2768-mK-E
 Geometrical tolerances unless otherwise stated according to:ISO-8015-E
 Roughness unless otherwise stated according to :ISO-1302



Material: **AISI 316**

Project: R&D CO2 Cooling

Units: mm

Date: 04/08/2010

Revision: A.0

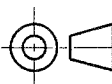
Top folder: Accumulator, co2

Size: A4

Engineer: A. de Snaijer

Name:

VCR Nut 1" Female



Checked:

Item number:
AA1044

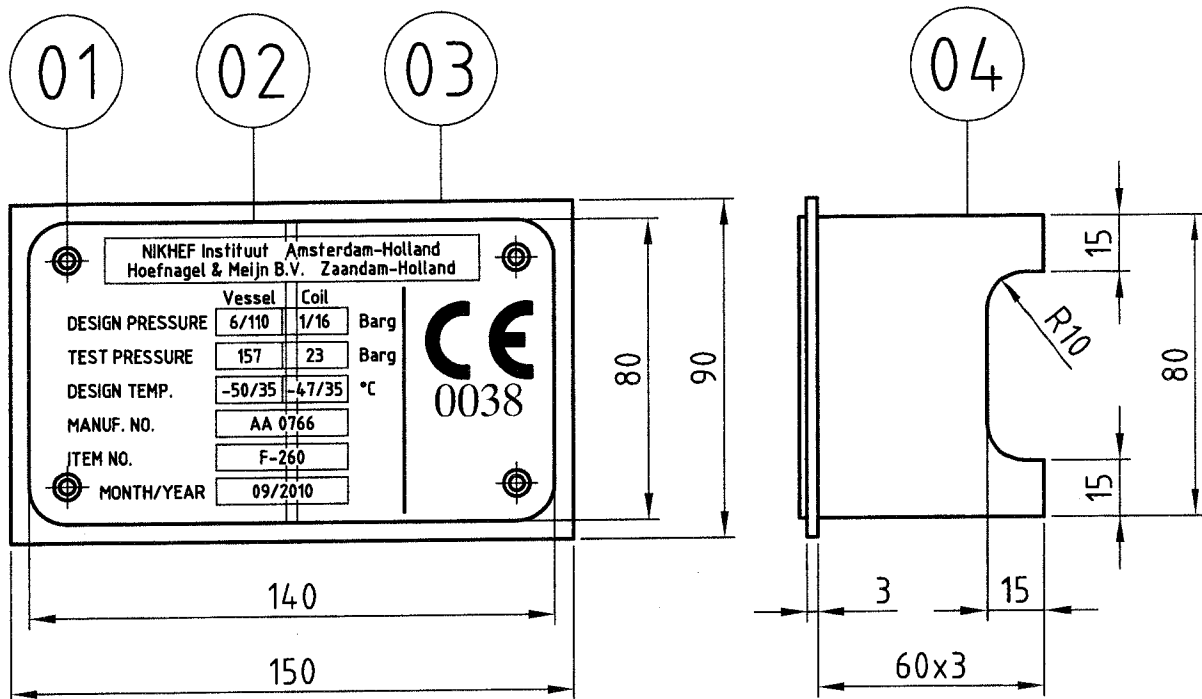
Status:
In Work



National Institute for
Subatomic Physics
Science Park 105, 1098XG Amsterdam



Nikhef number:
40030-ME-00081_2



| | |
|--|-----------------|
| | DUPLICATE No. : |
| | DATE : |

| | | | | |
|----------|---|---|---|---|
| | | | | |
| A | B | C | D | E |
| REVISION | | | | |

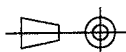
Client : Nikhef Instituut

Client Order No. : 43090

NAMEPLATE

ITEM NO. : F-260

Scale : 1:2



Drawn by : B. van Westerop Date : 01-09-'10

Checked by : -

Date : -

Revised by : -

Date : -

Remark:

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HOEFNAGEL & MEIJN B.V. ZAANDAM-HOLLAND

T : +31 (0)75 6166122, F : +31 (0)75 6313840, M : MAIL@HOEFNAGEL-MEIJN.DEMON.NL

4-10.345-01



-

Nikhef number:

Item number:

Date:

Page: 1 of 4

-

-

Status: -

Revision: -

Project: -

Department: -

Top folder: -

Abstract:

Document for pressure test on the cooling spiral (AA0768) of the CO₂ Accumulator (AA0766)

Created by:

-

Checked by:

Approved by:

Distribution list:



HISTORY OF CHANGES

| Rev. No. | Date | Pages | Description of changes |
|----------|------|-------|------------------------|
| | | | |

1. PURPOSE OF THIS DOCUMENT

The purpose of this document is to prove together with a pressure test to be performed at the firm Hoefnagel & Meijn that the Cooling Spiral is inherently safe to be used in the CE certified CO₂ Accumulator (AA0766).

1.1 Design parameters

The pressurized volume of the spiral is calculated from the length of the spiral (2x 11m) and its internal diameter D_i (O.D. 3/8" minus 2x the wall thickness 0.035")

$$V = 2 \cdot 11 \cdot \frac{1}{4} \pi \cdot D_i^2 = 22/4 \cdot \pi \cdot (7,75e^{-3})^2 = 1,04 \text{ liter}$$

As maximum design temperature 35 celcius is chosen (the same as the CO₂ Accumulator), with the refrigerant to be used in the spiral (R404a) one finds the maximum design pressure to be 16 bar (evaporation pressure of the coolant at the max. design temperature).

So the PS= 16,1 bar

The minimum pressure is 1 bar for the cooling machine, the minimum design temperature is the evaporative temperature of the coolant at this pressure -47 celcius.

To summarize:

$$V=1,04$$

$$PS \text{ (max/min)} = 1 / 16,1 \text{ bar}$$

$$T \text{ (max/min)} = -47 / 35 \text{ celcius}$$

1.2 Test pressure Spiral

The test pressure of the spiral should be 1,43 times the maximum design pressure (EN13445)

$$\text{Test pressure} = 1,43 \cdot PS = 23 \text{ bar.}$$

2. CLASSIFICATION COOLINGSPIRAL

The cooling spiral (AA0768) of the CO₂ Accumulator (AA0766) is classified to be designed and manufactured by sound engineering practice. The Lloyds program PED Category Selection 4.0.3 was used to determine its category.

2.1 Output Category selection tool



Print datum: 01-09-2010

Wegwijzer naar CE markering Drukapparaat

Omschrijving drukapparaat : **Cooling Spiral Accumulator AA0766**

Uw drukapparaat is ingedeeld in tabel : 2

Categorie : Art. 3, par. 3

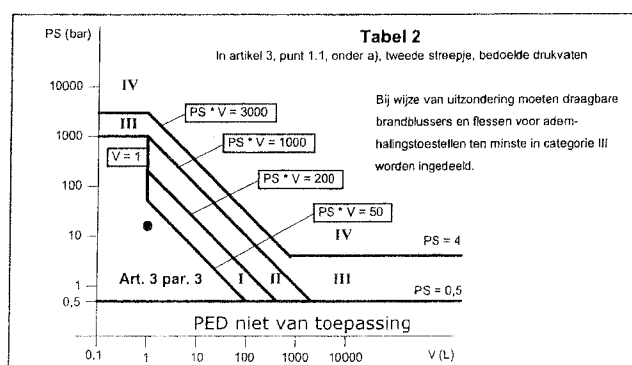
Beschikbare Module(s) voor
bovenstaande categorie* : Goed vakmanschap

Ontwerpegegevens :

Ontwerpdruk PS : 16,10 bar
Volume V : 1,04 L
PS x V : 16,744
Onstabiel Gas : N.v.t.
Temperatuur > 350 graden Celcius : N.v.t.

| Categorie | Module |
|----------------|--------------------------|
| Art. 3, par. 3 | Goed vakmanschap |
| I | A |
| II | A1, D1, E1 |
| III | B1+D, B1+F, B+E, B+C1, H |
| IV | B+D, B+F, G, H1 |

* Er mag te allen tijde een hogere module gekozen worden, behoudens in geval van 'goed vakmanschap'.



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Printout van programmasoftware : PED Categorie Bepaling Version 4.0.3