GE Oil & Gas
Nuovo Pignone S.p.A. - Italy

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INDEX of ENCLUSURES

Purchaser: / Cliente: CONOCOPHILLIPS
Order N°: / Ordine N°: 4545166
Refinery: / Raffineria: Wilhelmshavener Raffinerie Gmgh (D)

Shop Job: / Commessa: 3100276
Item: / Sigla: D-6212
S.N.: / N.F.: 85504
D.W.G.: / Dis. N°: SUO 0269057/1 Tav.1÷5
Q.C.P.N°: / P.F.C. N°: SOU 0110205/4

Code: / Norme: ASME VIII Div. 2(Edit.2004)
Inspecting Authority: / Ente di Collaudo: LL/RR - COP - FLUOR
Sheet: / Foglio: /

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Sub-Section A1

PED Dossier

ZERTIFIKAT
CERTIFICATE

Zertifikat / Certificate: HAM 0650902/1

Hiermit zertifizieren die Unterzeichner, dass die WPS / WPAR Nr.: WPS 1-0274-01 Rev.0-1 / PQR Q2729
The under signers hereby certify that the WPS / WPAR No.:

der Firma: Nuovo Pignone S.p.A.
of the Company:

in: Massa/Italy
in:

die Forderungen der Druckgeräterichtlinie 97/23/EG
the requirements of the Pressure Equipment Directive 97/23/EC

nach:
in accordance with:

☒ DIN EN ISO 15614-1
☐ AD 2000 HP 5
☒ andere: / other: ASME VIII Div. 2 and ASME IX Ed. 2004 Add. 2005

erfüllt.
comply.

Mitgeltende Unterlagen: N. SOU0111415/4 - welding map
Documents belonging to: N. SOU0111416/4 - welding book

Dieses Zertifikat ist nur gültig in Verbindung mit der oben genannten WPS / WPAR.
This certificate is only valid in conjunction with the above mentioned WPS / WPAR.

Für die Benannte Stelle gem. Artikel 12 der Richtlinie 97/23/EG, Kenn-Nr. 0525
On behalf of Notified Body in accordance article 12 of the PED Identification No. 0525

Name / Unterschrift: W.-D. Zschäckel — Prüfer:
Name / Signature: — Inspector:

Name / Unterschrift: H. Axnick — Fachzertifizierer:
Name / Signature: — Supervisor:

Ort: Rostock — Datum: 13/09/2006
Place: — Date:

Beigefügte Dokumente:
Attached documents:

Lloyd's Register Quality Assurance GmbH, Mönckebergstrasse 27, D-20095 Hamburg, Deutschland
Telefon +49 40 32 81 07 - 0 Fax +49 40 32 81 07 - 230 Email: PressureSystems.Germany@lr.org

ZERTIFIKAT

CERTIFICATE

Zertifikat / Certificate: HAM 0650902/2

Hiermit zertifizieren die Unterzeichner, dass die WPS / WPAR Nr.:
The under signers hereby certify that the WPS / WPAR No.: WPS 1-0274-01Pipe Rev.0 / PQR Q2698

der Firma:
of the Company: Nuovo Pignone S.p.A.

in:
in: Massa/Italy

die Forderungen der Druckgeräterichtlinie 97/23/EG
the requirements of the Pressure Equipment Directive 97/23/EC

nach:
in accordance with:

- ☒ DIN EN ISO 15614-1
- ☐ AD 2000 HP 5
- ☒ andere: / other: ASME VIII Div. 2 and ASME IX Ed. 2004 Add. 2005

erfüllt.
comply.

Mitgeltende Unterlagen:
Documents belonging to:
N. SOU0111415/4 - welding map
N. SOU0111416/4 - welding book

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Name / Signature: W.-D. Zschäckel
Prüfer:
Inspector:

Name / Unterschrift:
Name / Signature: H. Axnick
Fachzertifizierer:
Supervisor:

Ort:
Place: Rostock
Datum:
Date: 13/09/2006

Beigefügte Dokumente:
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Telefon +49 40 32 81 07 - 0 Fax +49 40 32 81 07 - 230 Email: PressureSystems.Germany@lr.org

ZERTIFIKAT
CERTIFICATE

Zertifikat / Certificate: HAM 0650902/3

Hiermit zertifizieren die Unterzeichner, dass die WPS / WPAR Nr.: WPS 1-0274-02 Rev.0-1 / PQR Q2688
The under signers hereby certify that the WPS / WPAR No.:

der Firma: Nuovo Pignone S.p.A.
of the Company:

in: Massa/Italy
in:

die Forderungen der Druckgeräterichtlinie 97/23/EG
the requirements of the Pressure Equipment Directive 97/23/EC

nach:
in accordance with:

- ☒ DIN EN ISO 15614-1
- ☐ AD 2000 HP 5
- ☒ andere: / other: ASME VIII Div. 2 and ASME IX Ed. 2004 Add. 2005

erfüllt.
comply.

Mitgeltende Unterlagen:
Documents belonging to:
N. SOU0111415/4 - welding map
N. SOU0111416/4 - welding book

Dieses Zertifikat ist nur gültig in Verbindung mit der oben genannten WPS / WPAR.
This certificate is only valid in conjunction with the above mentioned WPS / WPAR.

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Name / Signature: — Inspector:

Name / Unterschrift: H. Axnick — Fachzertifizierer:
Name / Signature: — Supervisor:

Ort: Rostock — Datum: 13/09/2006
Place: — Date:

Beigefügte Dokumente:
Attached documents:

Lloyd's Register Quality Assurance GmbH, Möckebergstrasse 27, D-20095 Hamburg, Deutschland
Telefon +49 40 32 81 07 - 0 Fax +49 40 32 81 07 - 230 Email: PressureSystems.Germany@lr.org

Lloyd's Register

ZERTIFIKAT

CERTIFICATE

Zertifikat / Certificate: HAM 0650902/4

Hiermit zertifizieren die Unterzeichner, dass die WPS / WPAR Nr.: WPS 1-0274-03 Rev.0-1 / PQR Q2782
The under signers hereby certify that the WPS / WPAR No.:

der Firma: Nuovo Pignone S.p.A.
of the Company:

in: Massa/Italy
in:

die Forderungen der Druckgeräterichtlinie 97/23/EG
the requirements of the Pressure Equipment Directive 97/23/EC

nach:
in accordance with:

- ☒ DIN EN ISO 15614-7
- ☐ AD 2000 HP 5
- ☒ andere: / other: ASME VIII Div. 2 and ASME IX Ed. 2004 Add. 2005

erfüllt.
comply.

Mitgeltende Unterlagen: N. SOU0111415/4 - welding map
Documents belonging to: N. SOU0111416/4 - welding book

Dieses Zertifikat ist nur gültig in Verbindung mit der oben genannten WPS / WPAR.
This certificate is only valid in conjunction with the above mentioned WPS / WPAR.

Für die Benannte Stelle gem. Artikel 12 der Richtlinie 97/23/EG, Kenn-Nr. 0525
On behalf of Notified Body in accordance article 12 of the PED Identification No. 0525

Name / Unterschrift: W.-D. Zschäckel Prüfer:
Name / Signature: Inspector:

Name / Unterschrift: H. Axnick Fachzertifizierer:
Name / Signature: Supervisor:

Ort: Rostock Datum: 13/09/2006
Place: Date:

Beigefügte Dokumente:
Attached documents:

Lloyd's Register Quality Assurance GmbH, Mönckebergstrasse 27, D-20095 Hamburg, Deutschland
Telefon +49 40 32 81 07 - 0 Fax +49 40 32 81 07 - 230 Email: PressureSystems.Germany@lr.org

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ZERTIFIKAT

CERTIFICATE

Zertifikat / Certificate: HAM 0650902/5

Hiermit zertifizieren die Unterzeichner, dass die WPS / WPAR Nr.:
The under signers hereby certify that the WPS / WPAR No.: WPS 1-0274-04 Rev.0-1 / PQR Q2740

der Firma:
of the Company: Nuovo Pignone S.p.A.

in:
in: Massa/Italy

die Forderungen der Druckgeräterichtlinie 97/23/EG
the requirements of the Pressure Equipment Directive 97/23/EC

nach:
in accordance with:

- ☒ DIN EN ISO 15614-7
- ☐ AD 2000 HP 5
- ☒ andere: / other: ASME VIII Div. 2 and ASME IX Ed. 2004 Add. 2005

erfüllt.
comply.

Mitgeltende Unterlagen:
Documents belonging to:
N. SOU0111415/4 - welding map
N. SOU0111416/4 - welding book

Dieses Zertifikat ist nur gültig in Verbindung mit der oben genannten WPS / WPAR.
This certificate is only valid in conjunction with the above mentioned WPS / WPAR.

Für die Benannte Stelle gem. Artikel 12 der Richtlinie 97/23/EG, Kenn-Nr. 0525
On behalf of Notified Body in accordance article 12 of the PED Identification No. 0525

Name / Unterschrift:
Name / Signature: W.-D. Zschäckel — Prüfer: / Inspector:

Name / Unterschrift:
Name / Signature: H. Axnick — Fachzertifizierer: / Supervisor:

Ort:
Place: Rostock — Datum: / Date: 13/09/2006

Beigefügte Dokumente:
Attached documents:

Lloyd's Register Quality Assurance GmbH, Mönckebergstrasse 27, D-20095 Hamburg, Deutschland
Telefon +49 40 32 81 07 - 0 Fax +49 40 32 81 07 - 230 Email: PressureSystems.Germany@lr.org

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ZERTIFIKAT

CERTIFICATE

Zertifikat / Certificate: HAM 0650902/6

Hiermit zertifizieren die Unterzeichner, dass die WPS / WPAR Nr.: WPS 1-0274-05 Rev.0-1 / PQR Q2739
The under signers hereby certify that the WPS / WPAR No.:

der Firma: Nuovo Pignone S.p.A.
of the Company:

in: Massa/Italy
in:

die Forderungen der Druckgeräterichtlinie 97/23/EG
the requirements of the Pressure Equipment Directive 97/23/EC

nach:
in accordance with:

- [x] DIN EN ISO 15614-7
- [ ] AD 2000 HP 5
- [x] andere: / other: ASME VIII Div. 2 and ASME IX Ed. 2004 Add. 2005

erfüllt.
comply.

Mitgeltende Unterlagen: N. SOU0111415/4 - welding map
Documents belonging to: N. SOU0111416/4 - welding book

Dieses Zertifikat ist nur gültig in Verbindung mit der oben genannten WPS / WPAR.
This certificate is only valid in conjunction with the above mentioned WPS / WPAR.

Für die Benannte Stelle gem. Artikel 12 der Richtlinie 97/23/EG, Kenn-Nr. 0525
On behalf of Notified Body in accordance article 12 of the PED Identification No. 0525

Name / Unterschrift: W.-D. Zschäckel — Prüfer:
Name / Signature: — Inspector:

Name / Unterschrift: H. Axnick — Fachzertifizierer:
Name / Signature: — Supervisor:

Ort: Rostock — Datum: 13/09/2006
Place: — Date:

Beigefügte Dokumente:
Attached documents:

Lloyd's Register Quality Assurance GmbH, Mönckebergstrasse 27, D-20095 Hamburg, Deutschland
Telefon +49 40 32 81 07 - 0 Fax +49 40 32 81 07 - 230 Email: PressureSystems.Germany@lr.org

ZERTIFIKAT

CERTIFICATE

Zertifikat / Certificate: HAM 0650902/7

Hiermit zertifizieren die Unterzeichner, dass die WPS / WPAR Nr.:
The under signers hereby certify that the WPS / WPAR No.: WPS 1-0274-06 Rev.0-1 / PQR Q2738

der Firma:
of the Company: Nuovo Pignone S.p.A.

in:
in: Massa/Italy

die Forderungen der Druckgeräterichtlinie 97/23/EG
the requirements of the Pressure Equipment Directive 97/23/EC

nach:
in accordance with:

- ☒ DIN EN ISO 15614-7
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- ☒ andere: / other: ASME VIII Div. 2 and ASME IX Ed. 2004 Add. 2005

erfüllt.
comply.

Mitgeltende Unterlagen:
Documents belonging to:
N. SOU0111415/4 - welding map
N. SOU0111416/4 - welding book

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On behalf of Notified Body in accordance article 12 of the PED Identification No. 0525

Name / Unterschrift:
Name / Signature: W.-D. Zschäckel

Prüfer:
Inspector:

Name / Unterschrift:
Name / Signature: H. Axnick

Fachzertifizierer:
Supervisor:

Ort:
Place: Rostock

Datum:
Date: 13/09/2006

Beigefügte Dokumente:
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ZERTIFIKAT

CERTIFICATE

Zertifikat / Certificate: HAM 0650902/8

Hiermit zertifizieren die Unterzeichner, dass die WPS / WPAR Nr.:
The under signers hereby certify that the WPS / WPAR No.:

WPS 1-0274-07 Rev.0-1 / PQR Q1236

der Firma:
of the Company:

Nuovo Pignone S.p.A.

in:
in:

Massa/Italy

die Forderungen der Druckgeräterichtlinie 97/23/EG
the requirements of the Pressure Equipment Directive 97/23/EC

nach:
in accordance with:

- ☒ DIN EN ISO 15614-1
- ☐ AD 2000 HP 5
- ☒ andere: / other: ASME VIII Div. 2 and ASME IX Ed. 2004 Add. 2005

erfüllt.
comply.

Mitgeltende Unterlagen:
Documents belonging to:

N. SOU0111415/4 - welding map
N. SOU0111416/4 - welding book

Dieses Zertifikat ist nur gültig in Verbindung mit der oben genannten WPS / WPAR.
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On behalf of Notified Body in accordance article 12 of the PED Identification No. 0525

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Name / Signature: Inspector:

Name / Unterschrift: H. Axnick Fachzertifizierer:
Name / Signature: Supervisor:

Ort: Rostock Datum: 13/09/2006
Place: Date:

Beigefügte Dokumente:
Attached documents:

Lloyd's Register Quality Assurance GmbH, Mönckebergstrasse 27, D-20095 Hamburg, Deutschland
Telefon +49 40 32 81 07 - 0 Fax +49 40 32 81 07 - 230 Email: PressureSystems.Germany@lr.org

ZERTIFIKAT

CERTIFICATE

Zertifikat / Certificate: HAM 0650902/9

Hiermit zertifizieren die Unterzeichner, dass die WPS / WPAR Nr.:
The under signers hereby certify that the WPS / WPAR No.: WPS 1-0274-08 Rev.0-1 / PQR Q2687

der Firma:
of the Company: Nuovo Pignone S.p.A.

in:
in: Massa/Italy

die Forderungen der Druckgeräterichtlinie 97/23/EG
the requirements of the Pressure Equipment Directive 97/23/EC

nach:
in accordance with:

- ☒ DIN EN ISO 15614-7
- ☐ AD 2000 HP 5
- ☒ andere: / other: ASME VIII Div. 2 and ASME IX Ed. 2004 Add. 2005

erfüllt.
comply.

Mitgeltende Unterlagen:
Documents belonging to:
N. SOU0111415/4 - welding map
N. SOU0111416/4 - welding book

Dieses Zertifikat ist nur gültig in Verbindung mit der oben genannten WPS / WPAR.
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Für die Benannte Stelle gem. Artikel 12 der Richtlinie 97/23/EG, Kenn-Nr. 0525
On behalf of Notified Body in accordance article 12 of the PED Identification No. 0525

Name / Unterschrift:
Name / Signature: W.-D. Zschäckel — Prüfer: / Inspector:

Name / Unterschrift:
Name / Signature: H. Axnick — Fachzertifizierer: / Supervisor:

Ort:
Place: Rostock — Datum: / Date: 13/09/2006

Beigefügte Dokumente:
Attached documents:

Lloyd's Register Quality Assurance GmbH, Mönckebergstrasse 27, D-20095 Hamburg, Deutschland
Telefon +49 40 32 81 07 - 0 Fax +49 40 32 81 07 - 230 Email: PressureSystems.Germany@lr.org

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ZERTIFIKAT
CERTIFICATE

Zertifikat / Certificate: HAM 0650902/10

Hiermit zertifizieren die Unterzeichner, dass die WPS / WPAR Nr.:
The under signers hereby certify that the WPS / WPAR No.: WPS 1-0274-09 Rev.0-1 / PQR Q2738

der Firma:
of the Company: Nuovo Pignone S.p.A.

in:
in: Massa/Italy

die Forderungen der Druckgeräterichtlinie 97/23/EG
the requirements of the Pressure Equipment Directive 97/23/EC

nach:
in accordance with:

- ☒ DIN EN ISO 15614-7
- ☐ AD 2000 HP 5
- ☒ andere: / other: ASME VIII Div. 2 and ASME IX Ed. 2004 Add. 2005

erfüllt.
comply.

Mitgeltende Unterlagen:
Documents belonging to:
N. SOU0111415/4 - welding map
N. SOU0111416/4 - welding book

Dieses Zertifikat ist nur gültig in Verbindung mit der oben genannten WPS / WPAR.
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Name / Unterschrift:
Name / Signature: W.-D. Zschäckel
Prüfer:
Inspector:

Name / Unterschrift:
Name / Signature: H. Axnick
Fachzertifizierer:
Supervisor:

Ort:
Place: Rostock
Datum:
Date: 13/09/2006

Beigefügte Dokumente:
Attached documents:

Lloyd's Register Quality Assurance GmbH, Mönckebergstrasse 27, D-20095 Hamburg, Deutschland
Telefon +49 40 32 81 07 - 0 Fax +49 40 32 81 07 - 230 Email: PressureSystems.Germany@lr.org

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ZERTIFIKAT

CERTIFICATE

Zertifikat / Certificate: HAM 0650902/11

Hiermit zertifizieren die Unterzeichner, dass die WPS / WPAR Nr.:
The under signers hereby certify that the WPS / WPAR No.: WPS 1-0274-10 Rev.0-1 / PQR Q2686 - Q2738

der Firma:
of the Company: Nuovo Pignone S.p.A.

in:
in: Massa/Italy

die Forderungen der Druckgeräterichtlinie 97/23/EG
the requirements of the Pressure Equipment Directive 97/23/EC

nach:
in accordance with:

- ☒ DIN EN ISO 15614-1
- ☐ AD 2000 HP 5
- ☒ andere: / other: ASME VIII Div. 2 and ASME IX Ed. 2004 Add. 2005

erfüllt.
comply.

Mitgeltende Unterlagen:
Documents belonging to:
N. SOU0111415/4 - welding map
N. SOU0111416/4 - welding book

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Prüfer:
Inspector:

Name / Unterschrift:
Name / Signature: H. Axnick
Fachzertifizierer:
Supervisor:

Ort:
Place: Rostock
Datum:
Date: 13/09/2006

Beigefügte Dokumente:
Attached documents:

Lloyd's Register Quality Assurance GmbH, Mönckebergstrasse 27, D-20095 Hamburg, Deutschland
Telefon +49 40 32 81 07 - 0 Fax +49 40 32 81 07 - 230 Email: PressureSystems.Germany@lr.org

Lloyd's Register

ZERTIFIKAT
CERTIFICATE

Zertifikat / Certificate: HAM 0650902/12

Hiermit zertifizieren die Unterzeichner, dass die WPS / WPAR Nr.:
The under signers hereby certify that the WPS / WPAR No.: WPS 1-0274-11 Rev.0-1 / PQR Q2686

der Firma:
of the Company: Nuovo Pignone S.p.A.

in:
in: Massa/Italy

die Forderungen der Druckgeräterichtlinie 97/23/EG
the requirements of the Pressure Equipment Directive 97/23/EC

nach:
in accordance with:

☒ DIN EN ISO 15614-1
☐ AD 2000 HP 5
☒ andere: / other: ASME VIII Div. 2 and ASME IX Ed. 2004 Add. 2005

erfüllt.
comply.

Mitgeltende Unterlagen:
Documents belonging to:
N. SOU0111415/4 - welding map
N. SOU0111416/4 - welding book

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Inspector:

Name / Unterschrift:
Name / Signature: H. Axnick
Fachzertifizierer:
Supervisor:

Ort:
Place: Rostock
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Date: 13/09/2006

Beigefügte Dokumente:
Attached documents:

Lloyd's Register Quality Assurance GmbH, Mönckebergstrasse 27, D-20095 Hamburg, Deutschland
Telefon +49 40 32 81 07 - 0 Fax +49 40 32 81 07 - 230 Email: PressureSystems.Germany@lr.org

Lloyd's Register Energy & Transportation Design Appraisal Document

Lloyd's Register EMEA
Hamburg Design Support Centre
Mönckebergstr. 27
D-20095 Hamburg
Telephone +49 40 32 81 07 -0 Fax +49 40 32 81 07 - 480
Email: hamburg-design-support@lr.org

Date
21 September 2006

Quote this reference on all future communications
HPC 0630012/6235-06/PMS/BHS

NUOVO PIGNONE S.P.A. (ITALY)
STAGE 2 PRETREATING REACTOR-TRAIN 2
ITEM D-6212 / D-6232
PROJECT: WRG-DEEP CONVERSION REACTOR
WILHELMSHAVEN, GERMANY
COMMISION NUMBERS: 3100276 AND 3100277

The document/s listed in the appendix has/have been examined for compliance with

PED 97 / 23 / EC

and is/are assigned an appraisal status as indicated, subject to satisfactory resolution of the following matters:

A. Details

Design pressure	191,5 bar / 1.03 bar
Design temperature	454 °C / 177 °C at external pressure
Min. Design Metal Temperature	- 15 °C
Test pressure	277 bar in vertical position at top

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Form 6438ET (2005.04)

B. Comments:

1. Only the load cases on the drawing have been considered.
2. Any amendments made in the technical documents to be taken into consideration.
3. Normative Notices: ASME VIII / Div.2 Ed. 2004, ASME B16.5, ASME B16.20, WRC 107, AD 2000-Merkblatt S3, DIN 1055-4 2005-03.

Peer M. Strehl (Ext. -215)
Senior Surveyor
Pressure Plant
Hamburg Design Support Centre
Lloyd's Register EMEA
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Appendix

Drawing No.	Rev.	Title	Appraisal Status	Appraisal Date
SOU0107840/4	1	Pressure Parts Calculation of Stage 2, Pretreating Reactors	RIM	21/09/2006
SOU0107841/4	1	Structural Parts Calculation of Stage 2, Hydrocracking Reactors	RIM	21/09/2006
SUO 0269057/1, Sheet 1/2	2	General Assembly	AM	21/09/2006
SUO 0269057/1, Sheet 3/4	2	Shell Nozzle Details	A	21/09/2006
SUO 0269057/1, Sheet 2/3	2	Head Nozzle Details	A	21/09/2006
SUO 0269057/1, Sheet 4/5	2	Details	RI	21/09/2006
SUO 0269057/1, Sheet 5/5	2	Skirt Details	A	21/09/2006
SUO 0269058/1, Sheet 1/2	2	General Assembly	AM	21/09/2006
SUO 0269058/1, Sheet 3/4	2	Shell Nozzle Details	A	21/09/2006
SUO 0269058/1, Sheet 2/3	2	Head Nozzle Details	A	21/09/2006
SUO 0269058/1, Sheet 4/5	2	Details	RI	21/09/2006
SUO 0269058/1, Sheet 5/5	2	Skirt Details	A	21/09/2006

Appraisal Status Codes

A	Approved
AM	Approved as amended, i.e. with conditions as marked or qualified on the design document
RI	Used for information only
RIM	Used as amended, for information only

Remarks:

Before issuing the EC-Type Examination Certificate (B1) or at the latest during final assessment for the certificate for Module G, the following documents are to be provided to the Surveyor / Certifier for review resp. approval:

- Hazard analysis
- Material test reports
- Particular material appraisals, if required
- Approval of operating procedures for permanent joints (listing)
- Qualifications and approvals for personnel performing permanent joints (listing)
- Qualifications and approvals for personnel performing non-destructive tests (listing)
- Qualifications and approvals for personnel performing permanent joints (listing)
- Operating instructions

Bericht zur Vorprüfung technischer Unterlagen

gemäß DGRL 97/23/EG.
Appraisal report of technical documents according PED 97/23/EC.

Firma / Company: Nuovo Pignone S.p.A.

Adresse / Address: Via Dorsale, 3
54100 Massa

Auftragsnummer / order number: 85504 & 85505

Datum / Date: 28 April 2010

Bitte diese Referenz im Schriftverkehr angeben / Please quote this reference on all correspondence:
HPC 0630012/10096-10/RWE/HB/hu

Upper Spool (Nozzles A and M)
Stage 1, Hydrocracking Reactor
Items: D-6212 / D-6232

Die aufgelisteten Dokumente wurden auf Übereinstimmung gemäß der **Druckgeräterichtlinie 97/23/EG** geprüft und haben den unten angezeigten Prüfstatus erhalten.
The document(s) listed in the appendix has/have been examined for compliance with **Pressure Equipment Directive 97/23/EC** and is/are assigned an appraisal status as indicated, in accordance with the following conditions:

A. Einzelheiten / Details:

Auslegungsdruck / Design pressure:	191,5 bar
Prüfdruck / Test pressure:	277 bar (vertical)
Auslegungstemperatur / Design temperature:	454 °C

B. In der Vorprüfung berücksichtigte Lastfälle / load cases considered in design appraisal:

	Ja / yes	Nein / no
Innendruck und / oder Außendruck / Internal and / or external pressure	☒	☐
Gewicht des Behälters / Weight of vessel	☒	☐
Inhaltsgewicht unter Betriebs- und Prüfbedingungen (statische Höhen) / Weight of content under design- and test conditions (statical height)	☒	☐
Überlagerte statische Belastungen durch Gewicht der Anbauteile und/oder Stutzenlasten / Superimposed statical loads due to weight of attachments and/or nozzle loads	☒	☐
Belastungen aus Lagerung (Standzarge, Stützfüße, Tragpratzen, etc.) / Loads due to vessel supports (lugs, rings, skirts, saddles, legs etc.)	☒	☐
Wind-, Schnee-, Erdbebenlasten / Wind-, snow-, earth quake loads	☒	☐
Wechselbeanspruchung / Fatigue	☐	☒
Stoßbelastung / Shock loads	☐	☒
Weitere Lastfälle / Other load cases:	☒	☐

C. Kommentare / Comments:

1. Please note that this examination includes exclusively the nozzle and flange at M and the flange at A as specified on drawing SUO0269057/1 Sheet 2/3 Rev.7 & SUO0269058/1 Sheet 2/3 Rev.6. These items are appropriate according to this Design Appraisal Document.

2. The examination of all other components and loading of the Preheating Reactor is stated in our Design Appraisal Document PPT 6235-06.

3. It should be noted that the examination of the external loading on the nozzles and flanges at M and A implies that the specified loads (Table "External loads on nozzles" as per drawings SUO0269057/1 Sheet 1/2 Rev.7 & SUO0269058/1 Sheet 1/2 Rev.6) are correct.

Normative Verweise / Normative Notices: ASME VIII-2, ASME B31.3

Anhang / Appendix:

Zeichnungs-Nr. / Drawing No.	Rev.	Titel / Title	Vorprüfstatus / Design status	Datum / Date
SU0 0269057/1 Sheet 1/2	7	General Assembly – Stage 1 Hydrocracking Reactor-Train 1 – Item D-6212	RI	28/04/10
SU0 0269057/1 Sheet 2/3	7	Head Nozzles Details-Stage 1 Hydrocracking Reactor-Train 1 – Item D-6212	A	28/04/10
SU0 0269058/1 Sheet 1/2	6	General Assembly – Stage 1 Hydrocracking Reactor-Train 2 – Item D-6232	RI	28/04/10
SU0 0269058/1 Sheet 2/3	6	Head Nozzles Details-Stage 1 Hydrocracking Reactor-Train 2 – Item D-6232	A	28/04/10
SOU 0107840/4	3	Pressure Parts Calculation of Stage 1 Hydrocracking Reactors Items: D-6212 / D-6232	RI	28/04/10

Vorprüfstatusschlüssel / Appraisal status codes:

A	=	Genehmigt / Approved
B	=	Geprüft in Übereinstimmung mit oben genannten Standards / Examined and in accordance with above mentioned standards
AM	=	Genehmigt wie berichtigt in Übereinstimmung mit oben genannten Standards / Approved as amended in accordance with above mentioned standards
BM	=	Geprüft wie berichtigt in Übereinstimmung mit oben genannten Standards / Examined as amended in accordance with above mentioned standards
R	=	Abgelehnt, nicht akzeptabel / Rejected, not acceptable
RI	=	Eingesehen als unterstützendes Dokument; dient nur zur Information / Retained for information only
RIM	=	Eingesehen als unterstützendes Dokument und berichtigt; dient nur zur Information / Retained for information only and amended

Für die LRQA GmbH, Benannte Stelle gemäß Artikel 12 der DGRL 97/23/EG, Kenn-Nr. 0525
On behalf of LRQA GmbH, Notified Body in accordance with article 12 of the PED 97/23/EC Identification No. 0525

R. Wederhake

Ralf Wederhake

Hans Balle

Hamburg, 28.04.2010

Name des Prüfers, Unterschrift Name of Inspector, Signature	Ort und Datum Place and date	Name des Prüfers der Benannten Stelle, Unterschrift Name of Inspector of Notified Body, Signature

Bemerkungen:
Dieser Prüfbericht ist keine EG-Entwurfsprüfbescheinigung (Modul B1) oder EG-Baumusterprüfbescheinigung (Modul B). Dieser Prüfbericht ist für die Zertifizierung der Module B, B1,G, H und H1 sowie deren Kombinationen erforderlich. Für die Erstellung der EG-Entwurfsprüfbescheinigung (Modul B1), EG-Baumusterprüfbescheinigung (Modul B) oder spätestens bei der Endabnahme zur Ausstellung des Zertifikates für Modul G, sind dem Fachzertifizierer (Prüfer / Surveyor) der benannten Stelle die folgenden Unterlagen zur Einsichtnahme bzw. Anerkennung vorzulegen:

Gefahrenanalyse, Werkstoffbescheinigungen, Werkstoffgutachten, falls erforderlich; Zulassungen der Arbeitsverfahren zur Ausführung der dauerhaften Werkstoffverbindungen (Übersicht), Qualifikationen und Zulassungen des Personals zur Ausführung der dauerhaften Werkstoffverbindungen (Übersicht), Qualifikationen und Zulassungen des Personals zur Ausführung der zerstörungsfreien Prüfungen (Übersicht), Berichte über die zerstörungsfreien und andere erforderliche Prüfungen, Betriebsanleitung.

Remarks:
This report is neither a Design-Examination Certificate (Module B1) nor a Type-Examination Certificate (Module B). This report is required for the certification of the Modules B, B1, G, H and H1 and there combinations. Before issuing the EC Design-Examination Certificate (Module B1), EC Type-Examination Certificate (Module B) or at the latest during final assessment for the Certificate for Module G, the following documents are to be provided to the Surveyor / Certifier for review resp. approval:

Hazard analysis, material test reports, particular material appraisals, if required; approval of operating procedures for permanent joints (listing), qualifications and approvals for personnel performing permanent joints (listing), qualifications and approvals for personnel performing non-destructive tests (listing), reports of NDE Examination or other required tests, operating instructions.

Lloyd's Register Quality Assurance GmbH, Am Sandtorkai 41, D-20457 Hamburg, Deutschland
Telefon +49 40 32 81 07 - 0 Fax +49 40 32 81 07 - 480 Email: PressureSystems.Germany@lr.org

Nuovo Pignone MASSA	CLIENTE – CUSTOMER **CONOCOPHILLIPS LTD**
	LOCALITA' - PLANT LOCATION **WILHELMSHAVEN (GERMANY)**
COMMESSA - JOB **3100274-75-76-77 <1>**	IMPIANTO – PLANT **WILHELMSHAVENER RAFFINERIEGESELLSCHAFT BMH. WRG-DEEP CONVERSION PROJECT**

TITOLO - TITLE

Title:

PARTICULAR MATERIAL APPRAISAL
RISK ANALYSIS
PED ESSENTIAL SAFETY REQUIREMENTS
FOR
EC CERTIFICATION AS PER
DIRECTIVE 97-23-EC

TOTAL PAGES: 30

1	REVI.DOVE INDIC. <1> - REV. WHERE INDICATED <1>	Lazzerini	Ricci S.	Ronchieri A.	09-03-10
0	EMISSIONE-ISSUE	Lazzerini	Ricci	Ronchieri	21-07-06
REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE

ITEM **D-6211-12-31-32**

N. SOU0120327/4

LINGUA-LANG.	PAGINA-SHEET
A	1 / 2

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

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5. PED ESSENTIAL SAFETY REQUIREMENTS

1.SCOPE

This specification covers the requirement needed to obtain the CE marching according to the PED 97/23 CE.

2.APPLICABLE CODES AND STANDARDS:

- ASME II, part A Ed. 2004 Boiler and pressure vessel code – Materials
- ASME VIII, Div.2 Ed. 2004 Boiler and pressure vessel code – Rules for construction of pressure vessels
- ASME IX Ed. 2004 – Welding
- ASME B31.3-2006 – (For top spool) <1>
- DIN 1055 Ed. March 2005 Design loads for buildings
- SOU0120328/4 Operating Manual
- SUO0269055/1 ÷ SUO0269058/1 Reference drawings <1>
- SOU0112430/4 Material additional requirements
- SOU0107838/4 ÷ SOU0107840/4 Pressure and structural part calculation <1>
- SOU0107844/4 ÷ SOU0107845/4 Skirt to vessel junction stress analysis <1>
- SOU0111416/4 WPS

3.PARTICULAR MATERIAL APPRAISAL

LIMITS OF APPLICATION (for all items)	
Type of equipment:	HYDROCRACKING REACTOR
Design Code:	ASME VIII DIV.2 edition 2004
Design pressure:	for item D-6211 and D-6231: 198,5 bar g for item D-6212 and D-6232: 191,5 bar g <1>
Designed temperature:	454 °C max <1>
Fluid characteristics:	Hydrocarbon (group 1, gas/vapour service)
PED category:	IV Modules G

Para. 3.1.a MATERIAL (nozzles, blind flanges, pipe necks, top spool)

Type:	2 ¼ Cr 1 Mo ¼ V
Specification:	ASME SA 182
Issue:	July 1, 2004
Grade:	F22V
Technical reference documents:	ASME II (BOILER AND PRESSURE VESSEL CODE) MATERIALS part A, Ferrous material specifications, 2004 edition SPECIFICATION FOR FORGED OR ROLLED ALLOY-STEEL PIPE FLANGES, FORGED FITTINGS, AND VALVES AND PARTS FOR HIGH-TEMPERATURE SERVICE
	MATERIAL ADDITIONAL REQUIREMENTS NUOVO PIGNONE spec. n° SOU0112430/4
Tensile Strength, min:	585-780 MPa
Yield Strength, min:	415 MPa
Elongation 50_{mm}, min:	18%

Para. 3.1.b COMPLIANCE WITH PED ESSENTIAL SAFETY REQUIREMENTS

Requirements	Annex 1 Paragraph	Complied with by	Considerations/comments
Resistance	2.2.3 (b)	ASME SA 182 F22 V (Tensile strength:585-780 MPa; Yield strength, min: 415 MPa)	Required certificates including: UTS, YS, RA, EL, MAX UTS in according to API 934 (see SOU0112430/4).
Wear			Not applicable
Heat treatment	3.1.4.	NUOVO PIGNONE spec. SOU0112430/4 and ASME SA 182 F22 V	P.W.H.T. 709°C for 8h
Traceability	3.1.5.	Material certificates	In addition to the Code required marking, all pieces shall be stamped with the procurement drawing number.
Ductility: elongation >14%	4.1(a)	ASME SA 182 F22 V	Minimum required elongation on 50 mm 18%
Toughness: energy absorbtion 27 J min.	4.1 (a)	NUOVO PIGNONE spec. SOU0112430/4	Material ordered with impact test (test temp. -29°C, 55 J ave, 47 J min) and transition curves.
Creeping	4.1 (a)		Creeping not pertinent in the temperature range.

Resistance to the chemical attack	4.1(b)	OVERLAY	Stainless Steel TP 347
Ageing	4.1(c)	NUOVO PIGNONE spec. SOU0112430/4	Step Cooling Test
Formability/workabi lty	4.1(d)	Material properties Experience	ASME SA 182, specification for forged or rolled alloy-steel pipe flanges, forged fittings, and valves and parts for high-temperature service.
Weldability	4.1 (d)	Qualification process	WPS/PQR according to ASME IX. See Summary Welding Sheet SOU0111416/4
Joining with different material	4.1 (e)	Qualification process experience	WPS/PQR according to ASME IX. See Summary Welding Sheet SOU0111416/4
Values for design calculations	4.2 (a)	According to ASME II Sect. "D"	
Material certificate	4.3.	Issued by supplier	According to EN10204 3.1.b (the extent of inspection to be notified by N.P.)
Material characteristics	7.5.	NUOVO PIGNONE spec. SOU0112430/4 and ASME SA 182 F22 V	The impact test should be made at the lowest scheduled operating temperature (that is–15°C). The impact test will be done at–29°C.

Para. 3.2.a MATERIAL (shell, man-way forging)

Type:	2 ¼ Cr 1 Mo ¼ V
Specification:	ASME SA 336
Issue:	July 1, 2004
Grade:	F22V
Technical reference documents:	ASME II (BOILER AND PRESSURE VESSEL CODE) MATERIALS part A, Ferrous material specifications, 2004 edition SPECIFICATION FOR ALLOY STEEL FORGINGS FOR PRESSURE AND HIGH-TEMPERATURE PARTS.
	MATERIAL ADDITIONAL REQUIREMENTS NUOVO PIGNONE spec. n° SOU0112430/4
Tensile Strength, min:	585-760 MPa
Yield Strength, min:	415 MPa
Elongation 50_{mm}, min:	18%

Para. 3.2.b COMPLIANCE WITH PED ESSENTIAL SAFETY REQUIREMENTS

Requirements	Annex 1 Paragraph	Complied with by	Considerations/comments
Resistance	2.2.3 (b)	ASME SA 336 F22 V (Tensile strength:585-760 MPa; Yield strength, min: 415 MPa)	Required certificates including: UTS, YS, RA, EL, MAX UTS in according to API 934 (see SOU0112430/4).
Wear			Not applicable
Heat treatment	3.1.4.	NUOVO PIGNONE spec. SOU0112430/4 and ASME SA 336 F22 V	P.W.H.T. 709°C for 8h
Traceability	3.1.5.	Material certificates	In addition to the Code required marking, all pieces shall be stamped with the procurement drawing number.
Ductility: elongation >14%	4.1(a)	ASME SA 336 F22 V	Minimum required elongation on 50 mm 18%
Toughness: energy absorbtion 27 J min.	4.1 (a)	NUOVO PIGNONE spec. SOU0112430/4	Material ordered with impact test (test temp. -29°C, 55 J ave, 47 J min) and transition curves.
Creeping	4.1 (a)		Creeping not pertinent in the temperature range.

Resistance to the chemical attack	4.1(b)	OVERLAY	Stainless Steel TP 347
Ageing	4.1(c)	NUOVO PIGNONE spec. SOU0112430/4	Step Cooling Test
Formability/workabi lty	4.1(d)	Material properties Experience	ASME SA 336, specification for alloy steel forgings for pressure and high-temperature parts.
Weldability	4.1 (d)	Qualification process	WPS/PQR according to ASME IX. See Summary Welding Sheet SOU0111416/4
Joining with different material	4.1 (e)	Qualification process experience	WPS/PQR according to ASME IX. See Summary Welding Sheet SOU0111416/4
Values for design calculations	4.2 (a)	According to ASME II Sect. "D"	
Material certificate	4.3.	Issued by supplier	According to EN10204 3.1.b (the extent of inspection to be notified by N.P.)
Material characteristics	7.5.	NUOVO PIGNONE spec. SOU0112430/4 and ASME SA 336 F22 V	The impact test should be made at the lowest scheduled operating temperature (that is–15°C). The impact test will be done at –29°C.

Para. 3.3.a MATERIAL (heads)

Type:	2 ¼ Cr 1 Mo ¼ V
Specification:	ASME SA 542
Issue:	July 1, 2004
Grade:	Gr. D Cl. 4a
Technical reference documents:	ASME II (BOILER AND PRESSURE VESSEL CODE) MATERIALS part A, Ferrous material specifications, 2004 edition PRESSURE VESSEL PLATES, ALLOY STEEL, QUENCHED-AND TEMPERED, CHROMIUM-MOLYBDENUM AND CHROMIUM-MOLYBDENUM-VANADIUM MATERIAL ADDITIONAL REQUIREMENTS NUOVO PIGNONE spec. n° SOU0112430/4
Tensile Strength, min:	585-760 MPa
Yield Strength, min:	415 MPa
Elongation 50_{mm}, min:	18%

Para. 3.3.b COMPLIANCE WITH PED ESSENTIAL SAFETY REQUIREMENTS

Requirements	Annex 1 Paragraph	Complied with by	Considerations/comments
Resistance	2.2.3 (b)	ASME SA 542 Gr. D Cl. 4a (Tensile strength:585-760 MPa; Yield strength, min: 415 MPa)	Required certificates including: UTS, YS, RA, EL, MAX UTS in according to API 934 (see SOU0112430/4).
Wear			Not applicable
Heat treatment	3.1.4.	NUOVO PIGNONE spec. SOU0112430/4 and ASME SA 542 Gr. D Cl. 4a	P.W.H.T. 709°C for 8h
Traceability	3.1.5.	Material certificates	In addition to the Code required marking, all pieces shall be stamped with the procurement drawing number.
Ductility: elongation >14%	4.1(a)	ASME SA 542 Gr. D Cl. 4a	Minimum required elongation on 50 mm 18%
Toughness: energy absorbtion 27 J min.	4.1 (a)	NUOVO PIGNONE spec. SOU0112430/4	Material ordered with impact test (test temp. -29°C, 55 J ave, 47 J min) and transition curves.
Creeping	4.1 (a)		Creeping not pertinent in the temperature range.

Resistance to the chemical attack	4.1(b)	OVERLAY	Stainless Steel TP 347
Ageing	4.1(c)	NUOVO PIGNONE spec. SOU0112430/4	Step Cooling Test
Formability/workabi lty	4.1(d)	Material properties Experience	ASME SA 542, pressure vessel plates, alloy steel, quenched-and tempered, chromium-molybdenum and chromium-molybdenum-vanadium
Weldability	4.1 (d)	Qualification process	WPS/PQR according to ASME IX. See Summary Welding Sheet SOU0111416/4
Joining with different material	4.1 (e)	Qualification process experience	WPS/PQR according to ASME IX. See Summary Welding Sheet SOU0111416/4
Values for design calculations	4.2 (a)	According to ASME II Sect. "D"	
Material certificate	4.3.	Issued by supplier	According to EN10204 3.1.b (the extent of inspection to be notified by N.P.)
Material characteristics	7.5.	NUOVO PIGNONE spec. SOU0112430/4 and ASME SA 542 Gr. D Cl. 4a	The impact test should be made at the lowest scheduled operating temperature (that is–15°C). The impact test will be done at –29°C.

Para. 3.4.a MATERIAL (ext. bolt-nut)

Type:	1 Cr ½ Mo V
Specification:	ASME SA 193
Issue:	July 1, 2004
Grade:	Gr. B16
Technical reference documents:	ASME II (BOILER AND PRESSURE VESSEL CODE) MATERIALS part A, Ferrous material specifications, 2004 edition ALLOY STEEL AND STAINLESS STEEL BOLTING MATERIALS FOR HIGH TEMPERATURE SERVICE
Tensile Strength, min:	760-860 MPa
Yield Strength, min:	655-725 MPa
Elongation 50_{mm}, min:	17-18%

Para. 3.4.b COMPLIANCE WITH PED ESSENTIAL SAFETY REQUIREMENTS

Requirements	Annex 1 Paragraph	Complied with by	Considerations/comments
Resistance	2.2.3 (b)	ASME SA 193 GR. B16 (Tensile strength:760-860 MPa; Yield strength, min: 655-725 MPa)	Required certificates including: UTS, YS, RA, EL
Wear			Not applicable
Heat treatment	3.1.4.	Not applicable	Not applicable
Traceability	3.1.5.	Material certificates	In addition to the Code required marking, all pieces shall be stamped with the procurement drawing number.
Ductility: elongation >14%	4.1(a)	ASME SA 193 GR. B16	Minimum required elongation on 50 mm 17-18%
Toughness: energy absorbtion 27 J min.	4.1 (a)	ASME VIII DIV. 2 para AM214 TABLE ABM-1	The impact test should be made at the lowest scheduled operating temperature (that is–15°C). The impact test will be done at –29°C. (Test performed for lot)
Creeping	4.1 (a)		Creeping not pertinent in the temperature range.
Resistance to the chemical attack	4.1(b)	OVERLAY	External bolting material not in contact with the process fluid.

Ageing	4.1(c)	Not applicable	Not applicable
Formability/workabi lty	4.1(d)	Material properties Experience	ASME SA 193, alloy steel and stainless steel bolting materials for high temperature service
Weldability	4.1 (d)	Not applicable	Not applicable
Joining with different material	4.1 (e)	Not applicable	Not applicable
Values for design calculations	4.2 (a)	According to ASME II Sect. "D"	
Material certificate	4.3.	Issued by supplier	According to EN10204 3.1b (the extent of inspection to be notified by N.P.)
Material characteristics	7.5.	ASME 2A ASME SA 193 GR. B16	The impact test should be made at the lowest scheduled operating temperature (that is –15°C). The impact test will be done at –29°C. (Test performed for lot)

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Para 3.5.a MATERIAL (ext. nut)

Type:	Nuts for use with bolting in SA 193 (See ASME SA 193)
Specification:	ASME SA 194
Issue:	July 1, 2004
Grade:	Gr. 4
Technical reference documents:	ASME II (BOILER AND PRESSURE VESSEL CODE) MATERIALS part A, Ferrous material specifications, 2004 edition CARBON AND ALLOY STEEL NUTS FOR BOLTS FOR HIGH-PRESSURE OR HIGH-TEMPERATURE SERVICE, OR BOTH
Tensile Strength, min:	/
Yield Strength, min:	/
Elongation 50_{mm}, min:	/

Para. 3.5.b COMPLIANCE WITH PED ESSENTIAL SAFETY REQUIREMENTS

Requirements	Annex 1 Paragraph	Complied with by	Considerations/comments
Resistance	2.2.3 (b)	ASME SA 194 GR. 4	Required certificates including: UTS, YS, RA, EL.
Wear			Not applicable
Heat treatment	3.1.4.	Not applicable	Not applicable
Traceability	3.1.5.	Material certificates	In addition to the Code required marking, all pieces shall be stamped with the procurement drawing number.
Ductility: elongation >14%	4.1(a)	ASME SA 194 GR. 4	/
Toughness: energy absorbtion 27 J min.	4.1 (a)	ASME VIII DIV. 2 para AM214 TABLE ABM-1	The impact test should be made at the lowest scheduled operating temperature (that is –15°C). The impact test will be done at –29°C. (Test performed for lot)
Creeping	4.1 (a)		Creeping not pertinent in the temperature range.
Resistance to the chemical attack	4.1(b)	OVERLAY	External bolting material not in contact with the process fluid.
Ageing	4.1(c)	Not applicable	Not applicable

Formability/workabi lty	4.1(d)	Material properties Experience	ASME SA 194, carbon and alloy steel nuts for bolts for high-pressure or high-temperature service, or both
Weldability	4.1 (d)	Not applicable	Not applicable
Joining with different material	4.1 (e)	Not applicable	Not applicable
Values for design calculations	4.2 (a)	According to ASME II Sect. "D"	
Material certificate	4.3.	Issued by supplier	According to EN10204 3.1b (the extent of inspection to be notified by N.P.)
Material characteristics	7.5.	ASME II, Sect. A ASME SA 194 GR. 4	The impact test should be made at the lowest scheduled operating temperature (that is –15°C). The impact test will be done at –29°C. (Test performed for lot)

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Para. 3.6.a MATERIAL (companion-flange)

Type:	18 Cr 8 Ni (modified with columbium)
Specification:	ASME SA 182
Issue:	July 1, 2004
Grade:	F 347
Technical reference documents:	ASME II (BOILER AND PRESSURE VESSEL CODE) MATERIALS part A, Ferrous material specifications, 2004 edition SPECIFICATION FOR FORGED OR ROLLED ALLOY-STEEL PIPE FLANGES, FORGED FITTINGS, AND VALVES AND PARTS FOR HIGH-TEMPERATURE SERVICE
Tensile Strength, min:	515 (or 485 for sections over 130 mm) MPa
Yield Strength, min:	205 MPa
Elongation 50_{mm}, min:	30%

Para. 3.6.b COMPLIANCE WITH PED ESSENTIAL SAFETY REQUIREMENTS

Requirements	Annex 1 Paragraph	Complied with by	Considerations/comments
Resistance	2.2.3 (b)	ASME SA 182 F347 (Tensile strength: 515 MPa; Yield strength, min: 205 MPa)	
Wear			Not applicable
Heat treatment	3.1.4.		Not applicable
Traceability	3.1.5.	Material certificates	In addition to the Code required marking, all pieces shall be stamped with the procurement drawing number.
Ductility: elongation >14%	4.1(a)	ASME SA 182 F 347	Minimum required elongation on 50 mm 30%
Toughness: energy absorbtion 27 J min.	4.1 (a)		This material doesn't have problem to respect this requirements (test temp. -15°C, 27 J min).
Creeping	4.1 (a)		Creeping not pertinent in the temperature range.
Resistance to the chemical attack	4.1(b)	Chemical analysis	Stainless Steel TP 347

Ageing	4.1(c)		Not applicable
Formability/workabilt y	4.1(d)	Material properties experience	ASME SA 182, specification for forged or rolled alloy-steel pipe flanges, forged fittings, and valves and parts for high-temperature service.
Weldability	4.1 (d)	Qualification process	No welding activities required during fabrication.
Joining with different material	4.1 (e)	Qualification process Experience Inconel 182 welding	No welding activities required during fabrication.
Values for design calculations	4.2 (a)	According to ASME II Sect. "D"	According to Code Case 1489-2
Material certificate	4.3.	Issued by supplier	According to EN10204 3.1b (the extent of inspection to be notified by N.P. and Technip)
Material characteristics	7.5.	ASME SA 182 F347	This material doesn't have problem to respect this requirements (test temp. -15°C, 27 J min).

RISK ANALYSIS ITEM R-001-2-3 A/B

Manufacturers:	**NUOVO PIGNONE MASSA**
Notified Body:	
Reference drawing n°:	**SUO0269055/1 ÷ SUO0269058/1 <1>**
Type of equipment:	**HYDROCRACKING REACTOR**
Design Code:	**ASME VIII DIV.2 edition 2004**
Fluid characteristics:	**Hydrocarbon (group 1, gas/vapour service)**
PED category:	**IV Modules G**
Note:	The pressure relief valves are not provided by the manufacturer. They are at User care.

	HAZARD	OPERATION	FAILURE MODE	CONSEQUENCE	LIKELIHOOD	SEVERITY	RISK	SOLUTION	NOTE
1.a	Overpressure	In service	Failure of overpressure devices	Yielding Leakage of fluid Fire Explosion	Unlikely	Critical	Negligible	Installation of safety valves	Safety valves are not provided by the manufacturer
1.b	Overpressure	In service	Human error	Yielding Leakage of fluid Fire Explosion	Unlikely	Critical	Negligible	Installation of temperature monitoring devices	See the operating manual
2.a	Over heating	In service	Failure of overheating devices	Yielding Creep Leakage of fluid Fire Explosion	Unlikely	Critical	Negligible	No action	Temper. Monitoring devices are not provided by the manufacturer

	HAZARD	OPERATION	FAILURE MODE	CONSEQUENCE	LIKELIHOOD	SEVERITY	RISK	SOLUTION	NOTE
2.b		In service	Human error	Yielding Creep Leakage of fluid Fire Explosion	Unlikely	Critical	Negligible	No action	See the operating manual
3.a	Temperature of vessel external wall surface	In service	Breaking of the external insulation	Burning	Unlikely	Critical	Negligible	No action	See the operating manual
4.a	Piping loads	In service	Failure of overpressure devices	Yielding Leakage of fluid Fire	Unlikely	Critical	Negligible	No action	
5.a	Fire	In service	Leakage of fluid	Injury to the operators Damage to the plant	Unlikely	Critical	Negligible	No action	
6.a	Temper embritlement	In service	Hydrogen with high pressure and high temperature	Brittle fracture Cracks Leakage of fluid Fire Explosion	Unlikely	Critical	Negligible	No action	See para. 3
7.a	Corrosion	In service	Fluid corrosion	Yielding Leakage of fluid Fire Explosion	Unlikely	Critical	Negligible	No action	Overlay
7.b		Transport	Atmospheric condition	Yielding Leakage of fluid Fire Explosion	Unlikely	Critical	Negligible	No action	Protective surface treatment
8.a	Wind	In service	Atmospheric condition	Yielding Breakdown Leakage of fluid Fire Explosion	Unlikely	Critical	Negligible	No action	Reference to "DIN 1055, Ed March 2005" See: SOU0107839/4 - SOU0107841/4 <1>
9.a	Leakage of fluid	In service	Welding Gasket	Fire Explosion	Unlikely	Critical	Negligible	No action	Planned maintenance

	HAZARD	OPERATION	FAILURE MODE	CONSEQUENCE	LIKELIHOOD	SEVERITY	RISK	SOLUTION	NOTE
9.b			Failure of overpressure devices	Fire Explosion	Unlikely	Critical	Negligible	No action	Safety valves are not provided by the manufacturer
9.c			Human error	Fire Explosion	Unlikely	Critical	Negligible	No action	See the operating manual
10.a	Earthquake	In service	Place of installation	Yielding Breakdown Leakage of fluid Fire Explosion	Unlikely	Critical	Negligible	No action	

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Section	PED Essential Safety Requirements (Annex 1)	Code Reference	Evidence of Compliance
1	**General**		
1.1	Pressure equipment must be designed, manufactured and inspected, equipped and installed to ensure its safety during service in accordance with the Manufacturer's working instructions.		
1.2	The Manufacturer must apply the following principles: - Eliminate or reduce hazards insofar as reasonably practical. - Apply appropriate protection methods against all hazards. - Inform end user of all residual hazards.		See para. 4
1.3	Pressure equipment must be designed against any foreseeable misuse and/or adequate warning given against any misuse.		Operating instructions
2	**Design**		
2.1	**General** Pressure equipment must be designed to ensure that it is safe throughout its intended design life and that all appropriate safety factors have been incorporated	ASME Section VIII Div 2 Ed. 2004 AG-100	
2.2	**Design for adequate strength**		
2.2.1	The pressure equipment must be designed for all appropriate load conditions for its intended use and take into account the following: - Internal/external pressure. - Ambient/operational temperature. - Static pressure and mass of contents (operating and test). - Transportation, wind, earthquake loading. - Reaction forces and moments due to supports, attachments, piping etc. - Corrosion and erosion, fatigue etc.	ASME Section VIII Div 2 Ed. 2004 AD-110 AD-160	<1> SOU0107838/4 (ITEM D-6211 / D-6231), SOU0107840/4 (ITEM D-6212 / D-6232), Pressure Parts Calculation. SOU0107839/4 (ITEM D-6211 / D-6231), SOU0107841/4 (ITEM D-6212 / D-6232), Structural part Calculation. SOU0107844/4 (ITEM D-6211 / D-6231), SOU0107845/4 (ITEM D-6212 / D-6232), Skirt

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Section	PED Essential Safety Requirements (Annex 1)	Code Reference	Evidence of Compliance
			Stress Analysis. Fatigue is not applicable.
2.2.2	The design must be based on, as a general rule, a calculation method and supplemented, if necessary by an experimental design method.	ASME Section VIII Div 2 Ed. 2004 ASME B31.3-2006 <1>	Only the calculation method has been used, no experimental design method.
2.2.3	**Calculation Method**		
2.2.3 (a)	**Pressure Containment and other Loading Aspects** Allowable stresses must be limited with regard to any foreseeable failure modes under operating conditions with the appropriate safety factors applied. These requirements may be met by applying one or more of the following: - Design by formula. - Design by analysis. - Design by fracture mechanics.	ASME Section VIII Div 2 Ed. 2004 ASME Section II part D, tables Y-land 2A	Design by formula only.
2.2.3 (b)	**Resistance** The resistance of the pressure equipment must be established by applying appropriate design calculations. - The design pressure must not be less than the maximum allowable pressure and take account of the static head, dynamic fluid forces and the decomposition of unstable fluids. - The design temperature must allow for the appropriate safety margins. - The design must take account of all possible combination of pressure/temperature. - Maximum stresses and peak stress concentration must be within safe limits. - The calculation of the pressure containment must utilise values appropriate to the material properties, based on documented data and having appropriate safety factors. - Appropriate joint factors must be applied. - The design must take account of all foreseeable degradation mechanism and highlighted in the operating instructions.	ASME Section VIII Div 2 Ed. 2004 Article 4-1 Article D-1 AD 110 AD-115 AD-121 AD-130 AD-132 AD-104 AD-105 AD-150 ASME B31.3-2006 <1> for top spool	
2.2.3 (c)	**Stability Aspects** Adequate precautions must be made to the equipment to censure		Shipping Drawing Document

Section	PED Essential Safety Requirements (Annex 1)	Code Reference	Evidence of Compliance
	structural stability during transportation and handling.		
2.2.4	**Experimental design method.** The design of the pressure equipment may be validated, in all or part by an appropriate test programme being carried out on a representative sample. The test programme must be clearly defined prior to testing and the test programme must include: - A pressure strength test to check that equipment does not exhibit leaks or deformation exceeding a determinate threshold. - If necessary, appropriate tests if creep or fatigue exists. - Where necessary, additional tests concerning other factors, i.e. corrosion, external damage etc.		Not Applicable
2.3	**Provision to ensure safe handling and operation.** The method of operation specified must be such as to prevent any reasonable foreseeable risk in operation of the pressure equipment. Particular attention to the following: - Closures and openings - Dangerous discharge of pressure relief blow off. - Devices to prevent physical access into the equipment whilst pressure or a vacuum exists. - Surface temperature. - Decomposition of unstable fluids. Furthermore, quick release access doors must be equipped with devices to prevent hazards from the fluid pressure or temperature.	ASME Section VIII Div 2 Ed. 2004 Article D-10 AD-414.1	Operating instructions
2.4	**Means of Examinations.** - Pressure equipment must be designed and constructed in such a way as to ensure that all necessary examination can be carried out. - The ability to determine the internal condition of pressure equipment. - The application of alternative methods to ensure the safe condition of pressure equipment.	ASME Section VIII Div 2 Ed. 2004 Article D-10 AD-414.1	There is a manhole.
2.5	**Means of Draining and Venting.** Where appropriate, the pressure equipment must be provided with methods for draining and venting: - To prevent water hammer, vacuum collapse, corrosion and chemical reactions etc. - To permit cleaning, inspection and maintenance.	ASME Section VIII Div 2 Ed. 2004 Article D-10 AD-414.1 AI-120	<1> SOU0107838/4 (ITEM D-6211 / D-6231), SOU0107840/4 (ITEM D-6212 / D-6232), Pressure Parts

Section	PED Essential Safety Requirements (Annex 1)	Code Reference	Evidence of Compliance
			Calculation.
2.6	**Corrosion or Other Chemical Attack.** Adequate allowance or protection against corrosion or other chemical attack must be provided.	ASME Section VIII Div 2 Ed. 2004 AD-115 AD-1000 A-101 AM-100	Additional welded overlay
2.7	**Wear** Adequate measures must be taken against the effects of erosion and abrasion: - In the design, i.e. cladding, linings etc. - By replacements parts. - Referenced in the operating instructions.	ASME Section VIII Div 2 Ed. 2004 AD-115 AD-1000 A-101 AM-100	Additional welded overlay
2.8	**Assemblies** Assemblies must be designed that: - The components are suitable and reliable for their duty. - The components are properly integrated and assembled.		Not applicable
2.9	**Provision for Filling and Discharge** Where applicable, the pressure equipment must be designed and provided with accessories, or provision made for their fitting, to ensure safe filling or discharge: - On filling; by overfilling overpressure and fluid instability. - On discharge: by uncontrolled release of fluid. - On filling or discharge: unsafe connection or disconnection.		Not applicable
2.10	Protection Against Exceeding the Allowable Limits of Pressure Equipment The pressure equipment must be fitted with, or appropriate provision made for, the fitting of suitable safety devices which are determined on the characteristics of the equipment.		It is the responsibility of the user to ensure that the required pressure limiting devices are properly installed prior to initial operation
2.11	**Safety Accessories**		

Section	PED Essential Safety Requirements (Annex 1)	Code Reference	Evidence of Compliance
2.11.1	**Safety Accessories** - Be designed and constructed to be reliable and suitable for their intended duty, including maintenance and testing. - Be independent or unaffected by other functions. - Comply with appropriate design principles in order to obtain suitable and reliable protection.		It is the responsibility of the user to ensure that the required pressure limiting devices are properly installed prior to initial operation
2.11.2	**Pressure Limiting Device** These devices must be designed so that pressure will not permanently exceed the maximum allowable design pressure except for short pressure surges of 1.1 times the design pressure.		It is the responsibility of the user to ensure that the required pressure limiting devices are properly installed prior to initial operation
2.11.3	**Temperature Monitoring Devices** These devices must have an adequate response time on safety grounds.		Thermocouple are at supplier care. It is the responsibility of the user to ensure that thermocouple are properly installed prior to initial operation
2.12	**External Fire** Where appropriate, the pressure equipment must be fitted with, or appropriate provision made for, the fitting of suitable equipment/devices to meet damage-limitation requirements in the event of an external fire.		It is the responsibility of the user to ensure that a fireproofing for the skirt is properly installed prior to initial operation
3	**Manufacturing**		

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Section	PED Essential Safety Requirements (Annex 1)	Code Reference	Evidence of Compliance
3.1	**Manufacturing Procedures** The manufacturer must ensure the competent execution of the provision set out at the design stage by applying appropriate techniques and relevant procedures.		
3.1.1	**Preparation of the Component Parts** Preparation of the Component Parts must not give rise to defects or cracks or changes in mechanical characteristics likely to be detrimental to the safety of the pressure equipment.	ASME Section IX	SOU0111416/4 Welding Summary Sheet
3.1.2	**Permanent Joining** - Permanent joints and adjacent zones must be free of any surface or internal defects detrimental to the safety of the equipment. - Properties to meet the minimum specified for the materials to be joined or taken into account in the design calculations. - Permanent joining of components to be carried out by suitably qualified personnel according to suitable operating procedures. - For pressure equipment in Categories II III and IV, the operating procedures and personnel must be approved by a Recognised Third Party/ Notified Body.	ASME Section IX ASME Section VIII Div 2 Ed. 2004 Article F-2	SOU0111416/4 Welding Summary Sheet
3.1.3	**Non-Destructive Tests** For pressure equipment, non-destructive tests of permanent joints must be carried out by suitably qualified personnel. - For Category III and IV equipment, the personnel must be approved by a Recognised Third Party.		SOU01100203-06/4 <1> Fabrication and inspection plan for part or component
3.1.4	**Heat Treatment** Where applicable, suitable heat treatment must be applied at the appropriate stage of manufacture.		SOU0113843/4 PWHT and LPWHT procedure
3.1.5	**Traceability** Suitable procedures must be established and maintained for identifying the materials making up the components of the equipment which form the pressure containment.		See Final Data Book and NP proc. ETV00091
3.2	**Final Assessment** Pressure equipment must be subjected to a final assessment as		

Section	PED Essential Safety Requirements (Annex 1)	Code Reference	Evidence of Compliance
	described below.		
3.2.1	**Final Inspection** Pressure equipment must undergo a final inspection to assess visually and by examination of accompanying documentation, compliance with the requirements of the Directive: - Account taken of tests carried out during manufacture. - Internal and external examination as far as possible on all components to be carried out.		SOU01100203-06/4 <1> Fabrication and inspection plan for part or component
3.2.2	**Proof test** Final assessment of the pressure equipment must include a test for the pressure containment, normally a hydrostatic pressure test to the requirements of 7.4. - Category 1 series produced equipment can be tested on a statistical basis. - Where the hydrostatic test is harmful or impracticable, alternative tests of a recognised value maybe carried out.		<1> SOU0107838/4 (ITEM D-6211 / D-6231), SOU0107840/4 (ITEM D-6212 / D-6232), Pressure Parts Calculation.
3.2.3	**Inspection of safety devices** For assemblies, the final assessment must include a check on the safety devices intended to check full compliance with the requirements referenced in 2.10.		Not applicable
3.3	**Marking and Labelling** In addition to the CE marking, the following must also be provided:		
3.3 (a)	For all pressure vessels: - The name and address or other means of identification of the manufacturer - The year of manufacture - Identification of the pressure equipment according to its nature - Essential maximum/minimum allowable limits.		
3.3 (b)	**Depending on the Type of Pressure Equipment** - The volume V of the pressure equipment in L (litres). - The nominal size for piping DN. - The test pressure PT applied in bar and date. - Safety device set pressure in bar. - Output of the pressure equipment in kW.		

Section	PED Essential Safety Requirements (Annex 1)	Code Reference	Evidence of Compliance
	- Supply voltage in V (Volts). - Inteded use. - Filling ratio in kg/L - Maximum filling mass in kg. - Tare mass in kg. - The product group.		
3.3 (c)	Any further information necessary for safe installations, operation or use, maintenance or inspection should also be provided, and any warnings against misuse must be fixed to the equipment.		
3.4	**Operating Instructions**		
3.4 (a)	All items of pressure equipment when place on the market must be accompanied with instructions for the user, containing the necessary safety information relating to: - Equipment mounting, including assembling of different pieces of the pressure equipment. - Putting into service. - Use. - Mainteinance, including check by the user.		See Operating Instructions
3.4 (b)	The instructions must cover all the information attached on the pressure equipment in accordance with 3.3.		See Operating Instructions
3.4 (c)	If appropriate, these instructions must also refer to hazards arising from misuse.		See Operating Instructions
4	**Materials** Materials use for the manufacture of pressure equipment must be suitable for the required application during the scheduled lifetime unless replacement is expected.		
4.1	**Materials for Pressurised Parts**	ASME II Ed. 2004 add. ASME SA-542 GR. D CL. 4a ASME SA-336 F22V ASME SA-182 F22V ASME SA-193 GR. B16 ASME SA-194 GR. 4 ASME SA-182 F 347	SOU0112430/4 See para 3
4.1 (a)	They must have appropriate properties for all the operating and test		SOU0112430/4

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Section	PED Essential Safety Requirements (Annex 1)	Code Reference	Evidence of Compliance
	conditions and should be sufficiently ductile and tough (reference should be made to 7.5). the effect of brittle fracture should also be considered if applicable.		See para 3
4.1 (b)	They must be chemically resistant to the fluid contained in the pressure equipment.		SOU0112430/4 See para 3
4.1 (c)	They must not be significantly affected by ageing.		SOU0112430/4 See para 3
4.1 (d)	They must be suitable for the intended processing procedures.		SOU0112430/4 See para 3
4.1 (e)	They must be selected to reduce undesiderable effects from the joining process.		SOU0112430/4 See para 3
4.2 (a)	The manufacturer must define in an appropriate manner the values necessary for the design calculations (referred to in 2.2.3) and essential characteristics of the materials and their treatment (referred to in 4.1).		SOU0112430/4 See para 3
4.2 (b)	The manufacturer must provide technical documentation relating to compliance with material specifications of the Directive in one of the following forms: - Materials complied with armonised standards - Materials covered by European Approval of Pressure Equipment Materials. - Particular material appraisal.		See para 3
4.2 (c)	For category III and IV equipment, the particular material appraisal must be carried out by the Notified Body in charge of the conformity assessments		See para 3
4.3	The manufacturer must take appropriate measures to ensure that the material conforms with the required specification and the documentation prepare by a material manufacturer confirms compliance with a specification. For main pressure parts in categories II, III and IV this must take the form of a certificate of specific product control.		At least certificate 3.1.b
SPECIFIC PRESSURE EQUIPMENT REQUIREMENTS			
In addition to the applicable requirements of the above Sections 1 to 4, the following requirements apply to the pressure equipment covered by section 5 and 6.			
5	**Fired or Otherwise Heated Pressure Equipment with a Risk of Overheating** This pressure equipment includes: - Steam and hot water generators. - Process-heating vessels other than steam or hot water generation. **Fired or Otherwise Heated Pressure Equipment with a Risk of Overheating Cont'd**		Not applicable

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Section	PED Essential Safety Requirements (Annex 1)	Code Reference	Evidence of Compliance
	This pressure equipment must be calculated, design and constructed so as to minimise the risk of loss of containment due to overheating. - Appropriate means of protections must be provided to restrict operating parameters in order to avoid risk of local and general overheating. - Sampling points must be provided for the evaluation of properties of the fluid so as to avoid risks from deposit and/or corrosion. - Adequate provisions must be made to eliminate the risk of damage from deposits. - Means must be provided for the safe removal of residual heat after shutdown. - Steps must be taken to avoid the dangerous accumulation of combustible substances and air, or flame blowback.		
6	**Piping** The design and construction must ensure: - The risk of overstressing from inadmissible free movement or eccessive forces being produced is adequately controlled. - Where there is a possibility of condensation occurring inside pipes for gaseous fluids there are means provided for drainage and the removal of deposits from low areas. - Due considerations is given to the potential damage from turbolence and the formation of vortices. - The consideration is give to the risk of fatigue due to pipe vibration. - That, where fluids of Group 1 are contain in the piping, appropriate means are provide to isolate "take-off" pipes. - The risk of inadvertent discharge is minimised. - The position and route of underground piping is at least recorded in the technical documentation.		Not applicable
7	**Specific Quantitative Requirements for Certain Pressure Equipment.** The following provisions apply as a general rule only. If however, they are not fully applied, the manufacturer must demonstrate that appropriate measures have been taken to achieve an equivalent overall level of safety. The subsequent provisions listed in this section supplement to essential requirements of sections 1 to 6 for the pressure equipment to which they apply.		
7.1	**Allowable Stresses**		
7.1.1	**Symbols:**		

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Section	PED Essential Safety Requirements (Annex 1)	Code Reference	Evidence of Compliance
	$R_{e/t}$ (yield strength at the design temperature) The upper flow limit for a material presenting upper and lower limits. The 0.1% proof strength of austenitic steel and not alloyed aluminium. The 0.2% proof strength in all other cases. $R_{m/20}$ (tensile strenght at 20°C). $R_{m/t}$ (tensile strength at the design temperature).		
7.1.2	The maximum permissible general membrane stress for static pressure loading, for equipment being operating outside the temperature range where creep is significant must not exceed the lowest value below: - Ferritic steels (including normalise, normalised rolled, steel and escluding fine grined steel and specially heat-treated steel), 2/3 $R_{e/t}$ or 5/12 $R_{m/20}$.	ASME Section VIII Div 2 Ed. 2004, Article 4-1 ASME Section II part D, tables Y-1and 2A	t=849.2°F (454°C) 5/12 $R_{m/20}$=35.42 ksi 2/3 $R_{e/t}$=32.65 ksi Allowable Stress $S_{m/t}$=24,5 ksi
7.2	**Joint Coefficients** For welded joints, the joint coefficient must not exceed the following: - For equipment subject to destructive and non-destructive tests confirming that the whole series of joints show no significant defects: 1,00.	ASME Section VIII Div 2 Ed. 2004	E=1
7.3	**Pressure Limiting Devices** The momentary pressure surge (referred to 2.11.2) to be kept to 10% of the design pressure.	ASME Section VIII Div 2 Ed. 2004, Article R-1	It is the responsibility of the user to ensure that the required pressure limiting devices are properly installed prior to initial operation
7.4	**Hydrostatic Test Pressure** The hydrostatic test pressure (referred to in 3.2.2) must not be less than: - The maximum loading to which the pressure equipment may be subject in service, taking account its maximum allowable pressure and temperature, multiplied by the coefficient 1,25 - The maximum allowable pressure multiplied by the	ASME Section VIII Div 2 Ed. 2004, Article T-3 and ASME B31.3-2006 for top spool <1>	<1> SOU0107838/4 (ITEM D-6211 / D-6231), SOU0107840/4 (ITEM D-6212 / D-6232), Pressure Parts Calculation.

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Section	PED Essential Safety Requirements (Annex 1)	Code Reference	Evidence of Compliance
	coefficient 1,43 whichever the greater. Note: Even if the top spool is calculated according to ASME B31.3-2006, it is tested with the vessel at the test pressure of the vessel itself in compliance with ASME B31.3 paragraph 345.4.3. <1>		
7.5	**Material Characteristics** A steel is considered to be ductile if its elongation after rupture is not less than 14%, and its impact strength measured on a standard ISO V test at 20°C, or the lowest scheduled operating temperature is greater than 27J.	ASME Section II part A	See para 3

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Nuovo Pignone MASSA	CUSTOMER - KUNDE **CONOCOPHILLIPS LTD**
	PLANT LOCATION - ANLAGEORT **WILHELMSHAVEN (GERMANY)**
JOB - AUFGABE **3100274-75-76-77**	PLANT - ANLAGE **WILHELMSHAVENER RAFFINERIEGESELLSCHAFT BMH. WRG-DEEP CONVERSION PROJECT**

TITLE - TITEL

***Title** (Titel):*

PRESSURE VESSELS OPERATING MANUAL

DRUCKBEHÄLTER BETRIEBSANLEITUNG

TYPE (Typ) — **PRETREATING REACTORS D-6211 / D-6231**
HYDROCRACKING REACTORS D-6212 / D-6232

FABRICATION SERIAL NUMBERS — **85502, 85503, 85504, 85505**
HERSTELLNUMMERN

YEARS OF FABRICATION — **2007, 2008**
HERSTELLUNGSJAHRE

TOTAL PAGES: 64
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ITEM **D-6211-12-31-32**

N. SOU0120328/4

LINGUA-LANG.	PAGINA-SHEET
A-D	**1 / 2**

REPLACES - ERSETZT — PARI NUMERO
REPLACED BY - ERSETZT DURCH

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This manual has been prepared to assist in the installation, operation and maintenance of the Pressure Vessels D-6211-12-31-32. We urge you to read and follow all of the direction in this manual. Anyway, the purpose of this manual is not to cover all situations and it is not intended to be a substitute of the Owner internal procedures applicable in the plant where these vessels will be installed.

The instructions contained in this manual are not intended to describe the vessels in minute details, or to cover any situation that might come up in relation to the installation, operation and maintenance of every vessel. The mere fact of having provided this instruction manual does not mean that Nuovo Pignone agrees to take on any of the responsibility for the activity carried out by the Owner or by the Contractors. Nuovo Pignone's responsibility is limited to what is laid out in the Sales Conditions.

If you have a problem that is not covered in this manual please do not hesitate to contact Nuovo Pignone' nearest sales office or representative.

1.0 GENERAL INDICATIONS

1.1 FOREWORD

This manual contains the installation, operation and maintenance instructions of the Nuovo Pignone HDC vessels laid out in the data sheets included in this manual. The User must read all of details before installation and start up the vessels.
The manual should be kept within easy reach, so that it can be readily consulted at any time during the operation and the maintenance of the vessels.

WARNING

For the sake of safety, the personnel in charge of operating and carrying out maintenance to these vessels should read the whole of this manual. IF INSTALLATION, OPERATION, MAINTENANCE AND PARTS REPLACEMENT ARE NOT CARRIED OUT CORRECTLY, THEY COULD CAUSE INJURY AND DAMAGE TO THESE VESSELS, TO THE AUXILIARY EQUIPMENTS, TO THE PLANT AND PEOPLE IN THE NEAREST.

1.2 WARRANTY

The guarantee period for the supply will be 30 months after the start up or 42 months from the date of the last shipping vessel.
During this period, Nuovo Pignone will repair, substitute all the defective parts, if the pressure vessels have been operated according to the instruction, operation and maintenance indications stated by Nuovo Pignone itself and included in this manual.

2.0 DESCRIPTION and TECHNICAL DATA

2.1 GENERAL

The supplied equipments are pressure vessels designed, fabricated and inspected in compliance with Customer specifications and with the applicable codes and norms mentioned regulating this kind of constructions.
For inlet fluid (composition and process data) and for functional performances to be guarantee, make reference to UOP and Fluor documentation.

2.2 CODES, NORMATIVE, STANDARDS AND APPLICABLE SPECIFICATIONS

2.2.1 "CE" MARKING

The pressure vessels are supplied and marked CE in accordance with requirements of directive n. 97/23/EC relevant to the pressure equipments (P.E.D. Pressure Equipment Directive) for Hydrocarbon (**group 1, gas/vapour service category IV module G**).
Notified Body used for inspection and conformity verification to PED is Lloyd's Register.
On the vessels, is applied the CE nameplate reported on the appendix A.

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2.2.2 CODES and STANDARDS for PRESSURE PART DESIGN

97/23/EC	Pressure Equipment Directive
API RP 934	Materials and Fabrication Requirements for 2-1/4 Cr 1 Mo & 3 Cr – 1 Mo Steel Heavy Wall Pressure Vessels for High Temperature, High Pressure Service.
ASME II, part A Ed. 2004	Boiler and pressure vessel code – Materials
ASME II, part D Ed. 2004	Boiler and pressure vessel code – Allowable stresses
ASME VIII, Div.2 Ed. 2004	Boiler and pressure vessel code – Rules for construction of pressure vessels
ASME B31.3-2006	Process piping <2>
ASME/ANSI B16/5, B16/47	Flanges, pipes and fittings.
ASME IX Ed. 2004	Welding
DIN 1055 Ed. March 2005	Design loads for buildings

2.2.3 CODES and STANDARDS for WIND and EARTHQUAKE VERIFICATION

Wind effect has been evaluated according to DIN 1055 - Design loads for buildings and FLUOR – Site and Utility Data – doc. Number 595705-225-002.
– Earthquake is not applicable as stated in Site and Utility Data – doc. Number 595705-225-002.

2.2.4 CUSTOMER SPECIFICATION

UOP Project Specification n° 939031-304 Rev.0
UOP standard specification N° 3-17-3 (01 Sept. 04) Pressure vessels ASME VIII Div.2
Purchase Order Number: 4507960234-1 Rev 0, March 8, 2010 (8959N WILHELMSHAEN UPGRADE PROJECT Re-certification of the reactors items D-6211/D-6212/D-6231/D-6232 <2>

2.3 UNITS

Length	millimetres	(mm)
Area	square millimetres	(mm^2)
Volume	cubic meters	(m^3)
Force	Newton	(N)
Moment	Newton per millimetre	(Nm)
Stress	mega Pascal	(Mpa)
Pressure	Bars	(Bar)
Temperature	Celsius degrees	(° C)

2.4 REF. DOCUMENTATION

The documents reported on the appendix B are issued by Nuovo Pignone and sent for approval to Client and Lloyd's Register. Documentation is reviewed including the comments and it is attached, in AS BUILT version, to the final data book.

2.5 TECHNICAL CHARACTERISTICS AND PERFORMANCES

These pressure equipments are constituted of a cylindrical body and two hemispherical heads. They are positioned in vertical position and they are supported by a steel skirt. They have been properly designed in respect of the design data here below indicated.

ITEM	D-6211/D-6231	D-6212/D-6232
Internal design pressure	198,5 Bar (g)	191,5 Bar (g)
Internal design temperature	454 °C	454 °C
External design pressure	1,03 Bar (g)	1,03 Bar (g)
External design temperature	177 °C	177 °C
Max Operating temperature	445 °C	439 °C
Stress Relieved	YES	YES
Internal corrosion allowance	TP 347 W.O.	TP 347 W.O.
TOFD / RT	FULL	FULL
Joint Efficiency %	100 %	100 %
Hydrotest pressure (vertical)	288 Bar (g)	277 Bar (g)
Hydrotest pressure (horizontal)	291 Bar (g)	282 Bar (g)
Capacity	585 m^3	585 m^3

Data have been reported on the nameplates applied to the vessels (see appendix A).

The fluid to be processed in the vessels is a liquid phase consisting of the petroleum cut, which is only partially vaporized at the temperatures and pressures at which the reaction occurs. The gas phase is rich in hydrogen and contains light hydrocarbons present in the feed or produced by the reaction.

In order to avoid corrosion phenomena on the pressure containing parts, as required in the contractual documentation, the vessel is internally weld overlaid 4.2 mm thk. with stainless steel TP 347.

The perfect vessels operation and the performance are guaranteed only in case that the design conditions are respected.

The nozzles have been designed in such way to resist also to the specified external loads (see fabrication drawings sheet 1/5).

<u>SPECIFIED EXTERNAL LOADS SHALL NOT BE NEVER EXCEEDED</u>

<u>Surfaces treatment and painting:</u>

- Sand Blasting and painting is not applicable

Stainless steel materials shall be neither sand blast nor painted.

The Owner shall provide adequate thermal insulation for all hot surfaces, and fireproofing on internal / external surfaces of support skirt. According to contractual terms, Nuovo Pignone supply do not includes the insulation.

WARNING: <u>NO WELDING IS ALLOWED ON 2 ¼ Cr 1 Mo and 2 ¼ Cr 1 Mo ¼ V MATERIALS AFTER FINAL PWHT</u>.

2.6 OVERALL DIMENSIONS (See sketch sheets 10 and 11)

Here below we summarize the principal dimensional data of the pressure vessels:

ITEM	D-6211 / D-6231	D-6212 / D-6232
Internal Diameter (with overlay)	4300 mm	4300 mm
Length BTL to TTL	37000 mm	37000 mm
Total length	49727,2 mm	49667,2 mm
Shell thk	270 + 4,2 W.O. mm	260 + 4,2 W.O. mm
Internal Volume	585 m^3	585 m^3
Weight (erection)	13605 kN	13139 kN

2.7 NOZZLES LIST

Nozzles are indicated with an own identification number. They shall be used only for the indicated required service. Nuovo Pignone is not responsible of malfunctions and accidents due too a no correct utilization of nozzles.
The detailed list of nozzles for every couple of pressure vessels have been reported on appendix D. Their elevation and orientation is shown on the vessels fabrication drawings.

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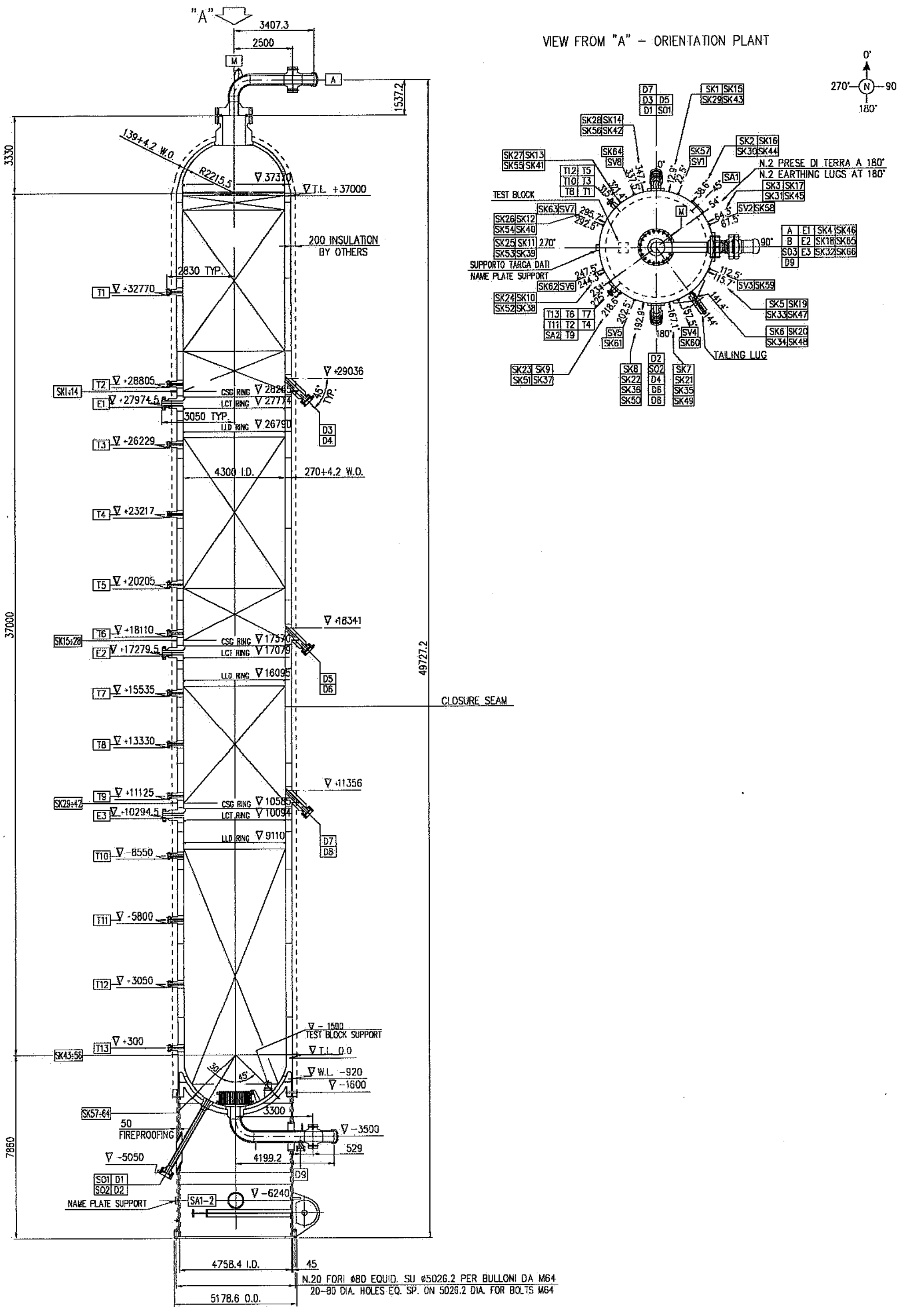
OVER-ALL DIMENSIONS ITEMS D-6211 / D-6231

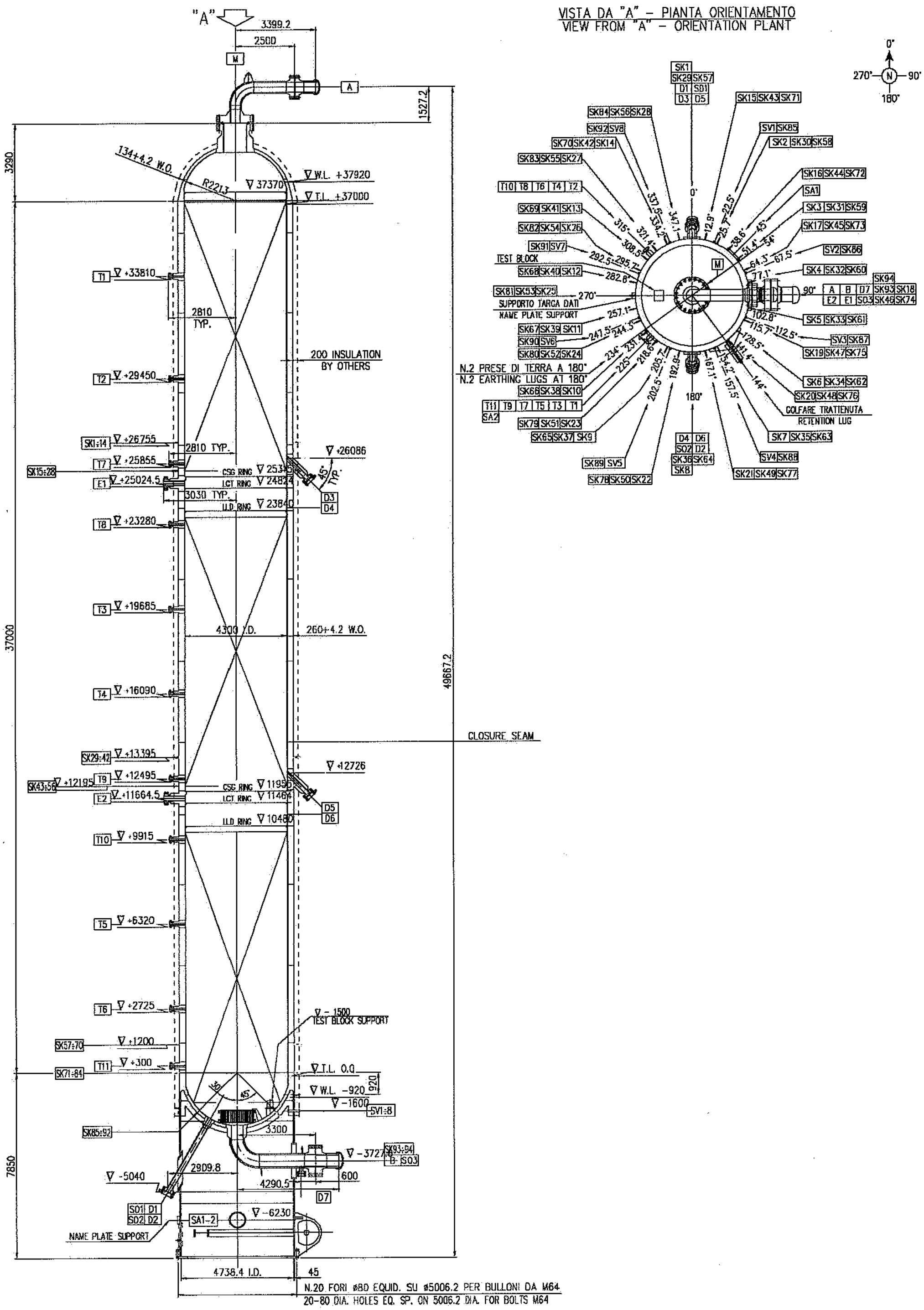


		ITEM	D-6211-12-31-32
2	REVISED WHERE INDICATED <2>		
1	GENERAL REVISION	N. SOU0120328/4	
0	EMISSIONE - ISSUE	LINGUA-LANG.	PAGINA-SHEET
REV.	DESCRIZIONE - DESCRIPTION	A-D	10 / 11

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

S7

OVER-ALL DIMENSIONS ITEMS D-6212 / D-6232



		ITEM	D-6211-12-31-32
2	REVISED WHERE INDICATED <2>		
1	GENERAL REVISION	N. SOU0120328/4	
0	EMISSIONE - ISSUE	LINGUA-LANG.	PAGINA-SHEET
REV.	DESCRIZIONE - DESCRIPTION	A-D	11 / 12

SOSTITUISCE IL - REPLACES | PARI NUMERO
SOSTITUITO DA - REPLACED BY

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3 MAIN WARNINGS AND SAFETY

3.1 GENERAL SAFETY REGULATION

These vessels have been designed and fabricated to be safe and reliable, in accordance with the project specifications.
They are heavy wall pressure vessels working at high temperature in hydrogen service.
Technical knowledge and adequate safety standards from the User are, therefore, absolutely necessary in order to avoid damage of the vessels, of the auxiliary equipments, of the environment and in order to avoid personnel injuries.
It is assumed that the User has a safety system already set up, which is based on an industrial risks analysis. Before installing, starting up, operating or carrying out maintenance on the vessels, we suggest checks are carried out to make sure that all risks coming from a pressure vessel at high temperature are covered.
It is important to give due consideration of risks coming from electrical energy, toxic and/or inflammable fluids (pressure and temperature). The correct installation and maintenance of the protections, the alarms and trip devices is necessary for the safe operation of the vessels. It should never be left running with the protections eliminated or excluded.

We remember that:

Dangerous zone is: whichever area in the nearest of a vessel, where the presence of exposed person is a risk for safety and health of that person.
Exposed person is: Any person staying in a dangerous zone partially or entirely.
Operator: People dedicated to installation, operation, control, maintenance, cleaning, transportation of a vessel.

1. User must respect all indications, recommendations and procedures reported in this manual and in the documents recalled.
2. The equipment installation have to be performed by adequate authorized and qualified operator.
3. The conditions of use provided for these vessels are laid out in the setting plans. The materials used have been selected for the project conditions (Pressure, Temperature, process fluid). Use under different conditions could prejudice the safety of people and environment.
   NOTE: The Minimum Design Metal Temperature (–15 °C for al vessels) indicated on setting plans SOU0269055/1 ÷ SOU0269058/1 are referred to the vessels new. The Owner is responsible to update the MDMT during the life of these vessels. Time by time the MDMT shall be set according to the result of maintenance inspections and tests conducted on the TEST PLATES representing the vessels material, installed on proper supports placed in the bottom head.
   Anyway Nuovo Pignone recommends to avoid vessels pressurization below a metal temperature of + 27°C. (start-up / shut down indications and considerations regarding the Minimum Pressurizing Temperature are included in this manual).
4. The people in charge of vessels operation and maintenance must carefully check and assure that the personnel are familiar with this manual and psycho, physical integer. Do not carry out any operation without having first consulted this instructional manual.
5. Do not try to start up a vessel without having understood how it works and without having determined the position of all the auxiliaries, instruments and control system.

6. Before starting up a vessel, be prepared to carry out an emergency stop, if any kind of malfunction occurs.
7. Access to a vessel area must be restricted to authorised personnel only, who must undergo appropriate training and wear the obligatory protection equipment (helmet, gloves, protective glasses, steel-toe-capped shoes).
8. Work on the control panel must be restricted to personnel with appropriate training. Varying the set points of the instruments could cause extremely dangerous situations to arise.
9. Check the appropriate instruction manuals for all the auxiliary and safety equipment related to the vessels.
10. Never start up a vessel without having checked that it has been installed correctly and without having followed all of the start up procedure.
11. The drain piping and valves, the vent piping and valves and those of vessel auxiliaries must be of a size which is adequate for the maximum working pressure and temperature. If the size is insufficient, it could cause serious damage and injury.
12. Accidental contact with a hot external vessel wall of inflammable fluids (for example if a seal leaks) could set off a fire. The User is responsible for taking precaution for the fire hazards (see normative 94/9/EC for reference).
13. Do not carry out repairs, disassembly or maintenance on a vessel while it is working.
14. Do not remove any cover, protection, sealing flange, blind flanges etc. while a vessel is working.
15. Do not replace any flange, bolt or gasket with unknown or inferior quality material. Do not mix up nuts and bolts during disassembly. Not using the right material could cause the pressure parts to yield. Before replacing any component, make sure that the spare part correspond precisely to that used for a vessel.
16. Before carrying out any maintenance operation make sure that the shutting down is correctly performed and a vessel is safe and ready for maintenance and it can be started-up. The use of appropriate safety signals to detect the state of a vessel (if it is in service or under maintenance) is recommended.
17. User must ensure that process fluid temperature shall not exceed the maximum foreseen Internal Design Temperature, by mean of temperature control system/devices or process intrinsic temperature control.
18. Equipment must be located as far as possible from:
    - every dangerous impact or friction source (i.e. maneuvering vehicles, unstable structure, working area, and so on) and must not be grinded, scratched or similarly treated;
    - stray current sources (i.e. electrical devices or lighting rods grounding);
    - lighting “catching” devises (i.e. antennas);
    - vibrations sources (i.e. ultrasound devices, vibrating machinery, and so on).
19. User must ensure that process fluid pressure shall not exceed the design pressure or the pressure giving a temperature higher than the process fluid ignition / degradation point, and that pressure variation shall be regular, without shockwaves, by mean of pressure / shockwaves control system / devices or process intrinsic pressure / shockwaves limitation.
20. The maximum surface temperature of a vessel is conditioned by the fluid flowing inside of the reactor. The installation of the equipment in potentially explosive atmosphere have to be done providing that the maximum surface temperature is compatible with the gas ignition temperature of the potential explosive atmosphere.
21. User must ensure that process fluid composition can’t ingenerate exothermic reaction, and that temperature and pressure limits shall not exceeded.

22. Each metallic part have to be connected each other and a vessel have to be connected to the earth by earth lug.

3.2 LIGHTING of VESSEL AREA

User shall provide that the area where a vessel will work, is supplied with a lighting adequate to the operations to be carried out, avoiding shadow areas and dazzling, annoying, stroboscopic effects.
We remember that an inadequate lighting could cause risk for operating personnel.

3.3 CONNECTIONS

Control pipes and instrumentation shall be connected exclusively to the vessels nozzles expressly dedicated to this purpose. Nozzles are listed at paragraph 2.7 and appendix D of this manual.

The execution of electrical connections shall comply with the general installation rules relevant the preparation and put in place of electrical installations according to CEI 64-8.

Installation and connection of electrical devices require necessarily qualified personnel. The personnel shall follows formation, training and specialization courses. Personnel shall have experience relevant to the installation and put in place. Involved maintenance people shall be aware about of prevention of accidents.

Qualified personnel shall have notions of first aid in the event of accident.

3.4 EARTHING

These pressure vessels and metallic structures shall be properly earthed. For this purpose, the pressure vessels are equipped of n° 2 proper clamps welded on the vessel skirt.
The normative CEI 81/1 settles the characteristics to be respected in the execution of earthing installation.

3.5 SAFETY DEVICES

According to the law, these pressure vessels shall be equipped with one or more rapid pressure discharge device. (the safety valves are supplied and installed by owner).

The scope of safety valves is to avoid that the pressure vessels are subjected to overpressure in case of control and automatic management system failure or operators mistake or in the event of fire.
The Owner is responsible that these vessels are adequately protected against overpressure. General requirement of ASME VIII div. 2 article R-1 and R-2 shall be meet.

WARNING : <u>Missing installation or malfunction of safety valves should cause heavy risks for operating personnel. Inspection and monitoring of safety devices are essential for safety</u>.

3.6 THERMOCOUPLES and DRAIN VALVES

Thermocouples and drain valves are out of Nuovo Pignone scope of supply.

3.7 LIFTING DEVICES

These pressure vessels are equipped with a lifting cover bolted to the flange MH instead of the top spool.
Each lifting operation shall be performed using these lifting lugs and adequate lifting devices in consideration of the weights and dimensions indicated on drawings SU-1413197/3 SU-1413198/3.
Each vessel is equipped with a tailing lug welded on the skirt. For vessel erection, the owner shall provide a proper retention device taking into account the vessel geometry and weight. The allowable stresses on these vessels, during lifting, have been indicated, by Nuovo Pignone, in the documents SOU0107839/4 and SOU0107841/4.

For transportation purpose each vessel is provided of n° 2 saddles, able to sustain the entire weight of the vessel. See drawings SUO1429235/1 , SUO1429236/1.
WARNING: **Missed respect of lifting indication could cause heavy risks for operating personnel and vessels damages.**

3.8 REFERRING NORMS

3.8.1 DIRECTIVES CONCERNING SAFETY IN A WORK PLACE

Directive 80/1107, 83/477, 86/188, 88/642 concerning operators protection against the risk due to explosion and chemical and physical agents during work.
Directive 89/321 concerning the improving of operators safety and health with particular directives 89/654 and 89/655.
Directive 90/394 concerning the operators protection against risks due to exposition at carcinogenic agents during work
Directives 77/576 and 79/640 concerning the safety system of signs on a work place.

3.8.2 DIRECTIVES CONCERNING INDIVIDUAL PROTECTION

Directives 89/656 and 89/686, concerning the use of individual protection devices

3.8.3 DIRECTIVES CONCERNING ENVIROMENT PRESERVATION

Directive 75/442, concerning refusals elimination
Directive 78/319, concerning toxic and harmful refusals elimination

4.0 INSTALLATION AND START-UP

4.1 GENERAL

In order to reduce the overall dimension during transportation, each pressure vessel is delivered without accessories carpentry and the following items.
Drawing SUO0269055-56-57-58/1
TOP SPOOL, GASKETS, BOLTS and NUTS
TOP/BOTTOM MATING FLANGE /APPENDIX
BOTTOM MATING FLANGE /APPENDIX
BLIND FLANGE, GASKETS, BOLTS and NUTS
TEST BLOCK
ANCHOR SQUARE WASHERS (mark 207)
INTERNALS

Entire internals assembly is at owner care

Is at Owner care also:

- Foundations Design and preparation (ref. to foundation template drawings n° SU 1408398/3, SU 1408400/3, SU 1408406/3, SU 1408408/3).
- Anchor bolts
- Material storage, handling and vessel erection
- Vessel setting before start- up (including observance of all safety requirements)
- Vessel Start up (see the relevant procedure in this manual)

Note: In case that some field weld is necessary, it is clearly indicated on fabrication drawings.

4.2 TRANSPORTATION, HANDLING, STORAGE and UNPACKING

The vessel shipping conditions are indicated in Nuovo Pignone drawings SUO1429238/1, SUO1429239/1.
In order to avoid infiltration of foreign matters inside the reactor, every opening is closed with a steel cover.
All temporary devices are painted with yellow paint. They shall be removed during vessel installation.
For preservation purpose during transportation and storage, the vessel is pressurized with dry nitrogen at 0.5 bar.

Accessories and spare parts are delivered properly packaged in dedicated wood boxes.
During unpacking, pay attention during metallic straps removing. They are in tension so they can cause a dangerous whip effect.

If the vessel is not immediately installed, it shall be properly protected to prevent sudden deterioration of surfaces protection.

The vessel shall be lifted exclusively using the dedicated lifting devices and using standing ropes adequate to this purpose.

4.3 PREPARATION FOR INSTALLATION.

4.3.1 GENERAL

Owner shall verify that the entire supply is in accordance with indications of the packing lists included in the shipping documentations and on fabrication drawings.
Owner shall verify the vessel operation area and the appropriateness of the foundation.

4.3.2 FOUNDATION and SUPPORT SKIRT

The foundation where a vessel will be installed is a very important matter in terms of vessel stability.
The preparation is at owner care and it shall be designed taking into account the stress induced by the vessel during its operational life. (See the general assembly drawings SUO0269055-56-57-58/1).
After the vessel erection is Owner responsibility to verify that the actual foundation has the characteristic considered during design in terms of mechanical behaviour and flatness tolerances.
The support skirt details are indicated on dwg. SUO0269055-56-57-58/1. It is fabricated using two materials. The upper section, where temperatures are very high, it has been fabricated in 2 ¼ Cr 1Mo material. The lower section is in Carbon steel (SA 516-65). The skirt shall be properly insulated in the area of skirt to shell attachment and it shall be properly fireproofed internally and externally in order to guarantee the vessel stability in case that a fire sets up.
Stresses on skirt have been deeply investigated by Nuovo Pignone (See doc. SOU0107839/4, SOU0107841/4 and SOU0107844/4, SOU0107845/).
The Owner is responsible to operate the vessel in respect of the allowable stresses indicated on Nuovo Pignone documents.

4.3.3 VESSEL ERECTION AND SETTING

- The erection and setting is at Owner care using own devices and structures.
- Considering the vessel weights indicated on fabrication drawings, adequate lifting devices shall be used.
- The anchor bolt have to be positioned with the foundation templates supplied by Nuovo Pignone.
- Anchor nuts (out of Nuovo Pignone scope of supply) and relevant square washers shall be put in place as indicated on the fabrication drawings.
- Foundation bolts tightening check.
- All temporary transportation devices shall be removed. (including the lifting covers bolted on the top man holes)
- All internals shall be installed (including test blocks).
- Requirements/suggestions to perform flange tightening are indicated in Nuovo Pignone document n° SOU0120351/4 (BOLT TENSIONING PROCEDURE).
- Insulation shall be installed where required. (Insulation supports are gage type and they are supplied loose and shall be installed on field by owner)
- The skirt surfaces (internal / external) shall be properly fire proofed. (fire proofing is not included in Nuovo Pignone scope of supply).

- These vessels shall be connected to the earthing line by the earthing clamps welded on the skirt.
- Monitoring and safety devices shall be installed. (Considering that these items are essential for safety and correct operation, they shall be handed carefully in such way to prevent damages and tampering)
- Final vessel inspection before start-up shall be performed at Owner care according to his internal procedure applicable for the plant. In any case is responsibility of the Owner to verify that, every inspection, procedure, etc applied to these vessels, does not cause injury and damages for the vessels itself and personnel and materials in the area. **In particular, in case that a pneumatic or hydrostatic test is performed, the hydrostatic test pressure indicated on the fabrication drawings shall not be exceeded.** At least the following verifications are required.
    1. **Safety devices check**
    2. **Control devices check**
    3. **Earthing connection check**
    4. **Lighting of the area check**
    5. **Vent and drain check**
    6. **Insulation status**

After the activities mentioned above these vessels can be considered ready for operation and they shall be filled with catalyst and operating fluid. Start up shall be performed according to indications of this manual.

NOTE: Catalyst dumping nozzles (D) have been closed for shipping, using the service covers and bolting but the gasket used for shop hydrotest has been left in place. Owner is responsible to replace the shipping gasket with the proper service gaskets (included in Nuovo Pignone scope of supply). For flanges retightening, reference to Nuovo Pignone document n° SOU01203351/4 (BOLT TENSIONING PROCEDURE) shall be made.

5.0 START UP AND SHUT DOWN PROCEDURE

5.1 GENERAL

This procedure describes the recommended main limits to perform a standard Start-Up and Shut-Down .

The specified value of pressure and temperature are relevant to the principal pressure part component (shell, top / bottom head and nozzles).

The heating / cooling rate and pressure gradient assumed shall be considered as maximum.

5.2 START UP LIMITS

During start-up we recommend to not exceed the following limits:

- For temperature lower than +10°C the pressure shall not be higher than 10% of design pressure.
- For temperature lower than +38°C the pressure shall not be higher than 25% of design pressure.

- Recommended pressure gradient during start-up is max. 8 bar/h for temperature lower than 120°C
- Recommended pressure gradient during start-up is max. 15 bar/h for temperature upper than 120°C
- Recommended temperature gradient is about 6÷8 °C/h for temperature lower than 120°C
- Recommended temperature gradient is about 15 °C/h for temperature upper than 120°C
-
- The application of the above procedure is strongly recommended to protect the vessel against damages during start-up and it is applicable over all core life of the vessels.
- Anyway, Minimum pressurization curves reported here below have been developed for items D-6211, D-6231, D-6212, D-6232. They have been determined by the following empirical formulas based on the results of the step-cooling test performed on samples representing the actual materials used for vessels fabrication.
- MPT25 = VTr55+2,5*(V'Tr55+10*(H ppm))-VTr55)
- MPT30 = VTr55+3*(V'Tr55+10*(H ppm))-VTr55)
- As shown in the graphics, MPT depends on the vessel age and on the actual hydrogen content diluted in the steel during pressurization. When the vessel is going to be operated for the first time, the steel hydrogen content induced during fabrication activities may be assumed 2ppm max. In this condition, the **MPT can be assumed +10 °C**. When the vessel has been operated in hydrogen service and a shut down is performed, the user has to know, the actual hydrogen content in the steel before a new pressurization occurs, in order to set the proper MPT according to the applicable graphic. User is responsible to set a suitable procedure to determine the hydrogen content in the steel.

WARNING: Reference to MPT curves shall be also made whenever a hydraulic test is to be performed at site.

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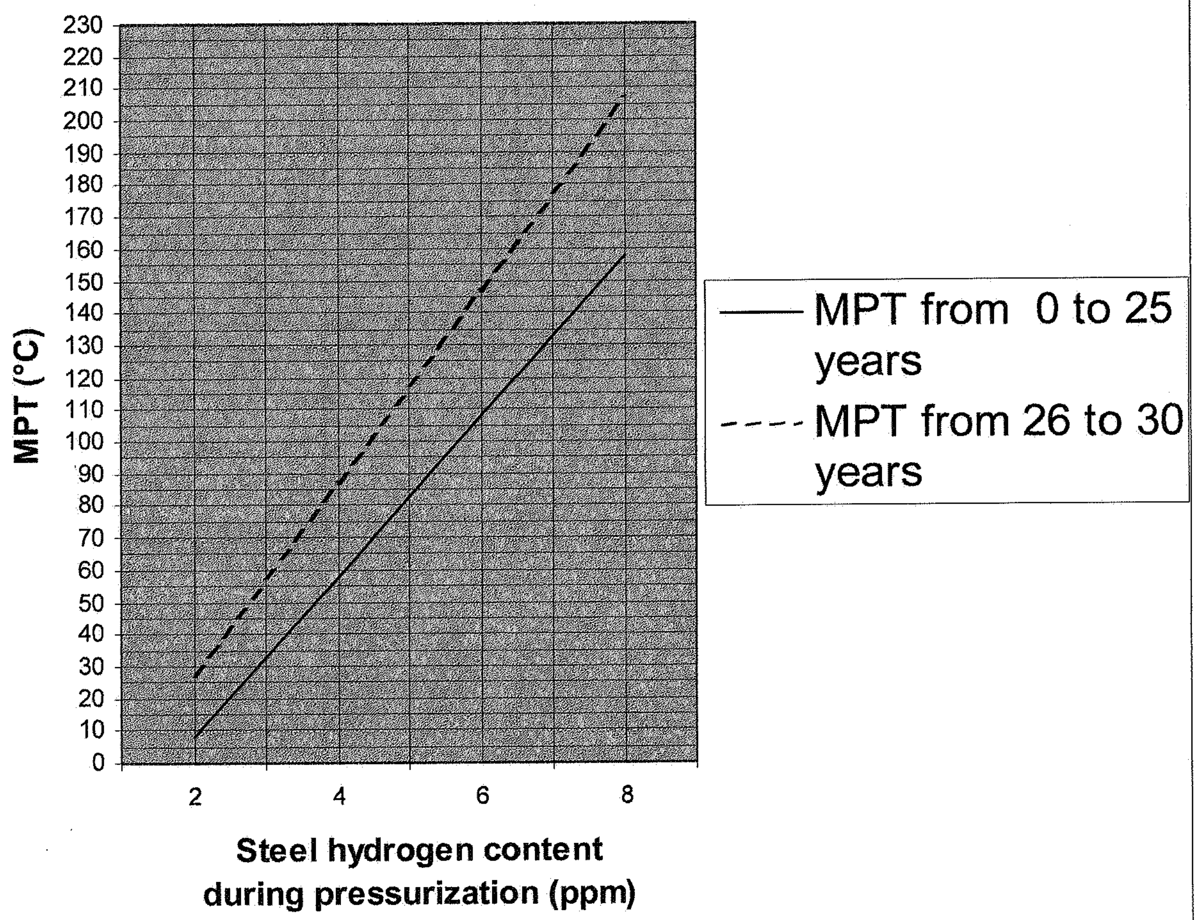
MPT curves ITEMS D-6211, D-6231, D-6212



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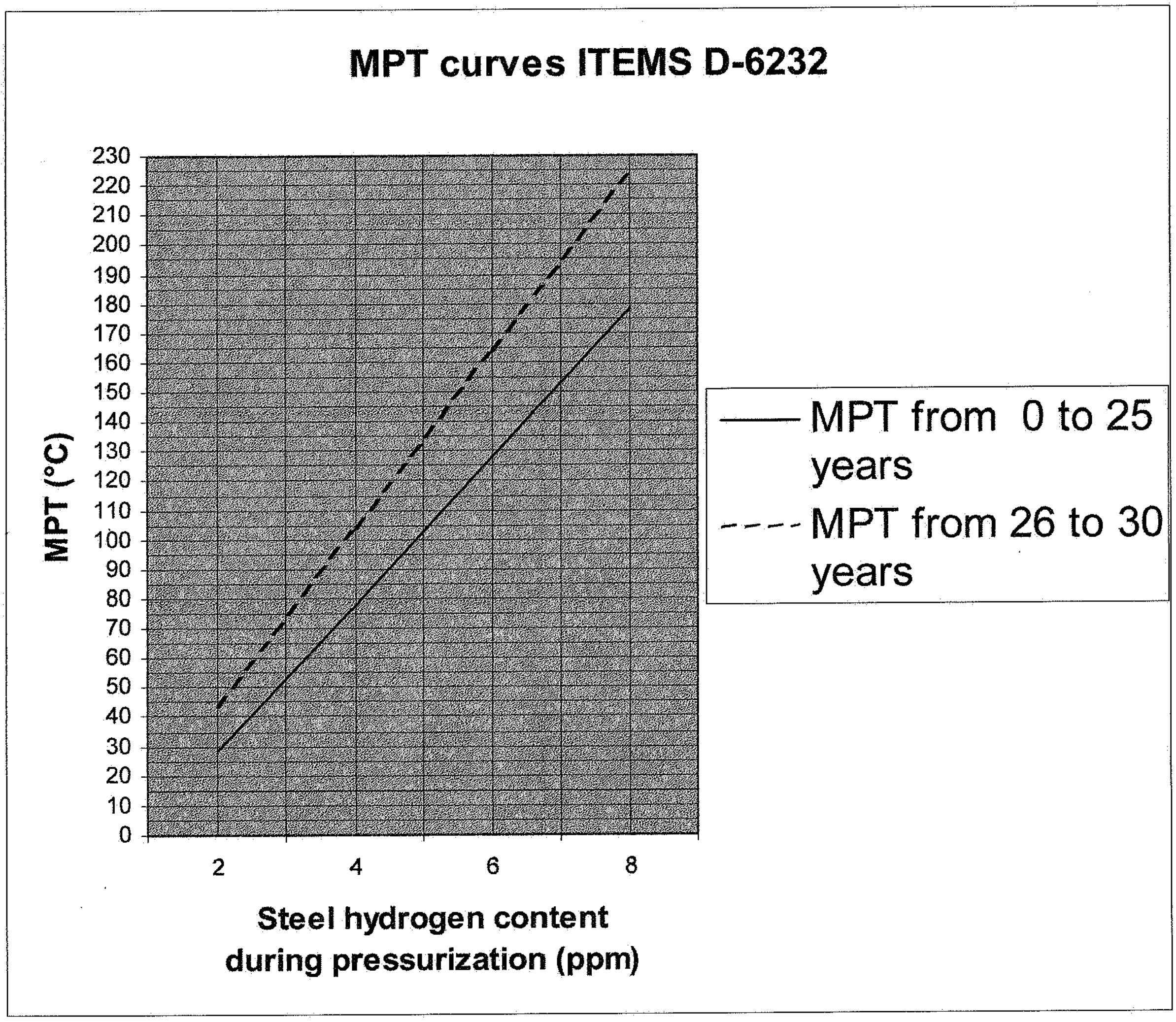

MPT curves ITEMS D-6232
MPT (°C)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
2
4
6
8
Steel hydrogen content during pressurization (ppm)
MPT from 0 to 25 years
MPT from 26 to 30 years

5.3 SHUT DOWN LIMITS

During shut-down we suggest to not exceed the following limits:

- It is recommended to maintain the vessel warm until sufficient time has elapsed for out-gassing of hydrogen from the vessel wall (example 315°C for 18h or 250°C for 40h or equivalent gradient). The out-gassing have to be done under nitrogen circulation at 40 bar max (7 bar as nitrogen pressure is acceptable).
- Recommended pressure gradient is max. 10 bar/h.
- Recommended temperature gradient is max 20 °C/h.

WARNING: In case of an emergency shut-down has to be performed, the user is responsible to undertaken all necessary actions, and to provide adequate systems to maintain the vessel warm for a sufficient time to allow hydrogen outgassing and to contain the pressure release at the lowest possible rate.

6.0 MAINTENANCE AND PERIODICAL INSPECTIONS

6.1 GENERAL

Maintenance activities, require specific knowledge so, they shall be performed by qualified and authorized personnel only. They shall be planned and performed at Owner care, according to the refinery internal procedures and local laws, taking into account Nuovo Pignone recommendation herein included.

Maintenance activities shall be performed after shut down when the vessel is completely depressurised and cold.
The shut down shall be performed according to indications of this manual.

Nuovo Pignone point out that, indications given in this section are finalized to the vessel operation in respect of safety and performances. Owner is responsible to apply all additional procedures in respect of the applicable laws /normative / directives in force in the country where the vessel is operating.

6.2 PERIODIC MAINTENANCE and INSPECTIONS

The following actions are periodically recommended on each vessel:

1. **Safety devices check**
2. **Control devices check**
3. **Earthing connection check**
4. **gaskets and gasket seats status**
5. **Illumination of the area check**

6. **Vent and drain check**
7. **Insulation and fireproofing status**
8. **internals cleaning**
9. **mechanical tests on test blocks**
10. **Ultrasonic examination of weld deposited cladding**

The most important phenomena in 2 ¼ Cr 1 Mo ¼ V materials in hydrogen service, is **temper embrittlement.**
Hydrogen attack is an elevated temperature phenomenon where dissolved hydrogen diffuses in the steel and reacts with the carbon or carbides in the steel to form methane. This formation can occur at the surface (surface decarburisation) or at locations within the metal, such as in fissures or grain boundaries (internal decarburisation). Initially methane forms in microscopic voids which grow and form cracks, which can then cause a decrease in the ductility and strength of the material.
Adequate tests shall be performed by owner in order to detect the status of material.
For this purpose each vessel is endowed of n° 1 test block representing the vessel fabrication activities has been performed by Nuovo Pignone. They shall be placed inside each vessel during its operating life. (a dedicated test plate supports is positioned on the bottom head of each vessel).
Ultrasonic examination of weld deposited cladding is required (see document n° SOU0116555/4 for all vessels).
Nuovo Pignone points out the importance to perform a periodic maintenance and check of control / safety devices and instrumentation according to the refinery internal procedures. As already said, this is essential to achieve the required performances of these vessels in respect of operating safety.

- During maintenance (whether the vessels are located in their foreseen installation zone):
- Tools that can generate hot surfaces must not be employed (i.e. welding machines)
- Anti-sparkling tools must be employed
- Movable parts must be handled with care, avoiding dangerous impacts or frictions with foreign bodies;
- Maintenance staff (and people who in general keep in touch, during maintenance and any other phase) must wear anti-static clothes (especially anti-static shoes) in order to avoid sparkling.
- Before opening, these vessels must be blanketed for a sufficient elapse of time in order to avoid residual hydrocarbon vapour to keep in contact with air, producing a potentially explosive atmosphere. Tools which can generate / spread hot or chemical unstable fluids must not be employed (i.e. welding machines)
- The personnel involved in the maintenance of the equipments has to be qualified and properly trained.
- A periodic and adequate maintenance is important to prevent the possibility of the process fluid leakage with potential dangerous consequence in explosive atmosphere.

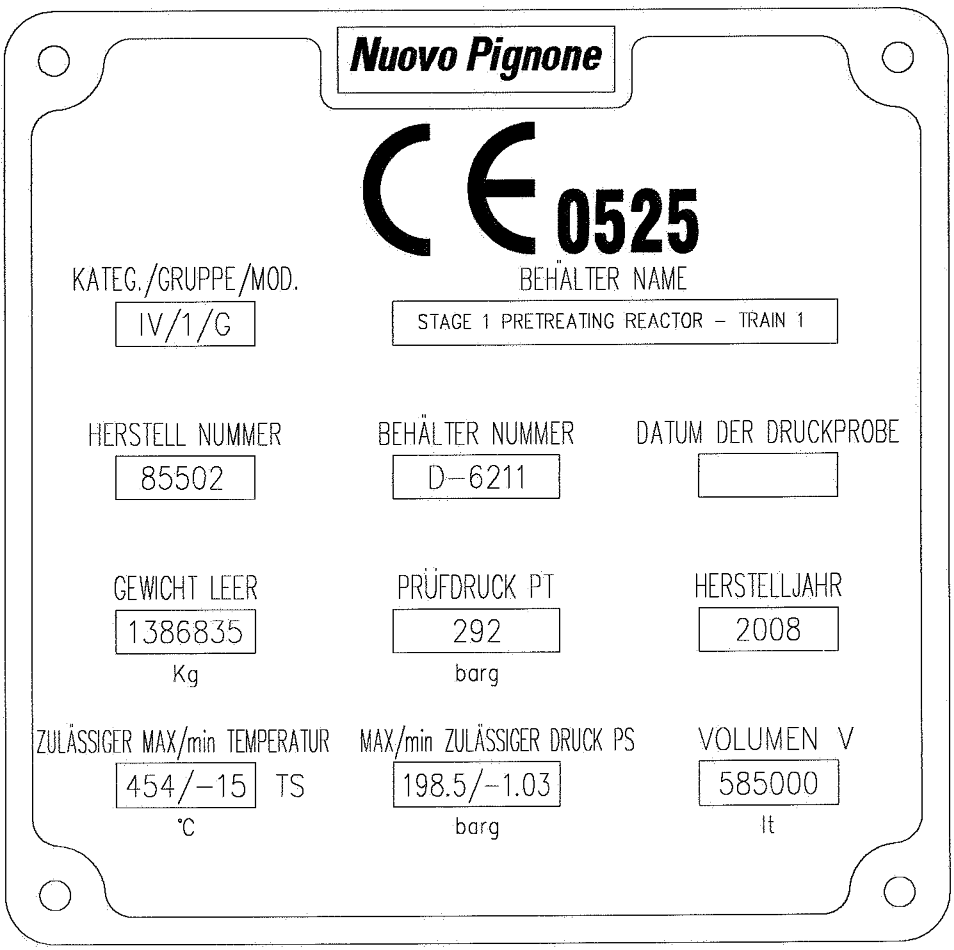
7.0 MODIFICATIONS and REPAIRS

Possible future needs of major or minor modifications and repairs shall be performed after deep analysis by specialized and authorised professional engineer according to national authorities, codes and applicable documents (see para. 2.4) and after agreement with Nuovo Pignone.

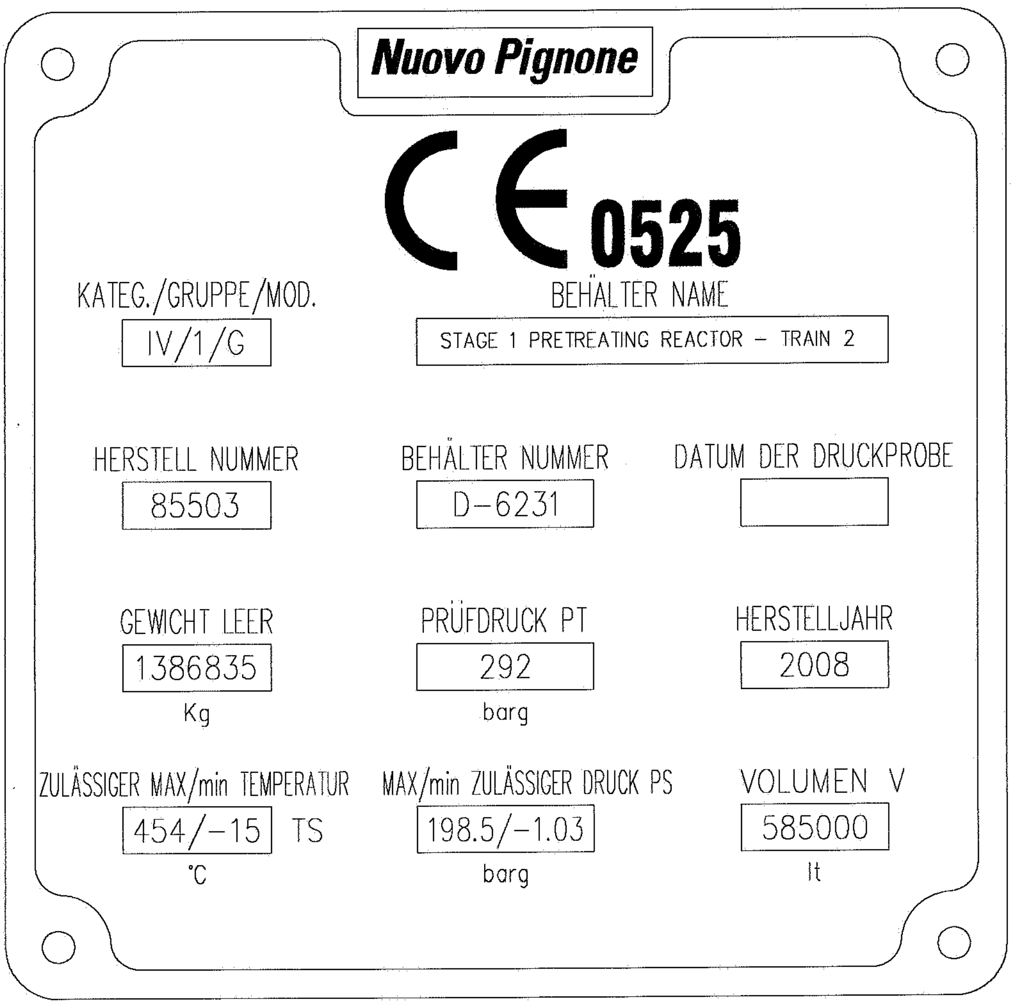
The base material supplied by Nuovo Pignone (2 ¼ Cr 1 Mo ¼ V) has been checked to guarantee mechanical behaviour after two (2) potential PWHT. The PWHT shall be performed as per spec. SOU0113843/4.
The chemical and mechanical properties and the tests applicable to base material are reported on spec. SOU0112430/4 (Material additional requirements for 2 ¼ Cr 1 Mo ¼ V material).

APPENDIX A:

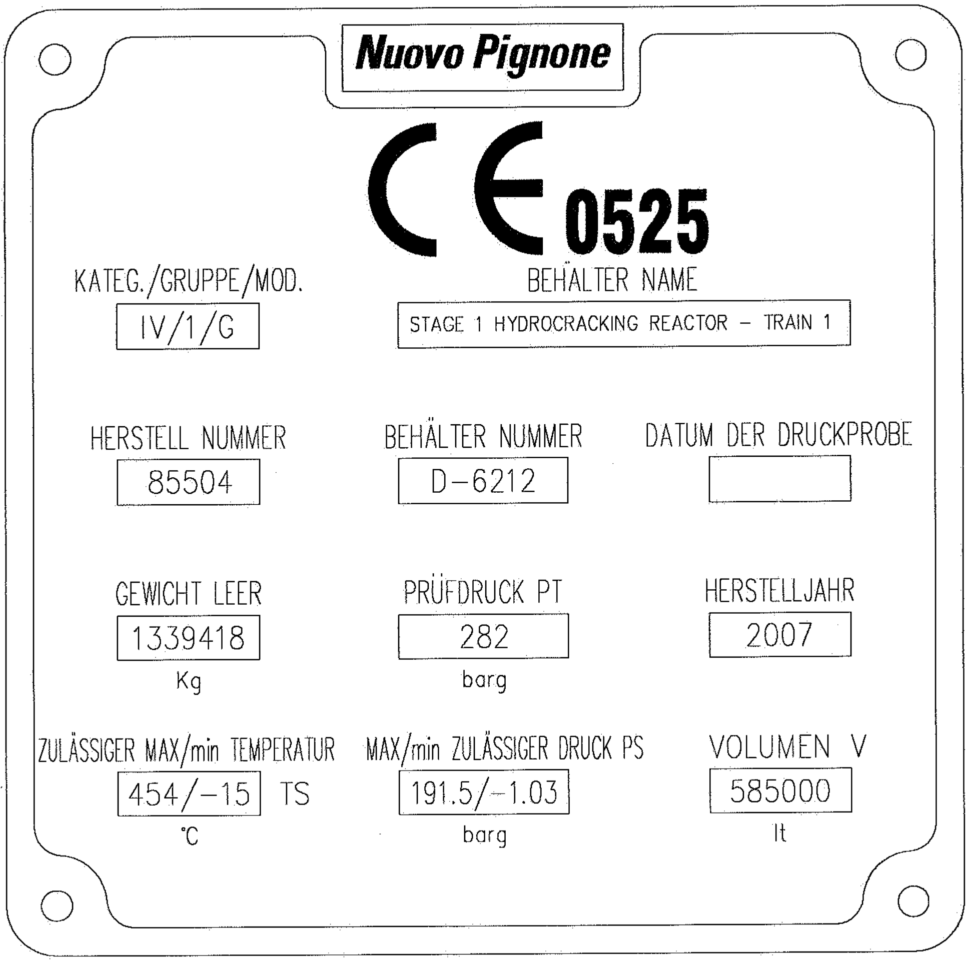
CE nameplate for item D-6211



CE nameplate for item D-6231



CE nameplate for item D-6212



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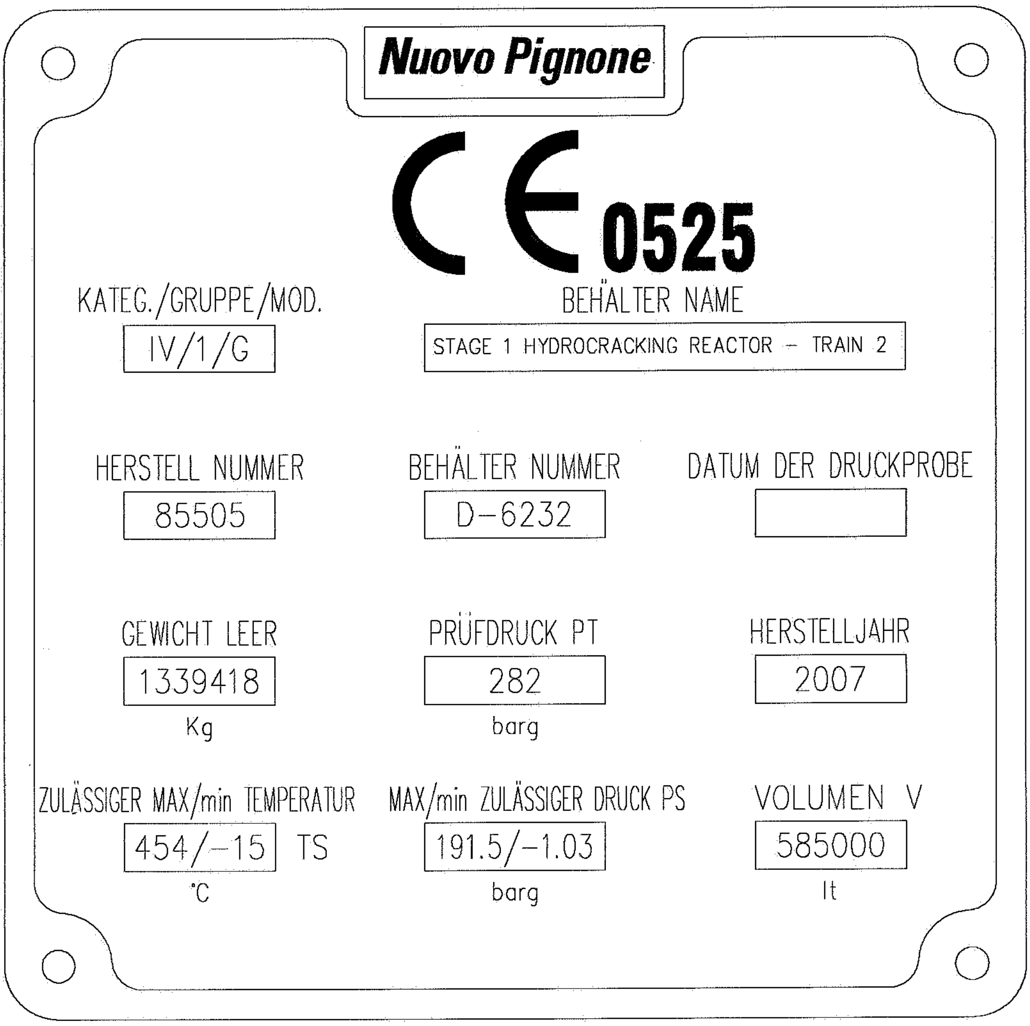
CE nameplate for item D-6232



APPENDIX B:

SUO0269055	General Assembly D-6211 (sheet 1/2)
SUO0269055	Heads, nozzles Detail Drawing D-6211 (sheet 2/3)
SUO0269055	Shell, nozzles Detail Drawing D-6211 (sheet 3/4)
SUO0269055	Detail Drawing D-6211 (sheet 4/5)
SUO0269055	Skirt & Name-Plate Detail Drawing R-001 (sheet 5/5)
SUO0269056	General Assembly D-6231 (sheet 1/2)
SUO0269056	Heads, nozzles Detail Drawing D-6231 (sheet 2/3)
SUO0269056	Shell, nozzles Detail Drawing D-6231 (sheet 3/4)
SUO0269056	Detail Drawing D-6231 (sheet 4/5)
SUO0269056	Skirt & Name-Plate Detail Drawing D-6231 (sheet 5/5)
SUO0269057	General Assembly D-6212 (sheet 1/2)
SUO0269057	Heads, nozzles Detail Drawing D-6212 (sheet 2/3)
SUO0269057	Shell, nozzles Detail Drawing D-6212 (sheet 3/4)
SUO0269057	Detail Drawing D-6212 (sheet 4/5)
SUO0269057	Skirt & Name-Plate Detail Drawing D-6212 (sheet 5/5)
SUO0269058	General Assembly D-6232 (sheet 1/2)
SUO0269058	Heads, nozzles Detail Drawing D-6232 (sheet 2/3)
SUO0269058	Shell, nozzles Detail Drawing D-6232 (sheet 3/4)
SUO0269058	Detail Drawing D-6232 (sheet 4/5)
SUO0269058	Skirt & Name-Plate Detail Drawing D-6232 (sheet 5/5)
SU 1408398/3	Foundation Template Drawing D-6211
SU 1408400/3	Foundation Template Drawing D-6231
SU 1408406/3	Foundation Template Drawing D-6212
SU 1408408/3	Foundation Template Drawing D-6232
SUO1427009/2	Fabrication Tolerances
SOU0107844	Stress Analysis - Skirt To Shell Junction D-6211 / D-6231
SOU0107845	Stress Analysis - Skirt To Shell Junction D-6212 / D-6232
SOU0117838	Pressure Part Calculation D-6211 / D-6231
SOU0117839	Structural Part Calculation D-6211 / D-6231
SOU0117840	Pressure Part Calculation D-6212 / D-6232
SOU0117841	Structural Part Calculation D-6212 / D-6232
SOU0115194	Hydrostatic Test Procedure R-001
SOU0113843	P.W.H.T. , L.P.W.H.T and DHT Procedure
SOU0111412	Base and welding Material Repair Specification
SOU0111413	Welding Repair Procedure for Weld Overlay
SOU0111414	Intermediate Stress Relieving in Shop for Nozzle Weld
SOU0111415	Weld Map for Welding Overlay
SOU0111416	Welding Summary Sheet
SOU0110203	Fabrication and Inspection Plan D-6211
SOU0110204	Fabrication and Inspection Plan D-6231
SOU0110205	Fabrication and Inspection Plan D-6212
SOU0110206	Fabrication and Inspection Plan D-6232
SOU0120351	Procedure for Flanged Connection Bolt Tensioning
SU-1413208	CE Name Plate D-6211

SU-1413210	CE Name Plate D-6231
SU-1413212	CE Name Plate D-6212
SU-1413214	CE Name Plate D-6232
SUO1429238	Shipping Drawings D-6211 / D-6231
SUO1429239	Shipping Drawings D-6212 / D-6232
SUO1429235	Shipping Saddle D-6211 / D-6231
SUO1429236	Shipping Saddle D-6212 / D-6232
SUO1419932	Insulation Support D-6211
SUO1419933	Insulation Support D-6231
SUO1419934	Insulation Support D-6212
SUO1419935	Insulation Support D-6232
SOU0116552	Liquid Penetrant Examination
SOU0116553	Magnetic Particle Examination
SOU0116556	Radiographic Testing Examination
SOU0116554	Ultrasonic Examination
SOU0116558	B-C Scan Technique for Ultrasonic Examination
SOU0116557	Ultrasonic Examination with TOFD
SOU0116555	Ultrasonic Examination of Weld Deposited Cladding
SOU0116561	Hardness Measurement Procedure
SOU0116559	Ferrite Check Specification
SOU0116560	Positive Material Identification
SU-1413197	Lifting lug D-6211 / D-6231
SU-1413198	Lifting lug D-6212 / D-6232

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APPENDIX C:

list of nozzles for item D-6211 / D-6231: (see also drawings SUO0269055/1 and SUO0269056/1)

ITEM D-6211 / D-6231				
SERVICE	**ITEM**	**No**	**NPS**	**TYPE-RATING**
INLET	A	1	18"	WN-RF SPECIAL FLANGE
OUTLET	B	1	20"	WN-RF SPECIAL FLANGE
MANWAY	M	1	38"	SPECIAL FLANGE RTJ
CATALYST WITHDRAWAL	D1 ÷ D2	2	8"	2500-WN-RF-FLANGE
CATALYST WITHDRAWAL	D3 ÷ D8	6	6"	2500-LWN-RF-NOZZLE AUTOREINF.
TI	T1 ÷ 13	13	3"	2500-LWN-RF-NOZZLE AUTOREINF.
QUENCH	E1 ÷ E3	3	8"	2500-LWN-RF-NOZZLE AUTOREINF.
NEUTRALIZATION	D9	1	4"	2500-LWN-RF-FLANGE
SKIN THERMOCOUPLE	SK1 ÷ 66	66	1"	/
SKIRT ACCESS	SA1 ÷ 2	2	24" ID	/
SKIRT VENT	SV1 ÷ 8	8	3"	/
SKIRT OPENING	SO1 ÷ 2	2	/	/
SKIRT OPENING	SO3	1	/	/

list of nozzles for item D-6212 / D-6232: (see also drawings SUO0269057/1 and SUO0269058/1)

ITEM D-6212 / D-6232				
SERVICE	**ITEM**	**No**	**NPS**	**TYPE-RATING**
INLET	A	1	20"	WN-RF SPECIAL FLANGE
OUTLET	B	1	24"	WN-RF SPECIAL FLANGE
MANWAY	C	1	38"	SPECIAL FLANGE RTJ
CATALYST WITHDRAWAL	D1 ÷ 2	2	8"	2500-WN-RF-FLANGE
CATALYST WITHDRAWAL	D3 ÷ 6	4	6"	2500-LWN-RF-NOZZLE AUTOREINF.
TI	T1 ÷ 6	6	3"	2500-LWN-RF-NOZZLE AUTOREINF.
QUENCH	E1 ÷ 2	2	8"	2500-LWN-RF-NOZZLE AUTOREINF.
TI	T7 ÷ 11	5	3"	2500-LWN-RF-NOZZLE AUTOREINF.
NEUTRALIZATION	D7	1	4"	2500-LWN-RF-FLANGE
SKIN THERMOCOUPLE	SK1 ÷ 94	94	1"	/
SKIRT ACCESS	SA1 ÷ 2	2	24"ID	/
SKIRT VENT	SV1 ÷ 8	8	3"	/
SKIRT OPENING	SO1 ÷ 2	2	/	/
SKIRT OPENING	SO3	1	/	/

DEUTSCH

VERZEICHNIS

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1.2 GARANTIE

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ANHANG A Namensschilde

ANHANG B Anhänge

ANHANG C Düsenliste

Diese Anleitung wurde ausgearbeitet um bei Montage, Betrieb und Wartung der Druckbehälter D-6211-12-31-32 zu helfen. Wir bitten dringend alle Anweisungen in diesem Handbuch zu lesen und zu befolgen. Immerhin, der Zweck dieser Anleitung ist nicht alle Situationen zu umfassen und sie beabsichtigt nicht ein Ersatz der inneren Verfahren des Besitzers, die in der Anlage wo diese Behälter montiert werden anwendbar sind, zu sein.

Die Anweisungen in diesem Handbuch beabsichtigen nicht die Behälter in Einzelheit zu beschreiben oder jede Situation zu umfassen, die in Verbindung mit der Montage, dem Betrieb und der Wartung jedes Behälters aufkommen könnte. Die bloße Tatsache, diese Anleitung geliefert zu haben, bedeutet nicht dass Nuovo Pignone einwilligt, jede Verantwortung für die vom Besitzer oder von den Kontraktoren ausgeführte Tätigkeit auf sich zu nehmen. Nuovo Pignone's Verantwortung ist beschränkt auf was in den Verkaufsbedingungen angegeben ist.

Falls Sie ein Problem haben, welches nicht in dieser Anleitung umfasst ist, zögern Sie bitte nicht sich an Nuovo Pignone's nahestem Verkaufsbüro oder Vertreter zu wenden.

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1.0 ALLGEMEINE ANWEISUNGEN

1.1 VORWORT

Dieses Handbuch enthält die Montage-, Betriebs- und Wartungsanweisungen der Nuovo Pignone HDC Behälter, angegeben in den Datenblättern aus dieser Anleitung. Der Benutzer muss alle Details lesen vor Montage und Anlass der Behälter.
Das Handbuch soll in Reichweite gehalten werden, so dass es jederzeit leicht konsultiert werden kann, während des Betriebs und der Wartung der Behälter.

WARNUNG

Für Sicherheit, soll das Personal welches für den Betrieb und für die Wartung dieser Behälter verantwortlich ist, diese Anleitung im Ganzen lesen. FALLS MONTAGE, BETRIEB, WARTUNG UND BESTANDTEILERSATZ NICHT RICHTIG AUSGEFÜHRT WERDEN, KÖNNEN SIE DIE BESCHÄDIGUNG DIESER BEHÄLTER, DER ZUSATZEINRICHTUNGEN, DER ANLAGE UND DIE VERLETZUNG DER LEUTE IN DER NÄHE VERURSACHEN.

1.2 GARANTIE

Die Garantiezeit für die Lieferung ist 30 Monate nach dem Anlass oder 42 Monate vom Datum des letzten Behältertransports.
Während dieser Zeit wird Nuovo Pignone alle fehlerhaften Teile reparieren, ersetzen, wenn die Druckbehälter gemäß den Betriebs- und Wartungsanweisungen, die von Nuovo Pignone selbst angegeben wurden und in diesem Handbuch eingeschlossen sind, betrieben wurden.

2.0 BESCHREIBUNG und TECHNISCHE DATEN

2.1 ALLGEMEINES

Die gelieferten Ausrüstungen sind Druckbehälter, die gemäß den Kundenspezifikationen und den angegebenen anwendbarten Koden und Normen, diese Bauarten verordnend, entworfen, hergestellt und geprüft wurden..
Für die Einlassflüssigkeit (Zusammensetzung und Prozessdaten) und für funktionelle Leistungen die garantiert werden müssen, beziehen sie sich auf UOP und Fluor Dokumentation.

2.2 KODEN, NORMEN, STANDARDS UND ANWENDBARE SPEZIFIKATIONEN

2.2.1 "CE" MARKIERUNG

Die Druckbehälter sind geliefert und CE markiert gemäß den Anforderungen der Richtlinie Nr. 97/23/EG bezüglich der Druckausrüstungen (P.E.D. Pressure Equipment Directive - Druckausrüstungsrichtlinie) für Kohlenwasserstoff (**Gruppe 1, Gas/Dampfbetrieb Kategorie IV Modul G**).
Benachrichtigtes Organismus für Prüfung und Konformitätsprüfung zu PED ist Lloyd's Register.
Auf den Behältern ist das CE Namensschild angebracht, angegeben in Anhang A.

2.2.2 KODEN und STANDARDS für DRUCKTEILENTWURF

97/23/EG	Druckausrüstungsrichtlinie
API RP 934	Stoff- und Herstellungserfordernisse für 2-1/4 Cr 1 Mo & 3 Cr – 1 Mo Stahldickwanddruckbehälter für Hochtemperatur-, Hochdruckbetrieb.
ASME II, Teil A Ausg. 2004	Kessel und Druckbehälterkode – Stoffe
ASME II, Teil D Ausg. 2004	Kessel und Druckbehälterkode – Zulässige Spannkräfte
ASME VIII, Div.2 Ausg. 2004	Kessel und Druckbehälterkode – Regeln für den Bau der Druckbehälter
ASME B31.3-2006	Process piping <2>
ASME/ANSI B16/5, B16/47	Flanschen, Rohre und Anschlussstücke.
ASME IX Ausg. 2004	Schweißen
DIN 1055 Ausg. März 2005	Nennbelastungen für Gebäude

2.2.3 KODEN und STANDARDS für WIND- und ERDBEBENPRÜFUNG

Die Windeinwirkung wurde gemäß DIN 1055 - Nennbelastungen für Gebäude und FLUOR – Montageort- und Nützlichkeitsdaten – Dok.Nr. 595705-225-002 ausgewertet.
– Erdbeben ist nicht anwendbar, wie in Montageort- und Nützlichkeitsdaten – Dok.Nr. 595705-225-002 angegeben ist.

2.2.4 KUNDENSPEZIFIKATION

UOP Projektspezifikation n° 939031-304 Rev.0
UOP Standardspezifikation N° 3-17-3 (01 Sept. 04) Druckbehälter ASME VIII Div.2
Purchase Order Number: 4507960234-1 Rev 0, March 8, 2010 (8959N WILHELMSHAEN UPGRADE PROJECT Re-certification of the reactors items D-6211/D-6212/D-6231/D-6232
<2>

2.3 EINHEITEN

Länge	Millimeter	(mm)
Fläche	Quadratmillimeter	(mm^2)
Volumen	Kubikmeter	(m^3)
Kraft	Newton	(N)
Moment	Newton per Millimeter	(Nm)
Spannkraft	Mega Pascal	(Mpa)
Druck	Bar	(Bar)
Temperatur	Grad Celsius	(° C)

2.4 BEZUGSDOKUMENTATION

Die in Anhang B angegebenen Dokumente sind von Nuovo Pignone ausgegeben und sind für Genehmigung an den Kunden und Lloyd's Register gesendet. Die Dokumentation, einschließlich Anmerkungen, wird überprüft und wird als Bestandsauffassung (AS BUILT) dem endgültigen Datenbuch angefügt.

2.5 TECHNISCHE KENNZEICHEN UND LEISTUNGEN

Diese Druckbehälter sind zusammengestellt aus einem Zylinderkörper und zwei Kalotten. Sie sind in senkrechter Lage gestellt und von einer Stahlumhüllung aufgehalten. Sie wurden passend entworfen mit Bezug auf den weiterhin angegebenen Nenndaten.

ARTIKEL	D-6211/D-6231	D-6212/D-6232
Innerer Nenndruck	198,5 Bar (g)	191,5 Bar (g)
Innere Nenntemperatur	454°C	454°C
Äußerer Nenndruck	1,03 Bar (g)	1,03 Bar (g)
Äußere Nenntemperatur	177 °C	177 °C
Max. Betriebstemperatur	445 °C	439 °C
Spannkraftfrei	JA	JA
Innere Korrosionszulassung	TP 347 W.O.	TP 347 W.O.
TOFD / RT	VOLL	VOLL
Anschlusswirksamkeit %	100 %	100 %
Hydroprobedruck (senkrecht)	288 Bar (g)	277 Bar (g)
Hydroprobedruck (waagerecht)	291 Bar (g)	282 Bar (g)
Volumen	585 m^3	585 m^3

Die Daten wurden auf den Namensschilden auf den Behältern angegeben (siehe Anhang A).

Die in den Behältern prozessierte Flüssigkeit ist im flüssigen Zustand, bestehend aus der Erdölverdünnung welche nur teilweise verdampft ist bei den Temperaturen und Drücken bei der die Reaktion auftritt. Der gasförmige Zustand ist reich in Wasserstoff und enthält leichte Kohlenwasserstoffe, vorhanden in der Zufuhr oder von der Reaktion erzeugt.

Um Korrosionserscheinungen auf den Druckteilen zu vermeiden, wie in der Vertragsdokumentation erfordert, ist der Behälter 4,2 mm dick mit nichtrostendem Stahl TP 347 schweißplattiert.

Der perfekte Betrieb der Behälter und die Leistungsfähigkeit sind garantiert nur wenn die Entwurfs- (Nenn-)bedingungen eingehalten werden.

Die Düsen wurden dermaßen entworfen, um auch den angegebenen äußeren Lasten (siehe Herstellungszeichnungen Seite 1/5) standzuhalten.

ANGEGEBENE ÄUßERE LASTEN SOLLEN NIEMALS ÜBERSCHRITTEN WERDEN

Oberflächenbehandlung und Anstrich:

- Sandstrahlen und Anstrich sind nicht anwendbar

Nirosta-Stahlstoffe werden weder sandgestrahlen noch angestrichen.

Der Besitzer soll geeignete Wärmedämmung für alle heißen Oberflächen und Feuerschutz auf den inneren / äußeren Flächen der Auflageumhüllung sichern. Gemäß den Vertragsbedingungen, schließt Nuovo Pignone Lieferung die Dämmung nicht ein.

WARNUNG: ES WIRD KEIN SCHWEIßEN AUF 2 ¼ Cr 1 Mo und 2 ¼ Cr 1 Mo ¼ V STOFFEN NACH ENDGÜLTIGEM PWHT (NACHSCHWEIßWÄRMEBEHANDLUNG) ERLAUBT.

2.6 GESAMTMAßE (Siehe Skizzenseiten 10 und 11)

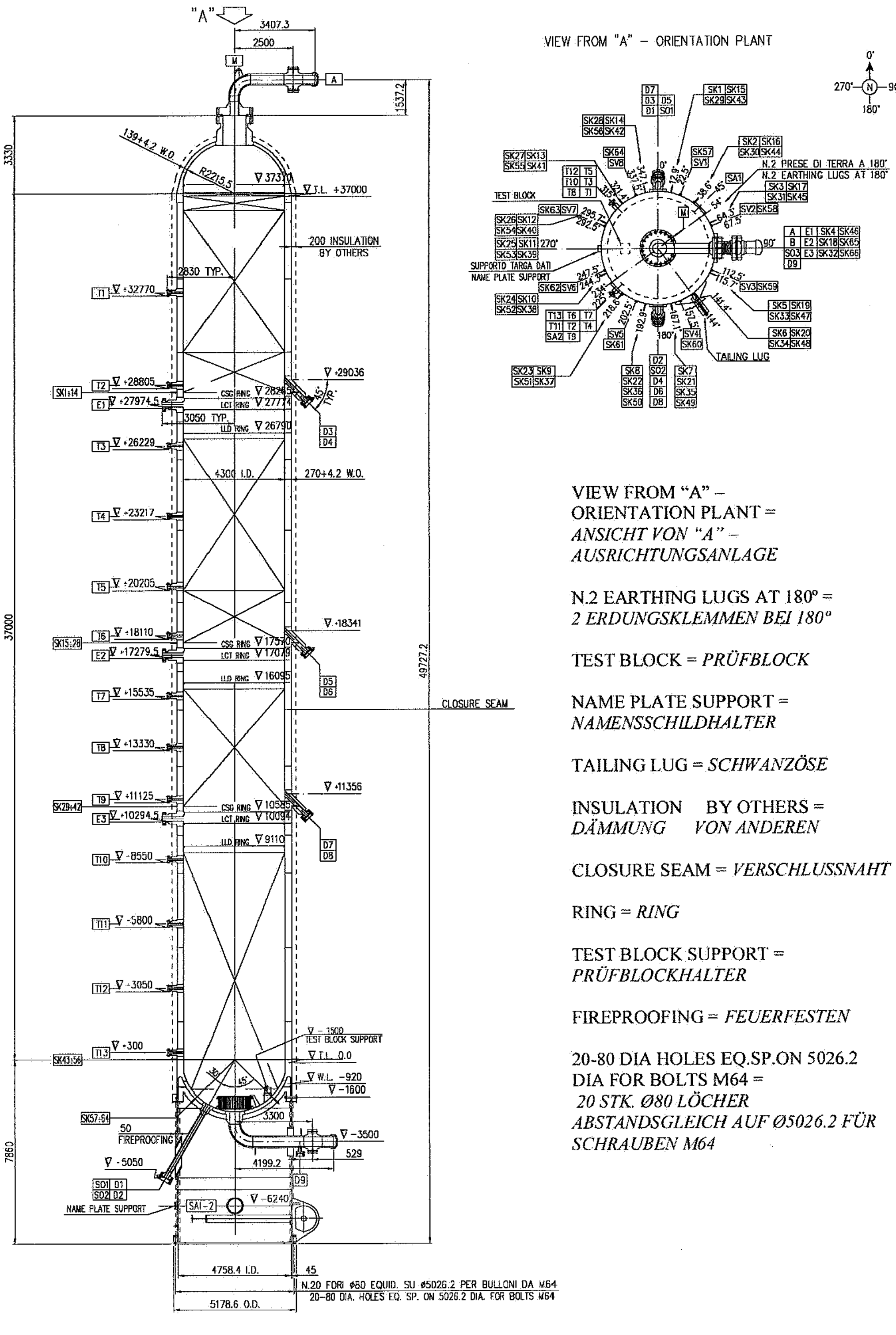
Weiterhin sind die Hauptmaßdaten der Druckbehälter zusammengefasst:

ARTIKEL	D-6211 / D-6231	D-6212 / D-6232
Innendurchmesser (mit Überzug)	4300 mm	4300 mm
Länge BTL zu TTL	37000 mm	37000 mm
Gesamtlänge	49727,2 mm	49667,2 mm
Schalendicke	270 + 4,2 W.O. mm	260 + 4,2 W.O. mm
Innenvolumen	585 m^3	585 m^3
Gewicht (Montage)	13605 kN	13139 kN

2.7 DÜSENLISTE

Die Düsen sind mit einer eigenen Identifikationsnummer angezeigt. Sie sollen nur für den angezeigten erforderten Betrieb benutzt werden. Nuovo Pignone ist nicht verantwortlich für Betriebsstörungen und Unfälle wegen falscher Benutzung der Düsen.
Die detaillierte Liste der Düsen für jedes Druckbehälterpaar ist in Anhang D angegeben. Ihre Höhe und Ausrichtung ist auf den Herstellzeichnungen des Behälters angezeigt.

GESAMTMAẞE ARTIKEL D-6211 / D-6231



VIEW FROM "A" – ORIENTATION PLANT = *ANSICHT VON "A" – AUSRICHTUNGSANLAGE*

N.2 EARTHING LUGS AT 180° = *2 ERDUNGSKLEMMEN BEI 180°*

TEST BLOCK = *PRÜFBLOCK*

NAME PLATE SUPPORT = *NAMENSSCHILDHALTER*

TAILING LUG = *SCHWANZÖSE*

INSULATION BY OTHERS = *DÄMMUNG VON ANDEREN*

CLOSURE SEAM = *VERSCHLUSSNAHT*

RING = *RING*

TEST BLOCK SUPPORT = *PRÜFBLOCKHALTER*

FIREPROOFING = *FEUERFESTEN*

20-80 DIA HOLES EQ.SP.ON 5026.2 DIA FOR BOLTS M64 = *20 STK. Ø80 LÖCHER ABSTANDSGLEICH AUF Ø5026.2 FÜR SCHRAUBEN M64*

SOSTITUISCE IL - ERSETZT PARI NUMERO
SOSTITUITO DA – ERSETZT DURCH

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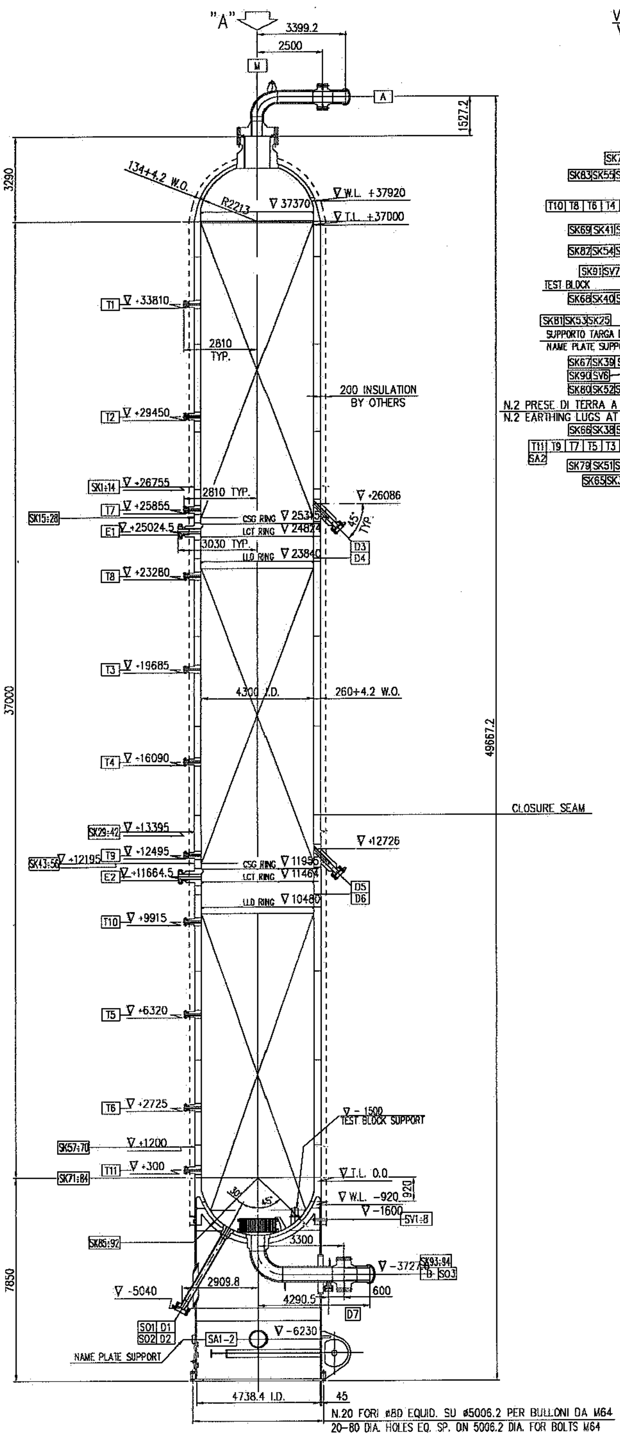
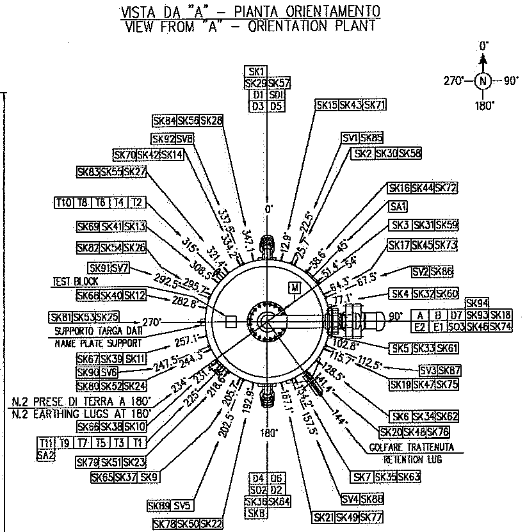
Nuovo Pignone MASSA	DRUCKBEHÄLTER BETRIEBSANLEITUNG

GESAMTMAßE ARTIKEL D-6212 / D-6232





VIEW FROM "A" – ORIENTATION PLANT = *ANSICHT VON "A" – AUSRICHTUNGSANLAGE*

N.2 EARTHING LUGS AT 180° = *2 ERDUNGSKLEMMEN BEI 180°*

TEST BLOCK = *PRÜFBLOCK*

NAME PLATE SUPPORT = *NAMENSSCHILDHALTER*

RETENTION LUG = *ANHALTSÖSE*

INSULATION BY OTHERS = *DÄMMUNG VON ANDEREN*

CLOSURE SEAM = *VERSCHLUSSNAHT*

RING = *RING*

TEST BLOCK SUPPORT = *PRÜFBLOCKHALTER*

FIREPROOFING = *FEUERFESTEN*

20-80 DIA HOLES EQ.SP.ON 5026.2 DIA FOR BOLTS M64 = *20 STK. Ø80 LÖCHER ABSTANDSGLEICH AUF Ø5026.2 FÜR SCHRAUBEN M64*

		ARTIKEL D-6211-12-31-32	
2	REVISED WHERE INDICATED <2>		
1	GENERAL REVISION	N. SOU0120328/4	
0	ISSUE - AUSGABE	LINGUA-SPR.	PAGINA-SEITE
REV.	DESCRIZIONE - BESCHREIBUNG	A-D	43 / 44

SOSTITUISCE IL - ERSETZT | PARI NUMERO
SOSTITUITO DA – ERSETZT DURCH

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3 HAUPTWARNUNGEN UND SICHERHEIT

3.1 ALLGEMEINE SICHERHEITSVORSCHRIFTEN

Diese Behälter wurden entworfen und hergestellt um sicher und zuverlässig zu sein, gemäß den Projektspezifikationen.
Sie sind Dickwanddruckbehälter, die bei hoher Temperatur in Wasserstoffbetrieb arbeiten.
Deshalb sind technische Kentnisse und angemessene Sicherheitsnormen des Benutzers absolut notwendig um die Beschädigung der Behälter, der Zusatzeinrichtungen, der Umwelt und Verletzung von Personen zu vermeiden.
Es wird vermutet dass der Benutzer schon ein Sicherheitssystem aufgebaut hat, welches auf einer industriellen Risikoanalyse gegründet ist. Vor Montage, Anlass, Betrieb oder Wartung der Behälter empfehlen wir Prüfungen auszuführen um sich zu vergewissern dass alle Gefahren, kommend von einem Druckbehälter bei hoher Temperatur, gedeckt sind.
Es ist wichtig, Gefahren kommend von elektrischer Energie, toxischen und/oder entflammbare nFlüssigkeiten (Druck und Temperatur) zu berücksichtigen. Die richtige Montage und Wartung der Schutzeinrichtungen, Alarme und Auslösevorrichtungen ist nötig für den sicheren Betrieb der Behälter. Er soll niemals in Betrieb gelassen werden mit den Schutzeinrichtungen beseitigt oder ausgeschlossen.

Wir erinnern dass:

Gefahrzone ist: jede Zone in der Nähe eines Behälters, wo die Anwesenheit einer ausgesetzten Person eine Gefahr für die Sicherheit und Gesundheit derjenigen Person ist.
Ausgesetzte Person ist: jede Person, welche teilweise oder gänzlich in einer Gefahrzone steht.
Bediener: Leute bestimmt für Montage, Betrieb, Kontrolle, Wartung, Reinigung, Transport eines Behälters.

1. Der Benutzer muss alle in diesem Handbuch und in den abgerufenen Dokumenten aufgeführten Anweisungen, Empfehlungen und Verfahren einhalten.
2. Die Montage der Ausrüstung muss von angemessenem autorisiertem und qualifiziertem Bediener ausgeführt werden.
3. Die Benutzungsbedingungen für diese Behälter sind in den Einstellplänen angegeben. Die benutzten Stoffe wurden für die Nennbedingungen (Druck, Temperatur, Prozessflüssigkeit) ausgewählt. Die Benutzung in anderen Bedingungen kann die Sicherheit der Leute und der Umwelt beeinträchtigen.
   BEMERKUNG: Die Mindestnennmetalltemperatur (MDMT) (–15 °C für alle Behälter), angegeben auf Einstellplänen SOU0269055/1 ÷ SOU0269058/1 beziehen sich auf neue Behälter. Der Benutzer ist verantwortlich die MDMT während der Lebensdauer dieser Behälter zu aktualisieren. Von Zeit zu Zeit soll die MDMT gemäß dem Ergebnis der Wartungsprüfungen und Proben ausgeführt auf den PRÜFPLATTEN den Behälterstoff darstellend, montiert auf geeigneten Auflagern in der unteren Kalotte, eingestellt werden. Jedenfalls empfiehlt Nuovo Pignone die Drucksetzung der Behälter unter einer Metalltemperatur von + 27° C zu vermeiden. (das Anlass/Abstellverfahren in Bezug auf die Druckbeaufschlagungs-Mindesttemperatur ist in dieser Anleitung eingeschlossen).
4. Die Leute, die für Betrieb und Wartung der Behälter verantwortlich sind müssen sorgfältig prüfen und sich vergewissern dass das Personal diese Anleitung kennt und psychisch und physisch integer ist. Führen Sie keine Tätigkeit aus bevor Sie erst dieses Anweisungshandbuch konsultiert haben.
5. Versuchen Sie nicht einen Behälter anzulassen bevor Sie verstanden haben wie er funktioniert und ohne die Stellung aller Zusatzeinrichtungen, Instrumenten und Prüfsystem bestimmt zu haben.

6. Vor dem Anlass eines Behälters, seien Sie bereit eine Notausschaltung auszuführen falls jedwelche Betriebsstörung auftritt.
7. Zugang zu einer Behälterzone muss nur auf autorisiertem Personal eingeschränkt werden, welches an einem angemessenen Training teilnehmen muss und welches die verpflichtende Schutzausrüstung (Helm, Handschuhe, Schutzbrille, Stahlkappenstiefel) tragen muss.
8. Die Arbeit an der Bedientafel muss auf Personal mit angemessenem Training eingeschränkt werden. Die Änderung der Sollwerte der Instrumenten kann den Auftritt äußerst gefährlicher Situationen verursachen.
9. Prüfen Sie die passenden Anleitungen für alle Zusatz- und Sicherheitseinrichtungen bezüglich des Behälters.
10. Lassen Sie niemals einen Behälter an ohne geprüft zu haben dass er richtig montiert wurde und ohne das ganze Anlassverfahren befogt zu haben.
11. Die Abflussrohre und –ventile, die Lüftungsrohre und –ventile und diejenigen der Behälterzusatzeinrichtungen müssen das passende Maß haben für maximalen Betriebsdruck und maximale Betriebstemperatur. Wenn das Maß ungenügend ist, kann das schwere Beschädigung und Verletzung verursachen.
12. Versehentlicher Kontakt mit einer heißen äußeren Behälterwand entflammbarer Flüssigkeiten (z.B. wenn eine Dichtung leckt) kann einen Brand auslösen. Der Benutzer ist verantwortlich für Vorsichtsmaßnahmen für Brandgefahren (siehe Norm 94/9/EG).
13. Führen Sie keine Reparaturen, Demontage oder Wartung bei einem Behälter während des Betriebs aus.
14. Demontieren Sie keinen Deckel, Schutz, Dichtungsflansch, Blindflanschen usw. während ein Behälter in Betrieb ist.
15. Ersetzen Sie keinen Flansch, keine Schraube oder Dichtung mit nicht bekanntem Stoff oder niedriger Qualität. Vermischen Sie nicht die Muttern und Schrauben während der Demontage. Nichtbenutzen des richtigen Stoffes kann zum Nachlassen der Druckteile führen. Bevor Sie jeden Bestrandteil ersetzen vergewissern Sie sich dass der Ersatzteil genau dem für einen Behälter benutzten Teil entspricht.
16. Bevor Sie jede Wartungstätigkeit ausführen, vergewissern Sie sich dass die Abstellung richtig ausgeführt ist und der Behälter sicher und wartungsbereit ist und er angelassen werden kann. Es wird die Benutzung angemessener Sicherheitssignale empfohlen, um den Zustand eines Behälters zu detektieren (ob er in Betrieb ist oder in Wartung).
17. Der Benutzer muss sich vergewissern dass die Prozessflüssigkeitstemperatur nicht die maximale vorausgesehene Innere Nenntemperatur überschreitet, mittels eines Temperaturkontrollsystems / -einrichtungen oder Eigenprozesstemperaturkontrolle.
18. Die Ausrüstung muss möglich weit von folgenden gelegen werden:
    - jedem gefährlichen Anstoß oder Ursache von Reibungen (d.h. Fahrzeugverkehr, instabile Struktur, Arbeitszone, usw.) und muss nicht abgeschliffen, gekratzt oder gleichermaßen behandelt werden;
    - Streustromquellen (d.h.. elektrische Vorrichtungen oder Beleuchtungsmasterdung);
    - Beleuchtung- “auffangende” Vorrichtungen (z.B.Antennen);
    - Schwingquellen (d.h.. Ultraschallvorrichtungen, schwingende Ausrüstung, usw.).
19. Der Benutzer muss sich vergewissern dass der Prozessflüssifkeitsdruck den Nenndruck oder den Druck, der eine höhere Temperatur als diejenige des Zündpunkts / Zersetzungspunkts der Prozessflüssigkeit gibt, nicht überschreitet, und dass die Druckschwankung gleichmäßig ist, ohne Stoßwellen, mittels eines Druck- / Stoßwellenkontrollsystem / -vorrichtungen oder Einschränkung des Prozesseigendrucks / Stoßwellen.
20. Die maximale Oberflächentemperatur eines Behälters ist von der Flüssigkeit, die innerhalb des Reaktors fließt, bedingt. Die Montage der Ausrüstung im explosionsgefährdetem Bereich muss ausgeführt werden vorausgesetzt dass die maximale Oberflächentemperatur kompatibel mit der Gasentzündungstemperatur des explosionsgefährdetem Bereichs ist.

21. Der Benutzer muss sich vergewissern dass die Zusammensetzung der Prozessflüssigkeit keine wärmeabgebende Reaktion erzeugen kann und dass Temperatur- und Druckgrenzwerte nicht überschritten werden.
22. Jeder Metallteil muss einander angeschlossen sein und ein Behälter muss mittels Erdungsklemme geerdet werden.

3.2 BELEUCHTUNG der BEHÄLTERZONE

Der Benutzer muss sichern dass die Zone wo ein Behälter in Betrieb ist, eine zu den auszuführenden Tätigkeiten passende Beleuchtung hat und Schattenbereiche, Blendung, störende, stroboskopische Effekte vermieden werden.
Wir erinnern dass eine unpassende Beleuchtung Gefahr für das Betriebspersonal hervorrufen kann.

3.3 ANSCHLÜSSE

Prüfrohre und Instrumentation werden ausschließlich zu den Behälterdüsen, ausdrücklich für diesen Zweck bestimmt, angeschlossen werden. Die Düsen sind in Paragraph 2.7 und Anhang D dieser Anleitung angegeben.

Die Ausführung der elektrischen Anschlüsse muss den allgemeinen Montageregeln sachbezogen zu der Vorbereitung und Einsetzung der elektrischen Anlagen gemäß CEI 64-8 entsprechen.

Montage und Anschluss der elektrischen Vorrichtungen erfordert unbedingt qualifiziertes Personal. Das Personal wird an Bildungs-, Training und Spezialisierungslehrgängen teilnehmen. Das Personal soll Erfahrung haben passend der Montage und Einsetzung. Die verwickelten Wartungsleute müssen die Unfallverhütung kennen.

Das qualifizierte Personal soll Erste Hilfe-Begriffe im Falle eines Unfalls haben.

3.4 ERDUNG

Diese Druckbehälter und Metallstrukturen sollen richtig geerdet werden. Zu diesem Zweck sind die Druckbehälter mit n° 2 passenden Klemmen, auf der Behälterumhüllung geschweißt, ausgestattet.
Norm CEI 81/1 legt die Kennzeichen fest, die in der Ausführung der Erdungsanlage eingehalten werden müssen.

3.5 SICHERHEITSVORRICHTUNGEN

Gesetzgemäß müssen diese Druckbehälter mit einer oder mehreren Schnelldruckauslassvorrichtungen ausgerüstet werden. (die Sicherheitsventile sind geliefert und werden vom Besitzer montiert).

Der Zweck der Sicherheitsventile ist zu vermeiden dass die Druckventile dem Überdruck ausgesetzt sind im Falle des Ausfalls des Kontrolle- und Automatmanagementsystems, im Falle eines Fehlers des Bedieners oder bei Brand.
Der Besitzer ist verantwortlich dass diese Behälter angemessen gegen Überdruck geschützt sind.
Es werden die allgemeinen Erfordernisse ASME VIII Div. 2 Artikel R-1 und R-2 eingehalten.

WARNUNG : <u>Nicht Vorhandensein oder Ausfall der Sicherheitsventile kann schwere Gefahren für das Betriebspersonal hervorrufen. Prüfung und Überwachung der Sicherheitsvorrichtungen sind wesentlich für die Sicherheit.</u>

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3.6 THERMOELEMENTE und ABFLUSSVENTILE

Thermoelemente und Abflussventile sind außerhalb von Nuovo Pignone Lieferungsbereich.

3.7 HEBEVORRICHTUNGEN

Diese Druckbehälter sind mit einem Hebedeckel ausgerüstet, geschraubt zum MH Flansch anstatt der Oberspule.
Jeder Hebevorgang wird mittels dieser Aufhängeösen und passender Hebevorrichtungen ausgeführt in Anbetracht der Gewichte und Maße angezeigt in Zeichnungen SU-1413197/3 SU-1413198/3.
Jeder Behälter ist zum Anheben mit einem Schweißansatz am Sockelblech ausgestattet. Für die Montage des Behälters wird der Besitzer eine passende Anhaltsvorrichtung sichern, die Geometrie und das Gewicht des Behälters berücksichtigend. Die zulässigen Spannkräfte auf diesen Behältern, während der Hebung, wurden von Nuovo Pignone, in den Dokumenten SOU0107839/4 und SOU0107841/4 angegeben.

Für den Transport ist jeder Behälter mit n° 2 Satteln ausgestattet, welche das gesamte Gewicht des Behälters aufhalten können. Siehe Zeichnungen SUO1429235/1 , SUO1429236/1.
WARNUNG: **Nichteinhaltung der Hebeanweisung kann schwere Gefahr für das Betriebspersonal und Beschädigungen der Behälter hervorrufen.**

3.8 BEZUGNEHMENDE NORMEN

3.8.1 RICHTLINIEN BEZÜGLICH DER SICHERHEIT AN EINEM ARBEITSORT

Richtlinie 80/1107, 83/477, 86/188, 88/642 bezüglich des Bedienerschutzes gegen Explosionsgefahr und Gefahr chemischer und physikalischer Wirkstoffe während der Arbeit.
Richtlinie 89/321 bezüglich der Vergrößerung der Sicherheit und Gesundheit der Bediener mit spezifischen Richtlinien 89/654 und 89/655.
Richtlinie 90/394 bezüglich des Bedienerschutzes gegen Gefahr wegen der Aussetzung zu karzinogenen Wirkstoffen während der Arbeit
Richtlinien 77/576 und 79/640 bezüglich des Sicherheitssystems der Zeichen an einem Arbeitsort.

3.8.2 RICHTLINIEN BEZÜGLICH DES EINZELSCHUTZES

Richtlinien 89/656 und 89/686, bezüglich der Benutzung der einzelnen Schutzvorrichtungen

3.8.3 RICHTLINIEN BEZÜGLICH DES UMWELTSCHUTZES

Richtlinie 75/442, bezüglich der Abfallbeseitigung
Richtlinie 78/319, bezüglich der Beseitigung der toxischen und gefährlichen Abfälle

4.0 MONTAGE UND ANLASS

4.1 ALLGEMEINES

Um die Gesamtmaße während des Transports zu verringern, wird jeder Druckbehälter ohne dem Zubehörzimmerhandwerk und folgenden Artikeln geliefert.
Zeichnung SUO0269055-56-57-58/1
OBERSPULE, DICHTUNGEN, SCHRAUBEN und MUTTERN
OBER-/UNTERPAARUNGSFLANSCH /ANHANG
UNTERPAARUNGSFLANSCH /ANHANG
BLINDFLANSCH, DICHTUNGEN, SCHRAUBEN und MUTTERN
PRÜFBLOCK
ANKERVIERKANTSCHEIBEN (Markierung 207)
INNERE TEILE

Die gesamte innere Zusammenstellung ist Sorge des Besitzers.

Ebenfalls Sorge des Besitzers sind:

- Entwurf und Vorbereitung des Fundaments (beziehen Sie sich auf Vorlagezeichnungen des Fundaments Nr. SU 1408398/3, SU 1408400/3, SU 1408406/3, SU 1408408/3).
- Ankerbolzen
- Lagerung der Stoffe, Handhabung und Montage des Behälters
- Einstellung des Behälters vor dem Anlass (einschließlich Einhaltung aller Sicherheitsvorschriften)
- Anlass des Behälters (siehe das entsprechende Verfahren in dieser Anleitung)

Bemerkung: Falls manches Ortschweißen notwendig ist, ist das klar auf den Herstellzeichnungen angezeigt.

4.2 TRANSPORT, HANDHABUNG, LAGERUNG und AUSPACKEN

Die Transportbedingungen der Behälter sind in Nuovo Pignone Zeichnungen SUO1429238/1, SUO1429239/1 angegeben.
Um Infiltrieren von Fremdkörpern in den Reaktor zu vermeiden, wird jede Öffnung mit einem Stahldeckel geschlossen.
Alle provisorische Vorrichtungen sind mit gelber Farbe angestrichen. Sie sollen während der Montage des Behälters entfernt werden.
Zum Schutz während Transport und Lagerung ist der Behälter mit trockenem Stickstoff bei 0,5 bar unter Druck gesetzt.

Zubehörteile und Ersatzteile werden angemessen eingepackt in bestimmten Holzschachteln geliefert.
Während des Auspackens, seien Sie aufmerksam bei der Beseitigung der Metallstreifen. Sie sind gespannt und sie können einen gefährlichen Peitsche-Effekt verursachen.

Falls der Behälter nicht gleich montiert wird, soll er angemessen geschützt werden um plötzliche Verschlechterung des Oberflächenschutzes zu verhindern.
Der Behälter soll ausschließlich mittels der bestimmten Hebevorrichtungen gehoben werden und mit Hilfe von dauernden passenden Seilen.

4.3 VORBEREITUNG FÜR MONTAGE.

4.3.1 ALLGEMEINES

Der Besitzer soll prüfen dass die gesamte Lieferung gemäß den Anweisungen der in den Transportdokumentationen eingeschlosssenen Packungslisten und den Herstellzeichnungen ist.
Der Besitzer muss die Behälterbetriebszone und die Angemessenheit des Fundaments prüfen.

4.3.2 FUNDAMENT und AUFLAGEUMHÜLLUNG

Das Fundament auf dem ein Behälter montiert wird ist sehr wichtig für die Stabilität des Behälters.
Die Vorbereitung ist Sorge des Besitzers und es wird entworfen indem man die vom Behälter während seiner Betriebsdauer induzierte Spannkraft berücksichtigt. (Siehe die allgemeinen Gesamtzeichnungen SUO0269055-56-57-58/1).
Nach der Behältermontage ist die Verantwortung des Besitzers zu prüfen dass das gegebene Fundament die Kennzeichen des Entwurfs hat hinsichtlich des mechanischen Verhaltens und der Flachheitstoleranzen.
Die Details der Auflageumhüllung sind auf Zeichnung SUO0269055-56-57-58/1 angezeigt. Sie ist aus zwei Stoffen hergestellt. Der obere Teil, wo die Temperaturen sehr hoch sind, wurde aus 2 ¼ Cr 1Mo Stoff hergestellt. Der untere Teil ist aus Kohlenstoffstahl (SA 516-70). Die Umhüllung wird angemessen gedämmt im Bereich des Umhüllung zu Schale-Anschlusses und sie wird richtig innen und außen feuerfest gemacht, um die Stabilität des Behälters im Falle eines Brandes zu garantieren.
Spannungskräfte auf der Auflageumhüllung wurden von Nuovo Pignone zutiefst untersucht (Siehe Dok. SOU0107839/4, SOU0107841/4 und SOU0107844/4, SOU0107845/).
Der Besitzer ist verantwortlich für den Betrieb des Behälters gemäß den zulässigen Spannungskräften angegeben in Nuovo Pignone Dokumenten.

4.3.3 MONTAGE UND EINSTELLUNG DES BEHÄLTERS

- Die Montage und die Einstellung sind Sorge des Besitzers mittels seiner eigenen Vorrichtungen und Strukturen.
- Mit Rücksicht auf den Behältergewichten angegeben auf den Herstellzeichnungen werden passende Hebevorrichtungen benutzt.
- Der Ankerbolzen muss mit den von Nuovo Pignone gelieferten Fundamentvorlagen positioniert.
- Ankermuttern (außerhalb Nuovo Pignone Lieferungsbereich) und entsprechende Vierkantscheiben werden montiert, wie in den Herstellzeichnungen angezeigt ist.
- Fundamentbolzenanziehung prüfen.
- Alle provisorischen Transportvorrichtungen werden beseitigt. (einschließlich die Hebedeckel, die auf den oberen Mannlöchern verschraubt sind)
- Alle inneren Teile sollen montiert werden (einschließlich Prüfblöcke).
- Erfordernisse/Empfehlungen für Flanschanziehung sind in Nuovo Pignone Dokument n° SOU0120351/4 angegeben (SCHRAUBENVERSPANNUNGSVERFAHREN).
- Dämmung wird montiert wo erforderlich ist. (Dämmungshalter sind Kalibertyp (?) und sie werden locker geliefert und werden an Ort vom Besitzer montiert)
- Die Umhüllungsflächen (innen / außen) werden angemessen feuerfest gemacht. (Feuerfestigkeit ist nicht eingeschlossen in Nuovo Pignone Lieferungsbereich).

- Diese Behälter werden zur Erdungsleitung angeschlossen mittels der an der Umhüllung angeschweißten Erdungsklemmen.
- Es werden Überwachungs- und Sicherheitsvorrichtungen montiert. (Diese sind wesentlich für Sicherheit und für richtigen Betrieb, deshalb soll man sorgfältig mit ihnen umgehen, um Beschädigungen und Stampferung zu vermeiden)
- Die endgültige Behälterprüfung vor dem Anlass soll in Obacht des Besitzers ausgeführt werden gemäß seines inneren Verfahrens anwendbar für die Anlage. Jedenfalls ist es die Verantwortung des Besitzers zu prüfen dass jede Prüfung, jedes Verfahren, usw. bei diesen Behältern keine Beschädigungen und Verletzungen verursachen, den Behältern selbst und dem Personal und Materialien in der Zone. **Im besonderen, falls eine pneumatische oder hydrostatische Probe durchgeführt wird, soll der in den Herstellzeichnungen angezeigte Hydrostatikprobedruck nicht überschritten werden.** Mindestens folgende Prüfungen sind erforderlich.
  1. **Prüfen der Sicherheitsvorrichtungen**
  2. **Prüfen der Kontrollvorrichtungen**
  3. **Prüfen des Erdungsanschlusses**
  4. **Prüfen der Beleuchtung der Zone**
  5. **Prüfen der Lüftung und Entleerung**
  6. **Dämmungszustand**

Nachdem die oben erwähnten Tätigkeiten durchgeführt wurden, können die Behälter für betriebsbereit gehalten werden und sie können mit Katalysator und Betriebsflüssigkeit gefüllt werden. Der Anlass wird gemäß den Anweisungen aus diesem Handbuch ausgeführt.

ANMERKUNG: die Katalysator-Ablassdüsen (D) wurden für den Versand mittels Wartungsdeckeln und Schrauben verschlossen, die Dichtmanschette für den werkseitigen Hydrotest wurde jedoch an Ort und Stelle belassen. Der Eigentümer hat dafür zu sorgen, dass die provisorische Versand-Dichtung durch die entsprechende Betriebsdichtung ersetzt wird (Teil des Lieferumfangs von Nuovo Pignone). Das Festziehen der Flansche hat gemäß Unterlage Nuovo Pignone Nr. SOU0120351/4 (SCHRAUBEN-ANZIEHVERFAHREN) zu erfolgen.

5.0 ANLASS- UND ABSTELLVERFAHREN

5.1 ALLGEMEINES

Dieses Verfahren beschreibt die empfohlenen Hauptgrenzwerte um ein Standardanlass und eine Standardabstellung auszuführen.

Die angegebenen Druck- und Temperaturwerte sind wichtig für den Hauptdruckbestandteil (Schale, Ober- / Unterkalotte und Düsen).

Die vorausgesetzten Heiz- / Kühlgeschwindigkeit und Druckgradient werden als maximal angenommen.

5.3 ANLASSGRENZWERTE

Während des Anlasses, empfehlen wir, folgende Grenzwerte nicht zu überschreiten:

- Für Temperatur unter +10°C soll der Druck nicht höher als 10% des Nenndrucks sein.
- Für Temperatur unter +38°C soll der Druck nicht höher als 25% des Nenndrucks sein.

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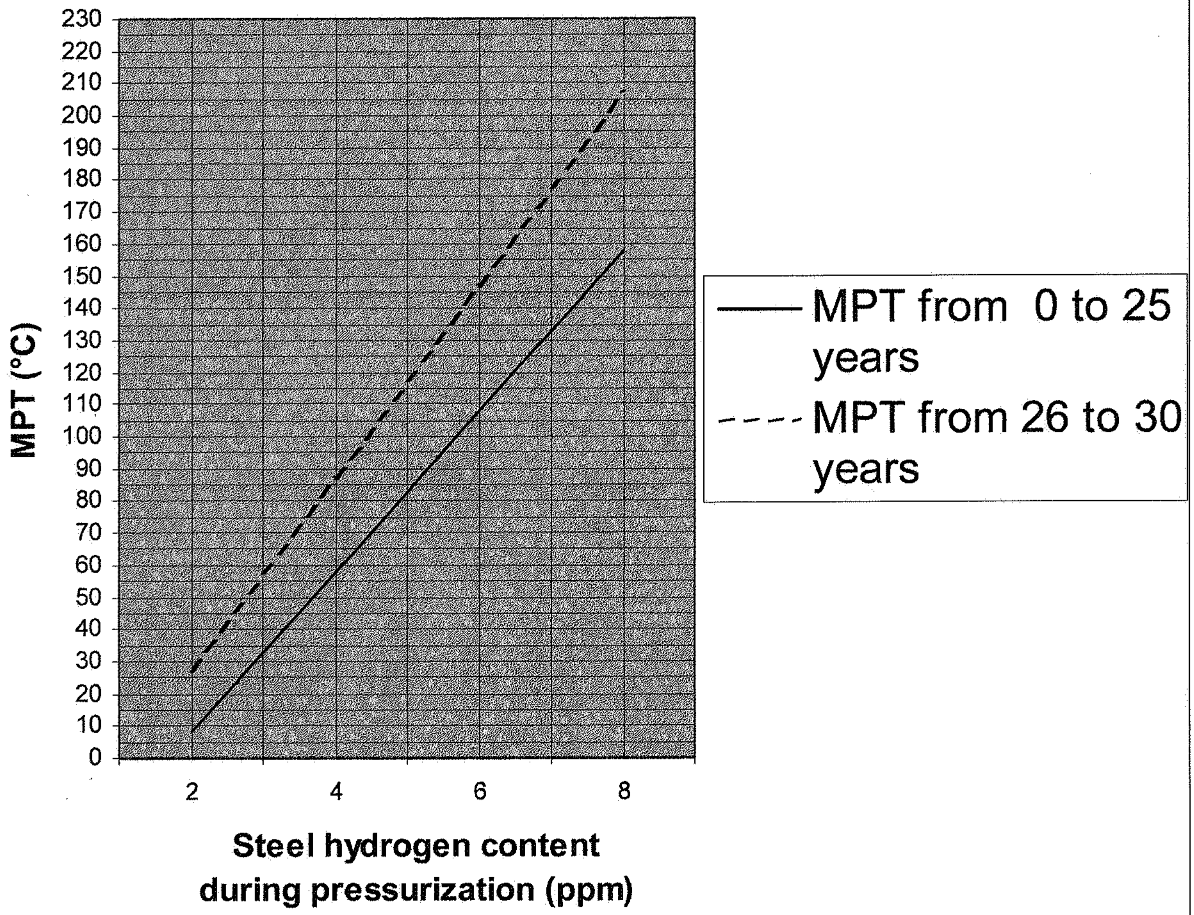
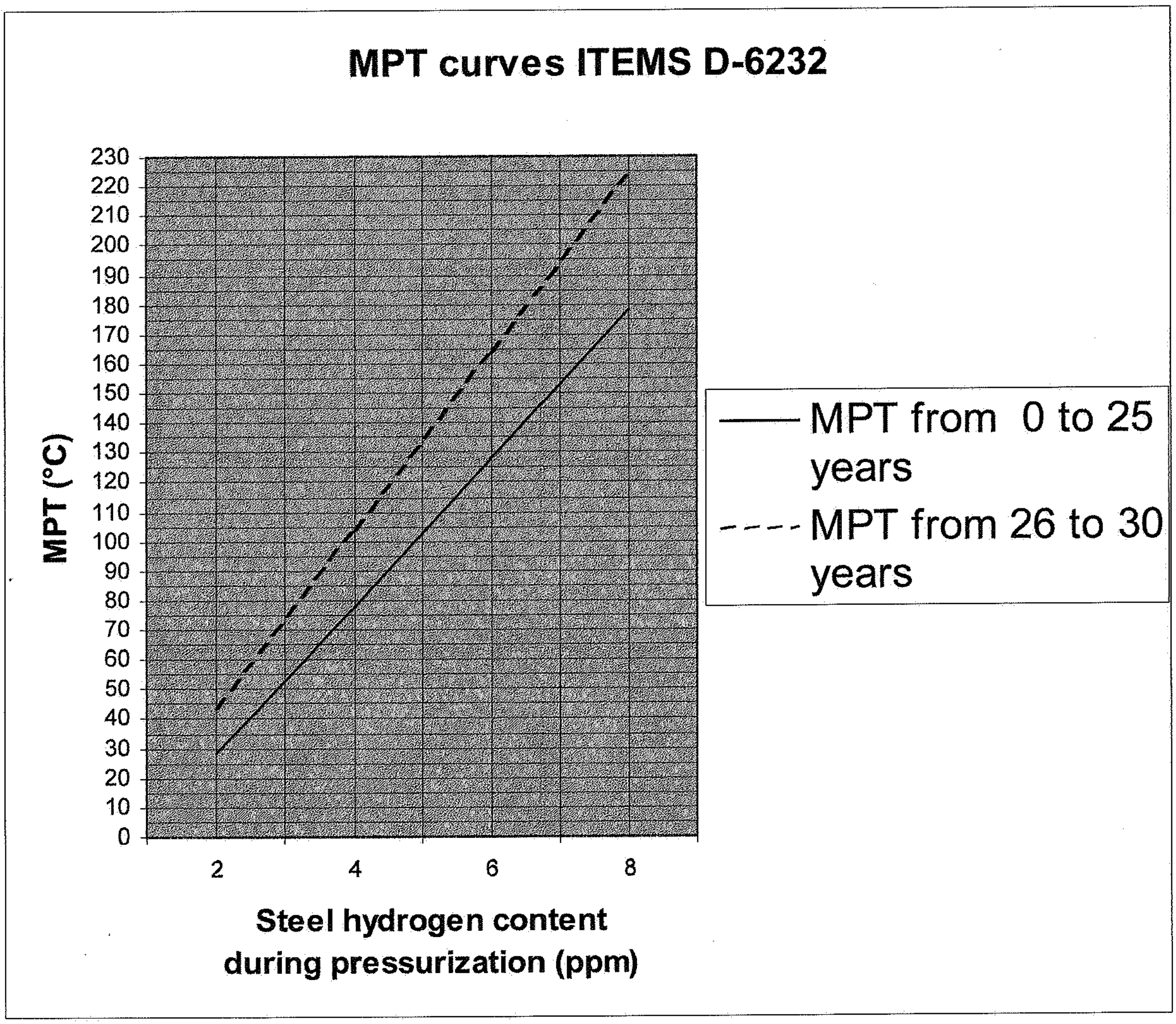
- Empfohlener Druckgradient während des Anlasses ist max. 8 bar/h für Temperatur unter 120°C
- Empfohlener Druckgradient während des Anlasses ist max. 15 bar/h für Temperatur über 120°C
- Empfohlener Temperaturgradient ist ungefähr 6÷8 °C/h für Temperatur unter 120°C
- Empfohlener Temperaturgradient ist ungefähr 15 °C/h für Temperatur über 120°C
- Obenstehende Richtlinien sollten zum Schutze des Behälters während des Anfahr-Vorgangs strikt befolgt und über die gesamte Einsatzdauer eines Behälters beibehalten werden.
- Die auf dem folgenden Schaubild wiedergegebenen Mindestdruckbeaufschlagungs-Kurven wurden für die Artikel D-6211, D-6231, D-6212, D-6232 erstellt. Sie wurden anhand folgender, empirischer Formeln bestimmt und zwar auf der Grundlage der Ergebnisse des an Musterproben des tatsächlich verwendeten Behälter-Baumaterials durchgeführten, schrittweisen Abkühltests.
- MPT25 = VTr55+2,5*(V'Tr55+10*(H ppm))-VTr55)
- MPT30 = VTr55+3*(V'Tr55+10*(H ppm))-VTr55)
- Gemäß Schaubild hängt die MPT vom Alter des Behälters ab sowie vom effektiv im Stahl enthaltenen Wasserstoff während der Druckbeaufschlagung. Bei erstmaliger Inbetriebsetzung des Behälters kann der im Verlaufe der Herstellung eingebrachte Wasserstoffgehalt im Stahl mit max. 2ppm angenommen werden. Unter dieser Voraussetzung lässt sich eine Druckbeaufschlagungstemperatur **(MPT)** von **+10° C** annehmen. Falls der Behälter für Wasserstoffbetrieb eingesetzt wurde und abgefahren werden soll, muss der Betreiber den tatsächlichen Wasserstoffanteil im Stahl kennen, bevor er den Behälter erneut mit Druck beaufschlägt, um die richtige MPT anhand des zutreffenden Graphen einstellen zu können. Es ist Aufgabe des Betreibers, ein geeignetes Verfahren zur Bestimmung des Wasserstoffgehalts im Stahle auszuarbeiten.

WARNUNG: auch bei Hydrauliktests vor Ort hat man sich stets an die MPT-Kurven zu halten.

MPT curves ITEMS D-6211, D-6231, D-6212





MPT curves ITEMS D-6232
MPT (°C)
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
2
4
6
8
Steel hydrogen content
during pressurization (ppm)
MPT from 0 to 25 years
MPT from 26 to 30 years

5.3 ABSSTELLGRENZWERTE

Während der Abstellung, empfehlen wir, folgende Grenzwerte nicht zu überschreiten:

- Es wird empfohlen, den Behälter warm zu halten bis genügend Zeit abgelaufen ist für Ausgasen des Wasserstoffs von der Behälterwand (zum Beispiel 315°C für 18h oder 250°C für 40h oder äquivalenter Gradient). Das Ausgasen muss ausgeführt werden unter Stickstoffumlauf bei max. 40 bar (7 bar als Stickstoffdruck ist akzeptierbar).
- Empfohlener Druckgradient ist max. 10 bar/h.
- Empfohlener Temperaturgradient ist max. 20 °C/h.

WARNUNG: bei erforderlichem Not-Aus hat der Betreiber für ein Verfahren zu sorgen, womit der Behälter so lange warm gehalten werden kann, bis die Wasserstoff-Entgasung hinreichend erfolgt – der Druckablass muss dabei so gering wie möglich gehalten werden.

6.0 WARTUNG UND PERIODISCHE PRÜFUNGEN

6.1 ALLGEMEINES

Wartungstätigkeiten erfordern spezifische Kentnisse, also können sie nur vom qualifiziertem und autorisiertem Personal ausgeführt werden. Ihre Planung und Ausführung ist Sorge des Besitzers, gemäß den inneren Raffinerieverfahren und lokalen Gesetzen, Nuovo Pignone Empfehlung, hier eingeschlossen, berücksichtigend.

Die Wartungstätigkeiten werden nach der Abstellung ausgeführt wenn der Behälter völlig drucklos und kalt ist.
Die Abstellung wird gemäß den Anweisungen aus diesem Handbuch ausgeführt.

Nuovo Pignone weist darauf hin, dass die Anweisungen in diesem Abschnitt für den Behälterbetrieb in Bezug auf Sicherheit und Leistungen finalisiert wurden. Der Besitzer ist verantwortlich alle zusätzliche Verfahren anzuwenden bezüglich der im Land wo der Behälter in Betrieb ist anwendbaren gültigen Gesetze /Normen / Richtlinien.

6.2 PERIODISCHE WARTUNG und PRÜFUNGEN

Folgende Tätigkeiten werden für jeden Behälter periodisch empfohlen:

1. **Prüfen der Sicherheitsvorrichtungen**
2. **Prüfen der Kontrollvorrichtungen**
3. **Prüfen des Erdungsanschlusses**
4. **Zustand der Dichtungen und Dichtungssitze**
5. **Prüfen der Beleuchtung der Zone**
6. **Prüfen der Lüftung und Entleerung**
7. **Zustand der Dämmung und Feuerfestigkeit**
8. **Reinigung der Innenteile**
9. **Mechanische Prüfungen auf den Prüfblöcken**
10. **Ultraschallprüfung der Schweißplattierung**

Die wichtigste Erscheinung bei 2 ¼ Cr 1 Mo ¼ V Stoffen in Wasserstoffbetrieb ist **Anlasssssprödigkeit.**
Wasserstoffangriff ist eine Hochtemperaturerscheinung wo sich aufgelöster Wasserstoff im Stahl zerstreut und mit Kohlenstoff oder Karbiden reagiert um Methan zu bilden. Diese Bildung kann an der Oberfläche erscheinen (Oberflächenentkohlung) oder an Stellen innerhalb des Metalls, wie in Rissen oder Korngrenzen (innere Entkohlung). Zuerst bildet sich Methan in mikroskopischen Lücken, die sich vergrößern und Brüche bilden, welche dann eine Verringerung der Streckbarkeit und der Festigkeit des Stoffes verursachen.
Der Besitzer wird angemessene Prüfungen ausführen um den Zustand des Stoffes zu bestimmen.
Zu diesem Zweck ist jeder Behälter mit n° 1 Prüfblock ausgestattet, die Behälterherstelltätigkeiten ausgeführt von Nuovo Pignone darstellend. Sie werden innerhalb jedes Behälters während seines Betriebsdauer gestellt. (ein bestimmter Prüfplattenhalter ist auf der unteren Kalotte jedes Behälters gestellt).
Ultraschallprüfung der Schweißplattierung ist erforderlich (siehe Dokument n° SOU0116555/4 für alle Behälter).
Nuovo Pignone weist auf die Wichtigkeit hin, eine periodische Wartung und Prüfung der Kontroll- / Sicherheitsvorrichtungen und Instrumentation gemäß den inneren Raffinerieverfahren durchzuführen. Wie schon vorher erwähnt, ist das wesentlich um die erforderlichen Leistungen dieser Behälter hinsichtlich der Betriebssicherheit zu erhalten.

- Während der Wartung (wenn sich die Behälter in derer vorausgesehenen Montagezone befinden):
- Werkzeuge, welche heiße Oberflächen erzeugen können werden nicht benutzt (d.h. Schweißapparate)
- Es müssen Antifunkelwerkzeuge benutzt werden
- Mit beweglichen Teilen muss man sorgfältig umgehen, um gefährliche Aufprälle oder Reibungen mit Fremdkörpern zu vermeiden;
- Das Wartungspersonal (und die Leute die im allgemeinen in Kontakt sind, während der Wartung und jedwelcher anderer Phase) muss antistatische Kleidung tragen (insbesondere antistatische Schuhe) um Funkeln zu vermeiden.
- Vor dem Öffnen müssen diese Behälter für einen genügenden Zeitablauf gedeckt werden um zu vermeiden dass Restkohlenwasserstoffdampf in Kontakt mit der Luft ist und somit einen explosionsgefährdeten Bereich erzeugt. Werkzeuge, die heiße oder chemische instabile Flüssigkeiten erzeugen / ausbreiten können, werden nicht benutzt (d.h. Schweißapparate)
- Das Personal welches in der Wartung der Ausrüstung verwickelt ist muss qualifiziert und angemessen geschult sein.
- Eine periodische und angemessene Wartung ist wichtig um eine mögliche Prozessflüssigkeitsleckage mit möglichen gefährlichen Folgen in Explosionsatmosphäre zu verhindern.

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7.0 ÄNDERUNGEN und REPARATUREN

Mögliche zukünftige große oder kleine Änderungen und Reparaturen werden ausgeführt nach einer strengen Analyse des autorisierten Fachingenieurs gemäß den Nationalbehörden, Koden und anwendbaren Dokumenten (siehe Paragr. 2.4) und nach Vereinbarung mit Nuovo Pignone.
Der Grundstoff geliefert von Nuovo Pignone (2 ¼ Cr 1 Mo ¼ V) wurde geprüft um das mechanische Verhalten nach zwei (2) möglichen PWHT (Nachschweißwärmebehandlungen) zu garantieren. PWHT soll gemäß Spez.. SOU0113843/4 ausgeführt werden.
Die chemischen und mechanischen Eigenschaften und die Prüfungen anwendbar am Grundstoff sind in den Spez. SOU0112430/4 (Zusätzliche Stofferfordernisse für 2 ¼ Cr 1 Mo ¼ V Stoff) angegeben.

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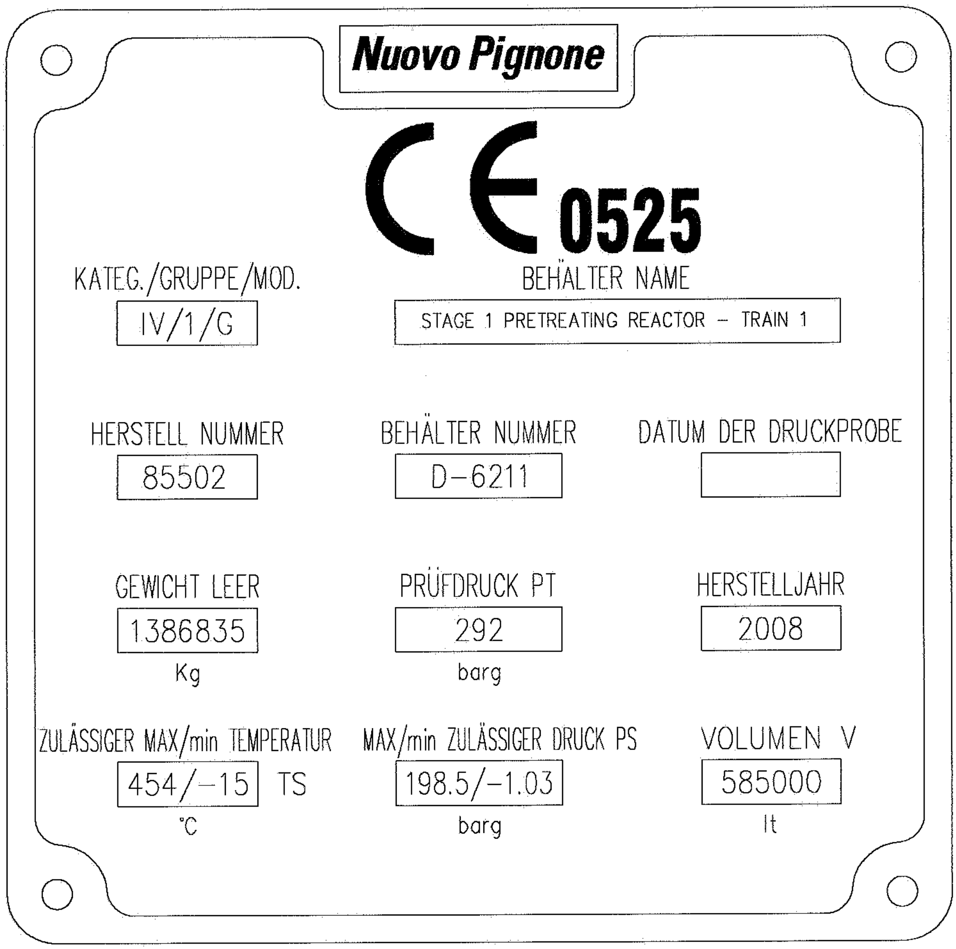
ANHANG A:

CE Namensschild für Artikel D-6211



STAGE 1 PRETREATING REACTOR – TRAIN 1 = *PHASE 1 VORBEHANDLUNGSREAKTOR – ZUG 1*
STAGE 1 PRETREATING REACTOR – TRAIN 2 = *PHASE 1 VORBEHANDLUNGSREAKTOR – ZUG 2*
STAGE 1 HYDROCRACKING REACTOR – TRAIN 1 = *PHASE 1 HYDROKRACKREAKTOR – ZUG 1*
STAGE 1 HYDROCRACKING REACTOR – TRAIN 2 = *PHASE 1 HYDROKRACKREAKTOR – ZUG 2*

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CE Namensschild für Artikel D-6231

STAGE 1 PRETREATING REACTOR – TRAIN 1 = *PHASE 1 VORBEHANDLUNGSREAKTOR – ZUG 1*
STAGE 1 PRETREATING REACTOR – TRAIN 2 = *PHASE 1 VORBEHANDLUNGSREAKTOR – ZUG 2*
STAGE 1 HYDROCRACKING REACTOR – TRAIN 1 = *PHASE 1 HYDROKRACKREAKTOR – ZUG 1*
STAGE 1 HYDROCRACKING REACTOR – TRAIN 2 = *PHASE 1 HYDROKRACKREAKTOR – ZUG 2*

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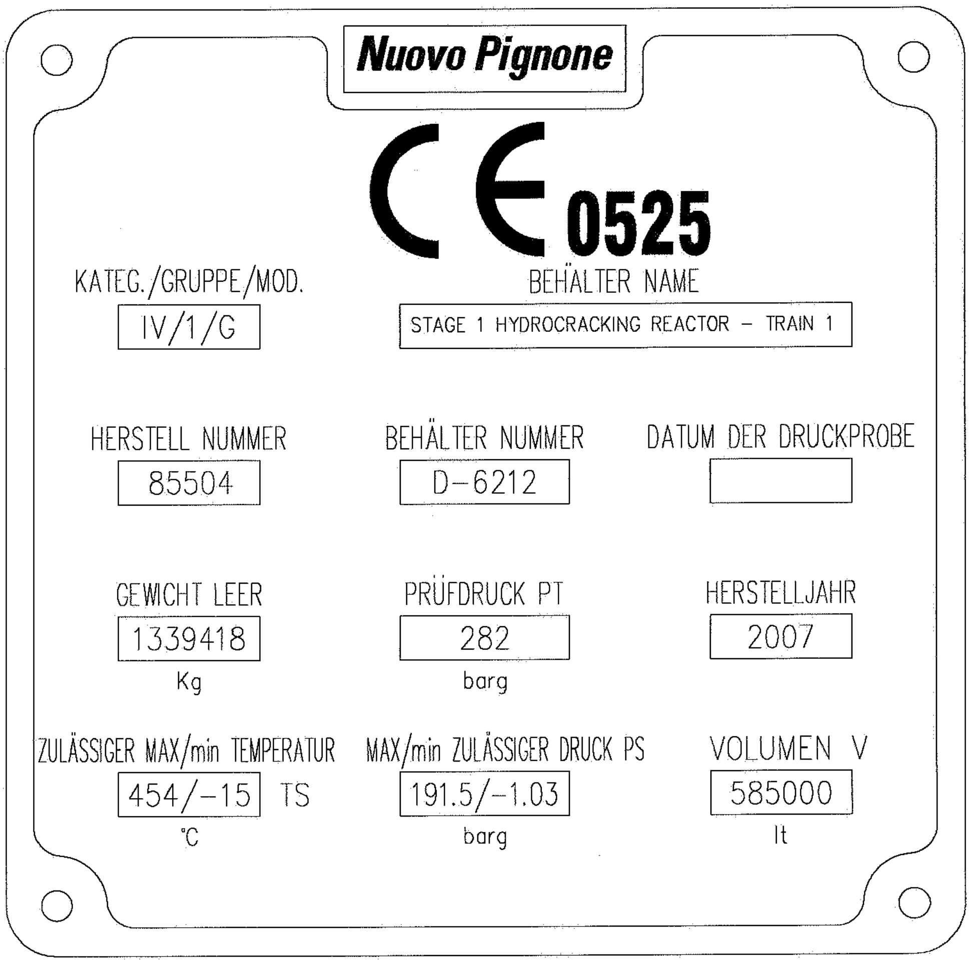
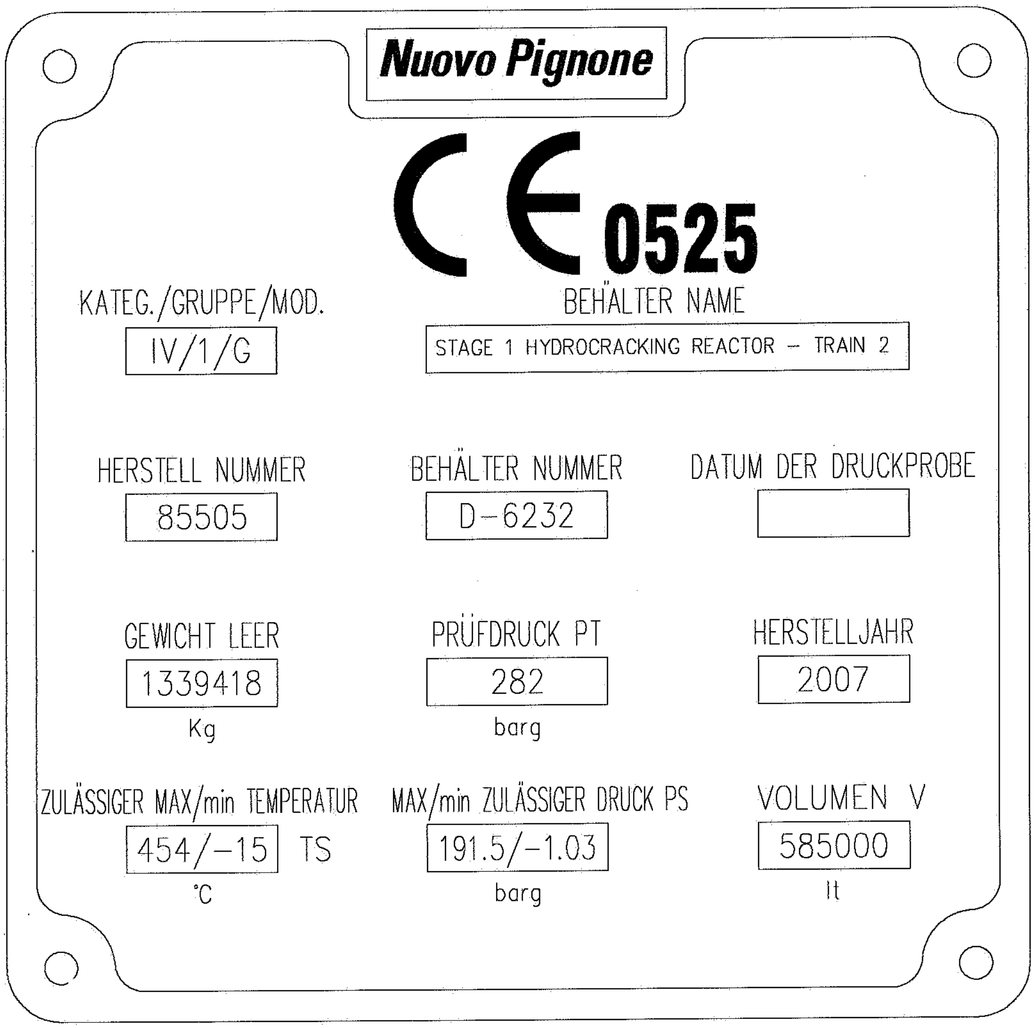
CE Namensschild für Artikel D-6212



STAGE 1 PRETREATING REACTOR – TRAIN 1 = *PHASE 1 VORBEHANDLUNGSREAKTOR – ZUG 1*
STAGE 1 PRETREATING REACTOR – TRAIN 2 = *PHASE 1 VORBEHANDLUNGSREAKTOR – ZUG 2*
STAGE 1 HYDROCRACKING REACTOR – TRAIN 1 = *PHASE 1 HYDROKRACKREAKTOR – ZUG 1*
STAGE 1 HYDROCRACKING REACTOR – TRAIN 2 = *PHASE 1 HYDROKRACKREAKTOR – ZUG 2*

CE Namensschild für Artikel D-6232



STAGE 1 PRETREATING REACTOR – TRAIN 1 = *PHASE 1 VORBEHANDLUNGSREAKTOR – ZUG 1*
STAGE 1 PRETREATING REACTOR – TRAIN 2 = *PHASE 1 VORBEHANDLUNGSREAKTOR – ZUG 2*
STAGE 1 HYDROCRACKING REACTOR – TRAIN 1 = *PHASE 1 HYDROKRACKREAKTOR – ZUG 1*
STAGE 1 HYDROCRACKING REACTOR – TRAIN 2 = *PHASE 1 HYDROKRACKREAKTOR – ZUG 2*

ANHANG B:

SUO0269055	Allgemeine Zusammenstellung D-6211	(Seite 1/2)
SUO0269055	Kalotten, Düsen - Detailzeichnung D-6211	(Seite 2/3)
SUO0269055	Schale, Düsen - Detailzeichnung D-6211	(Seite 3/4)
SUO0269055	Detailzeichnung D-6211	(Seite 4/5)
SUO0269055	Umhüllung & Namensschild - Detailzeichnung R-001	(Seite 5/5)
SUO0269056	Allgemeine Zusammenstellung D-6231	(Seite 1/2)
SUO0269056	Kalotten, Düsen - Detailzeichnung D-6231	(Seite 2/3)
SUO0269056	Schale, Düsen - Detailzeichnung D-6231	(Seite 3/4)
SUO0269056	Detailzeichnung D-6231	(Seite 4/5)
SUO0269056	Umhüllung & Namensschild - Detailzeichnung D-6231	(Seite 5/5)
SUO0269057	Allgemeine Zusammenstellung D-6212	(Seite 1/2)
SUO0269057	Kalotten, Düsen - Detailzeichnung D-6212	(Seite 2/3)
SUO0269057	Schale, Düsen - Detailzeichnung D-6212	(Seite 3/4)
SUO0269057	Detailzeichnung D-6212	(Seite 4/5)
SUO0269057	Umhüllung & Namensschild - Detailzeichnung D-6212	(Seite 5/5)
SUO0269058	Allgemeine Zusammenstellung D-6232	(Seite 1/2)
SUO0269058	Kalotten, Düsen - Detailzeichnung D-6232	(Seite 2/3)
SUO0269058	Schale, Düsen - Detailzeichnung D-6232	(Seite 3/4)
SUO0269058	Detailzeichnung D-6232	(Seite 4/5)
SUO0269058	Umhüllung & Namensschild - Detailzeichnung D-6232	(Seite 5/5)
SU 1408398/3	Fundament - Vorlagezeichnung D-6211	
SU 1408400/3	Fundament - Vorlagezeichnung D-6231	
SU 1408406/3	Fundament - Vorlagezeichnung D-6212	
SU 1408408/3	Fundament - Vorlagezeichnung D-6232	
SUO1427009/2	Herstellungstoleranzen	
SOU0107844	Spannkraftanalyse – Umhüllung zu Schale-Anschluss D-6211 / D-6231	
SOU0107845	Spannkraftsanalyse – Umhüllung zu Schale -Anschluss D-6212 / D-6232	
SOU0117838	Druckteilausrechnung D-6211 / D-6231	
SOU0117839	Strukturteilausrechnung D-6211 / D-6231	
SOU0117840	Druckteilausrechnung D-6212 / D-6232	
SOU0117841	Strukturteilausrechnung D-6212 / D-6232	
SOU0115194	Hydrostatikprobeverfahren R-001	
SOU0113843	P.W.H.T. , L.P.W.H.T und DHT Verfahren	
SOU0111412	Grund- und Schweißstoffreparaturspezifikation	
SOU0111413	Schweißreparaturverfahren für Schweißplattierung	
SOU0111414	Zwischenspannkraftbefreiung im Werk für Düsenschweißung	
SOU0111415	Schweißkarte für Schweißplattierung	
SOU0111416	Schweißübersichtsblatt	
SOU0110203	Herstell- und Prüfplan D-6211	
SOU0110204	Herstell- und Prüfplan D-6231	
SOU0110205	Herstell- und Prüfplan D-6212	
SOU0110206	Herstell- und Prüfplan D-6232	
SOU0120351	Verfahren für Schraubenanziehen des Flanschanschlusses	
SU-1413208	CE Namensschild D-6211	

SU-1413210	CE Namensschild D-6231
SU-1413212	CE Namensschild D-6212
SU-1413214	CE Namensschild D-6232
SUO1429238	Transportzeichnungen D-6211 / D-6231
SUO1429239	Transportzeichnungen D-6212 / D-6232
SUO1429235	Transportsattel D-6211 / D-6231
SUO1429236	Transportsattel D-6212 / D-6232
SUO1419932	Dämmungshalter D-6211
SUO1419933	Dämmungshalter D-6231
SUO1419934	Dämmungshalter D-6212
SUO1419935	Dämmungshalter D-6232
SOU0116552	Flüssigkeitseindringungsmittelprüfung
SOU0116553	Magnetikpartikelprüfung
SOU0116556	Radiographische Prüfung
SOU0116554	Ultraschallprüfung
SOU0116558	B-C Scan Technik für Ultraschallprüfung
SOU0116557	Ultraschallprüfung mit TOFD
SOU0116555	Ultraschallprüfung von Schweißplattierung
SOU0116561	Härtemessverfahren
SOU0116559	Ferritprüfspezifikation
SOU0116560	Positivstoffidentifizierung
SU-1413197	Aufhängeöse D-6211 / D-6231
SU-1413198	Aufhängeöse D-6212 / D-6232

ANHANG C:

Düsenliste für Artikel D-6211 / D-6231:
(siehe ebenfalls Zeichnungen SUO0269055/1 und SUO0269056/1)

ARTIKEL D-6211 / D-6231				
BETRIEB	**ARTIKEL**	**Menge**	**Ngr.**	**TYP**
EINLASS	A	1	18”	WN-RF SPEZIALFLANSCH
AUSLASS	B	1	20”	WN-RF SPEZIALFLANSCH
MANNLOCH	M	1	38”	SPEZIALFLANSCH RTJ
KATALYSATOR-ENTZUG	D1 ÷ D2	2	8”	2500-WN-RF-FLANSCH
KATALYSATOR-ENTZUG	D3 ÷ D8	6	6”	2500-LWN-RF- DÜSE SELBSTVERST.
TI	T1 ÷ 13	13	3”	2500-LWN-RF- DÜSE SELBSTVERST.
ABKÜHLUNG	E1 ÷ E3	3	8”	2500-LWN-RF- DÜSE SELBSTVERST.
NEUTRALISATION	D9	1	4”	2500-LWN-RF-FLANSCH
SCHALE THERMOELEMENT	SK1 ÷ 66	66	1”	/
UMHÜLLUNGSZUGANG	SA1 ÷ 2	2	24” ID	/
UMHÜLLUNGSLÜFTUNG	SV1 ÷ 8	8	3”	/
UMHÜLLUNGSÖFFNUNG	SO1 ÷ 2	2	/	/
UMHÜLLUNGSÖFFNUNG	SO3	1	/	/

Düsenliste für Artikel D-6212 / D-6232:
(siehe ebenfalls Zeichnungen SUO0269057/1 und SUO0269058/1)

ARTIKEL D-6212 / D-6232				
BETRIEB	**ARTIKEL**	**Menge**	**Ngr.**	**TYP**
EINLASS	A	1	20”	WN-RF SPEZIALFLANSCH
AUSLASS	B	1	24”	WN-RF SPEZIALFLANSCH
MANNLOCH	C	1	38”	SPEZIALFLANSCH RTJ
KATALYSATOR-ENTZUG	D1 ÷ 2	2	8”	2500-WN-RF-FLANSCH
KATALYSATOR-ENTZUG	D3 ÷ 6	4	6”	2500-LWN-RF-DÜSE SELBSTVERST.
TI	T1 ÷ 6	6	3”	2500-LWN-RF- DÜSE SELBSTVERST.
ABKÜHLUNG	E1 ÷ 2	2	8”	2500-LWN-RF- DÜSE SELBSTVERST.
TI	T7 ÷ 11	5	3”	2500-LWN-RF- DÜSE SELBSTVERST.
NEUTRALISATION	D7	1	4”	2500-LWN-RF-FLANSCH
SCHALE THERMOELEMENT	SK1 ÷ 94	94	1”	/
UMHÜLLUNGSZUGANG	SA1 ÷ 2	2	24”ID	/
UMHÜLLUNGSLÜFTUNG	SV1 ÷ 8	8	3”	/
UMHÜLLUNGSÖFFNUNG	SO1 ÷ 2	2	/	/
UMHÜLLUNGSÖFFNUNG	SO3	1	/	/

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Sub-Section A2

Declaration of Conformity

DECLARATION OF CONFORMITY - Rev.1 (*)
Dichiarazione di Conformita'
PED 97/23/EC

MANUFACTURER:
Nuovo Pignone S.p.A. – Via Dorsale, 3 – 54100 Massa

PRODUCT and ITEM: **MANUFACTURING S.N.:** 85504
STAGE 1 HYDROCRACKING REACTOR – TRAIN 1

DRAWING and Quality Control Plan No:
SUO 0269057/1 rev. 7 – SOU 0110205/4 rev. 2

VENDOR DOCUMENTS SHEET:
SIT 3100276 rev. 20

LOCATION OF FIRST INSTALLATION:
WILHELMSHAVEN (GERMANY)

We hereby declare that the above vessel/assembly have been designed, manufactured and tested to the requirements of PED 97/23/EC which apply to it for

CATEGORY and MODULE:
IV – G

CONFORMITY ASSESSMENT MODULE (and reference):
Module G (Hydro test report n. 276-01 DATED 13.09.2007)

NOTIFIED BOBY:
Lloyd's Register Quality Assurance GmbH
Mönckebergstrasse 27, D-20095 Hamburg, (Deutschland)
No Bo No 0525

EC-DESIGN APPRAISAL DOCUMENT
PPT 6235-06 rev. 0 and PPT 10096-10 rev.0

TECHNICAL STANDARD AND SPECIFICATION ADOPTED:
ASME VIII Div.2 Edition 2004 , API 934, B31.3-2006, UOP 939031-304, UOP 3-17-3, and ASME B31.3-2006.

It is intended that the above equipment need to be installed according to the requirements described in the relevant Installation and instruction Manual SOU0120328/4

(*) This revision has been issued exclusively for the change of the Top Spool design code, from ASME VIII Div.2 to ASME B31.3, due to the new nozzle loads communicated by Client after vessel delivery. New nozzle loads do not affect the vessel fabrication.

Manufacturer legal representative and position

(L. D'Oriano – Q.C. Manager)

Date: May 4th, 2010

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GE
Oil & Gas
Nuovo Pignone S.p.A. - Italy

Sub-Section A3

Inspection Releases Note LL/RR

Zertifikat / Certificate: **GEN1043005/ZE-1106/3**

Lloyd's Register

Konformitätsbescheinigung

gemäß DGR 97/23/EG, Anhang III, Modul B+F, B1+F oder G

Certificate of Conformity according to PED 97/23/EC, Annex III, Module B+F, B1+F or G

Hersteller / Manufacturer
Nuovo Pignone S.p.a.
Adresse / Address
Via Dorsale 3
Massa, Italy

Auftrags-Nummer des Herstellers / Manufacturer's order number
85504
Konformitätsbewertung gemäß Modul / Conformity assessment according module
G

☐ EG-Entwurfsprüfung Modul B1 / EC design-examination module B1
☐ EG-Baumusterprüfung Modul B / EC type-examination module B
☒ Vorprüfung Modul G / Design appraisal module G

Referenz / Reference: **PPT 6233-06 rev 0 and PPT 10097-10 rev 0**

Beschreibung des Druckgeräts / Description of pressure equipment

Anzahl und Typ / Quantity and description	**1 (one/ein) - Pressure vessel reactor (Reaktordruckbehälter)**		
Kategorie / Category	**IV**		
Prüfberichtnummer / Test report number	**GEN1043005/A-808/3**		
Seriennummer(n) / Identification number(s)	**85504 item no. D-6212**		
Herstellungsjahr / Year of manufacture	**2007**	Prüfdatum / Date of test	**27 September 2007**
Position / Druckraum-Nummer / Item / chamber number	Mantelseitig / Shell side	-- / --	-- / --
Maximal zulässige Drücke / Maximum allowed pressures	**191.5 / 1.03 (ext.) bar**		
Prüfdrücke / Medium / Test pressures / medium	**282 (horiz.) bar / water**		
Zulässige Temperaturen (min./max.) / Allowed temperatures (min./max.)	**-15 / 454 °C**		
Volumen / Volume	**585000 L**		
Nennweite / Nominal size	**N/A**		
Korrosionszuschlag / Corrosion allowance	**4.2/6 mm (TP347)**		
Fluidgruppe / Medium / Fluid group / medium	**I**		
Sicherheitseinrichtungen / Safety devices	**Nicht im Lieferumfang enthalten** / Not included in scope of delivery		

Die Sicherheitseinrichtungen und Druck tragenden Ausrüstungsteile wurden nicht geprüft. Eine Abnahmeprüfung vor Inbetriebnahme am Aufstellungsort ist noch erforderlich / The safety devices and pressure accessories have not been tested. An acceptance test has to be performed at the place of installation before putting into operation

Der Unterzeichner bescheinigt hiermit, dass der Entwurf, die Fertigung und Inspektion des Druckgeräts in Übereinstimmung mit den Anforderungen von der Richtlinie DGR 97/23/EG ist / The undersigned certifies that the design, manufacture and inspection of this pressure equipment is in conformity with the requirements PED 97/23/EC

Zum Zeichen der bestandenen Abnahmeprüfung wurde **das Typenschild** des Druckgeräts wie folgt gekennzeichnet / To indicate the passed final assessment, the pressure equipment has been marked on **name plate** as follows

CE 0525 iLRs 13.09.07 iLRs

Den Anweisungen in der Betriebsanleitung ist unbedingt Folge zu leisten. Das Gerät unterliegt wiederkehrenden Prüfungen nach den jeweils zutreffenden Rechtsvorschriften / Instructions given in the operating manual are strictly to obeyed to. The pressure equipment is subject to periodical inspections in conformity with the relevant statutory requirements

Bemerkungen / Remarks:
none

Für die Benannte Stelle LRQA GmbH gemäß Artikel 12 der Richtlinie 97/23/EG, Kenn-Nr. 0525
On behalf of LRQA GmbH, Notified Body in accordance article 12 of the PED Identification No. 0525

LLOYD'S REGISTER Lloyd's Register HAMBURG QUALITY ASSURANCE GmbH

Hamburg, 11 May 2010 — **H. Axnick**

Ort und Datum — Name des Prüfers der Benannten Stelle, Unterschrift und Stempel

Place and Date — Name of Inspector of Notified Body, Signature and Stamp

Lloyd's Register Quality Assurance GmbH, Mönckebergstrasse 27, D-20095 Hamburg, Deutschland
Telefon +49 40 32 81 07 - 0 Fax +49 40 32 81 07 - 230 Email: PressureSystems.Germany@lr.org

This certificate was issued to include new loadings on nozzles and flanges M and A - New pressure proof test is not required.

Zertifikat / Certificate: **GEN 1043005/A-808/3**

Lloyd's Register

Bericht zur Schluss- und Druckprüfung

gemäß DGR 97/23/EG, Anhang I, Abschnitt 3.2.1 und 3.2.2

Final Inspection and Proof Test Report according PED 97/23/EC, Annex I, Section 3.2.1 and 3.2.2

Hersteller / Manufacturer
Nuovo Pignone S.p.a.
Adresse / Address
Via Dorsale 3
Massa, Italy

Herstellernummer / Manufacturer's number
85504
Fertigungsstätte / Place of fabrication
Massa - Italy
Herstellungsjahr / Year of manufacture
2007

Druckgerätetyp nach DGR / Type of pressure equipment to PED	**Pressure vessel (Reactor) s.n. 85504 - Item n. D-6212**
Kategorie / Category	**IV**
Zeichnungsnummer / Drawing number	**SUO 0269057/1 rev.7**
Referenz EG-Baumuster- /Entwurfsprüfung / EC-type-/design examination reference	**Module G /D.A.D. PPT 6233-06 rev.0 and PPT 10096-10 rev.0**

	1. Druckraum First chamber	2. Druckraum Second chamber	3. Druckraum Third chamber
Maximal zulässiger Druck (bar) Maximum allowable pressure (bar)	**191,5 (int)/1,03 (ext)**		
Prüfdruck/Medium (bar) Test pressure/medium	**282 (horizontal position)/water**		
Zulässige min./max. Temperaturen (° C) Allowable min./max. temperatures (° C)	**-15°/454°**		
Inhalt (L) Capacity (L)	**585000**		
Korrosionszuschlag (mm) Corrosion allowance (mm)	**4.2/6 (overlay in S.S. Tp 347)**		
Datum der Schlussprüfung Date of final inspection	**27 September 2007**		
Datum der Druckprüfung Date of proof test	**13 September 2007**		

Überprüfung der Sicherheitseinrichtung / Check of safety devices: ☐ Zufrieden stellend / Satisfactory ☒ Nicht Bestandteil / Not included

Sicherheitsventile / Safety valves — Größe / Kapazität (m^3/h) / Size/Capacity: — Einstelldruck (bar) / Set pressure (bar): ---

Der Unterzeichner erklärt hiermit, dass die Ausführung des Druckgerätes in den wesentlichen Teilen der/den oben genannten Zeichnung/en entspricht. Es wird bestätigt, dass die obigen Prüfungen zufrieden stellend verliefen und die Forderungen der Druckgeräterichtlinie 97/23/EG in Bezug auf die verwendeten Werkstoffe, die Fertigung, die durchzuführenden Prüfungen, die Qualifikationen des Personals zur Herstellung dauerhafter Werkstoffverbindungen und zur Durchführung zerstörungsfreier Prüfungen erfüllt sind.

The undersigned herewith declares, that the construction of the essential parts of the equipment corresponds to the above mentioned drawing(s). It is confirmed, that the above inspections have been carried out with satisfactory results and the requirements of the PED 97/23/EC with respect to the materials used, manufacturing, examinations to be performed, qualifications of personnel producing permanent joints and performing non-destructive examinations, have been fulfilled.

Zum Zeichen der bestandenen Prüfungen wurde das Druckgerät wie folgt gekennzeichnet:
To indicate the satisfactorily passed final inspections and tests, the pressure equipment has been marked as follows:

CE 0525 iLRs 13.09.07 iLRs

Lloyd's Register EMEA
G.L. Frolla
Viareggio Office
Lloyd's Register

Viareggio, 04 May 2010 — Gianluca Frolla

Ort und Datum / Place and Date — Name des Prüfers, Unterschrift und Stempel / Name of Inspector, Signature and Stamp

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Sub-Section A4

Inspection Releases Note Client

STATEMENT OF INSPECTION RELEASE

Client	ConocoPhillips	Sub Vendor	//
Contract No.	4507753565	Sub Order	//
Work Order No.		Site Location	Massa - Italy
PO Number	4507960234	RBG File No.	I 14-04088 00001
Vendor	Nuovo Pignone	Statement No.	01-AA

The material / equipment listed below has been inspected on (date) 27 09 07 and on the basis of the results of inspection was found to be ACCEPTABLE / ~~CONDITIONALLY ACCEPTABLE~~ in accordance with the requirements and specifications stipulated within the above purchase order and any subsequently agreed concessions as tabulated below*.
**(If applicable)*

Description:

D-6212 - STAGE 1 HYDROCRACKING REACTOR – TRAIN 1 (Nuovo Pignone Job 3100276)

REASON FOR CONDITIONAL ACCEPTANCE (If applicable)

N.A.

The following Statements of Non-Acceptance are superseded by this Release (Copies attached)

No NCRs outstanding.

THIS BEING THE ~~WHOLE~~ / PART / ~~BALANCE~~ OF THE ORDER

INSPECTORS NAME: Angelo Arena

INSPECTORS SIGNATURE:* DATE: 27 09 07

*Non electronic submissions only

THIS STATEMENT IS ISSUED WITHOUT PREJUDICE TO ANY LIABILITY OF THE MANUFACTURER/SUPPLIER TOWARDS THE PURCHASER OR IT'S AGENTS ARISING OUT OF OR IN ANYWAY CONNECTED WITH THE RELEVANT PURCHASE ORDER OR OTHER CONTRACT

Sub-Section A5

Vendor Document Control Sheet

Nuovo Pignone
Massa

VENDOR DOCUMENT CONTROL SHEET

Rev.	Descrizione - Description	Prep.-Prep.'d	Contr.-Chk.'d	Appr.-Appr.'d	Data-Date
30					
29					
28					
27					
26					
25					
24					
23					
22					
21					
20	**not applicable**	LAZZERINI	KEMPINSKI	KEMPINSKI	**25/03/2010**
19	**TRANSMITTAL N°274-036**	LAZZERINI	KEMPINSKI	KEMPINSKI	**18/09/2007**
18	**TRANSMITTAL N°274-035**	LAZZERINI	KEMPINSKI	KEMPINSKI	**14/09/2007**
17	**TRANSMITTAL N°274-034**	LAZZERINI	KEMPINSKI	KEMPINSKI	**09/07/2007**
16	**TRANSMITTAL N°274-032**	LAZZERINI	KEMPINSKI	KEMPINSKI	**08/05/2007**
15	**TRANSMITTAL N°274-031**	LAZZERINI	KEMPINSKI	KEMPINSKI	**19/04/2007**
14	**TRANSMITTAL N°274-029**	LAZZERINI	KEMPINSKI	KEMPINSKI	**22/03/2007**
13	**TRANSMITTAL N°274-027**	LAZZERINI	KEMPINSKI	KEMPINSKI	**09/03/2007**
12	**TRANSMITTAL N°274-026**	LAZZERINI	KEMPINSKI	KEMPINSKI	**15/02/2007**
11	**TRANSMITTAL N°274-025**	LAZZERINI	KEMPINSKI	KEMPINSKI	**05/02/2007**
10	**TRANSMITTAL N°274-024**	LAZZERINI	KEMPINSKI	KEMPINSKI	**15/12/2006**
9	**TRANSMITTAL N°274-023**	LAZZERINI	KEMPINSKI	KEMPINSKI	**30/11/2006**
8	**TRANSMITTAL N°274-022**	LAZZERINI	KEMPINSKI	KEMPINSKI	**21/11/2006**
7	**TRANSMITTAL N°274-017**	LAZZERINI	KEMPINSKI	KEMPINSKI	**03/10/2006**
6	**TRANSMITTAL N°274-016**	LAZZERINI	KEMPINSKI	KEMPINSKI	**29/09/2006**
5	**TRANSMITTAL N°274-015**	LAZZERINI	KEMPINSKI	KEMPINSKI	**13/09/2006**
4	**TRANSMITTAL N°274-014**	LAZZERINI	KEMPINSKI	KEMPINSKI	**23/08/2006**
3	**TRANSMITTAL N°274-011**	LAZZERINI	KEMPINSKI	KEMPINSKI	**03/07/2006**
2	**TRANSMITTAL N°274-010**	LAZZERINI	KEMPINSKI	KEMPINSKI	**01/06/2006**
1	**TRANSMITTAL N°274-006**	LAZZERINI	KEMPINSKI	KEMPINSKI	**24/03/2006**
0	**TRANSMITTAL N°274-003**	LAZZERINI	KEMPINSKI	KEMPINSKI	**03/02/2006**

NOTE - NOTES

Revision Code Meaning:

A = Approved for Construction

B = Approved for Construction with Comments

C = Not Approved

D = For Information

Reactor Item: **D-6212**
Project: **UNICRACKING REACTORS**
PO:

CLIENTE - PURCHASER :
LOUIS DREYFUS (CONOCO PHILLIPS)
WILHELMSHAVEN (GERMANY)

COMMESSA - VENDOR JOB N°:
3100276

NUM. DOCUMENTO - DOCUMENT Nr.:

SIT-3100276

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"Attachment 1C"

Nuovo Pignone
Massa

N.P. NUMBER	CLIENT NUMB.	A. S.DATE		Submission Date 0	1	2	3	4	5	7	Return Date / Revision Code 0	1	2	3	4	5	7	
SUO0269057/1		02-feb-06	GENERAL ASSEMBLY (SHEET 1/4)	03/02	09/03	03/07	21/11	09/03	_	NA		19/04 B	14/08 B	15/01 B	16/03 B	_	NA	*
SUO0269057/1		09-mar-06	DETAILS (SHEET 2/5)		09/03	03/07	21/11	09/03	_	NA		19/04 B	14/08 B	15/01 B	16/03 B	_	NA	*
SUO0269057/1		09-mar-06	DETAILS (SHEET 3/5)		09/03	03/07	21/11	09/03	_	NA		19/04 B	14/08 B	15/01 A	16/03 B	_	NA	*
SUO0269057/1		09-mar-06	DETAILS (SHEET 4/5)		09/03	03/07	21/11	09/03	_	NA		19/04 B	14/08 B	15/01 A	16/03 A	_	NA	*
SUO0269057/1		09-mar-06	DETAILS (SHEET 5/5)		09/03	03/07	21/11	09/03	_	NA		19/04 B	14/08 B	15/01 A	16/03 A	_	NA	*
SUO1419934			INSULATION SUPPORTS 1/2	03/07	21/11	14/09					09/08 A	15/01 A	21/09 A					
SUO1419934			INSULATION SUPPORTS 2/2	03/07	21/11	14/09					09/08 A	15/01 A	21/09 A					
SU-1413198/3			LIFTING LUG	13/09	21/11						06/10 B	15/01 A						
SOU0107862/4			FEA UNDER THICKNESS AREA BELT "B"	_	29/09	related Deviation request closed (under thk eliminated)												
SOU0110205/4			FIP	01/06	23/08	03/10					28/06 B	28/09 B	13/10 A					
SOU0107840/4		09-mar-06	PRESSURE PARTS CALCULATION	09/03	03/07	21/11	NA				19/04 B	14/08 B	15/01 A	NA *				
SOU0107841/4		09-mar-06	STRUCTURAL PARTS CALCULATION	09/03	03/07	21/11	NA				19/04 B	14/08 B	15/01 A	NA *				
SOU0107853/4		30-ago-06	SHIPPING SADDLES CALCULATION	23/08	30/11	15/02					15/01 D		02/03 D					
SOU0107845/4		15-dic-06	Skirt to vessel junction stress analysis	15/12							12/01 D							
SUO1429239/1		30-ago-06	SHIPPING DRAWING	23/08	30/11	15/02	08/05	09/07	18/09		15/01 D		02/03 B	08/05 A	07/09 A	26/09 A		
SUO1429236/1		30-ago-06	SHIPPING SADDLES	23/08	30/11	15/02	08/05	09/07			15/01 D		02/03 B	08/05 A	07/09 A			
SU-1408400/3		23-mar-06	FOUNDATION AND DRILLING TEMPLATE DRAWING	24/03	03/07	23/08					21/04 B	12/07 B	28/09 A					
SOU0120367/4			W.O. REMOVAL AND RESTOR. "B" "E2" PROCED	19/04							23/04 A							
SU-1413211		30-giu-06	ASME NAME PLATE DWG.	03/07	23/08							28/09 A						
SU-1413212			PED NAMEPLATE	_	03/07	03/10	30/11	15/02			_	_	13/10 B	See278	27/02 A			
QCP 167-06-276			FIP GONNA (Caprenteria Corsi)	05/02	22/03						see 274 D	23/03 D						
* as built drawings (rev 7) inserted in the final data book with modified calculations report to include new requirement impacting the top spool design comunicad by Customer after the vessel delivery.																		
		4WAS	CMTRS (MAIN MATERIALS)															
		4WAS	FINAL DATA BOOK															

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"Attachment 1C"

				Submission Date							Return Date / Revision Code						
		e.s.d.	Title	0	1	2	3	4	5	6	0	1	2	3	4	5	6

"Attachment 1C"

Nuovo Pignone
Massa

DOCUMENTS RELEVANT TO ITEM "B" ONLY

Vendor nr.	N.P.number	e.s.d.	Title

"Attachment 1C"

GE
Oil & Gas
Nuovo Pignone S.p.A. - Italy

Sub-Section B 1

Calculations

SOU 0107840/4 Rev.3 -Pressure Parts Calculation of Stage 1, Hydrocracking Reactors
SOU 0107841/4 Rev.3 -Structural Parts Calculation of Stage 1, Hydrocracking Reactors
SOU 0107862/4 Rev.1 -Stress Analysis on Belt "B" Under thickness area
SOU 0107853/4 Rev.2 -Shipping Saddle Calculation

Nuovo Pignone MASSA	CLIENTE – CUSTOMER **CONOCO PHILLIPS**
	LOCALITA' - PLANT LOCATION **WILHELMSHAVEN, GERMANY**
COMMESSA - JOB **3100276-3100277**	IMPIANTO - PROJECT **WRG – DEEP CONVERSION PROJECT**

TITOLO - TITLE

PRESSURE PARTS CALCULATION OF STAGE 1 , HYDROCRACKING REACTORS

ITEMS: D-6212/ D-6232

TOTAL SHEET 138

REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
3	MODIFIED WHERE INDICATED <3>	Lazzerini	Ricci S.	Ronchieri A.	23/03/10
2	MODIFIED WHERE INDICATED <2>	Lazzerini	Ricci	Ronchieri	16/11/06
1	REVISIONE GENERALE	Lazzerini	Ricci	Ronchieri	17/05/06
0	EMISSIONE-ISSUE	Lazzerini	Ricci	Ronchieri	07/03/06

ITEM **D-6212/ D-6232**

N. SOU0107840/4

LINGUA-LANG.	PAGINA-SHEET
A	1 / 2

SOSTITUISCE IL - REPLACES

SOSTITUITO DA - REPLACED BY

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APPLICABLE CODE AND STANDARD <3>

- ASME VIII Div.2 Edition 2004
- ASME B16.5 , ASME B16.20
- NUOVO PIGNONE – DRAWING – SUO 0269057/1 and SUO 0269058/1
- ASME B31.3-2006 (TOP SPOOL)

DESIGN DATA <3>

Internal design pressure	191,5	Bar (g)	19,15	Mpa (g)	
Internal design temperature	454/409	°C (*)	454/409	°C (*)	<3>
External design pressure	1,03	Bar (g)	0,103	Mpa (g)	
External design temperature	177	°C	177	°C	
Operating press.		Bar (g)		Mpa (g)	
Operating temp.	439	°C	439	°C	<2>
Stress Relieved	YES		YES		
Joint Efficiency %	100%		100%		
Hydrotest pressure (horizontal)	282,00	Bar	28,20	MPa	
Hydrotest pressure (vertical)	277,00	Bar	27,70	MPa	

Note : <3>

1. This calculation has been done using Imperial Units
2. Translation to SI units is for information only ant it has been done according to ASME VIII div. 2 appendix N para. N500
3. ASME code case 2523 (use of metric units) is applicable.

(*) For top spool flange we use T = 409 °C according to B31.3 para 301.3.2 (90% of pressure vessel design temperature).

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DESIGN STRESS INTENSITY RATIO Sa / S <3>

ITEM	MATERIALS	Sa (MPa) Room	S (MPa) Design	Ratio
Heads	SA 542 Gr.D Cl.4a	195,12	169,00	1,155
Shell	SA 336 F22V	195,12	169,00	1,155
Nozzles	SA 182 F22V	195,12	169,00	1,155
Pipes, Bends	SA 182 F22V	195,12	169,00	1,155
Flanges	SA 336 F22V	167,54	144,86	1,157
Flanges (*)	SA 336 F22V	167,54	151,56	1,105
Bolts	SA 193 B16 >2.5"<= 4"	151,68	144,90	1,047
Bolts	SA 193 B16 <=2.5"	172,37	162,19	1,063

(*) FOR TOP SPOOL FLANGE WE USE T=409 °C ACCORDING TO B31.3 para 301.3.2 (90% of pressure vessel design temperature).

TEST PRESSURE CALCULATION

According to PED : Max between **P_{hv1} = 27,686 MPa**

P_{hV} = 1,25 x P_{des} x Max(Sa / S) = P_{hv} = 27,686 MPa

P_{hV} = 1,43 X P_{des} P_{hv} = 27,385 MPa

According to ASME VIII Div. 2 : **P_{hv2} = 25,058 MPa**

P_{hV} = 1,25 x P_{des} x Min(Sa / S) = P_{hv} = 25,058 MPa

DESIGN STRESS INTENSITY RATIO Sa / S TABLE A-1 of ASME B31.3 <3>

ITEM	MATERIALS	Sa (Mpa) Room	S (Mpa) Design	Ratio
Pipes, Bends	SA 182 F347	**137,90**	**125,49**	1,099
Pipes, Bends	SA 182 F22V	**195,12**	**169,00**	1,155
Bolts (*)	SA 193 B16 >2.5"<= 4"	**151,68**	**151,68**	1,000

(*) T=409 °C

TEST PRESSURE CALCULATION para 345.4.2 (Vertical position at the top)

P_{hV} = 1,5 x P_{des} x Min(Sa / S) = **P_{hv3} = 28,725 MPa**

According to 345.4.3 (b) , if vessel pressure test is not less than 77% of piping pressure test, piping can be tested attached to the vessel. **P_{hv2} / P_{hv3} = 87,23%**

Nuovo Pignone MASSA	PRESSURE PARTS CALCULATION OF STAGE 1, HYDROCRACKING REACTORS ITEMS: D-6212 / D-6232

TEST PRESSURE is : **(Vertical position at the top)**

P_{hV} =	Max (P_{hV1};P_{hV2}) =	P_{hV} =	**27,686**	**MPa**
P_{hV} =	**Assumed**	P_{hV} =	**27,700**	**MPa**

Max test static head calculation

Distance between nozzle A and B C.L.		h =	45.298	mm
Internal diameter of nozzle A		D_1 =	377,9	mm
Internal diameter of nozzle B		D_2 =	377,9	mm
Max water height	$H = h + D_1/2 + D_2/2$ =	H =	45.675,9	mm
	Hydrotest static head is	S_h =	**0,451**	**MPa**

TEST PRESSURE CALCULATION **(Horizontal position at the top)**

P_{hH} =	$P_{hV} + S_h$ =	P_{hV} =	**28,136**	**MPa**
P_{hH} =	**Assumed**	P_{hV} =	**28,200**	**MPa**

REV.	DESCRIZIONE - DESCRIPTION	
3	MODIFIED WHERE INDICATED <3>	ITEM D-6212/ D-6232
2	MODIFIED WHERE INDICATED <2>	
1	REVISIONE GENERALE	N. SOU0107840/4
0	EMISSIONE-ISSUE	LINGUA-LANG. A / PAGINA-SHEET 6 / 7

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

SPHERICAL HEAD POS. HEAD

================ (ASME VIII div.2 / Edit. 2004 D-2) ==================

```
* DESIGN TEMPERATURE                      T =  454.0  C     =  849.2  F

* HEAD  MATERIAL :                          SA 542 Gr.D Cl.4a

* ALLOW. STRESS                           S = 168.9985 Mpa = 24511.2 Psi

* ALLOW. STRESS,room temp.                Sa= 195.1213 Mpa = 28300.0 Psi

* YIELD STRENGTH at room temp.           Syh= 413.6847 Mpa = 60000.0 Psi

* MINIMUM ULTIMATE TENSILE STRENGTH     UTSh= 586.0533 Mpa = 85000.0 Psi


Internal design pressure                  P =  19.1500 Mpa =  2777.5 Psi
Internal hydrostatic test pressure      PHy =  28.2000 Mpa =  4090.1 Psi
Inside Crown Radius                       L =   2217.2 mm  =   87.29 "
Corrosion allowance                       c =     0.00 mm  =  0.0000 "

* MINIMUM REQUIRED THICKNESS , DESIGN CONDITION
tr    = 0.5*P*(L+c)/(S*E-0.25*P)            =   129.28 mm  =   5.090 "
tr+c  =                                     =   129.28 mm  =   5.0899 "

* MINIMUM REQUIRED THICKNESS , HYDROSTATIC TEST CONDITION
tr(Hy) = 0.5*PHy*L/(0.9*Syh-0.25*PHy)       =    85.59 mm  =   3.370 "

Adopted thickness                         t =   134.00 mm  =   5.2756 "
```

CYLINDRICAL SHELL POS.SHELL <2>

================ (ASME VIII div.2 / Edit. 2004 D-2) ===================

```
* DESIGN TEMPERATURE                          T =  454.0  C     =  849.2  F

* SHELL MATERIAL :                              SA 336 F22V

* ALLOW. STRESS                               S = 168.9985 Mpa = 24511.2 Psi

* ALLOW. STRESS,room temp.                    Sa= 195.1213 Mpa = 28300.0 Psi

* YIELD STRENGTH at room temp.               Sys= 413.6847 Mpa = 60000.0 Psi

* MINIMUM ULTIMATE TENSILE STRENGTH         UTSs= 586.0533 Mpa = 85000.0 Psi

* STRESS INTENSITY k FACTOR FOR LOAD COMBINATION               =     1.00


Internal design pressure                   P =   19.1500 Mpa =  2777.5 Psi
Internal hydrostatic test pressure       PHy =   28.2000 Mpa =  4090.1 Psi <2>
Internal diameter                    D = 2*R =    4308.4 mm  =  169.62 "
Corrosion allowance                        c =      0.00 mm  =  0.0000 "

* MINIMUM REQUIRED THICKNESS , DESIGN CONDITION (PRESSURE)
tr + c = P*(R+c)/(S-0.5*P) + c             =    258.76 mm  =  10.188 "

* MINIMUM REQUIRED THICKNESS , HYDROSTATIC TEST CONDITION
tr(Hy) = PHy*R/(0.9*Sys-0.5*PHy)           =    169.59 mm  =   6.677 "


Adopted thickness                          t =    260.00 mm  = 10.2362 "
```

REINFORCEMENT OF OPENING B <2>

================= (ASME VIII div.2 / Edition 2004 D-5) ================

**** DESIGN CONDITION ****

* DESIGN TEMPERATURE	T =	454.0	C	=	849.2	F
* ROOM TEMPERATURE	T0=	21.1	C	=	70.0	F
* HEAD MATERIAL :	SA 542 Gr.D Cl.4a					
* NOZZLE MATERIAL :	SA 182 F22V					
* HEAD ALLOWABLE STRESS	S =	168.9985	Mpa	=	24511.2	Psi
* NOZZLE ALLOWABLE STRESS	Sn=	168.9985	Mpa	=	24511.2	Psi
* HEAD MEAN □ AT DESIGN TEMP.	□s=	.0000141	mm/mm/□C	=	.0000078	mm/mm/□F
* NOZZLE MEAN □ AT DESIGN TEMP.	□n=	.0000141	mm/mm/□C	=	.0000078	mm/mm/□F
* NOZZLE ALLOWABLE STRESS at room temp.	Sna=	195.1213	Mpa	=	28300.0	Psi
* HEAD YIELD STRENGTH at room temp.	Syh=	413.6847	Mpa	=	60000.0	Psi
* NOZZLE YIELD STRENGTH at room temp.	Syn=	413.6847	Mpa	=	60000.0	Psi
* NOZZLE MIN.ULTIMATE TENSILE STRENGTH	=	586.0533	Mpa	=	85000.0	Psi
* HEAD MIN.ULTIMATE TENSILE STRENGTH	=	586.0533	Mpa	=	85000.0	Psi

Internal design pressure	P =	19.1500	Mpa	=	2777.5	Psi
Corrosion allowance	c =	0.00	mm	=	0.000	"
Nozzle wall tolerance	c1 =	0.00	mm	=	0.000	"
Adopted head thickness	t =	134.00	mm	=	5.2756	"
Pad thickness	te =	0.00	mm	=	0.000	"
Pad width	W =	0.00	mm	=	0.000	"
Dimension of fillet weld (pad to wall)	=	0.00	mm	=	0.000	"
Pipe outside diameter	=	609.60	mm	=	24.000	"
Reinf. outside diameter	=	790.00	mm	=	31.102	"
Reinforcement thickness	tn =	142.60	mm	=	5.614	"
Nozzle thickness	tp =	52.40	mm	=	2.063	"
Length of reinforcement	h =	353.00	mm	=	13.897	" <2>
Internal corner Radius	r1 =	20.00	mm	=	0.787	"
External fillet Radius	r2 =	30.00	mm	=	1.181	"
Type of connection:		INTEGRALLY REINFORCED				
Nozzle position:		RADIAL				
Opening size	d = 2*Rn =	504.80	mm	=	19.874	"

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```
                    REINFORCEMENT OF OPENING B
================= (ASME VIII div.2 / Edition 2004 D-5) =================

               ****        DESIGN CONDITION        ****

* NET THICKNESSES:
t - c                                          =   134.00 mm  =    5.276 "
tr (see calc. sheet of head)                   =   129.28 mm  =    5.090 "
tn - c                                         =   142.60 mm  =    5.614 "
trn  =    P*(Rn+c)/(Sn-0.5*P)                  =    30.32 mm  =    1.194 "
Adopted nozzle thickness       tn - c          =   142.60 mm  =   5.6142 "
Ins.radius of sph. portion of head  R=L+c      =  2217.20 mm  =  87.2913 "
Horiz. limit to Reinf. O.D.              Lo    =     0.01 mm  =    0.000 "
Horiz. limit to nozzle O.D. (AD-540.1(b))      =     0.01 mm  =    0.000 "
Vertic. limit to head  O.D.              ho    =   308.95 mm  =   12.163 "
* REQUIRED AREAS:
Areq = d*tr                                    =   65262.1 mm2=  101.156 #
2/3*Areq ( AD-540.1(b) )                       =   43508.1 mm2=   67.438 #

* REINFORCING AREAS: Rt = Sn/S  Max=1
Head     A1=2Lo(t-c-tr)                        =       0.1 mm2=    0.000 #
Nozzle   A2=2(tn-c-trn)(ho+(t-c-tr/Rt))Rt      =   70437.2 mm2=  109.178 #
Weld     A4=                                   =       0.0 mm2=    0.000 #
Pad      A5=2*W*te                             =       0.0 mm2=    0.000 #
Nozzle   A6=2*ho'(tn-2c)*Rt                    =       0.0 mm2=    0.000 #
Corner   A7=2*(r1^2-PI*r1^2/4)*Rt              =     171.7 mm2=    0.266 #
Fillet   A77=2*(r2^2-PI*r2^2/4)*Rt             =       0.5 mm2=    0.001 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=        70266.1 mm2=  108.913 #
* Ao (whithin limits of ( AD-540.1(b) )        =   70266.1 mm2=  108.913 #
```

REINFORCEMENT OF OPENING B
============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

**** HYDROSTATIC TEST CONDITION ****

```
* HYDROSTATIC TEST TEMPERATURE            T =   21.1   C     =    70.0  F
* HEAD  MATERIAL :                        SA 542 Gr.D Cl.4a
* NOZZLE MATERIAL :                       SA 182 F22V
* HEAD  ALLOWABLE STRESS         S=0.9*Syh= 372.3162 Mpa =   54000.0 Psi
* NOZZLE ALLOWABLE STRESS       Sn=0.9*Syn= 372.3162 Mpa =   54000.0 Psi
* HEAD   YIELD STRENGTH at room temp.  Syh= 413.6847 Mpa =   60000.0 Psi
* NOZZLE YIELD STRENGTH at room temp.  Syn= 413.6847 Mpa =   60000.0 Psi

Internal  hydrostatic test Pressure     P =  28.2000 Mpa =    4090.1 Psi
Corrosion allowance                     c =     0.00 mm  =     0.000 "
Nozzle wall tolerance                  c1 =     0.00 mm  =     0.000 "
Adopted head  thickness                 t =   134.00 mm  =    5.2756 "
Pad thickness                          te =     0.00 mm  =     0.000 "
Pad width                               W =     0.00 mm  =     0.000 "
Dimension of fillet weld (pad to wall)    =     0.00 mm  =     0.000 "
Pipe outside diameter                     =   609.60 mm  =    24.000 "
Reinf. outside diameter                   =   790.00 mm  =    31.102 "
Reinforcement thickness                tn =   142.60 mm  =     5.614 "
Nozzle thickness                       tp =    52.40 mm  =     2.063 "
Length of reinforcement                 h =   353.00 mm  =    13.897 " <2>
Internal corner Radius                 r1 =    20.00 mm  =     0.787 "
External fillet Radius                 r2 =    30.00 mm  =     1.181 "
Type of connection:                       INTEGRALLY REINFORCED
Nozzle position:                          RADIAL
Opening size                   d = 2*Rn =   504.80 mm  =    19.874 "
```

REINFORCEMENT OF OPENING B
============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

**** HYDROSTATIC TEST CONDITION ****

```
* NET THICKNESSES:
t - c                                              =   134.00 mm  =    5.276 "
tr (see calc. sheet of head)                       =    85.59 mm  =    3.370 "
tn - c                                             =   142.60 mm  =    5.614 "
trn  =     P*(Rn+c)/(Sn-0.5*P)                     =    19.87 mm  =    0.782 "
Adopted nozzle thickness       tn - c              =   142.60 mm  =   5.6142 "
Ins.radius of sph. portion of head   R=L+c         =  2217.20 mm  =  87.2913 "
Horiz. limit to Reinf. O.D.               Lo       =     0.01 mm  =    0.000 "
Horiz. limit to nozzle O.D. (AD-540.1(b))          =     0.01 mm  =    0.000 "
Vertic. limit to head  O.D.               ho       =   308.95 mm  =   12.163 "
* REQUIRED AREAS:
Areq = d*tr                                        =   43205.0 mm2=   66.968 #
2/3*Areq ( AD-540.1(b) )                           =   28803.3 mm2=   44.645 #

* REINFORCING AREAS: Rt = Sn/S  Max=1
Head     A1=2Lo(t-c-tr)                            =       1.0 mm2=    0.002 #
Nozzle   A2=2(tn-c-trn)(ho+(t-c-tr/Rt))Rt          =   87717.2 mm2=  135.962 #
Weld     A4=                                       =       0.0 mm2=    0.000 #
Pad      A5=2*W*te                                 =       0.0 mm2=    0.000 #
Nozzle   A6=2*ho'(tn-2c)*Rt                        =       0.0 mm2=    0.000 #
Corner   A7=2*(r1^2-PI*r1^2/4)*Rt                  =     171.7 mm2=    0.266 #
Fillet   A77=2*(r2^2-PI*r2^2/4)*Rt                 =       0.5 mm2=    0.001 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=            87547.0 mm2=  135.698 #
* Ao (whithin limits of ( AD-540.1(b) )            =   87547.0 mm2=  135.698 #
```

REINFORCEMENT OF OPENING M <2>

================ (ASME VIII div.2 / Edition 2004 D-5) ================

**** DESIGN CONDITION ****

* DESIGN TEMPERATURE	T =	454.0	C	=	849.2	F
* ROOM TEMPERATURE	T0=	21.1	C	=	70.0	F
* HEAD MATERIAL :	SA 542 Gr.D Cl.4a					
* NOZZLE MATERIAL :	SA 336 F22V					
* HEAD ALLOWABLE STRESS	S =	168.9985	Mpa	=	24511.2	Psi
* NOZZLE ALLOWABLE STRESS	Sn=	168.9985	Mpa	=	24511.2	Psi
* HEAD MEAN □ AT DESIGN TEMP.	□s=	.0000141	mm/mm/□C	=	.0000078	mm/mm/□F
* NOZZLE MEAN □ AT DESIGN TEMP.	□n=	.0000141	mm/mm/□C	=	.0000078	mm/mm/□F
* NOZZLE ALLOWABLE STRESS at room temp.	Sna=	195.1213	Mpa	=	28300.0	Psi
* HEAD YIELD STRENGTH at room temp.	Syh=	413.6847	Mpa	=	60000.0	Psi
* NOZZLE YIELD STRENGTH at room temp.	Syn=	413.6847	Mpa	=	60000.0	Psi
* NOZZLE MIN.ULTIMATE TENSILE STRENGTH	=	586.0533	Mpa	=	85000.0	Psi
* HEAD MIN.ULTIMATE TENSILE STRENGTH	=	586.0533	Mpa	=	85000.0	Psi

Internal design pressure	P =	19.1500	Mpa	=	2777.5	Psi
Corrosion allowance	c =	0.00	mm	=	0.000	"
Nozzle wall tolerance	c1 =	0.00	mm	=	0.000	"
Adopted head thickness	t =	134.00	mm	=	5.2756	"
Pad thickness	te =	0.00	mm	=	0.000	"
Pad width	W =	0.00	mm	=	0.000	"
Dimension of fillet weld (pad to wall)	=	0.00	mm	=	0.000	"
Pipe outside diameter	=	1134.00	mm	=	44.646	"
Reinf. outside diameter	=	1505.00	mm	=	59.252	"
Reinforcement thickness	tn =	265.70	mm	=	10.461	"
Nozzle thickness	tp =	80.20	mm	=	3.157	"
Length of reinforcement	h =	411.90	mm	=	16.216	" <2>
Internal corner Radius	r1 =	20.00	mm	=	0.787	"
External fillet Radius	r2 =	30.00	mm	=	1.181	"
Type of connection:	INTEGRALLY REINFORCED					
Nozzle position:	RADIAL					
Opening size	d = 2*Rn =	973.60	mm	=	38.331	"

REINFORCEMENT OF OPENING M

================ (ASME VIII div.2 / Edition 2004 D-5) ================

**** DESIGN CONDITION ****

* NET THICKNESSES:				
t - c	=	134.00 mm	=	5.276 "
tr (see calc. sheet of head)	=	129.28 mm	=	5.090 "
tp - c	=	80.20 mm	=	3.157 "
trn = P*(Rn+c)/(Sn-0.5*P)	=	58.47 mm	=	2.302 "
Adopted nozzle thickness tn - c	=	265.70 mm	=	10.4606 "
Ins.radius of sph. portion of head R=L+c	=	2217.20 mm	=	87.2913 "
Horiz. limit to Reinf. O.D. Lo	=	0.01 mm	=	0.000 "
Horiz. limit to nozzle O.D. (AD-540.1(b))	=	0.01 mm	=	0.000 "
Vertic. limit to head O.D. ho	=	335.00 mm	=	13.189 "
* REQUIRED AREAS:				
Areq = d*tr	=	125869.9 mm2	=	195.099 #
2/3*Areq (AD-540.1(b))	=	83913.3 mm2	=	130.066 #
* REINFORCING AREAS: Rt = Sn/S Max=1				
Head A1=2Lo(t-c-tr)	=	0.1 mm2	=	0.000 #
Nozzle A2=2(tn-c-trn)(ho+(t-c-tr/Rt))Rt	=	140796.0 mm2	=	218.234 #
Nozz.:areas within ho, decrease due to tp/tn transition profile at 45)				
Weld A4=	=	0.0 mm2	=	0.000 #
Pad A5=2*W*te	=	0.0 mm2	=	0.000 #
Nozzle A6=2*ho'(tn-2c)*Rt	=	0.0 mm2	=	0.000 #
Corner A7=2*(r1^2-PI*r1^2/4)*Rt	=	171.7 mm2	=	0.266 #
Fillet A77=2*(r2^2-PI*r2^2/4)*Rt	=	0.4 mm2	=	0.001 #
*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77	=	140624.8 mm2	=	217.969 #
* Ao (whithin limits of (AD-540.1(b))	=	140624.8 mm2	=	217.969 #

```
                    REINFORCEMENT OF OPENING M
============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

* HYDROSTATIC TEST TEMPERATURE              T =   21.1   C    =    70.0   F
* HEAD  MATERIAL :                          SA 542 Gr.D Cl.4a
* NOZZLE MATERIAL :                         SA 182 F22V
* HEAD  ALLOWABLE STRESS            S=0.9*Syh= 372.3162 Mpa =   54000.0 Psi
* NOZZLE ALLOWABLE STRESS          Sn=0.9*Syn= 372.3162 Mpa =   54000.0 Psi
* HEAD   YIELD STRENGTH at room temp.   Syh= 413.6847 Mpa =   60000.0 Psi
* NOZZLE YIELD STRENGTH at room temp.   Syn= 413.6847 Mpa =   60000.0 Psi

Internal  hydrostatic test Pressure      P =  28.2000 Mpa =    4090.1 Psi
Corrosion allowance                      c =      0.00 mm  =     0.000 "
Nozzle wall tolerance                   c1 =      0.00 mm  =     0.000 "
Adopted head  thickness                  t =    134.00 mm  =    5.2756 "
Pad thickness                           te =      0.00 mm  =     0.000 "
Pad width                                W =      0.00 mm  =     0.000 "
Dimension of fillet weld (pad to wall)     =      0.00 mm  =     0.000 "
Pipe outside diameter                      =   1134.00 mm  =    44.646 "
Reinf. outside diameter                    =   1505.00 mm  =    59.252 "
Reinforcement thickness                 tn =    265.70 mm  =    10.461 "
Nozzle thickness                        tp =     80.20 mm  =     3.157 "
Length of reinforcement                  h =    411.90 mm  =    16.216 " <2>
Internal corner Radius                  r1 =     20.00 mm  =     0.787 "
External fillet Radius                  r2 =     30.00 mm  =     1.181 "
Type of connection:                          INTEGRALLY REINFORCED
Nozzle position:                             RADIAL
Opening size                      d = 2*Rn =    973.60 mm  =    38.331 "
```

```
                  REINFORCEMENT OF OPENING M
============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

             ****   HYDROSTATIC TEST CONDITION   ****

* NET THICKNESSES:
t - c                                            =   134.00 mm  =    5.276 "
tr (see calc. sheet of head)                     =    85.59 mm  =    3.370 "
tp - c                                           =    80.20 mm  =    3.157 "
trn  =    P*(Rn+c)/(Sn-0.5*P)                    =    38.32 mm  =    1.509 "
Adopted nozzle thickness        tn - c           =   265.70 mm  =  10.4606 "
Ins.radius of sph. portion of head   R=L+c       =  2217.20 mm  =  87.2913 "
Horiz. limit to Reinf. O.D.                  Lo  =     0.01 mm  =    0.000 "
Horiz. limit to nozzle O.D.  (AD-540.1(b))       =     0.01 mm  =    0.000 "
Vertic. limit to head  O.D.                  ho  =   335.00 mm  =   13.189 "
* REQUIRED AREAS:
Areq = d*tr                                      =   83328.8 mm2=  129.160 #
2/3*Areq ( AD-540.1(b) )                         =   55552.5 mm2=   86.107 #

* REINFORCING AREAS: Rt = Sn/S  Max=1
Head     A1=2Lo(t-c-tr)                          =       1.0 mm2=    0.002 #
Nozzle   A2=2(tn-c-trn)(ho+(t-c-tr/Rt))Rt        =  174358.3 mm2=  270.256 #
Nozz.:areas within ho, decrease due to tp/tn transition profile at 45)
Weld     A4=                                     =       0.0 mm2=    0.000 #
Pad      A5=2*W*te                               =       0.0 mm2=    0.000 #
Nozzle   A6=2*ho'(tn-2c)*Rt                      =       0.0 mm2=    0.000 #
Corner   A7=2*(r1^2-PI*r1^2/4)*Rt                =     171.7 mm2=    0.266 #
Fillet   A77=2*(r2^2-PI*r2^2/4)*Rt               =       0.4 mm2=    0.001 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=  174188.0 mm2=  269.992 #
* Ao (whithin limits of ( AD-540.1(b) )          =  174188.0 mm2=  269.992 #
```

Nuovo Pignone MASSA	PRESSURE PARTS CALCULATION OF STAGE 1, HYDROCRACKING REACTORS ITEMS: D-6212 / D-6232

REINFORCEMENT OF OPENING D1-2 <2>

================= (ASME VIII div.2 / Edition 2004 D-5) ================

**** DESIGN CONDITION ****

* DESIGN TEMPERATURE	T =	454.0	C	=	849.2 F
* ROOM TEMPERATURE	T0=	21.1	C	=	70.0 F
* HEAD MATERIAL :	SA 542 Gr.D Cl.4a				
* NOZZLE MATERIAL :	SA 182 F22V				
* HEAD ALLOWABLE STRESS	S =	168.9985	Mpa	=	24511.2 Psi
* NOZZLE ALLOWABLE STRESS	Sn=	168.9985	Mpa	=	24511.2 Psi
* HEAD MEAN □ AT DESIGN TEMP.	□s=	.0000141	mm/mm/□C	=	.0000078 mm/mm/□F
* NOZZLE MEAN □ AT DESIGN TEMP.	□n=	.0000141	mm/mm/□C	=	.0000078 mm/mm/□F
* NOZZLE ALLOWABLE STRESS at room temp.	Sna=	195.1213	Mpa	=	28300.0 Psi
* HEAD YIELD STRENGTH at room temp.	Syh=	413.6847	Mpa	=	60000.0 Psi
* NOZZLE YIELD STRENGTH at room temp.	Syn=	413.6847	Mpa	=	60000.0 Psi
* NOZZLE MIN.ULTIMATE TENSILE STRENGTH	=	586.0533	Mpa	=	85000.0 Psi
* HEAD MIN.ULTIMATE TENSILE STRENGTH	=	586.0533	Mpa	=	85000.0 Psi

Internal design pressure	P =	19.1500	Mpa	=	2777.5	Psi
Corrosion allowance	c =	0.00	mm	=	0.000	"
Nozzle wall tolerance	c1 =	0.00	mm	=	0.000	"
Adopted head thickness	t =	134.00	mm	=	5.2756	"
Pad thickness	te =	0.00	mm	=	0.000	"
Pad width	W =	0.00	mm	=	0.000	"
Dimension of fillet weld (pad to wall)	=	0.00	mm	=	0.000	"
Pipe outside diameter	=	219.08	mm	=	8.625	"
Reinf. outside diameter	=	340.00	mm	=	13.386	"
Reinforcement thickness	tn =	78.70	mm	=	3.098	"
Nozzle thickness	tp =	18.24	mm	=	0.718	"
Length of reinforcement	h =	235.40	mm	=	9.267	" <2>
Internal corner Radius	r1 =	20.00	mm	=	0.787	"
External fillet Radius	r2 =	30.00	mm	=	1.181	"
Type of connection:	INTEGRALLY REINFORCED					
Nozzle position:	RADIAL					
Opening size	d = 2*Rn =	182.60	mm	=	7.189	"

REV.	DESCRIZIONE - DESCRIPTION	
3	MODIFIED WHERE INDICATED <3>	ITEM D-6212/ D-6232
2	MODIFIED WHERE INDICATED <2>	
1	REVISIONE GENERALE	N. SOU0107840/4
0	EMISSIONE-ISSUE	LINGUA-LANG. A — PAGINA-SHEET 17 / 18

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

REINFORCEMENT OF OPENING D1-2
================= (ASME VIII div.2 / Edition 2004 D-5) =================

**** DESIGN CONDITION ****

* NET THICKNESSES:

t - c	=	134.00	mm	=	5.276 "
tr (see calc. sheet of head)	=	129.28	mm	=	5.090 "
tn - c	=	78.70	mm	=	3.098 "
trn = P*(Rn+c)/(Sn-0.5*P)	=	10.97	mm	=	0.432 "
Adopted nozzle thickness tn - c	=	78.70	mm	=	3.0984 "
Ins.radius of sph. portion of head R=L+c	=	2217.20	mm	=	87.2913 "
Horiz. limit to Reinf. O.D. Lo	=	0.01	mm	=	0.000 "
Horiz. limit to nozzle O.D. (AD-540.1(b))	=	0.01	mm	=	0.000 "
Vertic. limit to head O.D. ho	=	196.75	mm	=	7.746 "

* REQUIRED AREAS:

Areq = d*tr	=	23607.1	mm2	=	36.591 #
2/3*Areq (AD-540.1(b))	=	15738.1	mm2	=	24.394 #

* REINFORCING AREAS: Rt = Sn/S Max=1

Head	A1=2Lo(t-c-tr)	=	0.1	mm2	=	0.000 #
Nozzle	A2=2(tn-c-trn)(ho+(t-c-tr/Rt))Rt	=	27291.9	mm2	=	42.303 #
Weld	A4=	=	0.0	mm2	=	0.000 #
Pad	A5=2*W*te	=	0.0	mm2	=	0.000 #
Nozzle	A6=2*ho'(tn-2c)*Rt	=	0.0	mm2	=	0.000 #
Corner	A7=2*(r1^2-PI*r1^2/4)*Rt	=	171.7	mm2	=	0.266 #
Fillet	A77=2*(r2^2-PI*r2^2/4)*Rt	=	0.5	mm2	=	0.001 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77	=	27120.9	mm2	=	42.037 #
* Ao (whithin limits of (AD-540.1(b))	=	27120.9	mm2	=	42.037 #

REINFORCEMENT OF OPENING D1-2

============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

**** HYDROSTATIC TEST CONDITION ****

* HYDROSTATIC TEST TEMPERATURE	T =	21.1 C	=	70.0 F
* HEAD MATERIAL :		SA 542 Gr.D Cl.4a		
* NOZZLE MATERIAL :		SA 182 F22V		
* HEAD ALLOWABLE STRESS	S=0.9*Syh=	372.3162 Mpa	=	54000.0 Psi
* NOZZLE ALLOWABLE STRESS	Sn=0.9*Syn=	372.3162 Mpa	=	54000.0 Psi
* HEAD YIELD STRENGTH at room temp.	Syh=	413.6847 Mpa	=	60000.0 Psi
* NOZZLE YIELD STRENGTH at room temp.	Syn=	413.6847 Mpa	=	60000.0 Psi

Internal hydrostatic test Pressure	P =	28.2000 Mpa	=	4090.1 Psi
Corrosion allowance	c =	0.00 mm	=	0.000 "
Nozzle wall tolerance	c1 =	0.00 mm	=	0.000 "
Adopted head thickness	t =	134.00 mm	=	5.2756 "
Pad thickness	te =	0.00 mm	=	0.000 "
Pad width	W =	0.00 mm	=	0.000 "
Dimension of fillet weld (pad to wall)	=	0.00 mm	=	0.000 "
Pipe outside diameter	=	219.08 mm	=	8.625 "
Reinf. outside diameter	=	340.00 mm	=	13.386 "
Reinforcement thickness	tn =	78.70 mm	=	3.098 "
Nozzle thickness	tp =	18.24 mm	=	0.718 "
Length of reinforcement	h =	235.40 mm	=	9.267 " <2>
Internal corner Radius	r1 =	20.00 mm	=	0.787 "
External fillet Radius	r2 =	30.00 mm	=	1.181 "
Type of connection:		INTEGRALLY REINFORCED		
Nozzle position:		RADIAL		
Opening size	d = 2*Rn =	182.60 mm	=	7.189 "

REINFORCEMENT OF OPENING D1-2

============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

**** HYDROSTATIC TEST CONDITION ****

```
* NET THICKNESSES:
t - c                                          =   134.00 mm  =    5.276 "
tr (see calc. sheet of head)                   =    85.59 mm  =    3.370 "
tn - c                                         =    78.70 mm  =    3.098 "
trn   =     P*(Rn+c)/(Sn-0.5*P)                =     7.19 mm  =    0.283 "
Adopted nozzle thickness      tn - c           =    78.70 mm  =   3.0984 "
Ins.radius of sph. portion of head  R=L+c      =  2217.20 mm  =  87.2913 "
Horiz. limit to Reinf. O.D.              Lo    =     0.01 mm  =    0.000 "
Horiz. limit to nozzle O.D. (AD-540.1(b))      =     0.01 mm  =    0.000 "
Vertic. limit to head  O.D.              ho    =   196.75 mm  =    7.746 "
* REQUIRED AREAS:
Areq = d*tr                                    =  15628.4 mm2=   24.224 #
2/3*Areq ( AD-540.1(b) )                       =  10419.0 mm2=   16.149 #

* REINFORCING AREAS: Rt = Sn/S  Max=1
Head     A1=2Lo(t-c-tr)                        =      1.0 mm2=    0.002 #
Nozzle   A2=2(tn-c-trn)(ho+(t-c-tr/Rt))Rt      =  35064.3 mm2=   54.350 #
Weld     A4=                                   =      0.0 mm2=    0.000 #
Pad      A5=2*W*te                             =      0.0 mm2=    0.000 #
Nozzle   A6=2*ho'(tn-2c)*Rt                    =      0.0 mm2=    0.000 #
Corner   A7=2*(r1^2-PI*r1^2/4)*Rt              =    171.7 mm2=    0.266 #
Fillet   A77=2*(r2^2-PI*r2^2/4)*Rt             =      0.5 mm2=    0.001 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=  34894.1 mm2=   54.086 #
* Ao (whithin limits of ( AD-540.1(b) )       =  34894.1 mm2=   54.086 #
```

Nuovo Pignone MASSA	PRESSURE PARTS CALCULATION OF STAGE 1, HYDROCRACKING REACTORS ITEMS: D-6212 / D-6232

REINFORCEMENT OF OPENING D3-6

```
================ (ASME VIII div.2 / Edition 2004  D-5) ==============

                 ****        DESIGN CONDITION          ****
* DESIGN TEMPERATURE                        T =  454.0  C    =   849.2  F
* ROOM    TEMPERATURE                       T0=   21.1  C    =    70.0  F
* SHELL MATERIAL :                          SA 336 F22V
* NOZZLE MATERIAL :                         SA 182 F22V
* SHELL ALLOWABLE STRESS                    S = 168.9985 Mpa =   24511.2 Psi
* NOZZLE ALLOWABLE STRESS                   Sn= 168.9985 Mpa =   24511.2 Psi
* SHELL   MEAN □ AT DESIGN TEMP. □s=.0000141 mm/mm/□C =.0000078 mm/mm/□F
* NOZZLE MEAN □ AT DESIGN TEMP. □n=.0000141 mm/mm/□C =.0000078 mm/mm/□F
* NOZZLE ALLOWABLE STRESS at room temp.Sna= 195.1213 Mpa =   28300.0 Psi
* SHELL   YIELD STRENGTH at room temp.  Sys= 413.6847 Mpa =   60000.0 Psi
* NOZZLE YIELD STRENGTH at room temp.   Syn= 413.6847 Mpa =   60000.0 Psi
* NOZZLE MIN.ULTIMATE TENSILE STRENGTH     = 586.0533 Mpa =   85000.0 Psi
* SHELL   MIN.ULTIMATE TENSILE STRENGTH    = 586.0533 Mpa =   85000.0 Psi
* STRESS INTENSITY k FACTOR FOR LOAD COMBINATION          =      1.00

Internal  design pressure                   P =  19.1500 Mpa =    2777.5 Psi
Meridional membrane force          F =      0.00 N/mm=         0.00 Lb/Inch
Shell inside diameter                D = 2*R =    4308.4 mm  =    169.62 "
Corrosion allowance                       c =       0.00 mm  =     0.000 "
Nozzle wall tolerance                    c1 =       0.00 mm  =     0.000 "
Adopted shell thickness                   t =     260.00 mm  =   10.2362 "
Pad thickness                            te =       0.00 mm  =     0.000 "
Pad width                                 W =       0.00 mm  =     0.000 "
Dimension of fillet weld (pad to wall)      =       0.00 mm  =     0.000 "
Nozzle outside diameter                     =     390.00 mm  =    15.354 "
Nozzle thickness                         tn =     118.80 mm  =     4.677 "
Internal corner Radius                   r1 =      35.00 mm  =     1.378 "
External fillet Radius                   r2 =      30.00 mm  =     1.181 "
Type of connection:                          SET-IN
Nzl.position: NOT RADIAL F=1, angle nzl/shell axes on plane=    45.0 deg
Opening size           d = 2*Rn/cos(teta) =     215.53 mm  =     8.485 "
```

REV.	DESCRIZIONE - DESCRIPTION	ITEM
3	MODIFIED WHERE INDICATED <3>	D-6212/ D-6232
2	MODIFIED WHERE INDICATED <2>	N. SOU0107840/4
1	REVISIONE GENERALE	LINGUA-LANG. A — PAGINA-SHEET 21 / 22
0	EMISSIONE-ISSUE	

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

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REINFORCEMENT OF OPENING D3-6

================ (ASME VIII div.2 / Edition 2004 D-5) ===============

**** DESIGN CONDITION ****

```
* NET THICKNESSES:
t - c                                          =   260.00 mm  =   10.236 "
tr   =   P*(R+c)/(S-0.5*P)                     =   258.76 mm  =   10.188 "
trn  =   P*Rn/(Sn-0.5*P)                       =     9.15 mm  =    0.360 "
Horiz. limit to nozzle O.D.                 Lo =     0.01 mm  =    0.000 "
Horiz. limit to nozzle O.D. (AD-540.1(b))      =     0.01 mm  =    0.000 "
Vertic. limit to shell O.D.                 ho =   297.00 mm  =   11.693 "
* REQUIRED AREAS:
Areq = d*F*tr                                  =   55770.2 mm2=   86.444 #
2/3*Areq ( AD-540.1(b) )                       =   37180.1 mm2=   57.629 #

* REINFORCING AREAS: Rt = Sn/S max=1
Shell   A1=2Lo(t-c-F*tr)                       =       0.0 mm2=    0.000 #
Nozzle  A2=2(tn-c-trn)(ho+(t-c-F*tr/Rt))Rt=        65401.4 mm2=  101.372 #
Weld    A4=                                    =       0.0 mm2=    0.000 #
Pad     A5=2*W*te                              =       0.0 mm2=    0.000 #
Nozzle  A6=2*ho'(tn-2c)*Rt                     =       0.0 mm2=    0.000 #
Corner  A7=2*(r1^2-PI*r1^2/4)*Rt               =     525.8 mm2=    0.815 #
Fillet  A77=2*(r2^2-PI*r2^2/4)*Rt              =       0.6 mm2=    0.001 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=        64876.3 mm2=  100.558 #
* Ao (whithin limits of ( AD-540.1(b) )        =   64876.3 mm2=  100.558 #
```


SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

REINFORCEMENT OF OPENING D3-6
============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

**** HYDROSTATIC TEST CONDITION ****

```
* HYDROSTATIC TEST TEMPERATURE              T =    21.1  C     =    70.0  F
* SHELL MATERIAL :                           SA 336 F22V
* NOZZLE MATERIAL :                          SA 182 F22V
* SHELL ALLOWABLE STRESS        S=0.9*Sys= 372.3162 Mpa =  54000.0 Psi
* NOZZLE ALLOWABLE STRESS      Sn=0.9*Syn= 372.3162 Mpa =  54000.0 Psi
* SHELL  YIELD STRENGTH at room temp.  Sys= 413.6847 Mpa =  60000.0 Psi
* NOZZLE YIELD STRENGTH at room temp.  Syn= 413.6847 Mpa =  60000.0 Psi

Internal  hydrostatic test Pressure     P = 28.2000 Mpa =   4090.1 Psi
Shell inside diameter              D = 2*R =  4308.4 mm  =   169.62 "
Corrosion allowance                     c =     0.00 mm  =    0.000 "
Nozzle wall tolerance                  c1 =     0.00 mm  =    0.000 "
Adopted shell thickness                 t =   260.00 mm  =  10.2362 "
Pad thickness                          te =     0.00 mm  =    0.000 "
Pad width                               W =     0.00 mm  =    0.000 "
Dimension of fillet weld (pad to wall)    =     0.00 mm  =    0.000 "
Nozzle outside diameter                   =   390.00 mm  =   15.354 "
Nozzle thickness                       tn =   118.80 mm  =    4.677 "
Internal corner Radius                 r1 =    35.00 mm  =    1.378 "
External fillet Radius                 r2 =    30.00 mm  =    1.181 "
Type of connection:                          SET-IN
Nzl.position: NOT RADIAL F=1, angle nzl/shell axes on plane=   45.0 deg
Opening size          d = 2*Rn/cos(teta) =   215.53 mm  =    8.485 "
```

```
                    REINFORCEMENT OF OPENING D3-6
============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ===========

              ****   HYDROSTATIC TEST CONDITION   ****

* NET THICKNESSES:
t - c                                          =   260.00 mm  =   10.236 "
tr   =    P*(R+c)/(S-0.5*P)                    =   169.59 mm  =    6.677 "
trn  =    P*Rn/(Sn-0.5*P)                      =     6.00 mm  =    0.236 "
Horiz. limit to nozzle O.D.              Lo =     0.01 mm  =    0.000 "
Horiz. limit to nozzle O.D.  (AD-540.1(b)) =     0.01 mm  =    0.000 "
Vertic. limit to shell O.D.              ho =   297.00 mm  =   11.693 "
* REQUIRED AREAS:
Areq = d*F*tr                                  =  36550.2 mm2=   56.653 #
2/3*Areq ( AD-540.1(b) )                       =  24366.8 mm2=   37.769 #

* REINFORCING AREAS: Rt = Sn/S max=1
Shell    A1=2Lo(t-c-F*tr)                      =      1.8 mm2=    0.003 #
Nozzle   A2=2(tn-c-trn)(ho+(t-c-F*tr/Rt))Rt=  87401.6 mm2=  135.473 #
Weld     A4=                                   =      0.0 mm2=    0.000 #
Pad      A5=2*W*te                             =      0.0 mm2=    0.000 #
Nozzle   A6=2*ho'(tn-2c)*Rt                    =      0.0 mm2=    0.000 #
Corner   A7=2*(r1^2-PI*r1^2/4)*Rt              =    525.8 mm2=    0.815 #
Fillet   A77=2*(r2^2-PI*r2^2/4)*Rt             =      0.6 mm2=    0.001 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=  86878.2 mm2=  134.662 #
* Ao (whithin limits of ( AD-540.1(b) )    =  86878.2 mm2=  134.662 #
```

REINFORCEMENT OF OPENING T1-6

================ (ASME VIII div.2 / Edition 2004 D-5) ===============

```
                  ****        DESIGN CONDITION        ****
* DESIGN TEMPERATURE                          T =  454.0  C    =   849.2  F
* ROOM   TEMPERATURE                          T0=   21.1  C    =    70.0  F
* SHELL MATERIAL :                            SA 336 F22V
* NOZZLE MATERIAL :                           SA 182 F22V
* SHELL ALLOWABLE STRESS                      S = 168.9985 Mpa =  24511.2 Psi
* NOZZLE ALLOWABLE STRESS                     Sn= 168.9985 Mpa =  24511.2 Psi
* SHELL  MEAN □ AT DESIGN TEMP. □s=.0000141 mm/mm/□C =.0000078 mm/mm/□F
* NOZZLE MEAN □ AT DESIGN TEMP. □n=.0000141 mm/mm/□C =.0000078 mm/mm/□F
* NOZZLE ALLOWABLE STRESS at room temp.Sna= 195.1213 Mpa =  28300.0 Psi
* SHELL  YIELD STRENGTH at room temp.  Sys= 413.6847 Mpa =  60000.0 Psi
* NOZZLE YIELD STRENGTH at room temp.  Syn= 413.6847 Mpa =  60000.0 Psi
* NOZZLE MIN.ULTIMATE TENSILE STRENGTH      = 586.0533 Mpa =  85000.0 Psi
* SHELL  MIN.ULTIMATE TENSILE STRENGTH      = 586.0533 Mpa =  85000.0 Psi
* STRESS INTENSITY k FACTOR FOR LOAD COMBINATION           =     1.00

Internal  design pressure                     P =  19.1500 Mpa =   2777.5 Psi
Meridional membrane force          F =        0.00 N/mm=          0.00 Lb/Inch
Shell inside diameter                  D = 2*R =   4308.4 mm   =   169.62 "
Corrosion allowance                          c =     0.00 mm   =    0.000 "
Nozzle wall tolerance                       c1 =     0.00 mm   =    0.000 "
Adopted shell thickness                      t =   260.00 mm   =  10.2362 "
Pad thickness                               te =     0.00 mm   =    0.000 "
Pad width                                    W =     0.00 mm   =    0.000 "
Dimension of fillet weld (pad to wall)        =     0.00 mm   =    0.000 "
Pipe outside diameter                         =   133.30 mm   =    5.248 "
Reinf. outside diameter                       =   230.00 mm   =    9.055 "
Reinforcement thickness                     tn =    73.00 mm   =    2.874 "
Nozzle thickness                            tp =    24.65 mm   =    0.970 "
Length of reinforcement                      h =   207.00 mm   =    8.150 "
Internal corner Radius                      r1 =    35.00 mm   =    1.378 "
External fillet Radius                      r2 =    30.00 mm   =    1.181 "
Type of connection:                           INTEGRALLY REINFORCED
Nozzle position:                              RADIAL  (F=1)
Opening size                         d = 2*Rn =    84.00 mm   =    3.307 "
```

```
                    REINFORCEMENT OF OPENING T1-6
================= (ASME VIII div.2 / Edition 2004  D-5) ===============

                ****         DESIGN CONDITION          ****

* NET THICKNESSES:
t - c                                         =   260.00 mm  =    10.236 "
tr    =     P*(R+c)/(S-0.5*P)                 =   258.76 mm  =    10.188 "
tn - c                                        =    73.00 mm  =     2.874 "
trn   =     P*Rn/(Sn-0.5*P)                   =     5.05 mm  =     0.199 "
Adopted nozzle thickness      tn - c          =    73.00 mm  =    2.8740 "
Horiz. limit to Reinf. O.D.               Lo  =     0.01 mm  =     0.000 "
Horiz. limit to nozzle O.D.  (AD-540.1(b))    =     0.01 mm  =     0.000 "
Vertic. limit to shell O.D.               ho  =   182.50 mm  =     7.185 "
* REQUIRED AREAS:
Areq = d*F*tr                                 =   21736.1 mm2=    33.691 #
2/3*Areq ( AD-540.1(b) )                      =   14490.7 mm2=    22.461 #

* REINFORCING AREAS: Rt = Sn/S max=1
Shell    A1=2Lo(t-c-F*tr)                     =       0.0 mm2=     0.000 #
Nozzle   A2=2(tn-c-trn)(ho+(t-c-F*tr/Rt))Rt=   24971.7 mm2=    38.706 #
Weld     A4=                                  =       0.0 mm2=     0.000 #
Pad      A5=2*W*te                            =       0.0 mm2=     0.000 #
Nozzle   A6=2*ho'(tn-2c)*Rt                   =       0.0 mm2=     0.000 #
Corner   A7=2*(r1^2-PI*r1^2/4)*Rt             =     525.8 mm2=     0.815 #
Fillet   A77=2*(r2^2-PI*r2^2/4)*Rt            =       0.6 mm2=     0.001 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=   24446.5 mm2=    38.705 #
* Ao (whithin limits of ( AD-540.1(b) )    =   24446.5 mm2=    38.705 #
```


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                    REINFORCEMENT OF OPENING T1-6
 ============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

                ****   HYDROSTATIC TEST CONDITION    ****
 * HYDROSTATIC TEST TEMPERATURE             T =   21.1  C     =   70.0  F
 * SHELL MATERIAL :                         SA 336 F22V
 * NOZZLE MATERIAL :                        SA 182 F22V
 * SHELL ALLOWABLE STRESS          S=0.9*Sys= 372.3162 Mpa =  54000.0 Psi
 * NOZZLE ALLOWABLE STRESS        Sn=0.9*Syn= 372.3162 Mpa =  54000.0 Psi
 * SHELL  YIELD STRENGTH at room temp.  Sys= 413.6847 Mpa =  60000.0 Psi
 * NOZZLE YIELD STRENGTH at room temp.  Syn= 413.6847 Mpa =  60000.0 Psi

 Internal  hydrostatic test Pressure      P =  28.2000 Mpa =   4090.1 Psi
 Shell inside diameter               D = 2*R =   4308.4 mm  =   169.62 "
 Corrosion allowance                      c =      0.00 mm  =    0.000 "
 Nozzle wall tolerance                   c1 =      0.00 mm  =    0.000 "
 Adopted shell thickness                  t =    260.00 mm  =  10.2362 "
 Pad thickness                           te =      0.00 mm  =    0.000 "
 Pad width                                W =      0.00 mm  =    0.000 "
 Dimension of fillet weld (pad to wall)    =      0.00 mm  =    0.000 "
 Pipe outside diameter                     =    133.30 mm  =    5.248 "
 Reinf. outside diameter                   =    230.00 mm  =    9.055 "
 Reinforcement thickness                 tn =     73.00 mm  =    2.874 "
 Nozzle thickness                        tp =     24.65 mm  =    0.970 "
 Length of reinforcement                  h =    207.00 mm  =    8.150 "
 Internal corner Radius                  r1 =     35.00 mm  =    1.378 "
 External fillet Radius                  r2 =     30.00 mm  =    1.181 "
 Type of connection:                         INTEGRALLY REINFORCED
 Nozzle position:                            RADIAL (F=1)
 Opening size                      d = 2*Rn =     84.00 mm  =    3.307 "
```


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                    REINFORCEMENT OF OPENING T1-6
============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ===========

              ****   HYDROSTATIC TEST CONDITION   ****

* NET THICKNESSES:
t - c                                         =   260.00 mm  =    10.236 "
tr    =    P*(R+c)/(S-0.5*P)                  =   169.59 mm  =     6.677 "
tn - c                                        =    73.00 mm  =     2.874 "
trn   =    P*Rn/(Sn-0.5*P)                    =     3.31 mm  =     0.130 "
Adopted nozzle thickness       tn - c         =    73.00 mm  =    2.8740 "
Horiz. limit to Reinf. O.D.               Lo  =     0.01 mm  =     0.000 "
Horiz. limit to nozzle O.D.  (AD-540.1(b))    =     0.01 mm  =     0.000 "
Vertic. limit to shell O.D.               ho  =   182.50 mm  =     7.185 "
* REQUIRED AREAS:
Areq = d*F*tr                                 =   14245.2 mm2=    22.080 #
2/3*Areq ( AD-540.1(b) )                      =    9496.8 mm2=    14.720 #

* REINFORCING AREAS: Rt = Sn/S max=1
Shell    A1=2Lo(t-c-F*tr)                     =       1.8 mm2=     0.003 #
Nozzle   A2=2(tn-c-trn)(ho+(t-c-F*tr/Rt))Rt=      38040.7 mm2=    58.963 #
Weld     A4=                                  =       0.0 mm2=     0.000 #
Pad      A5=2*W*te                            =       0.0 mm2=     0.000 #
Nozzle   A6=2*ho'(tn-2c)*Rt                   =       0.0 mm2=     0.000 #
Corner   A7=2*(r1^2-PI*r1^2/4)*Rt             =     525.8 mm2=     0.815 #
Fillet   A77=2*(r2^2-PI*r2^2/4)*Rt            =       0.6 mm2=     0.001 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=       37517.3 mm2=    58.152 #
* Ao (whithin limits of ( AD-540.1(b) )       =   37517.3 mm2=    58.152 #
```

REINFORCEMENT OF OPENING E1-2

================ (ASME VIII div.2 / Edition 2004 D-5) ===============

**** DESIGN CONDITION ****

* DESIGN TEMPERATURE T = 454.0 C = 849.2 F
* ROOM TEMPERATURE T0= 21.1 C = 70.0 F
* SHELL MATERIAL : SA 336 F22V
* NOZZLE MATERIAL : SA 182 F22V
* SHELL ALLOWABLE STRESS S = 168.9985 Mpa = 24511.2 Psi
* NOZZLE ALLOWABLE STRESS Sn= 168.9985 Mpa = 24511.2 Psi
* SHELL MEAN □ AT DESIGN TEMP. □s=.0000141 mm/mm/□C =.0000078 mm/mm/□F
* NOZZLE MEAN □ AT DESIGN TEMP. □n=.0000141 mm/mm/□C =.0000078 mm/mm/□F
* NOZZLE ALLOWABLE STRESS at room temp.Sna= 195.1213 Mpa = 28300.0 Psi
* SHELL YIELD STRENGTH at room temp. Sys= 413.6847 Mpa = 60000.0 Psi
* NOZZLE YIELD STRENGTH at room temp. Syn= 413.6847 Mpa = 60000.0 Psi
* NOZZLE MIN.ULTIMATE TENSILE STRENGTH = 586.0533 Mpa = 85000.0 Psi
* SHELL MIN.ULTIMATE TENSILE STRENGTH = 586.0533 Mpa = 85000.0 Psi
* STRESS INTENSITY k FACTOR FOR LOAD COMBINATION = 1.00

Internal design pressure	P =	19.1500 Mpa	=	2777.5 Psi	
Meridional membrane force	F =	0.00 N/mm=		0.00 Lb/Inch	
Shell inside diameter	D = 2*R =	4308.4 mm	=	169.62 "	
Corrosion allowance	c =	0.00 mm	=	0.000 "	
Nozzle wall tolerance	c1 =	0.00 mm	=	0.000 "	
Adopted shell thickness	t =	260.00 mm	=	10.2362 "	
Pad thickness	te =	0.00 mm	=	0.000 "	
Pad width	W =	0.00 mm	=	0.000 "	
Dimension of fillet weld (pad to wall)	=	0.00 mm	=	0.000 "	
Pipe outside diameter	=	304.80 mm	=	12.000 "	
Reinf. outside diameter	=	435.00 mm	=	17.126 "	
Reinforcement thickness	tn =	115.90 mm	=	4.563 "	
Nozzle thickness	tp =	50.80 mm	=	2.000 "	
Length of reinforcement	h =	314.50 mm	=	12.381 "	<2>
Internal corner Radius	r1 =	35.00 mm	=	1.378 "	
External fillet Radius	r2 =	30.00 mm	=	1.181 "	
Type of connection:		INTEGRALLY REINFORCED			
Nozzle position:		RADIAL (F=1)			
Opening size	d = 2*Rn =	203.20 mm	=	8.000 "	

```
                     REINFORCEMENT OF OPENING E1-2
================= (ASME VIII div.2 / Edition 2004  D-5) ================

                ****        DESIGN CONDITION        ****

* NET THICKNESSES:
t - c                                        =   260.00 mm  =   10.236 "
tr    =    P*(R+c)/(S-0.5*P)                 =   258.76 mm  =   10.188 "
tn - c                                       =   115.90 mm  =    4.563 "
trn   =    P*Rn/(Sn-0.5*P)                   =    12.20 mm  =    0.480 "
Adopted nozzle thickness      tn - c         =   115.90 mm  =   4.5630 "
Horiz. limit to Reinf. O.D.              Lo  =     0.01 mm  =    0.000 "
Horiz. limit to nozzle O.D.  (AD-540.1(b))   =     0.01 mm  =    0.000 "
Vertic. limit to shell O.D.              ho  =   289.75 mm  =   11.407 "
* REQUIRED AREAS:
Areq = d*F*tr                                =  52580.7 mm2=    81.500 #
2/3*Areq ( AD-540.1(b) )                     =  35053.8 mm2=    54.333 #

* REINFORCING AREAS: Rt = Sn/S max=1
Shell    A1=2Lo(t-c-F*tr)                    =      0.0 mm2=     0.000 #
Nozzle   A2=2(tn-c-trn)(ho+(t-c-F*tr/Rt))Rt= 60348.2 mm2=    93.540 #
Weld     A4=                                 =      0.0 mm2=     0.000 #
Pad      A5=2*W*te                           =      0.0 mm2=     0.000 #
Nozzle   A6=2*ho'(tn-2c)*Rt                  =      0.0 mm2=     0.000 #
Corner   A7=2*(r1^2-PI*r1^2/4)*Rt            =    525.8 mm2=     0.815 #
Fillet   A77=2*(r2^2-PI*r2^2/4)*Rt           =      0.6 mm2=     0.001 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=  59823.0 mm2=    92.726 #
* Ao (whithin limits of ( AD-540.1(b) )      =  59823.0 mm2=    92.726 #
```

```
                    REINFORCEMENT OF OPENING E1-2
============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

             ****   HYDROSTATIC TEST CONDITION   ****
* HYDROSTATIC TEST TEMPERATURE                T =    21.1  C    =   70.0  F
* SHELL MATERIAL :                            SA 336 F22V
* NOZZLE MATERIAL :                           SA 182 F22V
* SHELL ALLOWABLE STRESS           S=0.9*Sys= 372.3162 Mpa =  54000.0 Psi
* NOZZLE ALLOWABLE STRESS         Sn=0.9*Syn= 372.3162 Mpa =  54000.0 Psi
* SHELL  YIELD STRENGTH at room temp.   Sys= 413.6847 Mpa =  60000.0 Psi
* NOZZLE YIELD STRENGTH at room temp.   Syn= 413.6847 Mpa =  60000.0 Psi

Internal  hydrostatic test Pressure       P =  28.2000 Mpa =   4090.1 Psi
Shell inside diameter               D = 2*R =   4308.4 mm  =   169.62 "
Corrosion allowance                       c =     0.00 mm  =    0.000 "
Nozzle wall tolerance                    c1 =     0.00 mm  =    0.000 "
Adopted shell thickness                   t =   260.00 mm  =  10.2362 "
Pad thickness                            te =     0.00 mm  =    0.000 "
Pad width                                 W =     0.00 mm  =    0.000 "
Dimension of fillet weld (pad to wall)      =     0.00 mm  =    0.000 "
Pipe outside diameter                       =   304.80 mm  =   12.000 "
Reinf. outside diameter                     =   435.00 mm  =   17.126 "
Reinforcement thickness                  tn =   115.90 mm  =    4.563 "
Nozzle thickness                         tp =    50.80 mm  =    2.000 "
Length of reinforcement                   h =   314.50 mm  =   12.381 " <2>
Internal corner Radius                   r1 =    35.00 mm  =    1.378 "
External fillet Radius                   r2 =    30.00 mm  =    1.181 "
Type of connection:                           INTEGRALLY REINFORCED
Nozzle position:                              RADIAL (F=1)
Opening size                       d = 2*Rn =   203.20 mm  =    8.000 "
```


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REINFORCEMENT OF OPENING E1-2
============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

**** HYDROSTATIC TEST CONDITION ****

```
* NET THICKNESSES:
t - c                                              =   260.00 mm  =   10.236 "
tr   =     P*(R+c)/(S-0.5*P)                       =   169.59 mm  =    6.677 "
tn - c                                             =   115.90 mm  =    4.563 "
trn  =     P*Rn/(Sn-0.5*P)                         =     8.00 mm  =    0.315 "
Adopted nozzle thickness       tn - c              =   115.90 mm  =   4.5630 "
Horiz. limit to Reinf. O.D.                     Lo =     0.01 mm  =    0.000 "
Horiz. limit to nozzle O.D. (AD-540.1(b))          =     0.01 mm  =    0.000 "
Vertic. limit to shell O.D.                     ho =   289.75 mm  =   11.407 "
* REQUIRED AREAS:
Areq = d*F*tr                                      =  34459.9 mm2=   53.413 #
2/3*Areq ( AD-540.1(b) )                           =  22973.2 mm2=   35.609 #

* REINFORCING AREAS: Rt = Sn/S max=1
Shell   A1=2Lo(t-c-F*tr)                           =      1.8 mm2=    0.003 #
Nozzle  A2=2(tn-c-trn)(ho+(t-c-F*tr/Rt))Rt=           82040.7 mm2=  127.163 #
Weld    A4=                                        =      0.0 mm2=    0.000 #
Pad     A5=2*W*te                                  =      0.0 mm2=    0.000 #
Nozzle  A6=2*ho'(tn-2c)*Rt                         =      0.0 mm2=    0.000 #
Corner  A7=2*(r1^2-PI*r1^2/4)*Rt                   =    525.8 mm2=    0.815 #
Fillet  A77=2*(r2^2-PI*r2^2/4)*Rt                  =      0.6 mm2=    0.001 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=           81517.3 mm2=  126.349 #
* Ao (whithin limits of ( AD-540.1(b) )            =  81517.3 mm2=  126.349 #
```

REINFORCEMENT OF OPENING T7-11

================ (ASME VIII div.2 / Edition 2004 D-5) ================

**** DESIGN CONDITION ****				
* DESIGN TEMPERATURE	T =	454.0 C	=	849.2 F
* ROOM TEMPERATURE	T0=	21.1 C	=	70.0 F
* SHELL MATERIAL :		SA 336 F22V		
* NOZZLE MATERIAL :		SA 182 F22V		
* SHELL ALLOWABLE STRESS	S =	168.9985 Mpa	=	24511.2 Psi
* NOZZLE ALLOWABLE STRESS	Sn=	168.9985 Mpa	=	24511.2 Psi
* SHELL MEAN □ AT DESIGN TEMP.	□s=	.0000141 mm/mm/□C	=	.0000078 mm/mm/□F
* NOZZLE MEAN □ AT DESIGN TEMP.	□n=	.0000141 mm/mm/□C	=	.0000078 mm/mm/□F
* NOZZLE ALLOWABLE STRESS at room temp.	Sna=	195.1213 Mpa	=	28300.0 Psi
* SHELL YIELD STRENGTH at room temp.	Sys=	413.6847 Mpa	=	60000.0 Psi
* NOZZLE YIELD STRENGTH at room temp.	Syn=	413.6847 Mpa	=	60000.0 Psi
* NOZZLE MIN.ULTIMATE TENSILE STRENGTH	=	586.0533 Mpa	=	85000.0 Psi
* SHELL MIN.ULTIMATE TENSILE STRENGTH	=	586.0533 Mpa	=	85000.0 Psi
* STRESS INTENSITY k FACTOR FOR LOAD COMBINATION			=	1.00
Internal design pressure	P =	19.1500 Mpa	=	2777.5 Psi
Meridional membrane force	F =	0.00 N/mm=		0.00 Lb/Inch
Shell inside diameter	D = 2*R =	4308.4 mm	=	169.62 "
Corrosion allowance	c =	0.00 mm	=	0.000 "
Nozzle wall tolerance	c1 =	0.00 mm	=	0.000 "
Adopted shell thickness	t =	260.00 mm	=	10.2362 "
Pad thickness	te =	0.00 mm	=	0.000 "
Pad width	W =	0.00 mm	=	0.000 "
Dimension of fillet weld (pad to wall)	=	0.00 mm	=	0.000 "
Pipe outside diameter	=	133.30 mm	=	5.248 "
Reinf. outside diameter	=	230.00 mm	=	9.055 "
Reinforcement thickness	tn =	73.00 mm	=	2.874 "
Nozzle thickness	tp =	24.65 mm	=	0.970 "
Length of reinforcement	h =	207.00 mm	=	8.150 "
Internal corner Radius	r1 =	35.00 mm	=	1.378 "
External fillet Radius	r2 =	30.00 mm	=	1.181 "
Type of connection:		INTEGRALLY REINFORCED		
Nozzle position:		RADIAL (F=1)		
Opening size	d = 2*Rn =	84.00 mm	=	3.307 "

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                    REINFORCEMENT OF OPENING T7-11
 ================= (ASME VIII div.2 / Edition 2004  D-5) ===============

                ****        DESIGN CONDITION        ****

 * NET THICKNESSES:
 t - c                                        =   260.00 mm  =   10.236 "
 tr    =     P*(R+c)/(S-0.5*P)                =   258.76 mm  =   10.188 "
 tn - c                                       =    73.00 mm  =    2.874 "
 trn   =     P*Rn/(Sn-0.5*P)                  =     5.05 mm  =    0.199 "
 Adopted nozzle thickness      tn - c         =    73.00 mm  =   2.8740 "
 Horiz. limit to Reinf. O.D.              Lo  =     0.01 mm  =    0.000 "
 Horiz. limit to nozzle O.D. (AD-540.1(b))    =     0.01 mm  =    0.000 "
 Vertic. limit to shell O.D.              ho  =   182.50 mm  =    7.185 "
 * REQUIRED AREAS:
 Areq = d*F*tr                                =  21736.1 mm2=   33.691 #
 2/3*Areq ( AD-540.1(b) )                     =  14490.7 mm2=   22.461 #

 * REINFORCING AREAS: Rt = Sn/S max=1
 Shell    A1=2Lo(t-c-F*tr)                    =      0.0 mm2=    0.000 #
 Nozzle   A2=2(tn-c-trn)(ho+(t-c-F*tr/Rt))Rt= 24971.6 mm2=   38.706 #
 Weld     A4=                                 =      0.0 mm2=    0.000 #
 Pad      A5=2*W*te                           =      0.0 mm2=    0.000 #
 Nozzle   A6=2*ho'(tn-2c)*Rt                  =      0.0 mm2=    0.000 #
 Corner   A7=2*(r1^2-PI*r1^2/4)*Rt            =    525.8 mm2=    0.815 #
 Fillet   A77=2*(r2^2-PI*r2^2/4)*Rt           =      0.6 mm2=    0.001 #

 *TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=  24446.4 mm2=   38.705 #
 * Ao (whithin limits of ( AD-540.1(b) )      =  24446.4 mm2=   38.705 #
```


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REINFORCEMENT OF OPENING T7-11
============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

```
              ****    HYDROSTATIC TEST CONDITION    ****
* HYDROSTATIC TEST TEMPERATURE              T =    21.1  C     =    70.0  F
* SHELL MATERIAL :                          SA 336 F22V
* NOZZLE MATERIAL :                         SA 182 F22V
* SHELL ALLOWABLE STRESS           S=0.9*Sys= 372.3162 Mpa =   54000.0 Psi
* NOZZLE ALLOWABLE STRESS         Sn=0.9*Syn= 372.3162 Mpa =   54000.0 Psi
* SHELL  YIELD STRENGTH at room temp.   Sys= 413.6847 Mpa =   60000.0 Psi
* NOZZLE YIELD STRENGTH at room temp.   Syn= 413.6847 Mpa =   60000.0 Psi

Internal  hydrostatic test Pressure     P =  28.2000 Mpa =    4090.1 Psi
Shell inside diameter              D = 2*R =   4308.4 mm  =    169.62 "
Corrosion allowance                     c =     0.00 mm  =     0.000 "
Nozzle wall tolerance                  c1 =     0.00 mm  =     0.000 "
Adopted shell thickness                 t =   260.00 mm  =   10.2362 "
Pad thickness                          te =     0.00 mm  =     0.000 "
Pad width                               W =     0.00 mm  =     0.000 "
Dimension of fillet weld (pad to wall)    =     0.00 mm  =     0.000 "
Pipe outside diameter                     =   133.30 mm  =     5.248 "
Reinf. outside diameter                   =   230.00 mm  =     9.055 "
Reinforcement thickness                tn =    73.00 mm  =     2.874 "
Nozzle thickness                       tp =    24.65 mm  =     0.970 "
Length of reinforcement                 h =   207.00 mm  =     8.150 "
Internal corner Radius                 r1 =    35.00 mm  =     1.378 "
External fillet Radius                 r2 =    30.00 mm  =     1.181 "
Type of connection:                        INTEGRALLY REINFORCED
Nozzle position:                           RADIAL (F=1)
Opening size                     d = 2*Rn =    84.00 mm  =     3.307 "
```

```
                    REINFORCEMENT OF OPENING T7-11
============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

                ****   HYDROSTATIC TEST CONDITION   ****

* NET THICKNESSES:
t - c                                          =   260.00 mm   =   10.236 "
tr   =     P*(R+c)/(S-0.5*P)                   =   169.59 mm   =    6.677 "
tn - c                                         =    73.00 mm   =    2.874 "
trn  =     P*Rn/(Sn-0.5*P)                     =     3.31 mm   =    0.130 "
Adopted nozzle thickness      tn - c           =    73.00 mm   =   2.8740 "
Horiz. limit to Reinf. O.D.               Lo   =     0.01 mm   =    0.000 "
Horiz. limit to nozzle O.D.  (AD-540.1(b))     =     0.01 mm   =    0.000 "
Vertic. limit to shell O.D.               ho   =   182.50 mm   =    7.185 "
* REQUIRED AREAS:
Areq = d*F*tr                                  =  14245.2 mm2=    22.080 #
2/3*Areq ( AD-540.1(b) )                       =   9496.8 mm2=    14.720 #

* REINFORCING AREAS: Rt = Sn/S max=1
Shell    A1=2Lo(t-c-F*tr)                      =      1.8 mm2=     0.003 #
Nozzle   A2=2(tn-c-trn)(ho+(t-c-F*tr/Rt))Rt=     38040.7 mm2=    58.963 #
Weld     A4=                                   =      0.0 mm2=     0.000 #
Pad      A5=2*W*te                             =      0.0 mm2=     0.000 #
Nozzle   A6=2*ho'(tn-2c)*Rt                    =      0.0 mm2=     0.000 #
Corner   A7=2*(r1^2-PI*r1^2/4)*Rt              =    525.8 mm2=     0.815 #
Fillet   A77=2*(r2^2-PI*r2^2/4)*Rt             =      0.6 mm2=     0.001 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=      37517.3 mm2=    58.152 #
* Ao (whithin limits of ( AD-540.1(b) )        =  37517.3 mm2=    58.152 #
```

REINFORCEMENT OF OPENING D7 <2>

```
================= (ASME VIII div.2 / Edition 2004  D-5) ===============

                **** DESIGN CONDITION ****
* DESIGN TEMPERATURE                         T =  454.0  C     =  849.2  F
* ROOM   TEMPERATURE                         T0=   21.1  C     =   70.0  F
* SHELL MATERIAL :                           SA 182 F22V
* NOZZLE MATERIAL :                          SA 182 F22V
* SHELL ALLOWABLE STRESS                     S = 168.9985 Mpa =  24511.2 Psi
* NOZZLE ALLOWABLE STRESS                    Sn= 168.9985 Mpa =  24511.2 Psi
* SHELL  MEAN Ó AT DESIGN TEMP. Ós=.0000141 mm/mm/°C =.0000078 mm/mm/°F
* NOZZLE MEAN Ó AT DESIGN TEMP. Ón=.0000141 mm/mm/°C =.0000078 mm/mm/°F
* NOZZLE ALLOWABLE STRESS at room temp.Sna= 195.1213 Mpa =  28300.0 Psi
* SHELL  YIELD STRENGTH at room temp.  Sys= 413.6847 Mpa =  60000.0 Psi
* NOZZLE YIELD STRENGTH at room temp.  Syn= 413.6847 Mpa =  60000.0 Psi
* NOZZLE MIN.ULTIMATE TENSILE STRENGTH    = 586.0533 Mpa =  85000.0 Psi
* SHELL  MIN.ULTIMATE TENSILE STRENGTH    = 586.0533 Mpa =  85000.0 Psi
* STRESS INTENSITY k FACTOR FOR LOAD COMBINATION          =     1.00

Internal  design pressure                    P =  19.1500 Mpa =   2777.5 Psi
Meridional membrane force       F =          0.00 N/mm=        0.00 Lb/Inch
Shell inside diameter               D = 2*R =     504.8 mm   =    19.87 " <2>
Corrosion allowance                      c =       0.00 mm   =    0.000 "
Nozzle wall tolerance                   c1 =       0.00 mm   =    0.000 "
Adopted shell thickness                  t =      52.40 mm   =   2.0630 " <2>
Pad thickness                           te =       0.00 mm   =    0.000 "
Pad width                                W =       0.00 mm   =    0.000 "
Dimension of fillet weld (pad to wall)   =         0.00 mm   =    0.000 "
Nozzle outside diameter                  =       165.10 mm   =    6.500 "
Nozzle thickness                        tn =      31.75 mm   =    1.250 "
Internal corner Radius                  r1 =       7.00 mm   =    0.276 "
External fillet Radius                  r2 =      10.00 mm   =    0.394 "
Type of connection:                          SET-IN
Nozzle position:                             RADIAL (F=1)
Opening size                      d = 2*Rn =     101.60 mm   =    4.000 "
```


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                    REINFORCEMENT OF OPENING D7
================= (ASME VIII div.2 / Edition 2004  D-5) ================

              ****          DESIGN CONDITION          ****

* NET THICKNESSES:
t - c                                        =    52.40 mm  =    2.063 "
tr   =     P*(R+c)/(S-0.5*P)                 =    30.32 mm  =    1.194 "
trn  =     P*Rn/(Sn-0.5*P)                   =     6.10 mm  =    0.240 "
Horiz. limit to nozzle O.D.             Lo   =     0.01 mm  =    0.000 "
Horiz. limit to nozzle O.D.  (AD-540.1(b))   =     0.01 mm  =    0.000 "
Vertic. limit to shell O.D.             ho   =    80.00 mm  =    3.150 "
* REQUIRED AREAS:
Areq = d*F*tr                                =    3080.3 mm2=    4.775 #
2/3*Areq ( AD-540.1(b) )                     =    2053.6 mm2=    3.183 #

* REINFORCING AREAS: Rt = Sn/S max=1
Shell   A1=2Lo(t-c-F*tr)                     =       0.4 mm2=    0.001 #
Nozzle  A2=2(tn-c-trn)(ho+(t-c-F*tr/Rt))Rt=    5236.4 mm2=    8.116 #
Weld    A4=                                  =       0.0 mm2=    0.000 #
Pad     A5=2*W*te                            =       0.0 mm2=    0.000 #
Nozzle  A6=2*ho'(tn-2c)*Rt                   =       0.0 mm2=    0.000 #
Corner  A7=2*(r1^2-PI*r1^2/4)*Rt             =      21.0 mm2=    0.033 #
Fillet  A77=2*(r2^2-PI*r2^2/4)*Rt            =       0.2 mm2=    0.000 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=    5216.0 mm2=    8.085 #
* Ao (whithin limits of ( AD-540.1(b) )      =    5216.0 mm2=    8.085 #

* MINIMUM HYDROSTATIC TEST PRESSURE FOR NOZZLE
(HYD. pressure value)=1.25*P*Sna/Sn        =  27.6376 Mpa =  4008.5 Psi

    ALTERNATIVE RULES (AD-560)        ARE NOT APPLICABLE
    STRESS INDICES ( TABLE AD-560.7 ) ARE NOT APPLICABLE
```

REINFORCEMENT OF OPENING D7

============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

**** HYDROSTATIC TEST CONDITION ****

* HYDROSTATIC TEST TEMPERATURE	T =	21.1	C	=	70.0 F
* SHELL MATERIAL :		SA 182 F22V			
* NOZZLE MATERIAL :		SA 182 F22V			
* SHELL ALLOWABLE STRESS	S=0.9*Sys=	372.3162	Mpa	=	54000.0 Psi
* NOZZLE ALLOWABLE STRESS	Sn=0.9*Syn=	372.3162	Mpa	=	54000.0 Psi
* SHELL YIELD STRENGTH at room temp.	Sys=	413.6847	Mpa	=	60000.0 Psi
* NOZZLE YIELD STRENGTH at room temp.	Syn=	413.6847	Mpa	=	60000.0 Psi

Internal hydrostatic test Pressure	P =	28.2000	Mpa	=	4090.1 Psi
Shell inside diameter	D = 2*R =	504.8	mm	=	19.87 " <2>
Corrosion allowance	c =	0.00	mm	=	0.000 "
Nozzle wall tolerance	c1 =	0.00	mm	=	0.000 "
Adopted shell thickness	t =	52.40	mm	=	2.0630 " <2>
Pad thickness	te =	0.00	mm	=	0.000 "
Pad width	W =	0.00	mm	=	0.000 "
Dimension of fillet weld (pad to wall)	=	0.00	mm	=	0.000 "
Nozzle outside diameter	=	165.10	mm	=	6.500 "
Nozzle thickness	tn =	31.75	mm	=	1.250 "
Internal corner Radius	r1 =	7.00	mm	=	0.276 "
External fillet Radius	r2 =	10.00	mm	=	0.394 "
Type of connection:		SET-IN			
Nozzle position:		RADIAL (F=1)			
Opening size	d = 2*Rn =	101.60	mm	=	4.000 "

```
                         REINFORCEMENT OF OPENING D7
============ (ASME VIII div.2 / Edition 2004 AD-151.1, D-5) ============

               ****   HYDROSTATIC TEST CONDITION   ****

* NET THICKNESSES:
t - c                                        =    52.40 mm  =    2.063 "
tr   =      P*(R+c)/(S-0.5*P)                =    19.87 mm  =    0.782 "
trn  =      P*Rn/(Sn-0.5*P)                  =     4.00 mm  =    0.157 "
Horiz. limit to nozzle O.D.             Lo   =     0.01 mm  =    0.000 "
Horiz. limit to nozzle O.D.  (AD-540.1(b))   =     0.01 mm  =    0.000 "
Vertic. limit to shell O.D.             ho   =    80.00 mm  =    3.150 "
* REQUIRED AREAS:
Areq = d*F*tr                                =    2018.8 mm2=    3.129 #
2/3*Areq ( AD-540.1(b) )                     =    1345.8 mm2=    2.086 #

* REINFORCING AREAS: Rt = Sn/S max=1
Shell    A1=2Lo(t-c-F*tr)                    =       0.7 mm2=    0.001 #
Nozzle   A2=2(tn-c-trn)(ho+(t-c-F*tr/Rt))Rt=      6245.6 mm2=    9.681 #
Weld     A4=                                 =       0.0 mm2=    0.000 #
Pad      A5=2*W*te                           =       0.0 mm2=    0.000 #
Nozzle   A6=2*ho'(tn-2c)*Rt                  =       0.0 mm2=    0.000 #
Corner   A7=2*(r1^2-PI*r1^2/4)*Rt            =      21.0 mm2=    0.033 #
Fillet   A77=2*(r2^2-PI*r2^2/4)*Rt           =       0.2 mm2=    0.000 #

*TOTAL REINF.AREA Ao=A1+A2+A4+A5+A6-A7+A77=       6225.4 mm2=    9.649 #
* Ao (whithin limits of ( AD-540.1(b) )      =    6225.4 mm2=    9.649 #
```


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TOP SPOOL <3>

Top spool assembly is designed in accordance with ASME B31.3.

DESIGN STRESS INTENSITY RATIO Sa / S TABLE A-1 of ASME B31.3

ITEM	MATERIALS	Sa (Mpa) Room	S (Mpa) Design	Ratio
Pipes, Bends	SA 182 F347	137,90	125,49	1,099
Pipes, Bends	SA 182 F22V	195,12	169,00	1,155

CYLINDRICAL SHELL POS.PIPE A-347 <3>

PIPE VERIFICATION AS PER ASME B31.3

- Straight pipe thickness verification as per PARA 304.1.2

MATERIAL : **SA 182 F347**

Minimum required thickness is :

tr = P*D / (2* (S*E + P*Y)) = **36,53** mm

T = Assumed thickness **50,00** mm

Where:

P =	19,15	MPa	2.777,5 Psi	Design pressure
D =	508	mm		Outer pipe diameter
di =	408	mm		Inner pipe diameter
S =	125,49	MPa	18.201 Psi	Allowable stress
E =	1			Quality factor from table A-1A
Y =	0,4			Coefficient from table 304.1.1

CYLINDRICAL SHELL POS.PIPE A <3>

PIPE VERIFICATION AS PER ASME B31.3

- Straight pipe thickness verification as per PARA 304.1.2

MATERIAL : **SA 182 F22V**

Minimum required thickness is :

tr = P*D / (2* (S*E + P*Y)) = **27,53** mm

T = Assumed thickness **44,45** mm

Where:

P =	**19,15**	MPa	**2.777,5** Psi	Design pressure
D =	**508**	mm		Outer pipe diameter
di =	**419,1**	mm		Inner pipe diameter
S =	**169**	MPa	**24.511** Psi	Allowable stress
E =	**1**			Quality factor from table A-1A
Y =	**0,4**			Coefficient from table 304.1.1

PIPE BEND A 20'' L.R. 90° THK 44,45 <3>

BEND VERIFICATION AS PER ASME B31.3

- Straight bend thickness verification as per PARA 304.2.1

MATERIAL : **SA 182 F22V**

Minimum required thickness is :

tr =	P*D / (2* (S*E*W/I + P*Y)) =	**34,05**	mm
T =	Assumed thickness	**44,45**	mm

Where:

P =	19,15	MPa	2.777,5 Psi	Design pressure
D =	508	mm		Outer bend diameter
di =	419,1	mm		Inner bend diameter
R_1 =	762	mm		Bend radius
S =	169	MPa	24.511 Psi	Allowable stress
E =	1			Quality factor from table A-1A
Y =	0,4			Coefficient from table 304.1.1
W =	1			Coefficient from table 302.3.4
I =	1,250			$= MAX[I_1;I_2]$
I_1 =	1,250			$= [4x(R_1/D)-1]/[4x(R_1/D)-2]$
I_2 =	0,875			$= [4x(R_1/D)+1]/[4x(R_1/D)+2]$

CYLINDRICAL SHELL POS.PIPE B-347

```
================ (ASME VIII div.2 / Edit. 2004  D-2) ===================

  * DESIGN TEMPERATURE                         T =  454.0  C     =  849.2  F

  * SHELL MATERIAL :                             SA 182 F347 <=5 H.S.

  * ALLOW. STRESS             (Case 1489-2) S = 115.8317 Mpa = 16800.0 Psi

  * ALLOW. STRESS,room temp.(Case 1489-2) Sa= 137.8949 Mpa = 20000.0 Psi

  * YIELD STRENGTH at room temp.           Sys= 206.8424 Mpa = 30000.0 Psi

  * MINIMUM ULTIMATE TENSILE STRENGTH   UTSs= 517.1059 Mpa = 75000.0 Psi

  * STRESS INTENSITY k FACTOR FOR LOAD COMBINATION              =     1.00

  Internal design pressure                   P =  19.1500 Mpa =  2777.5 Psi
  Internal hydrostatic test pressure       PHy =  28.2000 Mpa =  4090.1 Psi
  Internal diameter                    D = 2*R =    490.4 mm  =   19.31 "
  Corrosion allowance                        c =     0.00 mm  =  0.0000 "

  * MINIMUM REQUIRED THICKNESS , DESIGN CONDITION (PRESSURE)
  tr + c = P*(R+c)/(S-0.5*P) + c              =    44.19 mm  =   1.740 "

  * MINIMUM REQUIRED THICKNESS , HYDROSTATIC TEST CONDITION
  tr(Hy) = PHy*R/(0.9*Sys-0.5*PHy)            =    40.19 mm  =   1.582 "


  Adopted thickness                          t =    59.60 mm  =  2.3465 "
```


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CYLINDRICAL SHELL POS.PIPE B

```
================ (ASME VIII div.2 / Edit. 2004  D-2) ===================

* DESIGN TEMPERATURE                         T =  454.0  C     =  849.2  F

* SHELL MATERIAL :                             SA 182 F22V

* ALLOW. STRESS                              S = 168.9985 Mpa = 24511.2 Psi

* ALLOW. STRESS,room temp.                   Sa= 195.1213 Mpa = 28300.0 Psi

* YIELD STRENGTH at room temp.              Sys= 413.6847 Mpa = 60000.0 Psi

* MINIMUM ULTIMATE TENSILE STRENGTH        UTSs= 586.0533 Mpa = 85000.0 Psi

* STRESS INTENSITY k FACTOR FOR LOAD COMBINATION              =     1.00

Internal design pressure                     P =  19.1500 Mpa =  2777.5 Psi
Internal hydrostatic test pressure         PHy =  28.2000 Mpa =  4090.1 Psi
Internal diameter                      D = 2*R =    504.8 mm  =   19.88 "
Corrosion allowance                          c =     0.00 mm  =  0.0000 "

* MINIMUM REQUIRED THICKNESS , DESIGN CONDITION (PRESSURE)
tr + c = P*(R+c)/(S-0.5*P) + c               =     30.32 mm  =   1.194 "

* MINIMUM REQUIRED THICKNESS , HYDROSTATIC TEST CONDITION
tr(Hy) = PHy*R/(0.9*Sys-0.5*PHy)             =     19.87 mm  =   0.782 "


Adopted thickness                            t =     52.40 mm  =  2.0630 "
```

PIPE BEND B 24'' L.R. 90° THK 52,4

========= (CALCULATION ACCORDING TO DIN 2413) =============

* DESIGN TEMPERATURE	T =	454 °C	849,2 °F
* ELBOW MATERIAL :	SA 182 F22V		
* ALLOW. STRESS	S =	168,999	24511 Psi
* ALLOW. STRESS,room temp.	Sa=	195,122 MPa	28300 Psi
* YIELD STRENGTH at room temp.	Sy=	413,685 MPa	60000 Psi

Internal design pressure	P =	19,15 MPa	=	2777 Psi	
Hydrotest pressure	P =	28,20 MPa	=	4090 Psi	
Bend center line curvature radius	R =	914,4 mm	=	36 "	
Bend outside diameter	Da =	609,6 mm	=	24 "	
Pipe required thickness (design)	tr =	30,32 mm	=	1,19363 "	(*)
Pipe required thickness (hydrotest)	trh =	19,87 mm	=	0,78227 "	(*)
Corrosion allowance	c =	mm	=	0,000 "	

(*) See pipe calculations B

* MINIMUM REQUIRED THICKNESS , DESIGN CONDITION (PRESSURE)

tp = tr -c	=	30,32 mm	=	1,194 "
tr = tp*(2*R-Da/2)/(2*R-Da)+ c	=	37,90 mm	=	1,492 "
Adopted thickness	t =	52,4 mm	=	2,063 "

* MINIMUM REQUIRED THICKNESS , HYDROTEST CONDITION (PRESSURE)

tp = trh	=	19,87 mm	=	0,782 "
tr = tp*(2*R-Da/2)/(2*R-Da)	=	24,84 mm	=	0,978 "
Adopted thickness	t =	52,4 mm	=	2,063 "

CYLINDRICAL SHELL POS.PIPE D1-2

================ (ASME VIII div.2 / Edit. 2004 D-2) ==================

```
* DESIGN TEMPERATURE                        T =  454.0  C     =  849.2  F

* SHELL MATERIAL :                            SA 182 F22V

* ALLOW. STRESS                             S = 168.9985 Mpa = 24511.2 Psi

* ALLOW. STRESS,room temp.                  Sa= 195.1213 Mpa = 28300.0 Psi

* YIELD STRENGTH at room temp.             Sys= 413.6847 Mpa = 60000.0 Psi

* MINIMUM ULTIMATE TENSILE STRENGTH       UTSs= 586.0533 Mpa = 85000.0 Psi

* STRESS INTENSITY k FACTOR FOR LOAD COMBINATION           =      1.00

Internal design pressure                    P =  19.1500 Mpa =  2777.5 Psi
Internal hydrostatic test pressure        PHy =  28.2000 Mpa =  4090.1 Psi
Internal diameter                     D = 2*R =    182.6 mm  =    7.19 "
Corrosion allowance                         c =     0.00 mm  =  0.0000 "

* MINIMUM REQUIRED THICKNESS , DESIGN CONDITION (PRESSURE)
tr + c = P*(R+c)/(S-0.5*P) + c              =     10.97 mm  =   0.432 "

* MINIMUM REQUIRED THICKNESS , HYDROSTATIC TEST CONDITION
tr(Hy) = PHy*R/(0.9*Sys-0.5*PHy)            =      7.19 mm  =   0.283 "


Adopted thickness                           t =    18.24 mm  =  0.7181 "
```


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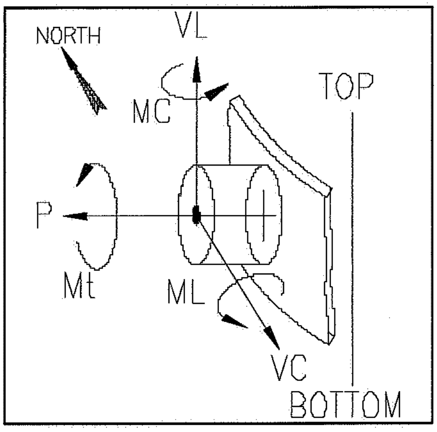
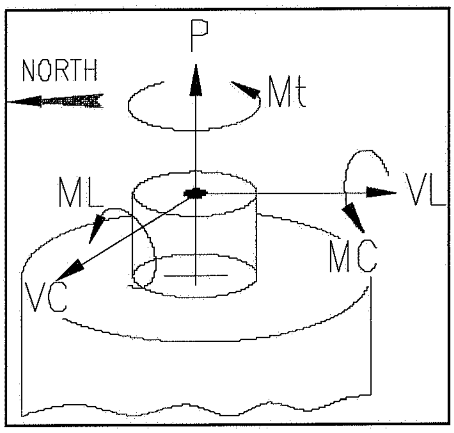
PIPING LOAD <3>





Nozzle	P	V_L	V_C	M_t	M_L	M_C
	N	N	N	N*m	N*m	N*m
A case 1	27.600	18.000	21.600	-162.000	42.000	68.400
A case 2	30.000	26.400	22.800	-190.800	42.000	75.600
A case 3	16.800	-16.800	13.200	-64.800	37.200	38.400
A case 4	30.000	27.600	22.800	-198.000	39.600	75.600
A case 5	1.200	-37.200	2.400	-34.800	7.200	-1.200
A case 6	38.850	28.350	-22.050	-178.500	-57.750	-119.700
M case 1	-84.000	21.600	27.600	118.800	-193.200	12.000
M case 2	-74.400	22.800	30.000	130.800	-225.600	-8.400
M case 3	-116.400	13.200	16.800	69.600	-84.000	84.000
M case 4	-73.200	22.800	30.000	130.800	-231.600	-9.600
M case 5	-138.000	2.400	1.200	2.400	-36.000	140.400
M case 6	-60.900	37.800	22.050	173.250	-211.050	-21.000
B	140.007	158.400	140.007	220.427	285.120	220.427
E	20.000	20.000	20.000	25.000	12.800	12.500

Nozzle	max(P)	max(V_L)	max(V_C)	max(M_t)	max(M_L)	max(M_C)
	N	N	N	N*m	N*m	N*m
A max	38.850	-37.200	22.800	-198.000	-57.750	-119.700

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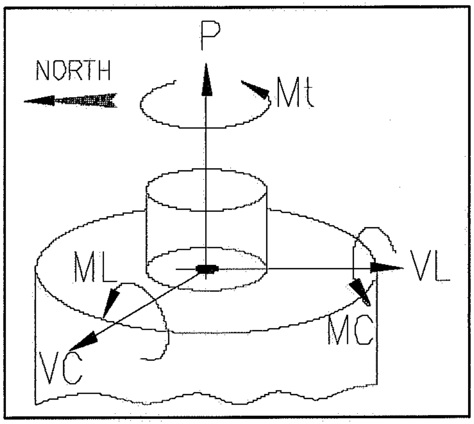
Nozzle & Shell intersection

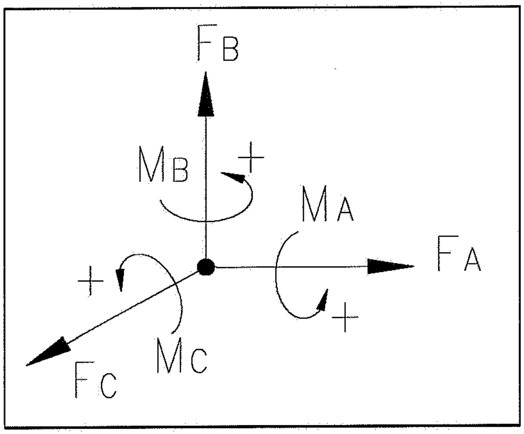


Nozzle	P	V_L	V_C	M_t	M_L	M_C
	N	N	N	N*m	N*m	N*m
$M_{case\ 1}$	-201.600	21.600	27.600	118.800	-218.400	44.400
$M_{case\ 2}$	-193.200	22.800	30.000	130.800	-252.000	28.800
$M_{case\ 3}$	-235.200	13.200	16.800	69.600	-98.400	103.200
$M_{case\ 4}$	-192.000	22.800	30.000	130.800	-259.200	27.600
$M_{case\ 5}$	-255.600	2.400	1.200	2.400	-38.400	141.600
$M_{case\ 6}$	-164.850	34.650	22.050	173.250	-211.050	24.150

Nozzle	max(P)	max(V_L)	max(V_C)	max(M_t)	max(M_L)	max(M_C)
	N	N	N	N*m	N*m	N*m
M_{max}	-255.600	34.650	30.000	173.250	-259.200	141.600

LOAD ON UPPER SPOOL <3>

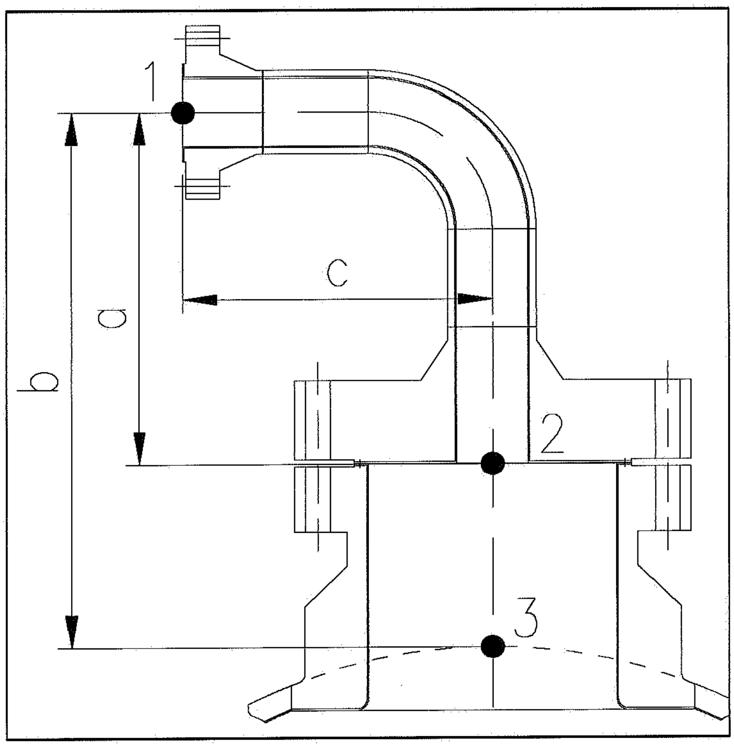
NPS 20"



LOAD ACTING ON POINT 1
(FLANGE A $_{max}$)

F_{A1} =	-38.850	N	
F_{B1} =	-37.200	N	
F_{C1} =	22.800	N	
M_{A1} =	198.000	N*m	
M_{B1} =	-119.700	N*m	
M_{C1} =	-57.750	N*m	
a =	1,527	m	<2>
b =	2,466	m	<2>
c =	2,500	m	

LOAD ACTING ON POINT 2
(FLANGE M $_{case\ 4}$)



F_{A2} =	22.800	N
F_{B2} =	-73.200	N
F_{C2} =	30.000	N
M_{A1} =	-9.600	N*m
M_{B2} =	130.800	N*m
M_{C2} =	-231.600	N*m

LOAD ACTING ON POINT 3
(NOZZLE M $_{max}$)

F_{A3} =	34.650	N
F_{B3} =	-255.600	N
F_{C3} =	30.000	N
M_{A3} =	141.600	N*m
M_{B3} =	173.250	N*m
M_{C3} =	-259.200	N*m

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE INDICATED <3>
2	MODIFIED WHERE INDICATED <2>
1	REVISIONE GENERALE
0	EMISSIONE-ISSUE

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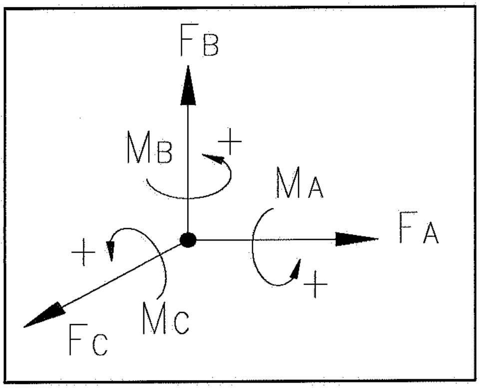
LOAD ON LOWER SPOOL

NPS 24"

LOAD ACTING ON POINT 1
(FLANGE B)

F_{A1} = **140.007** N
F_{B1} = **158.400** N
F_{C1} = **140.007** N
M_{A1} = **220.427** N*m
M_{B1} = **285.120** N*m
M_{C1} = **220.427** N*m

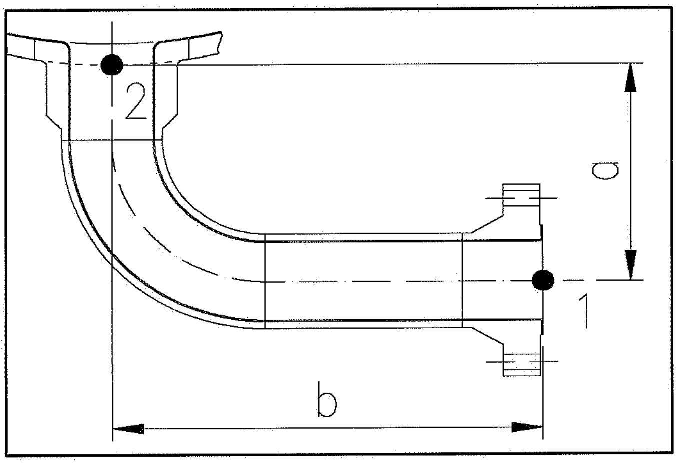
a = **1,362** m
b = **3,300** m



LOAD ACTING ON POINT 2
(NOZZLE B)

$F_{A2} = F_{A1}$
$F_{B2} = F_{B1}$
$F_{C2} = F_{C1}$
$M_{A2} = M_{A1} - F_{C1} \times a$
$M_{B2} = M_{B1} - F_{C1} \times b$
$M_{C2} = M_{C1} + F_{A1} \times a + F_{B1} \times b$

F_{A2} = **140.007** N
F_{B2} = **158.400** N
F_{C2} = **140.007** N
M_{A2} = **29.738** N*m
M_{B2} = **-176.904** N*m
M_{C2} = **933.837** N*m



REV.	DESCRIZIONE - DESCRIPTION
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1	REVISIONE GENERALE
0	EMISSIONE-ISSUE

ITEM
D-6212/ D-6232

N. SOU0107840/4

LINGUA-LANG. **A**

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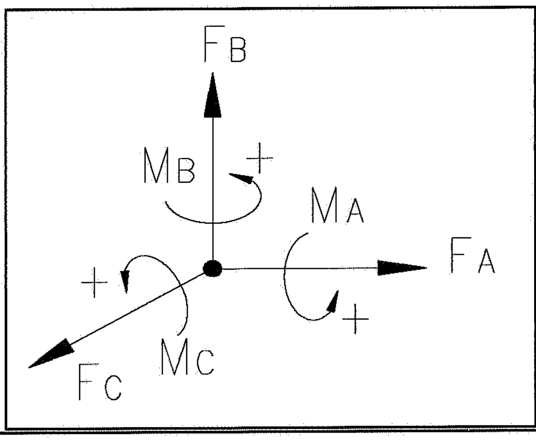
LOAD ON SHELL NOZZLE

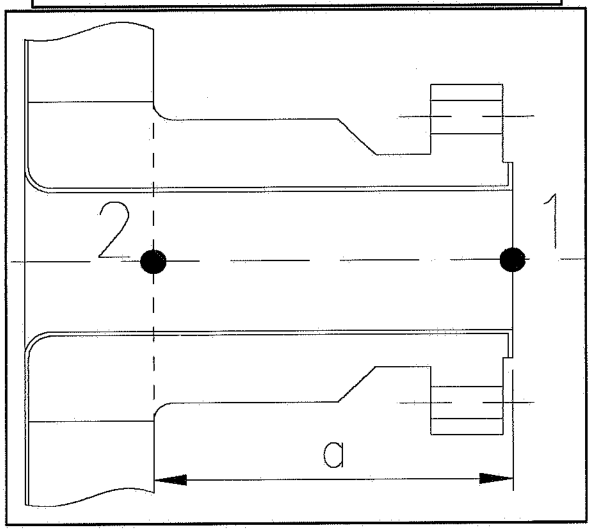
PIPING LOAD CALCULATION

LOAD ACTING ON POINT 1
(FLANGE E)

F_{A1} = 20.000 N
F_{B1} = 20.000 N
F_{C1} = 20.000 N
M_{A1} = 25.000 N*m
M_{B1} = 12.800 N*m
M_{C1} = 12.500 N*m

a = 0,616 m





LOAD ACTING ON POINT 2
(NOZZLE E)

$F_{A2} = F_{A1}$
$F_{B2} = F_{B1}$
$F_{C2} = F_{C1}$
$M_{A2} = M_{A1}$
$M_{B2} = M_{B1} - F_{C1} \times a$
$M_{C2} = M_{C1} + F_{B1} \times a$

F_{A2} = 20.000 N
F_{B2} = 20.000 N
F_{C2} = 20.000 N
M_{A2} = 25.000 N*m
M_{B2} = 480 N*m
M_{C2} = 24.820 N*m

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE INDICATED <3>
2	MODIFIED WHERE INDICATED <2>
1	REVISIONE GENERALE
0	EMISSIONE-ISSUE

ITEM D-6212/ D-6232
N. SOU0107840/4
LINGUA-LANG. A

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EQUIVALENT PRESSURE CALCULATION <3>

Due to piping load and moment acting on flanges the design pressure shall be incrased with an additional pressure calculated as follows:

$$P_{eq} = \frac{4*10^3*F}{\pi*g^2} + \frac{16*10^6*M}{\pi*g^3} \qquad P_{tot} = P_{eq} + P_{de}$$

Where:

Peq	: Additional or Equivalent pressure	[MPa]
Pde	: Desing pressure	[MPa]
Ptot	: Total flanges desing pressure	[MPa]
F	: Piping force acting on flanges	[KN]
M	: Piping moment acting on flanges	[KN*m]
g	: Mean gasket diameter	[mm]

Therefor we have:

Nozzle	Size in"	g mm	F KN	M1 KN*m	M2 KN*m	Mtot KN*m	Peqiv MPa	Pdes MPa	Ptot MPa
A case 1	20"	537,5	27,60	42,00	68,40	80,27	2,75	19,15	21,90
A case 2	20"	537,5	30,00	42,00	75,60	86,48	2,97	19,15	22,12
A case 3	20"	537,5	16,80	37,20	38,40	53,46	1,83	19,15	20,98
A case 4	20"	537,5	30,00	39,60	75,60	85,34	2,93	19,15	22,08
A case 5	20"	537,5	1,20	7,20	-1,20	7,30	0,24	19,15	19,39
A case 6	20"	537,5	38,85	-57,75	-119,70	132,90	4,53	19,15	23,68
B	24"	642,5	140,00	285,12	220,43	360,39	7,35	19,15	26,50
M case 1	38"	1062	-84,00	-193,20	12,00	193,57	0,92	19,15	20,07
M case 2	38"	1062	-74,40	-225,60	-8,40	225,76	1,04	19,15	20,19
M case 3	38"	1062	-116,40	-84,00	84,00	118,79	0,64	19,15	19,79
M case 4	38"	1062	-73,20	-231,60	-9,60	231,80	1,07	19,15	20,22
M case 5	38"	1062	-138,00	-36,00	140,40	144,94	0,77	19,15	19,92
M case 6	38"	1062	-60,90	-211,05	-21,00	212,09	0,97	19,15	20,12
E	8"	230	20,00	12,80	12,50	17,89	7,97	19,15	27,12

Note:

Piping load are considered acting on flange face
Piping force F is the axial load
Piping moment M is a resultance of two bending moment
Conservatively we consider the absolute value

WELDING NECK FLANGE POS.FLANGE A COMP <3>

```
===============(ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)=============

                 ****          DESIGN CONDITION          ****
 * DESIGN TEMPERATURE                      T =  409.0  C      =  768.2   F

 * MATERIAL :
       FLANGE              SA 182 F22V
       BOLTING             SA 193 B16
       GASKET              KAMMPROFILE GASKET S.S. 347/ THERMICULITE <2>

 * ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
                 from table 1A, 1B  from table 1A, 1B   from Table  3

                   Mpa  /  Psi         Mpa  /  Psi         Mpa  /  Psi
    DESIGN     151.558 / 21981.6  227.336 / 32972.4  151.684 / 22000.0
    SEATING    167.542 / 24300.0  251.313 / 36450.0  151.684 / 22000.0

 * GASKET PARAMETERS:     m = 4.25   y= 10100 Psi   N=37.5 mm    w=0.00 mm
 Design pressure                           P =     23.680 Mpa  =    3434.5 Psi
 Corrosion allowance                       c =        0.0 mm   =     0.000 "
 Flange outside diameter                   A =     1015.0 mm   =    39.961 "
 Bolt circle                               C =      861.0 mm   =    33.898 "
 Mean gasket diameter                      G =      537.5 mm   =    21.161 "
 Flange inside diameter (uncorroded)       B =      420.0 mm   =    16.535 "
 Hub at large end (uncorroded)             g1=      110.3 mm   =     4.341 "
 Shell thickness (uncorroded)              g0=       44.0 mm   =     1.732 "
 Flange thickness                          t =      185.0 mm   =     7.283 "
 Hub length                                h =      106.7 mm   =     4.201 "
 Bolt number and type                      n =        16 3 1/4 8UN-2A
 Area of one bolt                          ab=    4969.67 mm2  =     7.703  #

 --------------------- CALCULATED GASKET DIMENSIONS ---------------------
 bo     =        N/2                           =    18.750 mm   =     0.738 "
 b      =    .5*SQR(bo)  (bo > .25)            =    10.912 mm   =     0.430 "
 Effective gskt.diameter      Ge = G+N-2*b=   553.18  mm   =    21.779 "

 -------- CHECK OF BOLTING AREA (actual area:  Ab =  123.25 #  )--------
 Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P        =             2136396.000 lb
 Wm2 >=   3.14*Ge*b*y                         =              296722.969 lb

 Am1  =          Wm1/Sb                       =                   97.11  #
 Am2  =          Wm2/Sa                       =                   13.49  #
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                 WELDING NECK FLANGE POS.FLANGE A COMP
===============( ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)==============

           ****          DESIGN CONDITION          ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS ------------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)   =                 1.000
HD = .785*(B+2*c)^2*P =      737164.4 lb     hD=R+0.5*(g1-c) =   6.51 "
HT = .785*Ge^2*P - HD =      541609.3 lb     hT=(R+g1-c+hG)/2=   7.37 "
HG = Wm1 - HT - HD    =      857622.4 lb     hG=(C-Ge)/2     =   6.06 "
DESIGN:            M0 =    13988149.0 lb"     M=M0*cF/(B+2*c)= 845950 lb
W  = (Am+Ab)*Sa*0.5   =     2423926.0 lb     hG=(C-Ge)/2     =   6.06 "
BOLTING-UP:        M0 =    14687808.0 lb"     M=M0*cF/(B+2*c)= 888263 lb
--------------------------- FLANGE CONSTANTS ---------------------------
K = A/(B+2*c)                                                =   2.417
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)           =   2.569
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)       =   1.365
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)               =   2.338
Z = (K^2+1)/(K^2-1)                                          =   1.413
(g1-c)/(g0-c)                                                =   2.506
h/SQR((B+2*c)(g0-c))                                         =   0.785
f =   (figure 3-340.6)                                       =   1.000
F =   (figure 3-340.2)                                       =   0.748
V =   (figure 3-340.3)                                       =   0.128
e = F/SQR((B+2*c)(g0-c))                                     =   0.140
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                          = 322.815
L = (t*e+1)/T+t^3/d                                          =   2.676

-------------------- FLANGE STRESSES--(design   /   bolting-up) -----
                                  Mpa      Psi          Mpa      Psi
SH = f*M/L/(g1-c)^2           = 115.705  16781.6  /  121.492  17621.0
SR = (1.33*t*e+1)*M/L/t^2     =  96.719  14027.9  /  101.557  14729.6
ST = Y*M/t^2-Z*SR             = 120.353  17455.8  /  126.373  18328.9
0.5*(SH+SR)                   = 106.212  15404.7  /  111.524  16175.3
0.5*(SH+ST)                   = 118.029  17118.7  /  123.932  17974.9
------------------ FLANGE RIGIDITY --- (Design  / Bolting-up) -------
E                       = 182866.6   26522600  /  210979.2   30600000
k1                                        0.3  /                  0.3
h0=sqr(B*g0)            =               5.352  /                5.352
J=52.14*W0*V/(L*E*g0^2*h0*k1)         0.27264  /              0.24813
```

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE INDICATED <3>
2	MODIFIED WHERE INDICATED <2>
1	REVISIONE GENERALE
0	EMISSIONE-ISSUE

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                    WELDING NECK FLANGE POS.FLANGE A COMP
===============( ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)===============

               ****    HYDROSTATIC TEST CONDITION    ****

 * HYDROSTATIC TEST TEMPERATURE          T =   21.1  C      =   70.0   F

 * MATERIAL :
        FLANGE              SA 182 F22V
        BOLTING             SA 193 B16
        GASKET              KAMMPROFILE GASKET S.S. 347/ THERMICULITE <2>

 * ALLOW. STRESSES: ---Flange-------------Hub------------Bolting----
                            0.9 * Yield strength

                      Mpa   /  Psi        Mpa   /  Psi          Mpa   /  Psi
     HYDR.TEST   372.316 / 54000.0   558.474 / 81000.0    589.501 / 85500.0

 * GASKET PARAMETERS:      m = 4.25    y= 10100 Psi    N=37.5 mm    w=0.00 mm
 Hydrostatic test pressure              P =     28.200 Mpa   =    4090.1 Psi
 Corrosion allowance                    c =        0.0 mm    =     0.000 "
 Flange outside diameter                A =     1015.0 mm    =    39.961 "
 Bolt circle                            C =      861.0 mm    =    33.898 "
 Mean gasket diameter                   G =      537.5 mm    =    21.161 "
 Flange inside diameter (uncorroded)    B =      420.0 mm    =    16.535 "
 Hub at large end (uncorroded)          g1=      110.3 mm    =     4.341 "
 Shell thickness (uncorroded)           g0=       44.0 mm    =     1.732 "
 Flange thickness                       t =      185.0 mm    =     7.283 "
 Hub length                             h =      106.7 mm    =     4.201 "
 Bolt number and type                   n =        16 3 1/4 8UN-2A
 Area of one bolt                       ab=    4969.67 mm2   =     7.703  #

 --------------------- CALCULATED GASKET DIMENSIONS ---------------------
 bo     =        N/2                      =     18.750 mm    =     0.738 "
 b      =    .5*SQR(bo)  (bo > .25)       =     10.912 mm    =     0.430 "
 Effective gskt.diameter      Ge = G+N-2*b=    553.18  mm    =    21.779 "

 -------- CHECK OF BOLTING AREA (actual area:  Ab =  123.25 #  )--------
 Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P    =                2544188.000 lb
 Wm2 >=   3.14*Ge*b*y                     =                 296722.969 lb

 Am1   =           Wm1/Sb                 =                      29.76  #
 Am2   =           Wm2/Sa                 =                      13.49  #

 Ab(max.for gasket crush)=6.28*y*G*N/Sa   =                      90.08  #
```

```
                        WELDING NECK FLANGE POS.FLANGE A COMP
===============( ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)===============

                    ****   HYDROSTATIC TEST CONDITION   ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS ------------------

 cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                   1.000
 HD = .785*(B+2*c)^2*P =     877873.1 lb     hD=R+0.5*(g1-c) =    6.51 "
 HT = .785*Ge^2*P - HD =     644990.9 lb     hT=(R+g1-c+hG)/2=    7.37 "
 HG = Wm1 - HT - HD    =    1021324.0 lb     hG=(C-Ge)/2     =    6.06 "
 HYDR.TEST :        M0 =   16658186.0 lb"     M=M0*cF/(B+2*c)= 1007424 lb
 W  = (Am+Ab)*Sa*0.5   =    1683050.5 lb     hG=(C-Ge)/2     =    6.06 "
 -------------------------- FLANGE CONSTANTS --------------------------
 K = A/(B+2*c)                                              =   2.417
 U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)         =   2.569
 T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)     =   1.365
 Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)             =   2.338
 Z = (K^2+1)/(K^2-1)                                        =   1.413
 (g1-c)/(g0-c)                                              =   2.506
 h/SQR((B+2*c)(g0-c))                                       =   0.785
 f =   (figure 3-340.6)                                     =   1.000
 F =   (figure 3-340.2)                                     =   0.748
 V =   (figure 3-340.3)                                     =   0.128
 e = F/SQR((B+2*c)(g0-c))                                   =   0.140
 d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                        = 322.815
 L = (t*e+1)/T+t^3/d                                        =   2.676

 -------------------- FLANGE STRESSES--(hydrostatic test) ------------
                                  Mpa        Psi
 SH = f*M/L/(g1-c)^2           = 137.790    19984.8
 SR = (1.33*t*e+1)*M/L/t^2     = 115.180    16705.5
 ST = Y*M/t^2-Z*SR             = 143.326    20787.7
 0.5*(SH+SR)                   = 126.485    18345.2
 0.5*(SH+ST)                   = 140.558    20386.3
 ------------------ FLANGE RIGIDITY --- (Design   / Bolting-up) -------
 E                          = 182866.6   26522600  /  210979.2   30600000
 k1                                           0.3  /                  0.3
 h0=sqr(B*g0)                  =            5.352  /                5.352
 J=52.14*W0*V/(L*E*g0^2*h0*k1)            0.32468  /              0.17229
```


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WELDING NECK FLANGE POS.FLANGE A SPOOL <3>

===============(ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)===============

```
                    ****        DESIGN CONDITION        ****

 * DESIGN TEMPERATURE                    T =  409.0  C      =  768.2   F

 * MATERIAL :
        FLANGE              SA 182  F22V
        BOLTING             SA 193  B16
        GASKET              KAMMPROFILE GASKET S.S. 347/ THERMICULITE <2>

 * ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
                  from table 1A, 1B  from table 1A, 1B   from Table  3

                     Mpa  /  Psi         Mpa  /  Psi         Mpa  /  Psi
    DESIGN       151.558 / 21981.6  227.336 / 32972.4   151.684 / 22000.0
    SEATING      167.542 / 24300.0  251.313 / 36450.0   151.684 / 22000.0

 * GASKET PARAMETERS:       m = 4.25    y= 10100 Psi    N=37.5 mm    w=0.00 mm
 Design pressure                          P =    23.680 Mpa   =    3434.5 Psi
 Corrosion allowance                      c =       0.0 mm    =     0.000 "
 Flange outside diameter                  A =    1015.0 mm    =    39.961 "
 Bolt circle                              C =     861.0 mm    =    33.898 "
 Mean gasket diameter                     G =     537.5 mm    =    21.161 "
 Flange inside diameter (uncorroded)      B =     419.1 mm    =    16.500 "
 Hub at large end (uncorroded)            g1=     110.7 mm    =     4.358 "
 Shell thickness (uncorroded)             g0=      44.5 mm    =     1.752 "
 Flange thickness                         t =     185.0 mm    =     7.283 "
 Hub length                               h =     106.7 mm    =     4.201 "
 Bolt number and type                     n =       16 3 1/4 8UN-2A
 Area of one bolt                         ab=   4969.67 mm2   =     7.703   #

 --------------------- CALCULATED GASKET DIMENSIONS ---------------------
 bo     =       N/2                        =    18.750 mm    =     0.738 "
 b      =    .5*SQR(bo)  (bo > .25)        =    10.912 mm    =     0.430 "
 Effective gskt.diameter      Ge = G+N-2*b=   553.18  mm    =    21.779 "

 -------- CHECK OF BOLTING AREA (actual area:  Ab =  123.25 #  )--------
 Wm1 >=   .785*Ge^2*P + 2*b*3.14*Ge*m*P     =              2136396.000 lb
 Wm2 >=    3.14*Ge*b*y                      =               296722.969 lb

 Am1  =             Wm1/Sb                  =                    97.11   #
 Am2  =             Wm2/Sa                  =                    13.49   #

 Ab(max.for gasket crush)=6.28*y*G*N/Sa     =                    90.08   #
```

```
                    WELDING NECK FLANGE POS.FLANGE A SPOOL
===============( ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)==============


              ****          DESIGN CONDITION          ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS ------------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)   =                1.000
HD = .785*(B+2*c)^2*P =     734008.5 lb     hD=R+0.5*(g1-c) =    6.52 "
HT = .785*Ge^2*P - HD =     544765.1 lb     hT=(R+g1-c+hG)/2=    7.38 "
HG = Wm1 - HT - HD    =     857622.4 lb     hG=(C-Ge)/2     =    6.06 "
DESIGN:           M0 =  14002189.0 lb"     M=M0*cF/(B+2*c)=  848618 lb
W  = (Am+Ab)*Sa*0.5   =    2423926.0 lb     hG=(C-Ge)/2     =    6.06 "
BOLTING-UP:       M0 =  14687808.0 lb"     M=M0*cF/(B+2*c)=  890170 lb
--------------------------- FLANGE CONSTANTS --------------------------
K = A/(B+2*c)                                                =   2.422
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)           =   2.563
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)       =   1.363
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)               =   2.332
Z = (K^2+1)/(K^2-1)                                          =   1.411
(g1-c)/(g0-c)                                                =   2.488
h/SQR((B+2*c)(g0-c))                                         =   0.781
f =   (figure 3-340.6)                                       =   1.000
F =   (figure 3-340.2)                                       =   0.749
V =   (figure 3-340.3)                                       =   0.129
e = F/SQR((B+2*c)(g0-c))                                     =   0.139
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                          = 326.683
L = (t*e+1)/T+t^3/d                                          =   2.661

-------------------- FLANGE STRESSES--(design   /   bolting-up) -----
                              Mpa       Psi          Mpa       Psi
SH = f*M/L/(g1-c)^2        = 115.756   16789.0  /  121.424   17611.1
SR = (1.33*t*e+1)*M/L/t^2  =  97.396   14126.1  /  102.165   14817.8
ST = Y*M/t^2-Z*SR          = 119.790   17374.1  /  125.656   18224.8
0.5*(SH+SR)                = 106.576   15457.6  /  111.794   16214.4
0.5*(SH+ST)                = 117.773   17081.6  /  123.540   17918.0
------------------ FLANGE RIGIDITY --- (Design  / Bolting-up) -------
E                     = 182866.6   26522600  /  210979.2   30600000
k1                                      0.3  /                  0.3
h0=sqr(B*g0)               =          5.377  /                5.377
J=52.14*W0*V/(L*E*g0^2*h0*k1)       0.27049  /              0.24593
```

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE INDICATED <3>
2	MODIFIED WHERE INDICATED <2>
1	REVISIONE GENERALE
0	EMISSIONE-ISSUE

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

WELDING NECK FLANGE POS.FLANGE A SPOOL
===============(ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)==============

**** HYDROSTATIC TEST CONDITION ****

* HYDROSTATIC TEST TEMPERATURE T = 21.1 C = 70.0 F

* MATERIAL :
  - FLANGE SA 182 F22V
  - BOLTING SA 193 B16
  - GASKET KAMMPROFILE GASKET S.S. 347/ THERMICULITE <2>

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
  0.9 * Yield strength

	Flange Mpa / Psi	Hub Mpa / Psi	Bolting Mpa / Psi
HYDR.TEST	372.316 / 54000.0	558.474 / 81000.0	589.501 / 85500.0

* GASKET PARAMETERS: m = 4.25 y= 10100 Psi N=37.5 mm w=0.00 mm

Hydrostatic test pressure	P =	28.200 Mpa	=	4090.1 Psi
Corrosion allowance	c =	0.0 mm	=	0.000 "
Flange outside diameter	A =	1015.0 mm	=	39.961 "
Bolt circle	C =	861.0 mm	=	33.898 "
Mean gasket diameter	G =	537.5 mm	=	21.161 "
Flange inside diameter (uncorroded)	B =	419.1 mm	=	16.500 "
Hub at large end (uncorroded)	g1=	110.7 mm	=	4.358 "
Shell thickness (uncorroded)	g0=	44.5 mm	=	1.752 "
Flange thickness	t =	185.0 mm	=	7.283 "
Hub length	h =	106.7 mm	=	4.201 "
Bolt number and type	n =	16 3 1/4 8UN-2A		
Area of one bolt	ab=	4969.67 mm2	=	7.703 #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------

bo = N/2	=	18.750 mm	=	0.738 "
b = .5*SQR(bo) (bo > .25)	=	10.912 mm	=	0.430 "
Effective gskt.diameter Ge = G+N-2*b=		553.18 mm	=	21.779 "

-------- CHECK OF BOLTING AREA (actual area: Ab = 123.25 #)--------

Wm1 >= .785*Ge^2*P + 2*b*3.14*Ge*m*P	=	2544188.000 lb
Wm2 >= 3.14*Ge*b*y	=	296722.969 lb
Am1 = Wm1/Sb	=	29.76 #
Am2 = Wm2/Sa	=	13.49 #
Ab(max.for gasket crush)=6.28*y*G*N/Sa	=	90.08 #

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                    WELDING NECK FLANGE POS.FLANGE A SPOOL
===============( ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)==============

               ****   HYDROSTATIC TEST CONDITION    ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS ------------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                     1.000
HD = .785*(B+2*c)^2*P =     874114.8 lb     hD=R+0.5*(g1-c)  =     6.52 "
HT = .785*Ge^2*P - HD =     648749.2 lb     hT=(R+g1-c+hG)/2=      7.38 "
HG = Wm1 - HT - HD    =    1021324.0 lb     hG=(C-Ge)/2      =     6.06 "
HYDR.TEST :        M0 =   16674906.0 lb"     M=M0*cF/(B+2*c)= 1010600 lb
W  = (Am+Ab)*Sa*0.5   =    1683050.5 lb     hG=(C-Ge)/2      =     6.06 "
-------------------------- FLANGE CONSTANTS ---------------------------
K = A/(B+2*c)                                                 =   2.422
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)            =   2.563
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)        =   1.363
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)                =   2.332
Z = (K^2+1)/(K^2-1)                                           =   1.411
(g1-c)/(g0-c)                                                 =   2.488
h/SQR((B+2*c)(g0-c))                                          =   0.781
f =    (figure 3-340.6)                                       =   1.000
F =    (figure 3-340.2)                                       =   0.749
V =    (figure 3-340.3)                                       =   0.129
e = F/SQR((B+2*c)(g0-c))                                      =   0.139
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                           = 326.683
L = (t*e+1)/T+t^3/d                                           =   2.661

-------------------- FLANGE STRESSES--(hydrostatic test) ------------
                                    Mpa        Psi
SH = f*M/L/(g1-c)^2             = 137.851    19993.7
SR = (1.33*t*e+1)*M/L/t^2       = 115.987    16822.5
ST = Y*M/t^2-Z*SR               = 142.655    20690.5
0.5*(SH+SR)                     = 126.919    18408.1
0.5*(SH+ST)                     = 140.253    20342.1
------------------ FLANGE RIGIDITY --- (Design  / Bolting-up) -------
E                          = 182866.6   26522600  /  210979.2   30600000
k1                                           0.3  /                  0.3
h0=sqr(B*g0)                  =            5.377  /                5.377
J=52.14*W0*V/(L*E*g0^2*h0*k1)            0.32212  /              0.17076
```

WELDING NECK FLANGE POS.FLANGE B COMP <2>

```
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)==============

                   ****        DESIGN CONDITION          ****
* DESIGN TEMPERATURE                   T =   454.0   C       =   849.2    F

* MATERIAL :
       FLANGE              SA 182 F22V
       BOLTING             SA 193 B16
       GASKET              KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange-------------Hub-------------Bolting----
                   from table 1A, 1B  from table 1A, 1B   from Table  3
                                                          (Case 1489-2)
                     Mpa   /  Psi        Mpa   /  Psi        Mpa   /  Psi
    DESIGN        144.856 / 21009.6   217.284 / 31514.4   144.900 / 21016.0
    SEATING       167.542 / 24300.0   251.313 / 36450.0   151.684 / 22000.0

* GASKET PARAMETERS:       m = 4.25   y= 10100 Psi   N=42.5 mm   w=0.00 mm
Design pressure                       P =     26.500 Mpa   =    3843.5 Psi
Corrosion allowance                   c =        0.0 mm    =     0.000 "
Flange outside diameter               A =     1345.0 mm    =    52.953 "
Bolt circle                           C =     1167.0 mm    =    45.945 "
Mean gasket diameter                  G =      642.5 mm    =    25.295 "
Flange inside diameter (uncorroded)   B =      502.4 mm    =    19.780 "
Hub at large end (uncorroded)         g1=      129.8 mm    =     5.110 "
Shell thickness (uncorroded)          g0=       53.6 mm    =     2.110 "
Flange thickness                      t =      265.0 mm    =    10.433 "
Hub length                            h =      121.9 mm    =     4.799 "
Bolt number and type                  n =        16 3 3/4 8UN-2A
Area of one bolt                      ab=    6710.31 mm2   =    10.401  #

--------------------- CALCULATED GASKET DIMENSIONS --------------------
bo     =       N/2                       =    21.250 mm    =     0.837 "
b      =    .5*SQR(bo)  (bo > .25)       =    11.616 mm    =     0.457 "
Effective gskt.diameter      Ge = G+N-2*b=   661.77  mm    =    26.054 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =  166.42 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P    =               3270358.500 lb
Wm2 >=   3.14*Ge*b*y                     =                377895.250 lb

Am1  =           Wm1/Sb                  =                    155.61  #
Am2  =           Wm2/Sa                  =                     17.18  #
```

```
                 WELDING NECK FLANGE POS.FLANGE B COMP
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                ****        DESIGN CONDITION         ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS ------------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                1.000
HD = .785*(B+2*c)^2*P =    1180399.9 lb     hD=R+0.5*(g1-c)  =   10.53 "
HT = .785*Ge^2*P - HD =     867650.9 lb     hT=(R+g1-c+hG)/2=   11.51 "
HG = Wm1 - HT - HD    =    1222307.8 lb     hG=(C-Ge)/2      =    9.95 "
DESIGN:            M0 =   34573436.0 lb"     M=M0*cF/(B+2*c)= 1747940 lb
W  = (Am+Ab)*Sa*0.5   =    3542316.8 lb     hG=(C-Ge)/2      =    9.95 "
BOLTING-UP:        M0 =   35230192.0 lb"     M=M0*cF/(B+2*c)= 1781144 lb
-------------------------- FLANGE CONSTANTS ----------------------------
K = A/(B+2*c)                                                =   2.677
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)           =   2.300
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)       =   1.288
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)               =   2.093
Z = (K^2+1)/(K^2-1)                                          =   1.324
(g1-c)/(g0-c)                                                =   2.422
h/SQR((B+2*c)(g0-c))                                         =   0.743
f =   (figure 3-340.6)                                       =   1.000
F =   (figure 3-340.2)                                       =   0.759
V =   (figure 3-340.3)                                       =   0.139
e = F/SQR((B+2*c)(g0-c))                                     =   0.118
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                          = 474.828
L = (t*e+1)/T+t^3/d                                          =   4.120

-------------------- FLANGE STRESSES--(design    /  bolting-up) -----
                                      Mpa      Psi        Mpa      Psi
SH = f*M/L/(g1-c)^2            = 112.019   16247.0  /  114.147   16555.6
SR = (1.33*t*e+1)*M/L/t^2      =  70.714   10256.2  /   72.057   10451.1
ST = Y*M/t^2-Z*SR              = 138.060   20023.9  /  140.683   20404.3
0.5*(SH+SR)                    =  91.366   13251.6  /   93.102   13503.3
0.5*(SH+ST)                    = 125.039   18135.5  /  127.415   18480.0
```


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                 WELDING NECK FLANGE POS.FLANGE B COMP
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                  ****   HYDROSTATIC TEST CONDITION   ****

* HYDROSTATIC TEST TEMPERATURE        T =    21.1  C      =    70.0   F

* MATERIAL :
       FLANGE               SA 182 F22V
       BOLTING              SA 193 B16
       GASKET               KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange-------------Hub-------------Bolting----
                            0.9 * Yield strength

                    Mpa   /  Psi        Mpa   /  Psi         Mpa   /  Psi
    HYDR.TEST   372.316 / 54000.0   558.474 / 81000.0   589.501 / 85500.0

* GASKET PARAMETERS:        m = 4.25    y= 10100 Psi    N=42.5 mm    w=0.00 mm
Hydrostatic test pressure                  P =     28.200 Mpa   =    4090.1 Psi
Corrosion allowance                        c =        0.0 mm    =     0.000 "
Flange outside diameter                    A =     1345.0 mm    =    52.953 "
Bolt circle                                C =     1167.0 mm    =    45.945 "
Mean gasket diameter                       G =      642.5 mm    =    25.295 "
Flange inside diameter (uncorroded)        B =      502.4 mm    =    19.780 "
Hub at large end (uncorroded)              g1=      129.8 mm    =     5.110 "
Shell thickness (uncorroded)               g0=       53.6 mm    =     2.110 "
Flange thickness                           t =      265.0 mm    =    10.433 "
Hub length                                 h =      121.9 mm    =     4.799 "
Bolt number and type                       n =        16 3 3/4 8UN-2A
Area of one bolt                           ab=    6710.31 mm2   =    10.401  #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------
bo     =       N/2                         =     21.250 mm    =     0.837 "
b      =    .5*SQR(bo)  (bo > .25)         =     11.616 mm    =     0.457 "
Effective gskt.diameter      Ge = G+N-2*b=     661.77  mm    =    26.054 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =  166.42 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P      =                3480155.250 lb
Wm2 >=   3.14*Ge*b*y                       =                 377895.250 lb

Am1   =            Wm1/Sb                  =                      40.70  #
Am2   =            Wm2/Sa                  =                      17.18  #
```


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```
                    WELDING NECK FLANGE POS.FLANGE B COMP
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                  ****   HYDROSTATIC TEST CONDITION   ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS ------------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                1.000
HD = .785*(B+2*c)^2*P =    1256123.8 lb     hD=R+0.5*(g1-c)  =   10.53 "
HT = .785*Ge^2*P - HD =     923311.5 lb     hT=(R+g1-c+hG)/2=   11.51 "
HG = Wm1 - HT - HD    =    1300720.0 lb     hG=(C-Ge)/2      =    9.95 "
HYDR.TEST :         M0 =  36791360.0 lb"     M=M0*cF/(B+2*c)= 1860073 lb
W  = (Am+Ab)*Sa*0.5   =    2278315.3 lb     hG=(C-Ge)/2      =    9.95 "
--------------------------- FLANGE CONSTANTS ---------------------------
K = A/(B+2*c)                                                =    2.677
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)           =    2.300
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)       =    1.288
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)               =    2.093
Z = (K^2+1)/(K^2-1)                                          =    1.324
(g1-c)/(g0-c)                                                =    2.422
h/SQR((B+2*c)(g0-c))                                         =    0.743
f =    (figure 3-340.6)                                      =    1.000
F =    (figure 3-340.2)                                      =    0.759
V =    (figure 3-340.3)                                      =    0.139
e = F/SQR((B+2*c)(g0-c))                                     =    0.118
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                          =  474.828
L = (t*e+1)/T+t^3/d                                          =    4.120

-------------------- FLANGE STRESSES--(hydrostatic test) ------------
                                        Mpa        Psi
SH = f*M/L/(g1-c)^2             = 119.205    17289.2
SR = (1.33*t*e+1)*M/L/t^2       =  75.251    10914.2
ST = Y*M/t^2-Z*SR               = 146.917    21308.5
0.5*(SH+SR)                     =  97.228    14101.7
0.5*(SH+ST)                     = 133.061    19298.9
```

WELDING NECK FLANGE POS.FLANGE B SPOOL <2>

```
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)==============

                ****        DESIGN CONDITION        ****

* DESIGN TEMPERATURE                    T =  454.0  C      =  849.2    F

* MATERIAL :
      FLANGE             SA 182 F22V
      BOLTING            SA 193 B16
      GASKET             KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
                 from table 1A, 1B  from table 1A, 1B   from Table  3
                                                        (Case 1489-2)
                   Mpa   /  Psi        Mpa   /  Psi        Mpa   /  Psi
    DESIGN      144.856 / 21009.6  217.284 / 31514.4   144.900 / 21016.0
    SEATING     167.542 / 24300.0  251.313 / 36450.0   151.684 / 22000.0

* GASKET PARAMETERS:       m = 4.25    y= 10100 Psi   N=42.5 mm    w=0.00 mm
Design pressure                         P =     26.500 Mpa  =     3843.5 Psi
Corrosion allowance                     c =        0.0 mm   =      0.000 "
Flange outside diameter                 A =     1345.0 mm   =     52.953 "
Bolt circle                             C =     1167.0 mm   =     45.945 "
Mean gasket diameter                    G =      642.5 mm   =     25.295 "
Flange inside diameter (uncorroded)     B =      504.8 mm   =     19.878 "
Hub at large end (uncorroded)           g1=      128.6 mm   =      5.063 "
Shell thickness (uncorroded)            g0=       52.4 mm   =      2.063 "
Flange thickness                        t =      265.0 mm   =     10.433 "
Hub length                              h =      121.9 mm   =      4.799 "
Bolt number and type                    n =       16 3 3/4 8UN-2A
Area of one bolt                        ab=    6710.31 mm2  =     10.401  #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------
bo     =       N/2                          =    21.250 mm   =      0.837 "
b      =    .5*SQR(bo)  (bo > .25)          =    11.616 mm   =      0.457 "
Effective gskt.diameter     Ge = G+N-2*b=   661.77  mm   =     26.054 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =  166.42 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P   =              3270358.750 lb
Wm2 >=   3.14*Ge*b*y                    =               377843.656 lb

Am1  =          Wm1/Sb                  =                    155.61  #
Am2  =          Wm2/Sa                  =                     17.17  #
```

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE INDICATED <3>
2	MODIFIED WHERE INDICATED <2>
1	REVISIONE GENERALE
0	EMISSIONE-ISSUE

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

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WELDING NECK FLANGE POS.FLANGE B SPOOL
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)==============

**** DESIGN CONDITION ****

---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS -----------------

```
cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                         1.000
HD = .785*(B+2*c)^2*P =     1192176.9 lb     hD=R+0.5*(g1-c)  =   10.50 "
HT = .785*Ge^2*P - HD =      855874.0 lb     hT=(R+g1-c+hG)/2=    11.49 "
HG = Wm1 - HT - HD    =     1222307.9 lb     hG=(C-Ge)/2      =    9.95 "
DESIGN:            M0 =    34510252.0 lb"    M=M0*cF/(B+2*c)= 1736107 lb
W   = (Am+Ab)*Sa*0.5  =     3542317.0 lb     hG=(C-Ge)/2      =    9.95 "
BOLTING-UP:        M0 =    35230192.0 lb"    M=M0*cF/(B+2*c)= 1772325 lb
--------------------------- FLANGE CONSTANTS --------------------------
K = A/(B+2*c)                                                 =   2.664
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)            =   2.312
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)        =   1.292
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)                =   2.104
Z = (K^2+1)/(K^2-1)                                           =   1.328
(g1-c)/(g0-c)                                                 =   2.454
h/SQR((B+2*c)(g0-c))                                          =   0.749
f =   (figure 3-340.6)                                        =   1.000
F =   (figure 3-340.2)                                        =   0.757
V =   (figure 3-340.3)                                        =   0.136
e = F/SQR((B+2*c)(g0-c))                                      =   0.118
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                           = 462.869
L = (t*e+1)/T+t^3/d                                           =   4.182

-------------------- FLANGE STRESSES--(design    /  bolting-up) -----
                                 Mpa      Psi          Mpa      Psi
SH = f*M/L/(g1-c)^2          = 111.659  16194.8   /  113.988  16532.6
SR = (1.33*t*e+1)*M/L/t^2    =  69.432  10070.3   /   70.881  10280.4
ST = Y*M/t^2-Z*SR            = 139.117  20177.2   /  142.019  20598.2
0.5*(SH+SR)                  =  90.546  13132.6   /   92.435  13406.5
0.5*(SH+ST)                  = 125.388  18186.0   /  128.004  18565.4
```


SOSTITUISCE IL - REPLACES
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Nuovo Pignone MASSA	PRESSURE PARTS CALCULATION OF STAGE 1, HYDROCRACKING REACTORS ITEMS: D-6212 / D-6232

```
                    WELDING NECK FLANGE POS.FLANGE B SPOOL
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

               ****    HYDROSTATIC TEST CONDITION    ****
* HYDROSTATIC TEST TEMPERATURE           T =    21.1  C      =    70.0   F

* MATERIAL :
      FLANGE             SA 182 F22V
      BOLTING            SA 193 B16
      GASKET             KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
                            0.9 * Yield strength

                    Mpa   /  Psi         Mpa   /  Psi          Mpa   /  Psi
    HYDR.TEST  372.316 / 54000.0   558.474 / 81000.0    589.501 / 85500.0

* GASKET PARAMETERS:       m = 4.25    y= 10100 Psi    N=42.5 mm    w=0.00 mm
Hydrostatic test pressure                  P =      28.200 Mpa    =    4090.1 Psi
Corrosion allowance                        c =         0.0 mm     =     0.000 "
Flange outside diameter                    A =      1345.0 mm     =    52.953 "
Bolt circle                                C =      1167.0 mm     =    45.945 "
Mean gasket diameter                       G =       642.5 mm     =    25.295 "
Flange inside diameter (uncorroded)        B =       504.8 mm     =    19.878 "
Hub at large end (uncorroded)              g1=       128.6 mm     =     5.063 "
Shell thickness (uncorroded)               g0=        52.4 mm     =     2.063 "
Flange thickness                           t =       265.0 mm     =    10.433 "
Hub length                                 h =       121.9 mm     =     4.799 "
Bolt number and type                       n =         16 3 3/4 8UN-2A
Area of one bolt                           ab=     6710.31 mm2    =    10.401  #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------
bo     =      N/2                          =       21.250 mm     =     0.837 "
b      =    .5*SQR(bo)  (bo > .25)         =       11.616 mm     =     0.457 "
Effective gskt.diameter      Ge = G+N-2*b=     661.77  mm     =    26.054 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =  166.42 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P      =                 3480155.250 lb
Wm2 >=   3.14*Ge*b*y                       =                  377843.656 lb

Am1  =            Wm1/Sb                   =                       40.70  #
Am2  =            Wm2/Sa                   =                       17.17  #
```

REV.	DESCRIZIONE - DESCRIPTION	ITEM D-6212/ D-6232
3	MODIFIED WHERE INDICATED <3>	N. SOU0107840/4
2	MODIFIED WHERE INDICATED <2>	LINGUA-LANG. A
1	REVISIONE GENERALE	PAGINA-SHEET 68 / 69
0	EMISSIONE-ISSUE	

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SOSTITUITO DA - REPLACED BY

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```
                WELDING NECK FLANGE POS.FLANGE B SPOOL
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)==============

                 ****   HYDROSTATIC TEST CONDITION    ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS -----------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                 1.000
HD = .785*(B+2*c)^2*P =    1268656.0 lb     hD=R+0.5*(g1-c) =   10.50 "
HT = .785*Ge^2*P - HD =     910779.3 lb     hT=(R+g1-c+hG)/2=   11.49 "
HG = Wm1 - HT - HD    =    1300720.0 lb     hG=(C-Ge)/2     =    9.95 "
HYDR.TEST :          M0 =  36724116.0 lb"     M=M0*cF/(B+2*c)= 1847480 lb
W  = (Am+Ab)*Sa*0.5   =    2278315.3 lb     hG=(C-Ge)/2     =    9.95 "
-------------------------- FLANGE CONSTANTS ---------------------------
K = A/(B+2*c)                                               =   2.664
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)          =   2.312
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)      =   1.292
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)              =   2.104
Z = (K^2+1)/(K^2-1)                                         =   1.328
(g1-c)/(g0-c)                                               =   2.454
h/SQR((B+2*c)(g0-c))                                        =   0.749
f =    (figure 3-340.6)                                     =   1.000
F =    (figure 3-340.2)                                     =   0.757
V =    (figure 3-340.3)                                     =   0.136
e = F/SQR((B+2*c)(g0-c))                                    =   0.118
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                         = 462.869
L = (t*e+1)/T+t^3/d                                         =   4.182

-------------------- FLANGE STRESSES--(hydrostatic test) ------------
                                 Mpa       Psi
SH = f*M/L/(g1-c)^2          = 118.822   17233.7
SR = (1.33*t*e+1)*M/L/t^2    =  73.887   10716.4
ST = Y*M/t^2-Z*SR            = 148.041   21471.6
0.5*(SH+SR)                  =  96.354   13975.0
0.5*(SH+ST)                  = 133.432   19352.7
```

WELDING NECK FLANGE POS.NOZZLE M <3>

```
===============( ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)===============

               ****        DESIGN CONDITION         ****
* DESIGN TEMPERATURE                   T =  454.0  C     =  849.2    F

    * MATERIAL :
         FLANGE              SA 336 F22V
         BOLTING             SA 193 B16
         GASKET              SPECIAL RTJ

    * ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
                    from table 1A, 1B  from table 1A, 1B  from Table  3
                                                         (Case 1489-1)
                      Mpa  /  Psi        Mpa  /  Psi        Mpa  /  Psi
      DESIGN      144.856 / 21009.6  217.284 / 31514.4   151.684 / 22000.0
      SEATING     167.542 / 24300.0  251.313 / 36450.0   151.684 / 22000.0
    ALLOW. STRESSES:  Bolting, DESIGN TEMPERATURE T =  409.0 C =  768.2    F
    * GASKET PARAMETERS:      m = 6.50    y= 26000 Psi    N=34.9 mm    w=0.00 mm
    Design pressure                        P =    20.220 Mpa   =     2932.7 Psi
    Corrosion allowance                    c =       0.0 mm    =      0.000 "
    Flange outside diameter                A =    1554.0 mm    =     61.181 "
    Bolt circle                            C =    1370.0 mm    =     53.937 "
    Mean gasket diameter                   G =    1062.0 mm    =     41.811 "
    Flange inside diameter (uncorroded)    B =     973.6 mm    =     38.331 "
    Hub at large end (uncorroded)          g1=      80.2 mm    =      3.157 "
    Shell thickness (uncorroded)           g0=      80.2 mm    =      3.157 "
    Flange thickness                       t =     300.0 mm    =     11.811 "
    Hub length                             h =     155.0 mm    =      6.102 "
    Bolt number and type                   n =      20 4 8UN-2A
    Area of one bolt                       ab=   7461.92 mm2   =     11.566  #

    --------------------- CALCULATED GASKET DIMENSIONS ---------------------
    bo      =      N/8                        =     4.363 mm    =      0.172 "
    b       =      bo   (bo <= .25)           =     4.363 mm    =      0.172 "
    Effective gskt.diameter     Ge =     G    =   1062.00  mm   =     41.811 "

    -------- CHECK OF BOLTING AREA (actual area:  Ab =  231.32 #  )--------
    Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P     =              4884185.000 lb
    Wm2 >=   3.14*Ge*b*y                      =               586267.250 lb

    Am1  =            Wm1/Sb                  =                   222.01  #
    Am2  =            Wm2/Sa                  =                    26.65  #
```


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```
                   WELDING NECK FLANGE POS.NOZZLE M
===============( ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)==============

             ****          DESIGN CONDITION          ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS -----------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                    1.000
HD = .785*(B+2*c)^2*P =    3382410.3 lb     hD=R+0.5*(g1-c)  =    6.22 "
HT = .785*Ge^2*P - HD =     642111.0 lb     hT=(R+g1-c+hG)/2=     6.93 "
HG = Wm1 - HT - HD    =     859663.8 lb     hG=(C-Ge)/2      =    6.06 "
DESIGN:            M0 =   30717444.0 lb"     M=M0*cF/(B+2*c)=  801380 lb
W  = (Am+Ab)*Sa*0.5   =    4986612.5 lb     hG=(C-Ge)/2      =    6.06 "
BOLTING-UP:        M0 =   30233792.0 lb"     M=M0*cF/(B+2*c)=  788762 lb
--------------------------- FLANGE CONSTANTS -------------------------
K = A/(B+2*c)                                              =    1.596
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)         =    4.755
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)     =    1.669
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)             =    4.327
Z = (K^2+1)/(K^2-1)                                        =    2.292
(g1-c)/(g0-c)                                              =    1.000
h/SQR((B+2*c)(g0-c))                                       =    0.555
f =   (figure 3-340.6)                                     =    1.000
F =   (figure 3-340.2)                                     =    0.909
V =   (figure 3-340.3)                                     =    0.550
e = F/SQR((B+2*c)(g0-c))                                   =    0.083
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                        =  948.044
L = (t*e+1)/T+t^3/d                                        =    2.922

-------------------- FLANGE STRESSES--(design   /  bolting-up) -----
                                   Mpa        Psi        Mpa       Psi
SH = f*M/L/(g1-c)^2          = 189.692    27512.6   /  186.706   27079.4
SR = (1.33*t*e+1)*M/L/t^2    =  31.151     4518.1   /   30.661    4447.0
ST = Y*M/t^2-Z*SR            =  99.977    14500.5   /   98.403   14272.2
0.5*(SH+SR)                  = 110.422    16015.4   /  108.683   15763.2
0.5*(SH+ST)                  = 144.835    21006.5   /  142.554   20675.8
------------------ FLANGE RIGIDITY --- (Design   / Bolting-up) -------
E                       = 178957.3   25955602   /  210979.2   30600000
k1                                        0.3   /                  0.3
h0=sqr(B*g0)            =              11.001   /               11.001
J=52.14*W0*V/(L*E*g0^2*h0*k1)         0.35310   /              0.29479
```

```
                WELDING NECK FLANGE POS.NOZZLE M
===============( ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)===============

                ****   HYDROSTATIC TEST CONDITION   ****

* HYDROSTATIC TEST TEMPERATURE          T =   21.1  C      =   70.0   F

* MATERIAL :
     FLANGE            SA 336 F22V
     BOLTING           SA 193 B16
     GASKET            SPECIAL RTJ

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
                        0.9 * Yield strength

                   Mpa  /  Psi        Mpa  /  Psi        Mpa  /  Psi
    HYDR.TEST  372.316 / 54000.0  558.474 / 81000.0  589.501 / 85500.0

* GASKET PARAMETERS:     m = 6.50   y= 26000 Psi   N=34.9 mm   w=0.00 mm
Hydrostatic test pressure                P =    28.200 Mpa  =   4090.1 Psi
Corrosion allowance                      c =       0.0 mm   =    0.000 "
Flange outside diameter                  A =    1554.0 mm   =   61.181 "
Bolt circle                              C =    1370.0 mm   =   53.937 "
Mean gasket diameter                     G =    1062.0 mm   =   41.811 "
Flange inside diameter (uncorroded)      B =     973.6 mm   =   38.331 "
Hub at large end (uncorroded)            g1=      80.2 mm   =    3.157 "
Shell thickness (uncorroded)             g0=      80.2 mm   =    3.157 "
Flange thickness                         t =     300.0 mm   =   11.811 "
Hub length                               h =     155.0 mm   =    6.102 "
Bolt number and type                     n =      20 4 8UN-2A
Area of one bolt                         ab=   7461.92 mm2  =   11.566  #

--------------------- CALCULATED GASKET DIMENSIONS --------------------
bo     =      N/8                         =    4.363 mm    =    0.172 "
b      =     bo   (bo <= .25)             =    4.363 mm    =    0.172 "
Effective gskt.diameter     Ge =     G    =  1062.00  mm   =   41.811 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =  231.32 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P     =              6811771.000 lb
Wm2 >=   3.14*Ge*b*y                      =               586267.250 lb

Am1   =           Wm1/Sb                  =                    79.67  #
Am2   =           Wm2/Sa                  =                    26.65  #
```


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SOSTITUITO DA - REPLACED BY

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                    WELDING NECK FLANGE POS.NOZZLE M
===============( ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)===============

              ****   HYDROSTATIC TEST CONDITION    ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS -----------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                   1.000
HD = .785*(B+2*c)^2*P =    4717308.5 lb     hD=R+0.5*(g1-c)  =    6.22 "
HT = .785*Ge^2*P - HD =     895525.5 lb     hT=(R+g1-c+hG)/2=    6.93 "
HG = Wm1 - HT - HD    =    1198937.0 lb     hG=(C-Ge)/2     =    6.06 "
HYDR.TEST :        M0 =   42840352.0 lb"    M=M0*cF/(B+2*c)= 1117651 lb
W  = (Am+Ab)*Sa*0.5   =    3420888.3 lb     hG=(C-Ge)/2     =    6.06 "
-------------------------- FLANGE CONSTANTS ---------------------------
K = A/(B+2*c)                                              =   1.596
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)         =   4.755
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)     =   1.669
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)             =   4.327
Z = (K^2+1)/(K^2-1)                                        =   2.292
(g1-c)/(g0-c)                                              =   1.000
h/SQR((B+2*c)(g0-c))                                       =   0.555
f =   (figure 3-340.6)                                     =   1.000
F =   (figure 3-340.2)                                     =   0.909
V =   (figure 3-340.3)                                     =   0.550
e = F/SQR((B+2*c)(g0-c))                                   =   0.083
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                        = 948.044
L = (t*e+1)/T+t^3/d                                        =   2.922

-------------------- FLANGE STRESSES--(hydrostatic test) ------------
                                   Mpa       Psi
SH = f*M/L/(g1-c)^2          = 264.556    38370.7
SR = (1.33*t*e+1)*M/L/t^2    =  43.445     6301.2
ST = Y*M/t^2-Z*SR            = 139.434    20223.2
0.5*(SH+SR)                  = 154.001    22336.0
0.5*(SH+ST)                  = 201.995    29296.9
------------------ FLANGE RIGIDITY --- (Design   / Bolting-up) -------
E                         = 178957.3   25955602  /  210979.2   30600000
k1                                          0.3  /                  0.3
h0=sqr(B*g0)              =              11.001  /               11.001
J=52.14*W0*V/(L*E*g0^2*h0*k1)           0.49245  /              0.20223
```


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Nuovo Pignone

MASSA

PRESSURE PARTS CALCULATION OF
STAGE 1, HYDROCRACKING REACTORS
ITEMS: D-6212 / D-6232

WELDING NECK FLANGE REDUCTION FLANGE M 38" / 20" <3>

```
===============( ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)==============

                 ****         DESIGN CONDITION          ****
* DESIGN TEMPERATURE                    T =  409.0  C      =  768.2    F

* MATERIAL :
       FLANGE             SA 182 F22V
       BOLTING            SA 193 B16
       GASKET             SPECIAL RTJ

* ALLOW. STRESSES: ---Flange-------------Hub-------------Bolting----
                 from table 1A, 1B  from table 1A, 1B   from Table  3

                   Mpa  /  Psi         Mpa  /  Psi         Mpa  /  Psi
    DESIGN     151.558 / 21981.6  227.336 / 32972.4   151.684 / 22000.0
    SEATING    167.542 / 24300.0  251.313 / 36450.0   151.684 / 22000.0

* GASKET PARAMETERS:      m = 6.50    y= 26000 Psi    N=34.9 mm    w=0.00 mm
Design pressure                         P =    20.220 Mpa   =    2932.7 Psi
Corrosion allowance                     c =       0.0 mm    =     0.000 "
Flange outside diameter                 A =    1554.0 mm    =    61.181 "
Bolt circle                             C =    1370.0 mm    =    53.937 "
Mean gasket diameter                    G =    1062.0 mm    =    41.811 "
Flange inside diameter (uncorroded)     B =     419.1 mm    =    16.500 "
Hub at large end (uncorroded)           g1=     180.0 mm    =     7.087 "
Shell thickness (uncorroded)            g0=      44.5 mm    =     1.752 "
Flange thickness                        t =     300.0 mm    =    11.811 "
Hub length                              h =     200.0 mm    =     7.874 "
Bolt number and type                    n =      20 4 8UN-2A
Area of one bolt                        ab=   7461.92 mm2   =    11.566  #

--------------------- CALCULATED GASKET DIMENSIONS --------------------
bo     =      N/8                          =     4.363 mm   =     0.172 "
b      =     bo   (bo <= .25)              =     4.363 mm   =     0.172 "
Effective gskt.diameter     Ge =     G     =  1062.00  mm   =    41.811 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =  231.32 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P      =              4884185.000 lb
Wm2 >=   3.14*Ge*b*y                       =               586267.250 lb

Am1  =            Wm1/Sb                   =                   222.01  #
Am2  =            Wm2/Sa                   =                    26.65  #
```

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE INDICATED <3>
2	MODIFIED WHERE INDICATED <2>
1	REVISIONE GENERALE
0	EMISSIONE-ISSUE

ITEM
D-6212/ D-6232

N. SOU0107840/4

LINGUA-LANG.	PAGINA-SHEET
A	74 / 75

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

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```
                    WELDING NECK FLANGE POS.FLANGE M
===============( ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)===============

                 ****         DESIGN CONDITION          ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS -----------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                     1.000
HD = .785*(B+2*c)^2*P =      626758.9 lb      hD=R+0.5*(g1-c)  =   15.18 "
HT = .785*Ge^2*P - HD =     3397762.3 lb      hT=(R+g1-c+hG)/2=    12.39 "
HG = Wm1 - HT - HD    =      859663.8 lb      hG=(C-Ge)/2      =    6.06 "
DESIGN:            M0 =    56824140.0 lb"      M=M0*cF/(B+2*c)= 3443887 lb
W  = (Am+Ab)*Sa*0.5   =     4986612.5 lb      hG=(C-Ge)/2      =    6.06 "
BOLTING-UP:        M0 =    30233792.0 lb"      M=M0*cF/(B+2*c)= 1832351 lb
--------------------------- FLANGE CONSTANTS -------------------------
K = A/(B+2*c)                                                  =   3.708
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)             =   1.695
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)         =   1.059
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)                 =   1.543
Z = (K^2+1)/(K^2-1)                                            =   1.157
(g1-c)/(g0-c)                                                  =   4.045
h/SQR((B+2*c)(g0-c))                                           =   1.465
f =   (figure 3-340.6)                                         =   1.000
F =   (figure 3-340.2)                                         =   0.586
V =   (figure 3-340.3)                                         =   0.036
e = F/SQR((B+2*c)(g0-c))                                       =   0.109
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                            = 775.376
L = (t*e+1)/T+t^3/d                                            =   4.285

-------------------- FLANGE STRESSES--(design    /  bolting-up) -----
                                   Mpa         Psi        Mpa       Psi
SH = f*M/L/(g1-c)^2           = 110.345    16004.2   /  58.710    8515.2
SR = (1.33*t*e+1)*M/L/t^2     = 107.722    15623.8   /  57.314    8312.8
ST = Y*M/t^2-Z*SR             = 137.953    20008.4   /  73.399   10645.7
0.5*(SH+SR)                   = 109.033    15814.0   /  58.012    8414.0
0.5*(SH+ST)                   = 124.149    18006.3   /  66.055    9580.4
------------------ FLANGE RIGIDITY --- (Design   / Bolting-up) -------
E                         = 182866.6    26522600  /  210979.2   30600000
k1                                           0.3  /                  0.3
h0=sqr(B*g0)              =                5.377  /                5.377
J=52.14*W0*V/(L*E*g0^2*h0*k1)            0.18999  /              0.08762
```

```
                    WELDING NECK FLANGE POS.FLANGE M
===============( ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)===============

              ****   HYDROSTATIC TEST CONDITION    ****

* HYDROSTATIC TEST TEMPERATURE        T =   21.1  C      =   70.0   F

* MATERIAL :
     FLANGE              SA 182 F22V
     BOLTING             SA 193 B16
     GASKET              SPECIAL RTJ

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
                          0.9 * Yield strength

                    Mpa  /  Psi        Mpa  /  Psi        Mpa  /  Psi
    HYDR.TEST   372.316 / 54000.0  558.474 / 81000.0   589.501 / 85500.0

* GASKET PARAMETERS:      m = 6.50    y= 26000 Psi   N=34.9 mm   w=0.00 mm
Hydrostatic test pressure              P =     28.200 Mpa  =    4090.1 Psi
Corrosion allowance                    c =        0.0 mm   =     0.000 "
Flange outside diameter                A =     1554.0 mm   =    61.181 "
Bolt circle                            C =     1370.0 mm   =    53.937 "
Mean gasket diameter                   G =     1062.0 mm   =    41.811 "
Flange inside diameter (uncorroded)    B =      419.1 mm   =    16.500 "
Hub at large end (uncorroded)          g1=      180.0 mm   =     7.087 "
Shell thickness (uncorroded)           g0=       44.5 mm   =     1.752 "
Flange thickness                       t =      300.0 mm   =    11.811 "
Hub length                             h =      200.0 mm   =     7.874 "
Bolt number and type                   n =      20 4 8UN-2A
Area of one bolt                       ab=    7461.92 mm2  =    11.566  #

--------------------- CALCULATED GASKET DIMENSIONS --------------------
bo     =       N/8                     =      4.363 mm    =     0.172 "
b      =     bo   (bo <= .25)          =      4.363 mm    =     0.172 "
Effective gskt.diameter    Ge =    G   =   1062.00  mm    =    41.811 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =  231.32 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P  =               6811771.000 lb
Wm2 >=   3.14*Ge*b*y                   =                586267.250 lb

Am1   =           Wm1/Sb               =                     79.67  #
Am2   =           Wm2/Sa               =                     26.65  #
```

```
                    WELDING NECK FLANGE POS.FLANGE M
===============( ASME VIII div.2 / Ed.04+Add.05 APPEND. 3)==============

               ****   HYDROSTATIC TEST CONDITION   ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS -----------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)   =                   1.000
HD = .785*(B+2*c)^2*P =      874114.8 lb     hD=R+0.5*(g1-c)  =   15.18 "
HT = .785*Ge^2*P - HD =     4738719.0 lb     hT=(R+g1-c+hG)/2=    12.39 "
HG = Wm1 - HT - HD    =     1198937.0 lb     hG=(C-Ge)/2      =    6.06 "
HYDR.TEST :         M0 =   79250280.0 lb"     M=M0*cF/(B+2*c)= 4803047 lb
W  = (Am+Ab)*Sa*0.5   =     3420888.3 lb     hG=(C-Ge)/2      =    6.06 "
-------------------------- FLANGE CONSTANTS ---------------------------
K = A/(B+2*c)                                                =    3.708
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)           =    1.695
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)       =    1.059
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)               =    1.543
Z = (K^2+1)/(K^2-1)                                          =    1.157
(g1-c)/(g0-c)                                                =    4.045
h/SQR((B+2*c)(g0-c))                                         =    1.465
f =   (figure 3-340.6)                                       =    1.000
F =   (figure 3-340.2)                                       =    0.586
V =   (figure 3-340.3)                                       =    0.036
e = F/SQR((B+2*c)(g0-c))                                     =    0.109
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                          =  775.376
L = (t*e+1)/T+t^3/d                                          =    4.285

-------------------- FLANGE STRESSES--(hydrostatic test) ------------
                                     Mpa        Psi
SH = f*M/L/(g1-c)^2              = 153.893    22320.4
SR = (1.33*t*e+1)*M/L/t^2        = 150.235    21789.8
ST = Y*M/t^2-Z*SR                = 192.398    27905.0
0.5*(SH+SR)                      = 152.064    22055.1
0.5*(SH+ST)                      = 173.145    25112.7
------------------ FLANGE RIGIDITY --- (Design  / Bolting-up) -------
E                        = 182866.6   26522600  /  210979.2    30600000
k1                                         0.3  /                   0.3
h0=sqr(B*g0)                   =         5.377  /                 5.377
J=52.14*W0*V/(L*E*g0^2*h0*k1)          0.26497  /               0.06011
```

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE INDICATED <3>
2	MODIFIED WHERE INDICATED <2>
1	REVISIONE GENERALE
0	EMISSIONE-ISSUE

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

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WELDING NECK FLANGE POS.FLANGE D1-2 <2>

```
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)==============

              ****        DESIGN CONDITION        ****

* DESIGN TEMPERATURE                     T =  454.0  C      =  849.2   F

* MATERIAL :
     FLANGE             SA 182 F22V
     BOLTING            SA 193 B16
     GASKET             KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
               from table 1A, 1B  from table 1A, 1B   from Table  3
                                                      (Case 1489-2)
                  Mpa  /  Psi          Mpa  /  Psi        Mpa  /  Psi
   DESIGN     144.856 / 21009.6  217.284 / 31514.4   162.192 / 23524.0
   SEATING    167.542 / 24300.0  251.313 / 36450.0   172.369 / 25000.0

* GASKET PARAMETERS:      m = 4.25    y= 10100 Psi   N=20.0 mm    w=0.00 mm
Design pressure                          P =     19.150 Mpa  =    2777.5 Psi
Corrosion allowance                      c =        0.0 mm   =     0.000 "
Flange outside diameter                  A =      552.5 mm   =    21.750 "
Bolt circle                              C =      438.1 mm   =    17.250 "
Mean gasket diameter                     G =      230.0 mm   =     9.055 "
Flange inside diameter (uncorroded)      B =      182.6 mm   =     7.189 "
Hub at large end (uncorroded)            g1=       61.0 mm   =     2.402 "
Shell thickness (uncorroded)             g0=       18.2 mm   =     0.717 "
Flange thickness                         t =      127.0 mm   =     5.000 "
Hub length                               h =      115.0 mm   =     4.528 "
Bolt number and type                     n =         12     2''ANSI
Area of one bolt                         ab=    1710.96 mm2  =     2.652  #

--------------------- CALCULATED GASKET DIMENSIONS --------------------
bo     =      N/2                           =     10.000 mm   =     0.394 "
b      =    .5*SQR(bo)  (bo > .25)          =      7.969 mm   =     0.314 "
Effective gskt.diameter      Ge = G+N-2*b=   234.06   mm   =     9.215 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =   31.82 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P    =                 399461.156 lb
Wm2 >=   3.14*Ge*b*y                     =                  91689.289 lb

Am1  =          Wm1/Sb                   =                      16.98  #
Am2  =          Wm2/Sa                   =                       3.67  #
```


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```
                 WELDING NECK FLANGE POS.FLANGE D1-2
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

               ****        DESIGN CONDITION          ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS ------------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)   =                   1.000
HD = .785*(B+2*c)^2*P =     112682.0 lb     hD=R+0.5*(g1-c)  =     3.83 "
HT = .785*Ge^2*P - HD =      72465.1 lb     hT=(R+g1-c+hG)/2=      4.52 "
HG = Wm1 - HT - HD    =     214314.0 lb     hG=(C-Ge)/2      =     4.02 "
DESIGN:            M0 =    1620372.3 lb"     M=M0*cF/(B+2*c)=   225397 lb
W   = (Am+Ab)*Sa*0.5  =     610062.6 lb     hG=(C-Ge)/2      =     4.02 "
BOLTING-UP:        M0 =    2450906.8 lb"     M=M0*cF/(B+2*c)=   340926 lb
-------------------------- FLANGE CONSTANTS ---------------------------
K = A/(B+2*c)                                               =     3.025
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)          =     2.037
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)      =     1.199
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)              =     1.854
Z = (K^2+1)/(K^2-1)                                         =     1.245
(g1-c)/(g0-c)                                               =     3.352
h/SQR((B+2*c)(g0-c))(ASSUMED VALUE)                         =     1.995
f =   (figure 3-340.6)                                      =     1.000
F =   (figure 3-340.2)                                      =     0.567
V =   (figure 3-340.3)                                      =     0.041
e = F/SQR((B+2*c)(g0-c))                                    =     0.250
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                         =    58.013
L = (t*e+1)/T+t^3/d                                         =     4.029

-------------------- FLANGE STRESSES--(design   /  bolting-up) -----
                                 Mpa        Psi        Mpa        Psi
SH = f*M/L/(g1-c)^2         =  66.872     9699.0  /  101.148    14670.3
SR = (1.33*t*e+1)*M/L/t^2   =  41.045     5953.1  /   62.083     9004.3
ST = Y*M/t^2-Z*SR           =  64.105     9297.6  /   96.962    14063.2
0.5*(SH+SR)                 =  53.959     7826.0  /   81.615    11837.3
0.5*(SH+ST)                 =  65.488     9498.3  /   99.055    14366.8
```

WELDING NECK FLANGE POS.FLANGE D1-2

===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

**** HYDROSTATIC TEST CONDITION ****

* HYDROSTATIC TEST TEMPERATURE T = 21.1 C = 70.0 F

* MATERIAL :

FLANGE	SA 182 F22V
BOLTING	SA 193 B16
GASKET	KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----

0.9 * Yield strength

	Flange Mpa / Psi	Hub Mpa / Psi	Bolting Mpa / Psi
HYDR.TEST	372.316 / 54000.0	558.474 / 81000.0	651.553 / 94500.0

* GASKET PARAMETERS: m = 4.25 y= 10100 Psi N=20.0 mm w=0.00 mm

Hydrostatic test pressure	P =	28.200 Mpa	=	4090.1 Psi
Corrosion allowance	c =	0.0 mm	=	0.000 "
Flange outside diameter	A =	552.5 mm	=	21.750 "
Bolt circle	C =	438.1 mm	=	17.250 "
Mean gasket diameter	G =	230.0 mm	=	9.055 "
Flange inside diameter (uncorroded)	B =	182.6 mm	=	7.189 "
Hub at large end (uncorroded)	g1=	61.0 mm	=	2.402 "
Shell thickness (uncorroded)	g0=	18.2 mm	=	0.717 "
Flange thickness	t =	127.0 mm	=	5.000 "
Hub length	h =	115.0 mm	=	4.528 "
Bolt number and type	n =	12	2''ANSI	
Area of one bolt	ab=	1710.96 mm2	=	2.652 #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------

bo	= N/2	=	10.000 mm	=	0.394 "
b	= .5*SQR(bo) (bo > .25)	=	7.969 mm	=	0.314 "
Effective gskt.diameter	Ge = G+N-2*b=		234.06 mm	=	9.215 "

-------- CHECK OF BOLTING AREA (actual area: Ab = 31.82 #)--------

Wm1 >=	.785*Ge^2*P + 2*b*3.14*Ge*m*P	=	588240.500 lb
Wm2 >=	3.14*Ge*b*y	=	91689.289 lb
Am1 =	Wm1/Sb	=	6.22 #
Am2 =	Wm2/Sa	=	3.67 #

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

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                WELDING NECK FLANGE POS.FLANGE D1-2
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                 ****   HYDROSTATIC TEST CONDITION    ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS -----------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                  1.000
HD = .785*(B+2*c)^2*P =     165933.8 lb     hD=R+0.5*(g1-c)  =   3.83 "
HT = .785*Ge^2*P - HD =     106711.1 lb     hT=(R+g1-c+hG)/2=    4.52 "
HG = Wm1 - HT - HD    =     315595.7 lb     hG=(C-Ge)/2      =   4.02 "
HYDR.TEST :        M0 =    2386135.8 lb"     M=M0*cF/(B+2*c)=  331916 lb
W   = (Am+Ab)*Sa*0.5  =     475609.6 lb     hG=(C-Ge)/2      =   4.02 "
-------------------------- FLANGE CONSTANTS ---------------------------
K = A/(B+2*c)                                              =    3.025
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)         =    2.037
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)     =    1.199
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)             =    1.854
Z = (K^2+1)/(K^2-1)                                        =    1.245
(g1-c)/(g0-c)                                              =    3.352
h/SQR((B+2*c)(g0-c))(ASSUMED VALUE)                        =    1.995
f =   (figure 3-340.6)                                     =    1.000
F =   (figure 3-340.2)                                     =    0.567
V =   (figure 3-340.3)                                     =    0.041
e = F/SQR((B+2*c)(g0-c))                                   =    0.250
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                        =   58.013
L = (t*e+1)/T+t^3/d                                        =    4.029

-------------------- FLANGE STRESSES--(hydrostatic test) ------------
                                    Mpa       Psi
SH = f*M/L/(g1-c)^2             =  98.475   14282.6
SR = (1.33*t*e+1)*M/L/t^2       =  60.442    8766.4
ST = Y*M/t^2-Z*SR               =  94.400   13691.5
0.5*(SH+SR)                     =  79.458   11524.5
0.5*(SH+ST)                     =  96.437   13987.1
```


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FLAT COVER POS. D1-2 <2>

```
=====(ASME VIII div.2 /Ed.04/TEMA RCB-9.21 - English units)=====

* DESIGN TEMPERATURE                          T =   454.0  C     =   849.2  F
* MATERIAL:                                     SA 182 F22V
* ALL. STRESS              (Table 1A,1B)  S =   144.856 Mpa = 21009.6 Psi
* ALL. STRESS , room temp.(Table 1A,1B)  Sa=   167.542 Mpa = 24300.0 Psi
* YIELD STRENGTH at room temp.           Sys= 413.6847 Mpa = 60000.0 Psi
Design pressure                            P =    19.150 Mpa =  2777.5 Psi
Hydr. test  pressure                       P'=    28.200 Mpa =  4090.1 Psi
Bolt load at design conditions           Wm1 = 399641.0 Lb
Bolt load at bolting-up                  W   = 610062.0 Lb
Bolt load at hydr. test conditions       Wm0 = 588240.0 Lb
Gasket load reaction diameter            G   =    234.1 mm  =    9.21 "
Bolt circle                          G+2*hG  =    438.1 mm  =   17.25 "

Nominal channel inside diameter          ND=                 not applicable
Total bolt area                          AB=                 not applicable
Bolt allowable design stress             SB=                 not applicable
Elastic modulus                          E =                 not applicable
Corrosion allowance                      c1=      0.00 mm  =   0.000  "
Gasket grove                             c2=      0.00 mm  =   0.000  "
c = max(c1,c2)                              =      0.00 mm  =   0.000  "
Adopted thickness (CENTER)               T =    127.10 mm  =   5.004  "
Adopted thickness (PERIPHERY)            T'=    127.10 mm  =   5.004  "

------------------------ DESIGN    CONDITIONS ------------------------
t  = G*SQR(CP/S+1.9*Wm1*hG/S/G^3) + c       =    111.07 mm  =   4.373  "
t' = G*SQR(1.9*Wm1*hG/S/G^3)                =    100.81 mm  =   3.969  "

------------------------ BOLTING-UP CONDITIONS -----------------------
t  = G*SQR(1.9*W*hG/So/G^3) + c             =    115.82 mm  =   4.560  "

-------------------- HYDROSTATIC TEST CONDITIONS ---------------------
t =G*SQR(CP'/Sys/.9+1.9*Wm0*hG/Sys/.9/G^3)=      84.05 mm  =   3.309  "
t' = G*SQR(1.9*Wm0*hG/Sys/.9/G^3)           =     76.29 mm  =   3.004  "

------------ MINIMUM THICKNESS ACCORDING TO TEMA RCB-9.21 -------------
                   *       NOT REQUIRED      *
```


205

WELDING NECK FLANGE POS.NOZZLE D3-6 <2>

```
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)==============

              ****        DESIGN CONDITION        ****

* DESIGN TEMPERATURE                  T =   454.0  C      =  849.2    F

* MATERIAL :
       FLANGE              SA 182 F22V
       BOLTING             SA 193 B16
       GASKET              KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
               from table 1A, 1B  from table 1A, 1B   from Table  3
                                                     (Case 1489-2)
                  Mpa   /  Psi         Mpa   /  Psi       Mpa   /  Psi
    DESIGN     144.856 / 21009.6  217.284 / 31514.4   162.192 / 23524.0
    SEATING    167.542 / 24300.0  251.313 / 36450.0   172.369 / 25000.0

* GASKET PARAMETERS:      m = 4.25   y= 10100 Psi   N=17.5 mm   w=0.00 mm
Design pressure                       P =    19.150 Mpa  =    2777.5 Psi
Corrosion allowance                   c =       0.0 mm   =     0.000 "
Flange outside diameter               A =     482.6 mm   =    19.000 "
Bolt circle                           C =     368.3 mm   =    14.500 "
Mean gasket diameter                  G =     177.5 mm   =     6.988 "
Flange inside diameter (uncorroded)   B =     152.4 mm   =     6.000 "
Hub at large end (uncorroded)         g1=      41.3 mm   =     1.624 "
Shell thickness (uncorroded)          g0=      41.3 mm   =     1.624 "
Flange thickness                      t =     107.9 mm   =     4.248 "
Hub length                            h =      80.0 mm   =     3.150 "
Bolt number and type                  n =       8      2''ANSI
Area of one bolt                      ab=   1710.96 mm2  =     2.652  #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------
bo     =       N/2                     =     8.750 mm   =     0.344 "
b      =    .5*SQR(bo)  (bo > .25)     =     7.454 mm   =     0.293 "
Effective gskt.diameter     Ge = G+N-2*b=   180.09  mm   =     7.090 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =   21.22 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P  =              263854.844 lb
Wm2 >=   3.14*Ge*b*y                   =               65991.023 lb

Am1  =          Wm1/Sb                 =                   11.22  #
Am2  =          Wm2/Sa                 =                    2.64  #
```


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```
                WELDING NECK FLANGE POS.NOZZLE D3-6
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                 ****        DESIGN CONDITION         ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS -----------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)   =                1.000
HD = .785*(B+2*c)^2*P =       78491.5 lb      hD=R+0.5*(g1-c)  =    3.44 "
HT = .785*Ge^2*P - HD =       31116.3 lb      hT=(R+g1-c+hG)/2=     3.98 "
HG = Wm1 - HT - HD    =      154247.1 lb      hG=(C-Ge)/2      =    3.70 "
DESIGN:            M0 =      965083.6 lb"     M=M0*cF/(B+2*c)=  160847 lb
W  = (Am+Ab)*Sa*0.5   =      405405.1 lb      hG=(C-Ge)/2      =    3.70 "
BOLTING-UP:        M0 =     1501978.4 lb"     M=M0*cF/(B+2*c)=  250330 lb
--------------------------- FLANGE CONSTANTS --------------------------
K = A/(B+2*c)                                                  =   3.167
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)             =   1.951
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)         =   1.167
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)                 =   1.776
Z = (K^2+1)/(K^2-1)                                            =   1.222
(g1-c)/(g0-c)                                                  =   1.000
h/SQR((B+2*c)(g0-c))                                           =   1.009
f =    (figure 3-340.6)                                        =   1.000
F =    (figure 3-340.2)                                        =   0.909
V =    (figure 3-340.3)                                        =   0.550
e = F/SQR((B+2*c)(g0-c))                                       =   0.291
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                            =  29.203
L = (t*e+1)/T+t^3/d                                            =   4.542

-------------------- FLANGE STRESSES--(design    /   bolting-up) -----
                                  Mpa        Psi        Mpa       Psi
SH = f*M/L/(g1-c)^2          =  92.583    13428.0  /  144.088   20898.2
SR = (1.33*t*e+1)*M/L/t^2    =  35.791     5191.1  /   55.703    8079.0
ST = Y*M/t^2-Z*SR            =  65.405     9486.2  /  101.791   14763.6
0.5*(SH+SR)                  =  64.187     9309.5  /   99.895   14488.6
0.5*(SH+ST)                  =  78.994    11457.1  /  122.940   17830.9
```


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Nuovo Pignone MASSA	PRESSURE PARTS CALCULATION OF STAGE 1, HYDROCRACKING REACTORS ITEMS: D-6212 / D-6232

```
                    WELDING NECK FLANGE POS.NOZZLE D3-6
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                ****   HYDROSTATIC TEST CONDITION   ****

* HYDROSTATIC TEST TEMPERATURE         T =   21.1  C      =   70.0   F

* MATERIAL :
       FLANGE             SA 182 F22V
       BOLTING            SA 193 B16
       GASKET             KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange-------------Hub-------------Bolting----
                          0.9 * Yield strength

                  Mpa   /  Psi        Mpa   /  Psi        Mpa   /  Psi
    HYDR.TEST  372.316 / 54000.0  558.474 / 81000.0  651.553 / 94500.0

* GASKET PARAMETERS:      m = 4.25   y= 10100 Psi   N=17.5 mm   w=0.00 mm
Hydrostatic test pressure                P =     28.200 Mpa   =    4090.1 Psi
Corrosion allowance                      c =      0.0 mm      =    0.000 "
Flange outside diameter                  A =    482.6 mm      =   19.000 "
Bolt circle                              C =    368.3 mm      =   14.500 "
Mean gasket diameter                     G =    177.5 mm      =    6.988 "
Flange inside diameter (uncorroded)      B =    152.4 mm      =    6.000 "
Hub at large end (uncorroded)            g1=     41.3 mm      =    1.624 "
Shell thickness (uncorroded)             g0=     41.3 mm      =    1.624 "
Flange thickness                         t =    107.9 mm      =    4.248 "
Hub length                               h =     80.0 mm      =    3.150 "
Bolt number and type                     n =      8      2''ANSI
Area of one bolt                         ab=  1710.96 mm2     =    2.652  #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------
bo     =       N/2                       =      8.750 mm      =    0.344 "
b      =    .5*SQR(bo)  (bo > .25)       =      7.454 mm      =    0.293 "
Effective gskt.diameter     Ge = G+N-2*b=   180.09  mm        =    7.090 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =    21.22 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P    =                 388548.688 lb
Wm2 >=   3.14*Ge*b*y                     =                  65991.023 lb

Am1  =            Wm1/Sb                 =                       4.11  #
Am2  =            Wm2/Sa                 =                       2.64  #
```

REV.	DESCRIZIONE - DESCRIPTION	ITEM
3	MODIFIED WHERE INDICATED <3>	D-6212/ D-6232
2	MODIFIED WHERE INDICATED <2>	
1	REVISIONE GENERALE	N. SOU0107840/4
0	EMISSIONE-ISSUE	LINGUA-LANG. A / PAGINA-SHEET 85 / 86

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

```
                    WELDING NECK FLANGE POS.NOZZLE D3-6
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                 ****   HYDROSTATIC TEST CONDITION   ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS -----------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                   1.000
HD = .785*(B+2*c)^2*P =     115585.4 lb     hD=R+0.5*(g1-c)  =    3.44 "
HT = .785*Ge^2*P - HD =      45821.4 lb     hT=(R+g1-c+hG)/2=     3.98 "
HG = Wm1 - HT - HD    =     227141.9 lb     hG=(C-Ge)/2      =    3.70 "
HYDR.TEST :        M0 =    1421167.6 lb"     M=M0*cF/(B+2*c)=  236861 lb
W   = (Am+Ab)*Sa*0.5  =     316595.3 lb     hG=(C-Ge)/2      =    3.70 "
-------------------------- FLANGE CONSTANTS ---------------------------
K = A/(B+2*c)                                                =   3.167
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)           =   1.951
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)       =   1.167
Y =  (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)              =   1.776
Z =  (K^2+1)/(K^2-1)                                         =   1.222
(g1-c)/(g0-c)                                                =   1.000
h/SQR((B+2*c)(g0-c))                                         =   1.009
f =    (figure 3-340.6)                                      =   1.000
F =    (figure 3-340.2)                                      =   0.909
V =    (figure 3-340.3)                                      =   0.550
e = F/SQR((B+2*c)(g0-c))                                     =   0.291
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                          =  29.203
L =  (t*e+1)/T+t^3/d                                         =   4.542

-------------------- FLANGE STRESSES--(hydrostatic test) ------------
                                       Mpa        Psi
SH = f*M/L/(g1-c)^2            =  136.336    19773.8
SR = (1.33*t*e+1)*M/L/t^2      =   52.706     7644.3
ST = Y*M/t^2-Z*SR              =   96.315    13969.3
0.5*(SH+SR)                    =   94.521    13709.1
0.5*(SH+ST)                    =  116.325    16871.6
```


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FLAT COVER POS. D3-6 <2>

```
=====(ASME VIII div.2 /Ed.04/TEMA RCB-9.21 - English units)=====

* DESIGN TEMPERATURE                              T =   454.0  C     =   849.2  F
* MATERIAL:                                         SA 182 F22V
* ALL. STRESS              (Table 1A,1B) S =  144.856 Mpa = 21009.6 Psi
* ALL. STRESS , room temp.(Table 1A,1B) Sa=  167.542 Mpa = 24300.0 Psi
* YIELD STRENGTH at room temp.          Sys= 413.6847 Mpa = 60000.0 Psi
Design pressure                          P =    19.150 Mpa =  2777.5 Psi
Hydr. test  pressure                     P'=    28.200 Mpa =  4090.1 Psi
Bolt load at design conditions         Wm1 = 263854.0 Lb
Bolt load at bolting-up                W   = 405405.0 Lb
Bolt load at hydr. test conditions     Wm0 = 388548.0 Lb
Gasket load reaction diameter          G   =    180.1 mm  =    7.09 "
Bolt circle                        G+2*hG  =    369.3 mm  =   14.54 "


Nominal channel inside diameter          ND=                not applicable
Total bolt area                          AB=                not applicable
Bolt allowable design stress             SB=                not applicable
Elastic modulus                          E =                not applicable
Corrosion allowance                      c1=    0.00 mm  =  0.000  "
Gasket grove                             c2=    0.00 mm  =  0.000  "
c = max(c1,c2)                             =    0.00 mm  =  0.000  "
Adopted thickness (CENTER)               T =  108.00 mm  =  4.252  "
Adopted thickness (PERIPHERY)            T'=  108.00 mm  =  4.252  "

------------------------ DESIGN    CONDITIONS ------------------------
t  = G*SQR(CP/S+1.9*Wm1*hG/S/G^3) + c    =    96.81 mm  =  3.812  "
t' = G*SQR(1.9*Wm1*hG/S/G^3)             =    89.92 mm  =  3.540  "

------------------------ BOLTING-UP CONDITIONS -----------------------
t  = G*SQR(1.9*W*hG/So/G^3) + c          =   103.64 mm  =  4.080  "

-------------------- HYDROSTATIC TEST CONDITIONS ---------------------
t =G*SQR(CP'/Sys/.9+1.9*Wm0*hG/Sys/.9/G^3)=   73.28 mm  =  2.885  "
t' = G*SQR(1.9*Wm0*hG/Sys/.9/G^3)        =    68.07 mm  =  2.680  "

------------ MINIMUM THICKNESS ACCORDING TO TEMA RCB-9.21 ------------
                    *       NOT REQUIRED      *
```


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Nuovo Pignone MASSA	PRESSURE PARTS CALCULATION OF STAGE 1, HYDROCRACKING REACTORS ITEMS: D-6212 / D-6232

WELDING NECK FLANGE POS.NOZZLE T1-6 <2>

===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

**** DESIGN CONDITION ****

* DESIGN TEMPERATURE T = 454.0 C = 849.2 F

* MATERIAL :

FLANGE	SA 182 F22V
BOLTING	SA 193 B16
GASKET	KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES:

	---Flange--- from table 1A, 1B	---Hub--- from table 1A, 1B	---Bolting--- from Table 3 (Case 1489-2)
	Mpa / Psi	Mpa / Psi	Mpa / Psi
DESIGN	144.856 / 21009.6	217.284 / 31514.4	162.192 / 23524.0
SEATING	167.542 / 24300.0	251.313 / 36450.0	172.369 / 25000.0

* GASKET PARAMETERS: m = 4.25 y= 10100 Psi N=12.5 mm w=0.00 mm

Design pressure	P =	19.150 Mpa	=	2777.5 Psi
Corrosion allowance	c =	0.0 mm	=	0.000 "
Flange outside diameter	A =	304.8 mm	=	12.000 "
Bolt circle	C =	228.6 mm	=	9.000 "
Mean gasket diameter	G =	97.5 mm	=	3.839 "
Flange inside diameter (uncorroded)	B =	84.0 mm	=	3.307 "
Hub at large end (uncorroded)	g1=	24.6 mm	=	0.969 "
Shell thickness (uncorroded)	g0=	24.6 mm	=	0.969 "
Flange thickness	t =	66.7 mm	=	2.626 "
Hub length	h =	56.7 mm	=	2.232 "
Bolt number and type	n =	8 1.1/4''ANSI		
Area of one bolt	ab=	599.35 mm2	=	0.929 #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------

bo	= N/2	=	6.250 mm	=	0.246 "
b	= bo (bo <= .25)	=	6.250 mm	=	0.246 "
Effective gskt.diameter	Ge = G	=	97.50 mm	=	3.839 "

-------- CHECK OF BOLTING AREA (actual area: Ab = 7.43 #)--------

Wm1 >=	.785*Ge^2*P + 2*b*3.14*Ge*m*P	=	102145.469 lb
Wm2 >=	3.14*Ge*b*y	=	29956.035 lb
Am1 =	Wm1/Sb	=	4.34 #
Am2 =	Wm2/Sa	=	1.20 #

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE INDICATED <3>
2	MODIFIED WHERE INDICATED <2>
1	REVISIONE GENERALE
0	EMISSIONE-ISSUE

ITEM D-6212/ D-6232

N. SOU0107840/4

LINGUA-LANG. A

PAGINA-SHEET 88 / 89

SOSTITUISCE IL - REPLACES

SOSTITUITO DA - REPLACED BY

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                    WELDING NECK FLANGE POS.NOZZLE T1-6
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                ****        DESIGN CONDITION        ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS -----------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                  1.000
HD = .785*(B+2*c)^2*P =      23845.8 lb     hD=R+0.5*(g1-c)  =   2.36 "
HT = .785*Ge^2*P - HD =       8280.6 lb     hT=(R+g1-c+hG)/2=    2.71 "
HG = Wm1 - HT - HD    =      70019.1 lb     hG=(C-Ge)/2      =   2.58 "
DESIGN:            M0 =     259497.6 lb"     M=M0*cF/(B+2*c)=   78467 lb
W  = (Am+Ab)*Sa*0.5   =     147177.3 lb     hG=(C-Ge)/2      =   2.58 "
BOLTING-UP:        M0 =     379821.7 lb"     M=M0*cF/(B+2*c)=  114851 lb
--------------------------- FLANGE CONSTANTS --------------------------
K = A/(B+2*c)                                              =   3.629
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)         =   1.727
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)     =   1.073
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)             =   1.572
Z = (K^2+1)/(K^2-1)                                        =   1.164
(g1-c)/(g0-c)                                              =   1.000
h/SQR((B+2*c)(g0-c))                                       =   1.247
f =   (figure 3-340.6)                                     =   1.000
F =   (figure 3-340.2)                                     =   0.909
V =   (figure 3-340.3)                                     =   0.550
e = F/SQR((B+2*c)(g0-c))                                   =   0.508
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                        =   5.271
L = (t*e+1)/T+t^3/d                                        =   5.610

-------------------- FLANGE STRESSES--(design    /   bolting-up) -----
                                 Mpa       Psi        Mpa       Psi
SH = f*M/L/(g1-c)^2          = 102.813   14911.8  /  150.485   21826.1
SR = (1.33*t*e+1)*M/L/t^2    =  38.791    5626.2  /   56.778    8235.0
ST = Y*M/t^2-Z*SR            =  78.143   11333.6  /  114.376   16588.8
0.5*(SH+SR)                  =  70.802   10269.0  /  103.632   15030.5
0.5*(SH+ST)                  =  90.478   13122.7  /  132.430   19207.4
```

```
                     WELDING NECK FLANGE POS.NOZZLE T1-6
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                **** HYDROSTATIC TEST CONDITION ****
* HYDROSTATIC TEST TEMPERATURE        T =   21.1  C      =   70.0   F

* MATERIAL :
     FLANGE            SA 182 F22V
     BOLTING           SA 193 B16
     GASKET            KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
                           0.9 * Yield strength

                   Mpa  /  Psi        Mpa  /  Psi        Mpa  /  Psi
    HYDR.TEST   372.316 / 54000.0  558.474 / 81000.0  651.553 / 94500.0

* GASKET PARAMETERS:       m = 4.25   y= 10100 Psi   N=12.5 mm   w=0.00 mm
Hydrostatic test pressure              P =    28.200 Mpa  =   4090.1 Psi
Corrosion allowance                    c =      0.0 mm    =    0.000 "
Flange outside diameter                A =    304.8 mm    =   12.000 "
Bolt circle                            C =    228.6 mm    =    9.000 "
Mean gasket diameter                   G =     97.5 mm    =    3.839 "
Flange inside diameter (uncorroded)    B =     84.0 mm    =    3.307 "
Hub at large end (uncorroded)          g1=     24.6 mm    =    0.969 "
Shell thickness (uncorroded)           g0=     24.6 mm    =    0.969 "
Flange thickness                       t =     66.7 mm    =    2.626 "
Hub length                             h =     56.7 mm    =    2.232 "
Bolt number and type                   n =      8 1.1/4''ANSI
Area of one bolt                       ab=   599.35 mm2   =    0.929  #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------
bo     =      N/2                         =     6.250 mm  =    0.246 "
b      =     bo   (bo <= .25)             =     6.250 mm  =    0.246 "
Effective gskt.diameter     Ge =    G     =    97.50  mm  =    3.839 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =     7.43 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P     =              150417.875 lb
Wm2 >=   3.14*Ge*b*y                      =               29956.035 lb

Am1   =          Wm1/Sb                   =                    1.59  #
Am2   =          Wm2/Sa                   =                    1.20  #
```


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```
                    WELDING NECK FLANGE POS.NOZZLE T1-6
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                  ****   HYDROSTATIC TEST CONDITION    ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS ------------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                    1.000
HD = .785*(B+2*c)^2*P =      35114.9 lb      hD=R+0.5*(g1-c)  =    2.36 "
HT = .785*Ge^2*P - HD =      12193.9 lb      hT=(R+g1-c+hG)/2=     2.71 "
HG = Wm1 - HT - HD    =     103109.0 lb      hG=(C-Ge)/2      =    2.58 "
HYDR.TEST :         M0 =    382132.2 lb"      M=M0*cF/(B+2*c)=  115550 lb
W  = (Am+Ab)*Sa*0.5   =     112796.5 lb      hG=(C-Ge)/2      =    2.58 "
--------------------------- FLANGE CONSTANTS ---------------------------
K = A/(B+2*c)                                                 =   3.629
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)            =   1.727
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)        =   1.073
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)                =   1.572
Z = (K^2+1)/(K^2-1)                                           =   1.164
(g1-c)/(g0-c)                                                 =   1.000
h/SQR((B+2*c)(g0-c))                                          =   1.247
f =   (figure 3-340.6)                                        =   1.000
F =   (figure 3-340.2)                                        =   0.909
V =   (figure 3-340.3)                                        =   0.550
e = F/SQR((B+2*c)(g0-c))                                      =   0.508
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                           =   5.271
L = (t*e+1)/T+t^3/d                                           =   5.610

-------------------- FLANGE STRESSES--(hydrostatic test) ------------
                                 Mpa        Psi
SH = f*M/L/(g1-c)^2          = 151.401    21958.8
SR = (1.33*t*e+1)*M/L/t^2    =  57.124     8285.1
ST = Y*M/t^2-Z*SR            = 115.072    16689.8
0.5*(SH+SR)                  = 104.262    15122.0
0.5*(SH+ST)                  = 133.236    19324.3
```


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WELDING NECK FLANGE POS.NOZZLE E1-2 <2>

```
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                 ****        DESIGN CONDITION        ****

* DESIGN TEMPERATURE                         T =  454.0  C      =  849.2   F

* MATERIAL :
       FLANGE              SA 182 F22V
       BOLTING             SA 193 B16
       GASKET              KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
                 from table 1A, 1B  from table 1A, 1B   from Table  3
                                                        (Case 1489-2)
                   Mpa  /  Psi        Mpa  /  Psi        Mpa  /  Psi
    DESIGN     144.856 / 21009.6  217.284 / 31514.4  162.192 / 23524.0
    SEATING    167.542 / 24300.0  251.313 / 36450.0  172.369 / 25000.0

* GASKET PARAMETERS:      m = 4.25    y= 10100 Psi   N=20.0 mm    w=0.00 mm
Design pressure                              P =    27.120 Mpa  =    3933.4 Psi
Corrosion allowance                          c =       0.0 mm   =     0.000 "
Flange outside diameter                      A =     552.5 mm   =    21.750 "
Bolt circle                                  C =     438.1 mm   =    17.250 "
Mean gasket diameter                         G =     230.0 mm   =     9.055 "
Flange inside diameter (uncorroded)          B =     203.2 mm   =     8.000 "
Hub at large end (uncorroded)                g1=      50.8 mm   =     2.000 "
Shell thickness (uncorroded)                 g0=      50.8 mm   =     2.000 "
Flange thickness                             t =     127.0 mm   =     5.000 "
Hub length                                   h =      83.5 mm   =     3.287 "
Bolt number and type                         n =      12     2''ANSI
Area of one bolt                             ab=   1710.96 mm2  =     2.652  #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------
bo     =       N/2                          =     10.000 mm   =     0.394 "
b      =    .5*SQR(bo)  (bo > .25)          =      7.969 mm   =     0.314 "
Effective gskt.diameter      Ge = G+N-2*b=    234.06  mm   =     9.215 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =   31.82 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P     =                 565712.125 lb
Wm2 >=   3.14*Ge*b*y                      =                  91689.289 lb

Am1  =           Wm1/Sb                   =                      24.05  #
Am2  =           Wm2/Sa                   =                       3.67  #
```

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE INDICATED <3>
2	MODIFIED WHERE INDICATED <2>
1	REVISIONE GENERALE
0	EMISSIONE-ISSUE

ITEM
D-6212/ D-6232
N. SOU0107840/4

LINGUA-LANG.	PAGINA-SHEET
A	92 / 93

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

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                    WELDING NECK FLANGE POS.NOZZLE E1-2
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)==============

                ****       DESIGN CONDITION        ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS ------------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                 1.000
HD = .785*(B+2*c)^2*P =     197615.5 lb     hD=R+0.5*(g1-c)  =   3.63 "
HT = .785*Ge^2*P - HD =      64587.6 lb     hT=(R+g1-c+hG)/2=    4.32 "
HG = Wm1 - HT - HD    =     303509.0 lb     hG=(C-Ge)/2      =   4.02 "
DESIGN:            M0 =    2214792.0 lb"     M=M0*cF/(B+2*c)= 276849 lb
W  = (Am+Ab)*Sa*0.5   =     698403.7 lb     hG=(C-Ge)/2      =   4.02 "
BOLTING-UP:        M0 =    2805814.5 lb"     M=M0*cF/(B+2*c)= 350727 lb
--------------------------- FLANGE CONSTANTS ---------------------------
K = A/(B+2*c)                                               =    2.719
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)          =    2.263
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)      =    1.277
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)              =    2.060
Z = (K^2+1)/(K^2-1)                                         =    1.313
(g1-c)/(g0-c)                                               =    1.000
h/SQR((B+2*c)(g0-c))                                        =    0.822
f =   (figure 3-340.6)                                      =    1.000
F =   (figure 3-340.2)                                      =    0.909
V =   (figure 3-340.3)                                      =    0.550
e = F/SQR((B+2*c)(g0-c))                                    =    0.227
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                         =   65.834
L = (t*e+1)/T+t^3/d                                         =    3.571

-------------------- FLANGE STRESSES--(design    /   bolting-up) -----
                                  Mpa       Psi          Mpa        Psi
SH = f*M/L/(g1-c)^2         = 133.616   19379.3   /  169.271   24550.7
SR = (1.33*t*e+1)*M/L/t^2   =  53.683    7786.1   /   68.009    9863.8
ST = Y*M/t^2-Z*SR           =  86.786   12587.3   /  109.945   15946.2
0.5*(SH+SR)                 =  93.649   13582.7   /  118.640   17207.3
0.5*(SH+ST)                 = 110.201   15983.3   /  139.608   20248.5
```

```
                 WELDING NECK FLANGE POS.NOZZLE E1-2
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

               ****    HYDROSTATIC TEST CONDITION    ****

* HYDROSTATIC TEST TEMPERATURE         T =    21.1  C       =    70.0    F

* MATERIAL  :
       FLANGE               SA 182 F22V
       BOLTING              SA 193 B16
       GASKET               KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange-------------Hub-------------Bolting----
                              0.9 * Yield strength

                    Mpa   /  Psi         Mpa   /  Psi         Mpa   /  Psi
    HYDR.TEST    372.316 / 54000.0   558.474 / 81000.0    651.553 / 94500.0

* GASKET PARAMETERS:       m = 4.25    y= 10100 Psi    N=20.0 mm    w=0.00 mm
Hydrostatic test pressure                P =     28.200 Mpa   =    4090.1 Psi
Corrosion allowance                      c =        0.0 mm    =     0.000 "
Flange outside diameter                  A =      552.5 mm    =    21.750 "
Bolt circle                              C =      438.1 mm    =    17.250 "
Mean gasket diameter                     G =      230.0 mm    =     9.055 "
Flange inside diameter (uncorroded)      B =      203.2 mm    =     8.000 "
Hub at large end (uncorroded)            g1=       50.8 mm    =     2.000 "
Shell thickness (uncorroded)             g0=       50.8 mm    =     2.000 "
Flange thickness                         t =      127.0 mm    =     5.000 "
Hub length                               h =       83.5 mm    =     3.287 "
Bolt number and type                     n =       12       2''ANSI
Area of one bolt                         ab=    1710.96 mm2   =     2.652   #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------
bo     =       N/2                        =     10.000 mm    =     0.394 "
b      =    .5*SQR(bo)  (bo > .25)        =      7.969 mm    =     0.314 "
Effective gskt.diameter     Ge = G+N-2*b=    234.06  mm    =     9.215 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =    31.82 #   )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P     =                 588240.500 lb
Wm2 >=   3.14*Ge*b*y                      =                  91689.289 lb

Am1   =           Wm1/Sb                  =                       6.22   #
Am2   =           Wm2/Sa                  =                       3.67   #
```


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                    WELDING NECK FLANGE POS.NOZZLE E1-2
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                 ****   HYDROSTATIC TEST CONDITION   ****
----------------- FLANGE LOADS, LEVER ARMS AND MOMENTS ------------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                   1.000
HD = .785*(B+2*c)^2*P =    205485.2 lb     hD=R+0.5*(g1-c)  =    3.63 "
HT = .785*Ge^2*P - HD =     67159.6 lb     hT=(R+g1-c+hG)/2=     4.32 "
HG = Wm1 - HT - HD    =    315595.7 lb     hG=(C-Ge)/2      =    4.02 "
HYDR.TEST :        MO =   2302991.8 lb"     M=MO*cF/(B+2*c)=   287874 lb
W  = (Am+Ab)*Sa*0.5   =    475609.6 lb     hG=(C-Ge)/2      =    4.02 "
--------------------------- FLANGE CONSTANTS ---------------------------
K = A/(B+2*c)                                               =    2.719
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)          =    2.263
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)      =    1.277
Y =  (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)             =    2.060
Z =  (K^2+1)/(K^2-1)                                        =    1.313
(g1-c)/(g0-c)                                               =    1.000
h/SQR((B+2*c)(g0-c))                                        =    0.822
f =    (figure 3-340.6)                                     =    1.000
F =    (figure 3-340.2)                                     =    0.909
V =    (figure 3-340.3)                                     =    0.550
e = F/SQR((B+2*c)(g0-c))                                    =    0.227
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                         =   65.834
L =  (t*e+1)/T+t^3/d                                        =    3.571

-------------------- FLANGE STRESSES--(hydrostatic test) ------------
                                     Mpa      Psi
SH = f*M/L/(g1-c)^2              = 138.937   20151.1
SR = (1.33*t*e+1)*M/L/t^2        =  55.821    8096.2
ST = Y*M/t^2-Z*SR                =  90.242   13088.5
0.5*(SH+SR)                      =  97.379   14123.6
0.5*(SH+ST)                      = 114.589   16619.8
```

WELDING NECK FLANGE POS.NOZZLE T7-11 <2>

```
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

               ****         DESIGN CONDITION        ****
* DESIGN TEMPERATURE                  T =  454.0  C      =  849.2    F

* MATERIAL :
     FLANGE            SA 182 F22V
     BOLTING           SA 193 B16
     GASKET            KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
               from table 1A, 1B  from table 1A, 1B   from Table  3
                                                      (Case 1489-2)
                 Mpa   /  Psi         Mpa   /  Psi        Mpa   /  Psi
   DESIGN     144.856 / 21009.6  217.284 / 31514.4   162.192 / 23524.0
   SEATING    167.542 / 24300.0  251.313 / 36450.0   172.369 / 25000.0

* GASKET PARAMETERS:      m = 4.25   y= 10100 Psi   N=12.5 mm   w=0.00 mm
Design pressure                       P =    19.150 Mpa   =    2777.5 Psi
Corrosion allowance                   c =       0.0 mm    =     0.000 "
Flange outside diameter               A =     304.8 mm    =    12.000 "
Bolt circle                           C =     228.6 mm    =     9.000 "
Mean gasket diameter                  G =      97.5 mm    =     3.839 "
Flange inside diameter (uncorroded)   B =      84.0 mm    =     3.307 "
Hub at large end (uncorroded)         g1=      24.6 mm    =     0.969 "
Shell thickness (uncorroded)          g0=      24.6 mm    =     0.969 "
Flange thickness                      t =      66.7 mm    =     2.626 "
Hub length                            h =      56.7 mm    =     2.232 "
Bolt number and type                  n =         8 1.1/4''ANSI
Area of one bolt                      ab=    599.35 mm2   =     0.929  #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------
bo     =      N/2                        =     6.250 mm    =     0.246 "
b      =     bo   (bo <= .25)            =     6.250 mm    =     0.246 "
Effective gskt.diameter     Ge =    G    =     97.50  mm   =     3.839 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =    7.43 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P    =               102145.469 lb
Wm2 >=   3.14*Ge*b*y                     =                29956.035 lb

Am1  =           Wm1/Sb                  =                     4.34  #
Am2  =           Wm2/Sa                  =                     1.20  #
```

```
                    WELDING NECK FLANGE POS.NOZZLE T7-11
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                ****        DESIGN CONDITION        ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS -----------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)   =                 1.000
HD = .785*(B+2*c)^2*P =      23845.8 lb     hD=R+0.5*(g1-c)  =    2.36 "
HT = .785*Ge^2*P - HD =       8280.6 lb     hT=(R+g1-c+hG)/2=     2.71 "
HG = Wm1 - HT - HD    =      70019.1 lb     hG=(C-Ge)/2      =    2.58 "
DESIGN:            MO =     259497.6 lb"     M=MO*cF/(B+2*c)=    78467 lb
W  = (Am+Ab)*Sa*0.5   =     147177.3 lb     hG=(C-Ge)/2      =    2.58 "
BOLTING-UP:        MO =     379821.7 lb"     M=MO*cF/(B+2*c)=   114851 lb
-------------------------- FLANGE CONSTANTS --------------------------
K = A/(B+2*c)                                              =    3.629
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)         =    1.727
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)     =    1.073
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)             =    1.572
Z = (K^2+1)/(K^2-1)                                        =    1.164
(g1-c)/(g0-c)                                              =    1.000
h/SQR((B+2*c)(g0-c))                                       =    1.247
f =   (figure 3-340.6)                                     =    1.000
F =   (figure 3-340.2)                                     =    0.909
V =   (figure 3-340.3)                                     =    0.550
e = F/SQR((B+2*c)(g0-c))                                   =    0.508
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                        =    5.271
L = (t*e+1)/T+t^3/d                                        =    5.610

-------------------- FLANGE STRESSES--(design    /   bolting-up) -----
                               Mpa        Psi          Mpa       Psi
SH = f*M/L/(g1-c)^2        = 102.813   14911.8   /  150.485   21826.1
SR = (1.33*t*e+1)*M/L/t^2  =  38.791    5626.2   /   56.778    8235.0
ST = Y*M/t^2-Z*SR          =  78.143   11333.6   /  114.376   16588.8
0.5*(SH+SR)                =  70.802   10269.0   /  103.632   15030.5
0.5*(SH+ST)                =  90.478   13122.7   /  132.430   19207.4
```


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                    WELDING NECK FLANGE POS.NOZZLE T7-11
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                 ****    HYDROSTATIC TEST CONDITION    ****
* HYDROSTATIC TEST TEMPERATURE          T =    21.1  C       =   70.0   F

* MATERIAL :
     FLANGE                 SA 182 F22V
     BOLTING                SA 193 B16
     GASKET                 KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
                                 0.9 * Yield strength

                      Mpa   /  Psi         Mpa   /  Psi          Mpa   /  Psi
    HYDR.TEST   372.316 / 54000.0   558.474 / 81000.0   651.553 / 94500.0

* GASKET PARAMETERS:      m = 4.25    y= 10100 Psi   N=12.5 mm   w=0.00 mm
Hydrostatic test pressure              P =     28.200 Mpa   =    4090.1 Psi
Corrosion allowance                    c =        0.0 mm    =     0.000 "
Flange outside diameter                A =      304.8 mm    =    12.000 "
Bolt circle                            C =      228.6 mm    =     9.000 "
Mean gasket diameter                   G =       97.5 mm    =     3.839 "
Flange inside diameter (uncorroded)    B =       84.0 mm    =     3.307 "
Hub at large end (uncorroded)          g1=       24.6 mm    =     0.969 "
Shell thickness (uncorroded)           g0=       24.6 mm    =     0.969 "
Flange thickness                       t =       66.7 mm    =     2.626 "
Hub length                             h =       56.7 mm    =     2.232 "
Bolt number and type                   n =          8 1.1/4''ANSI
Area of one bolt                       ab=     599.35 mm2   =     0.929  #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------
bo      =       N/2                    =       6.250 mm    =     0.246 "
b       =      bo   (bo <= .25)        =       6.250 mm    =     0.246 "
Effective gskt.diameter     Ge =    G  =       97.50  mm   =     3.839 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =    7.43 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P   =              150417.875 lb
Wm2 >=   3.14*Ge*b*y                    =               29956.035 lb

Am1  =           Wm1/Sb                 =                     1.59  #
Am2  =           Wm2/Sa                 =                     1.20  #
```


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                    WELDING NECK FLANGE POS.NOZZLE T7-11
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                ****   HYDROSTATIC TEST CONDITION   ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS -----------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                 1.000
HD = .785*(B+2*c)^2*P =       35114.9 lb     hD=R+0.5*(g1-c)  =    2.36 "
HT = .785*Ge^2*P - HD =       12193.9 lb     hT=(R+g1-c+hG)/2=     2.71 "
HG = Wm1 - HT - HD    =      103109.0 lb     hG=(C-Ge)/2      =    2.58 "
HYDR.TEST :        M0 =      382132.2 lb"    M=M0*cF/(B+2*c)= 115550 lb
W  = (Am+Ab)*Sa*0.5   =      112796.5 lb     hG=(C-Ge)/2      =    2.58 "
-------------------------- FLANGE CONSTANTS --------------------------
K = A/(B+2*c)                                              =   3.629
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)         =   1.727
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)     =   1.073
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)             =   1.572
Z = (K^2+1)/(K^2-1)                                        =   1.164
(g1-c)/(g0-c)                                              =   1.000
h/SQR((B+2*c)(g0-c))                                       =   1.247
f =   (figure 3-340.6)                                     =   1.000
F =   (figure 3-340.2)                                     =   0.909
V =   (figure 3-340.3)                                     =   0.550
e = F/SQR((B+2*c)(g0-c))                                   =   0.508
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                        =   5.271
L = (t*e+1)/T+t^3/d                                        =   5.610

-------------------- FLANGE STRESSES--(hydrostatic test) ------------
                                   Mpa        Psi
SH = f*M/L/(g1-c)^2          = 151.401    21958.8
SR = (1.33*t*e+1)*M/L/t^2    =  57.124     8285.1
ST = Y*M/t^2-Z*SR            = 115.072    16689.8
0.5*(SH+SR)                  = 104.262    15122.0
0.5*(SH+ST)                  = 133.236    19324.3
```

Nuovo Pignone MASSA	PRESSURE PARTS CALCULATION OF STAGE 1, HYDROCRACKING REACTORS ITEMS: D-6212 / D-6232

WELDING NECK FLANGE POS.NOZZLE D7 <2>

```
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                   ****        DESIGN CONDITION        ****

* DESIGN TEMPERATURE                          T =   454.0  C      =  849.2   F

* MATERIAL :
       FLANGE            SA 182 F22V
       BOLTING           SA 193 B16
       GASKET            KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
                 from table 1A, 1B  from table 1A, 1B   from Table  3
                                                        (Case 1489-2)
                   Mpa   /  Psi         Mpa   /  Psi        Mpa   /  Psi
    DESIGN     144.856 / 21009.6   217.284 / 31514.4   162.192 / 23524.0
    SEATING    167.542 / 24300.0   251.313 / 36450.0   172.369 / 25000.0

* GASKET PARAMETERS:      m = 4.25    y= 10100 Psi    N=12.5 mm    w=0.00 mm
Design pressure                          P =     19.150 Mpa   =    2777.5 Psi
Corrosion allowance                      c =        0.0 mm    =     0.000 "
Flange outside diameter                  A =      355.6 mm    =    14.000 "
Bolt circle                              C =      273.0 mm    =    10.750 "
Mean gasket diameter                     G =      122.5 mm    =     4.823 "
Flange inside diameter (uncorroded)      B =      101.6 mm    =     4.000 "
Hub at large end (uncorroded)            g1=       31.8 mm    =     1.250 "
Shell thickness (uncorroded)             g0=       31.8 mm    =     1.250 "
Flange thickness                         t =       76.2 mm    =     3.000 "
Hub length                               h =       50.0 mm    =     1.969 "
Bolt number and type                     n =         8 1.1/2''ANSI
Area of one bolt                         ab=     906.45 mm2   =     1.405  #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------
bo     =       N/2                          =     6.250 mm    =     0.246 "
b      =     bo   (bo <= .25)               =     6.250 mm    =     0.246 "
Effective gskt.diameter      Ge =     G     =   122.50   mm   =     4.823 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =   11.24 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P      =                 138686.344 lb
Wm2 >=   3.14*Ge*b*y                        =                  37637.070 lb

Am1  =          Wm1/Sb                      =                       5.90  #
Am2  =          Wm2/Sa                      =                       1.51  #
```

3	MODIFIED WHERE INDICATED <3>	ITEM D-6212/ D-6232		
2	MODIFIED WHERE INDICATED <2>			
1	REVISIONE GENERALE	N. SOU0107840/4		
0	EMISSIONE-ISSUE	LINGUA-LANG.	PAGINA-SHEET	
REV.	DESCRIZIONE - DESCRIPTION	A	100 / 101	

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

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                    WELDING NECK FLANGE POS.NOZZLE D7
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)==============

                ****       DESIGN CONDITION        ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS ------------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)  =                  1.000
HD = .785*(B+2*c)^2*P =      34885.1 lb     hD=R+0.5*(g1-c)  =    2.75 "
HT = .785*Ge^2*P - HD =      15828.5 lb     hT=(R+g1-c+hG)/2=     3.17 "
HG = Wm1 - HT - HD    =      87972.7 lb     hG=(C-Ge)/2      =    2.96 "
DESIGN:            M0 =     406813.6 lb"     M=M0*cF/(B+2*c)=   101703 lb
W  = (Am+Ab)*Sa*0.5   =     214194.1 lb     hG=(C-Ge)/2      =    2.96 "
BOLTING-UP:        M0 =     634781.8 lb"     M=M0*cF/(B+2*c)=   158695 lb
-------------------------- FLANGE CONSTANTS --------------------------
K = A/(B+2*c)                                                =   3.500
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)          =   1.783
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)      =   1.098
Y = (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)              =   1.622
Z = (K^2+1)/(K^2-1)                                          =   1.178
(g1-c)/(g0-c)                                                =   1.000
h/SQR((B+2*c)(g0-c))                                         =   0.880
f =   (figure 3-340.6)                                       =   1.000
F =   (figure 3-340.2)                                       =   0.909
V =   (figure 3-340.3)                                       =   0.550
e = F/SQR((B+2*c)(g0-c))                                     =   0.406
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                          =  11.321
L = (t*e+1)/T+t^3/d                                          =   4.407

-------------------- FLANGE STRESSES--(design    /  bolting-up) -----
                                  Mpa       Psi         Mpa       Psi
SH = f*M/L/(g1-c)^2          = 101.838   14770.4  /  158.906   23047.4
SR = (1.33*t*e+1)*M/L/t^2    =  46.355    6723.3  /   72.331   10490.8
ST = Y*M/t^2-Z*SR            =  71.789   10412.1  /  112.018   16246.8
0.5*(SH+SR)                  =  74.097   10746.8  /  115.619   16769.1
0.5*(SH+ST)                  =  86.814   12591.3  /  135.462   19647.1
```


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                  WELDING NECK FLANGE POS.NOZZLE D7
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

               ****   HYDROSTATIC TEST CONDITION   ****

* HYDROSTATIC TEST TEMPERATURE        T =   21.1  C      =   70.0   F

* MATERIAL :
     FLANGE            SA 182 F22V
     BOLTING           SA 193 B16
     GASKET            KAMMPROFILE GASKET S.S. 347 / THERMICULITE <2>

* ALLOW. STRESSES: ---Flange--------------Hub-------------Bolting----
                        0.9 * Yield strength

                    Mpa  /  Psi        Mpa  /  Psi        Mpa  /  Psi
    HYDR.TEST  372.316 / 54000.0  558.474 / 81000.0  651.553 / 94500.0

* GASKET PARAMETERS:      m = 4.25   y= 10100 Psi   N=12.5 mm   w=0.00 mm
Hydrostatic test pressure               P =    28.200 Mpa  =   4090.1 Psi
Corrosion allowance                     c =       0.0 mm   =    0.000 "
Flange outside diameter                 A =     355.6 mm   =   14.000 "
Bolt circle                             C =     273.0 mm   =   10.750 "
Mean gasket diameter                    G =     122.5 mm   =    4.823 "
Flange inside diameter (uncorroded)     B =     101.6 mm   =    4.000 "
Hub at large end (uncorroded)           g1=      31.8 mm   =    1.250 "
Shell thickness (uncorroded)            g0=      31.8 mm   =    1.250 "
Flange thickness                        t =      76.2 mm   =    3.000 "
Hub length                              h =      50.0 mm   =    1.969 "
Bolt number and type                    n =        8 1.1/2''ANSI
Area of one bolt                        ab=    906.45 mm2  =    1.405  #

--------------------- CALCULATED GASKET DIMENSIONS ---------------------
bo     =      N/2                         =     6.250 mm   =    0.246 "
b      =     bo   (bo <= .25)             =     6.250 mm   =    0.246 "
Effective gskt.diameter      Ge =    G    =   122.50  mm   =    4.823 "

-------- CHECK OF BOLTING AREA (actual area:  Ab =   11.24 #  )--------
Wm1 >=  .785*Ge^2*P + 2*b*3.14*Ge*m*P     =             204227.422 lb
Wm2 >=   3.14*Ge*b*y                      =              37637.070 lb

Am1  =           Wm1/Sb                   =                   2.16  #
Am2  =           Wm2/Sa                   =                   1.51  #
```


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```
                         WELDING NECK FLANGE POS.NOZZLE D7
===============(ASME VIII div.2 / Edition 2004 APPEND. 3)===============

                 ****    HYDROSTATIC TEST CONDITION     ****
---------------- FLANGE LOADS, LEVER ARMS AND MOMENTS ------------------

cF =  MAX(SQR(PI*C/n/(2*dB+6*t/(m+0.5))),1)   =                  1.000
HD = .785*(B+2*c)^2*P =      51371.3 lb     hD=R+0.5*(g1-c)  =    2.75 "
HT = .785*Ge^2*P - HD =      23308.9 lb     hT=(R+g1-c+hG)/2=     3.17 "
HG = Wm1 - HT - HD    =     129547.2 lb     hG=(C-Ge)/2      =    2.96 "
HYDR.TEST :        M0 =     599067.6 lb"     M=M0*cF/(B+2*c)=  149767 lb
W   = (Am+Ab)*Sa*0.5  =     167514.2 lb     hG=(C-Ge)/2      =    2.96 "
--------------------------- FLANGE CONSTANTS --------------------------
K = A/(B+2*c)                                                =   3.500
U =(K^2*(1+8.55246*LGT(K)-1)/1.36136/(K^2-1)/(K-1)           =   1.783
T =(K^2*(1+8.55246*LGT(K)-1)/(1.0472+1.9448*K^2)/(K-1)       =   1.098
Y =  (0.66845+5.71690*K^2*LGT(K)/(K^2-1))/(K-1)              =   1.622
Z =  (K^2+1)/(K^2-1)                                         =   1.178
(g1-c)/(g0-c)                                                =   1.000
h/SQR((B+2*c)(g0-c))                                         =   0.880
f =    (figure 3-340.6)                                      =   1.000
F =    (figure 3-340.2)                                      =   0.909
V =    (figure 3-340.3)                                      =   0.550
e = F/SQR((B+2*c)(g0-c))                                     =   0.406
d = U/V*SQR((B+2*c)(g0-c))*(g0-c)^2                          =  11.321
L =  (t*e+1)/T+t^3/d                                         =   4.407

-------------------- FLANGE STRESSES--(hydrostatic test) ------------
                                  Mpa        Psi
SH = f*M/L/(g1-c)^2          = 149.965    21750.7
SR = (1.33*t*e+1)*M/L/t^2    =  68.262     9900.6
ST = Y*M/t^2-Z*SR            = 105.715    15332.7
0.5*(SH+SR)                  = 109.114    15825.6
0.5*(SH+ST)                  = 127.840    18541.7
```

FLAT COVER POS. D7 <2>

```
=====(ASME VIII div.2 /Ed.04/TEMA RCB-9.21 - English units)=====

* DESIGN TEMPERATURE                           T =  454.0  C     =  849.2  F
* MATERIAL:                                      SA 182 F22V
* ALL. STRESS            (Table 1A,1B)  S =  144.856 Mpa = 21009.6 Psi
* ALL. STRESS , room temp.(Table 1A,1B) Sa=  167.542 Mpa = 24300.0 Psi
* YIELD STRENGTH at room temp.          Sys= 413.6847 Mpa = 60000.0 Psi
Design pressure                         P =   19.150 Mpa =  2777.5 Psi
Hydr. test  pressure                    P'=   28.200 Mpa =  4090.1 Psi
Bolt load at design conditions          Wm1 = 138686.0 Lb
Bolt load at bolting-up                 W   = 214194.0 Lb
Bolt load at hydr. test conditions      Wm0 = 204227.0 Lb
Gasket load reaction diameter           G   =    122.5 mm  =    4.82 "
Bolt circle                         G+2*hG  =    273.0 mm  =   10.75 "


Nominal channel inside diameter         ND=                not applicable
Total bolt area                         AB=                not applicable
Bolt allowable design stress            SB=                not applicable
Elastic modulus                         E =                not applicable
Corrosion allowance                     c1=     0.00 mm  =  0.000  "
Gasket grove                            c2=     0.00 mm  =  0.000  "
c = max(c1,c2)                            =     0.00 mm  =  0.000  "
Adopted thickness (CENTER)              T =    76.20 mm  =  3.000  "
Adopted thickness (PERIPHERY)           T'=    76.20 mm  =  3.000  "

------------------------ DESIGN    CONDITIONS -------------------------
t  = G*SQR(CP/S+1.9*Wm1*hG/S/G^3) + c     =    74.60 mm  =  2.937  "
t' = G*SQR(1.9*Wm1*hG/S/G^3)              =    70.50 mm  =  2.776  "

------------------------ BOLTING-UP CONDITIONS ------------------------
t  = G*SQR(1.9*W*hG/So/G^3) + c           =    74.04 mm  =  2.915  "

-------------------- HYDROSTATIC TEST CONDITIONS ----------------------
t =G*SQR(CP'/Sys/.9+1.9*Wm0*hG/Sys/.9/G^3)=    56.47 mm  =  2.223  "
t' = G*SQR(1.9*Wm0*hG/Sys/.9/G^3)         =    53.36 mm  =  2.101  "

------------ MINIMUM THICKNESS ACCORDING TO TEMA RCB-9.21 -------------
                  *       NOT REQUIRED      *
```


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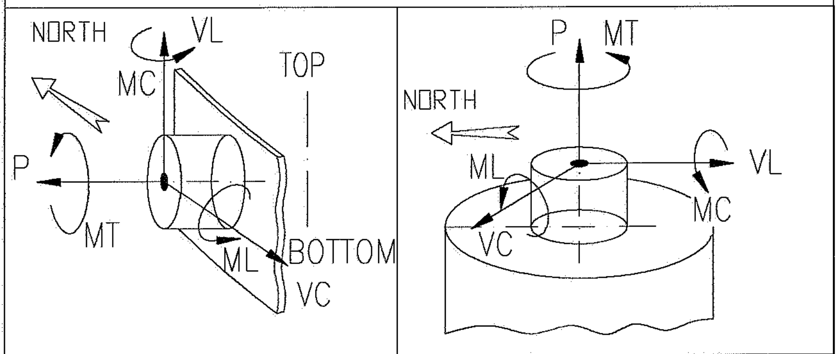
NOZZLE TO SHELL / HEAD ATTACHMENT VERIFICATION <3>

GENERAL

The analysis has been performed with the finite elements program Nozzle/PRO v7.5.

CARICHI ESTERNI SUI BOCCHELLI – EXTERNAL LOADS ON NOZZLES



NOZZLE CONNESSIONI		P [N]	VL [N]	VC [N]	MT [N*m]	ML [N*m]	MC [N*m]	NOTES NOTE
A	case 1 99%	27600	18000	21600	-162000	42000	68400	
A	case 2 78%	30000	26400	22800	-190800	42000	75600	
A	case 3 cool.	16800	-16800	13200	-64800	37200	38400	
A	case 4 Delta T	30000	27600	22800	-198000	39600	75600	
A	case 5 sust.	1200	-37200	2400	-34800	7200	-1200	
A	case 6 wind	38850	28350	-22050	-178500	-57750	-119700	
M	case 1 99%	-84000	21600	27600	118800	-193200	12000	
M	case 2 78%	-74400	22800	30000	130800	-225600	-8400	
M	case 3 cool.	-116400	13200	16800	69600	-84000	84000	
M	case 4 Delta T	-73200	22800	30000	130800	-231600	-9600	
M	case 5 sust.	-138000	2400	1200	2400	-36000	140400	
M	case 6 wind	-60900	37800	22050	173250	-211050	-21000	
B		140007	158400	140007	220427	285120	220427	
E		20000	20000	20000	25000	12800	12500	

CONCENTRATED LOADS ON NOZZLE:NOZZLE B

Stress Analysis acc. to ASME VIII Div. 2, Sect. 4

USER DEFINED NOZZLE LOADS

VL'	P'	VC'	MC'	MT'	ML'
N	N	N	N·m	N·m	N·m
158000	140000	140000	220000	220000	285000

See note (1)

VL	P	VC	MC	MT	ML
FX	FY	FZ	MX	MY	MZ
N	N	N	N·m	N·m	N·m
140000	-158000	140000	412696	-682000	-429096

See note (2)

(1) Loads applied at the flange.
(2) Loads applied at the nozzle-to-shell intersection. The following formulas have been used:

VL = -P' MC = MT'+VC'·b Where: a = 3300 mm
P = -VL' MT = -MC'-VC'·a b = 1376.4 mm
VC = VC' ML = ML'-VL'·a-P'·b

GENERAL

The analysis has been performed with the finite element program Nozzle/PRO v7.5.

FEA REPORT

```
Model Notes

 Model Type                     : Hemispherical Head

 Parent Outside Diameter        :    4702.400 mm.
        Thickness               :     134.000 mm.

        Parent Properties:
        Cold Allowable          :        169.0 MPa
        Hot  Allowable          :        169.0 MPa
        Material ID #2          :  Low Alloy Steel
        Ultimate Tensile (Amb)  :        506.6 MPa
        Yield Strength (Amb)    :        337.9 MPa
        Yield Strength (Hot)    :        337.9 MPa
        Elastic Modulus (Amb)   :     179600.0 MPa
        Poissons Ratio          :        0.300
        Weight Density          :   0.0000E+00  N /cu.mm.(NOT USED)

 Nozzle Reinforced OD           :     790.000 mm.
```

```
Reinforced Thickness        :    142.600 mm.
Reinforced Length           :    344.000 mm.
Transition Length           :     90.200 mm.
Neck OD                     :    609.600 mm.
Neck Thickness              :     52.400 mm.
Neck Length                 :    300.000 mm.
Location perpendicular
to the head centerline      :      0.000 mm.

Nozzle Tilt Angle           :      0.000 deg.

Nozzle Properties
Cold Allowable              :      169.0 MPa
Hot  Allowable              :      169.0 MPa
Material ID #2              :  Low Alloy Steel
Ultimate Tensile (Amb)      :      506.6 MPa
Yield Strength (Amb)        :      337.9 MPa
Yield Strength (Hot)        :      337.9 MPa
Elastic Modulus (Amb)       :   179600.0 MPa
Poissons Ratio              :      0.300
Weight Density              :  0.0000E+00  N /cu.mm. (NOT USED)
```

The following temperatures have been specified for the analysis:

```
Nozzle Inside  Temperature   :      454.00 deg.
Nozzle Outside Temperature   :      454.00 deg.
Vessel Inside  Temperature   :      454.00 deg.
Vessel Outside Temperature   :      454.00 deg.
Nozzle Pressure              :      19.150 MPa
Vessel Pressure              :      19.150 MPa
```

User Defined Loads:
- Loads are given at the Nozzle/Header Junction
- Loads are defined in Global Coordinates

Forces(N) Moments (N-m)

Load Case	FX	FY	FZ	MX	MY	MZ
WEIGHT:	140000.0	-158000.0	140000.0	412696.0	-682000.0	-429096.0
OPER:	140000.0	-158000.0	140000.0	412696.0	-682000.0	-429096.0

Stresses ARE nodally AVERAGED.

No weld dimensions have been given for the nozzle connection to the shell. This will produce conservative results for external loads and may tend to produce more realistic inside surface pressure stresses.

Load Case Report

Inner and outer element temperatures are the same throughout the model. No thermal ratcheting calculations will be performed.

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THE LOAD CASES ANALYZED ARE:

2 SUSTAINED
Sustained case run to satisfy Pl<1.5Sm limit, as per 04 ASME Section VIII Div 2 Table 4-120.1 and 2.
Loads in Case 2
Loads due to Weight
Pressure Case 1

4 OPERATING
Operating case run to compute the extreme operating stress state to be used in the shakedown and peak stress calculations per ASME Section VIII Div 2.
By assuming both uniform temperature and Operating Loads identical to Weight Loads, the Operating Case run to satisfy Pl+Pb+Q<3Smavg limit, as per 04 ASME Section VIII Div 2 Table 4-120.1 and 2.
Loads in Case 4
Pressure Case 1
Temperature Case 1 (Uniform Temperature)
Loads from (Operating)

Solution Data

Number of Nodes = 8209
Number of Elements = 2736

Summation of Loads per Case

Case #	FX	FY	FZ
2	144231.	313739384.	141998.
4	144231.	313739384.	141998.

ASME Code Stress Output Plots

1) Pl < 1.5(k)Smh (SUS,Membrane) Case 2
4) Pl+Pb+Q < 3(Smavg) (OPE,Inside) Case 4
5) Pl+Pb+Q < 3(Smavg) (OPE,Outside) Case 4

ASME Overstressed Areas

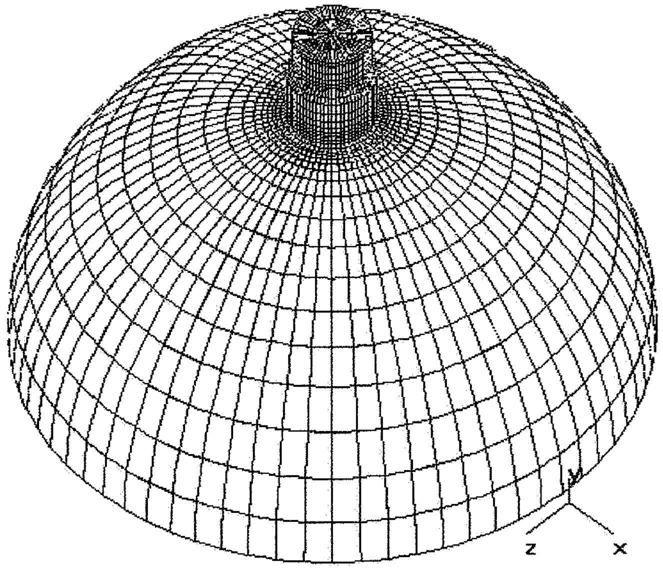
*** NO OVERSTRESSED NODES IN THIS MODEL ***

Stress Summary Table

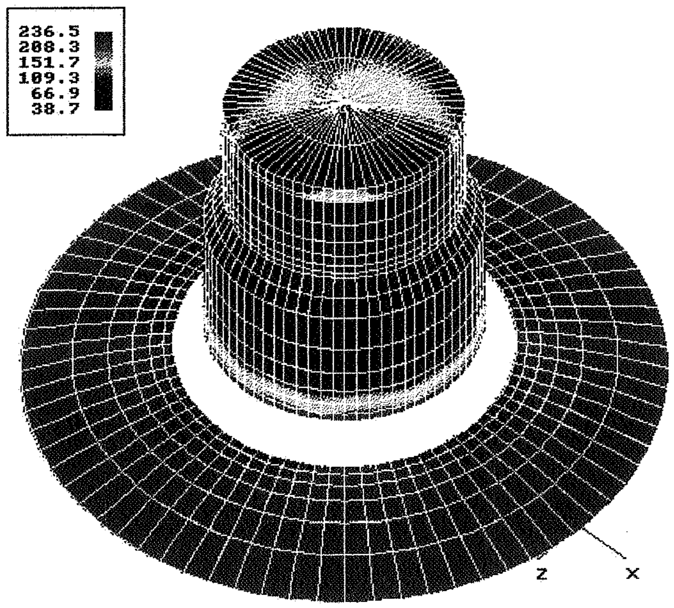
Location	ASME Category	Stress	Allowable Stress	Percent of Allowable
Nozzle Next to Shell	Pl+Pb < 1.5(k)Smh [Pb=0]	204.56	253.56	81
Shell Next to Nozzle	Pl+Pb < 1.5(k)Smh [Pb=0]	236.52	253.56	93
Nozzle Next to Shell	Pl+Pb+Q < 3(k)Smavg	247.52	507.12	49
Shell Next to Nozzle	Pl+Pb+Q < 3(k)Smavg	294	507.12	58

Figures

Finite Element Model



1) Pl < 1.5(k)Smh (SUS Membrane) Case 2



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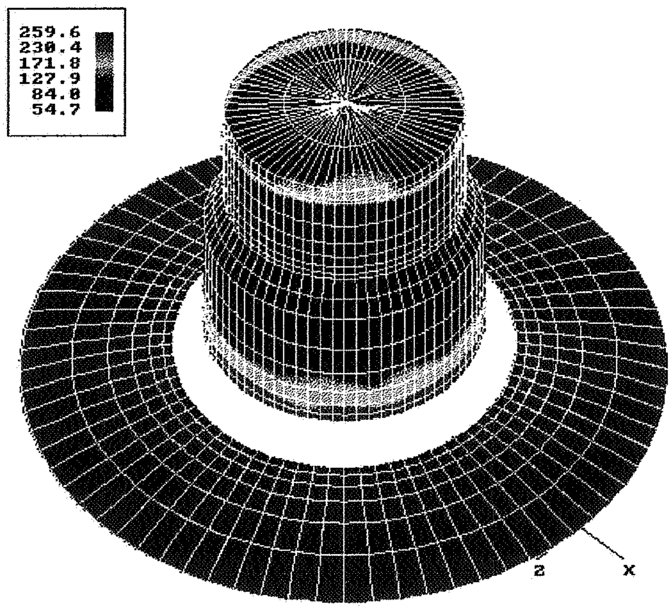
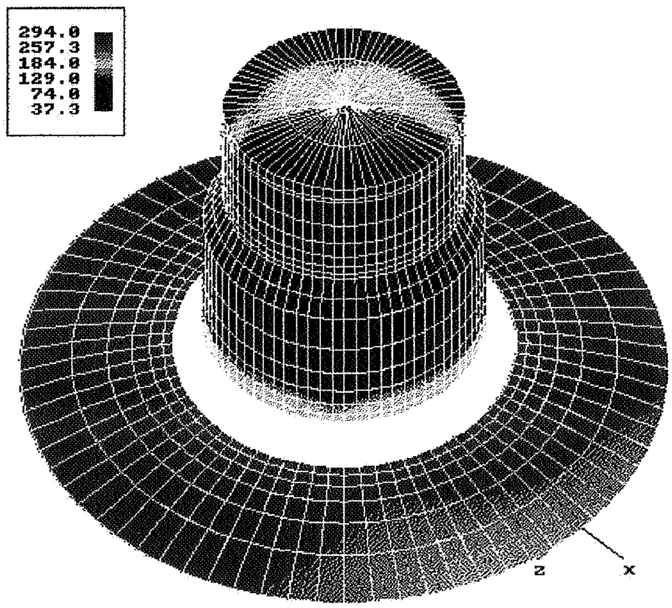
4) Pl+Pb+Q < 3(Smavg) (OPE Inside) Case 4



5) Pl+Pb+Q < 3(Smavg) (OPE Outside) Case 4



CONCENTRATED LOADS ON NOZZLE:NOZZLE M <3>

Stress Analysis acc. to ASME VIII Div. 2, Sect. 4

USER DEFINED NOZZLE LOADS

(1)	VL	P	VC	MC	MT	ML
(1)	FX	FY	FZ	MX	MY	MZ
	N	*N*	*N*	*N·m*	*N·m*	*N·m*
Case #1	21600	-201600	27600	44400	118800	-218400
Case #2	22800	-193200	30000	28800	130800	-252000
Case #3	13200	-235200	16800	103200	69600	-98400
Case #4	22800	-192000	30000	27600	130800	-259200
Case #5	2400	-255600	1200	141600	2400	-38400
Case #6	34650	-164850	22050	24150	173250	-211050
Case "Worst" (2)	**34650**	**-255600**	**30000**	**141600**	**173250**	**-259200**

(1) Loads are applied at the nozzle-to-shell intersection.
(2) This case has been obtained considering for each component the maximum value among cases #1 to #6.

Only the nozzle loads case "Worst" has been analyzed, covering all the other cases.

FEA REPORT

<u>Model Notes</u>

```
 Model Type                    : Hemispherical Head

 Parent Outside Diameter       :    4702.400 mm.
        Thickness              :     134.000 mm.

        Parent Properties:
        Cold Allowable         :       169.0 MPa
        Hot  Allowable         :       169.0 MPa
        Material ID #2         :  Low Alloy Steel
        Ultimate Tensile (Amb) :       506.6 MPa
        Yield Strength (Amb)   :       337.9 MPa
        Yield Strength (Hot)   :       337.9 MPa
        Elastic Modulus (Amb)  :    179600.0 MPa
        Poissons Ratio         :       0.300
        Weight Density         :  0.0000E+00  N /cu.mm.(NOT USED)

 Nozzle Reinforced OD          :    1505.000 mm.
        Reinforced Thickness   :     265.700 mm.
        Reinforced Length      :     404.400 mm.
        Transition Length      :     185.500 mm.
```

```
Neck OD                       :    1134.000 mm.
Neck Thickness                :      80.200 mm.
Neck Length                   :     155.000 mm.
Location perpendicular
to the head centerline        :       0.000 mm.

Nozzle Tilt Angle             :       0.000 deg.

Nozzle Properties
Cold Allowable                :       169.0 MPa
Hot  Allowable                :       169.0 MPa
Material ID #2                :   Low Alloy Steel
Ultimate Tensile (Amb)        :       506.6 MPa
Yield Strength (Amb)          :       337.9 MPa
Yield Strength (Hot)          :       337.9 MPa
Elastic Modulus (Amb)         :    179600.0 MPa
Poissons Ratio                :       0.300
Weight Density                :  0.0000E+00  N /cu.mm.  (NOT USED)
```

The following temperatures have been specified for the analysis:

```
Nozzle Inside  Temperature    :     454.00 deg.
Nozzle Outside Temperature    :     454.00 deg.
Vessel Inside  Temperature    :     454.00 deg.
Vessel Outside Temperature    :     454.00 deg.
Nozzle Pressure               :     19.150 MPa
Vessel Pressure               :     19.150 MPa
```

User Defined Loads:
- Loads are given at the Nozzle/Header Junction
- Loads are defined in Global Coordinates

Forces(N) Moments (N-m)

Load Case	FX	FY	FZ	MX	MY	MZ
WEIGHT:	34650.0	-255600.0	30000.0	141600.0	173250.0	-259200.0
OPER:	34650.0	-255600.0	30000.0	141600.0	173250.0	-259200.0

No weld dimensions have been given for the nozzle connection to the shell. This will produce conservative results for external loads and may tend to produce more realistic inside surface pressure stresses.

Load Case Report

Inner and outer element temperatures are the same throughout the model. No thermal ratcheting calculations will be performed.

THE LOAD CASES ANALYZED ARE:

2 SUSTAINED
Sustained case run to satisfy Pl<1.5Sm limit, as per 04 ASME Section VIII Div 2 Table 4-120.1 and 2.
Loads in Case 2
Loads due to Weight
Pressure Case 1

4 OPERATING
Operating case run to compute the extreme operating stress state to be used in the shakedown and peak stress calculations per ASME Section VIII Div 2.
By assuming both uniform temperature and Operating Loads identical to Weight Loads, the Operating Case run to satisfy Pl+Pb+Q<3Smavg limit, as per 04 ASME Section VIII Div 2 Table 4-120.1 and 2.
Loads in Case 4
Pressure Case 1
Temperature Case 1 (Uniform Temperature)
Loads from (Operating)

Solution Data

Number of Nodes = 7345
Number of Elements = 2448

Summation of Loads per Case

Case #	FX	FY	FZ
2	28211.	313640952.	25890.
4	28211.	313640952.	25890.

ASME Code Stress Output Plots

1) Pl < 1.5(k)Smh (SUS,Membrane) Case 2
4) Pl+Pb+Q < 3(Smavg) (OPE,Inside) Case 4
5) Pl+Pb+Q < 3(Smavg) (OPE,Outside) Case 4

ASME Overstressed Areas

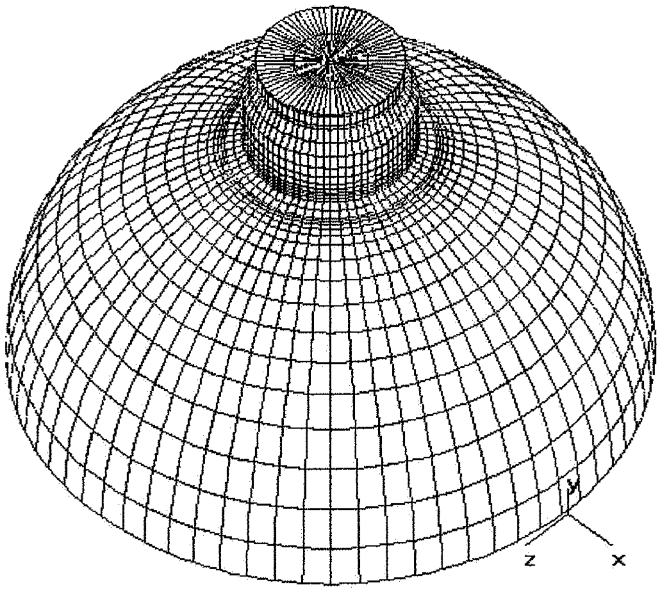
*** NO OVERSTRESSED NODES IN THIS MODEL ***

Stress Summary Table

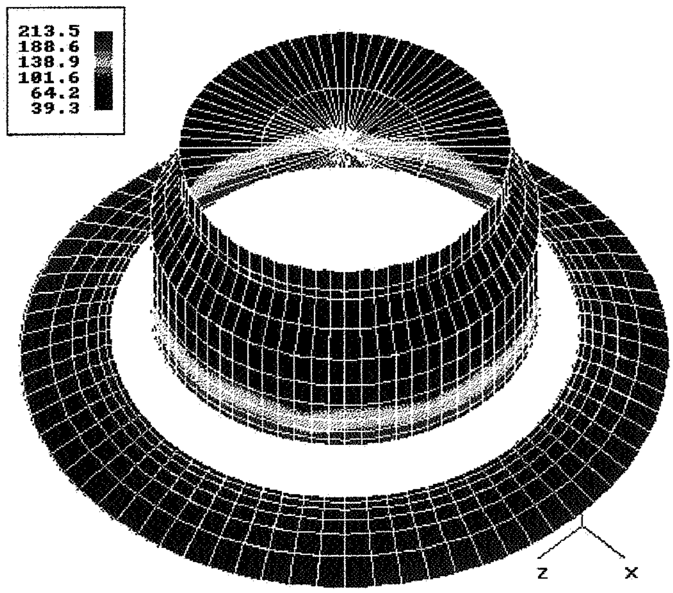
Location	ASME Category	Stress	Allowable Stress	Percent of Allowable
Nozzle 1 Next to Shell	Pl+Pb < 1.5(k)Smh [Pb=0]	183.11	253.56	72
Shell Next to Nozzle 1	Pl+Pb < 1.5(k)Smh [Pb=0]	213.52	253.56	84
Nozzle 1 Next to Shell	Pl+Pb+Q < 3(k)Smavg	219.35	507.12	43
Shell Next to Nozzle 1	Pl+Pb+Q < 3(k)Smavg	269.22	507.12	53

Figures

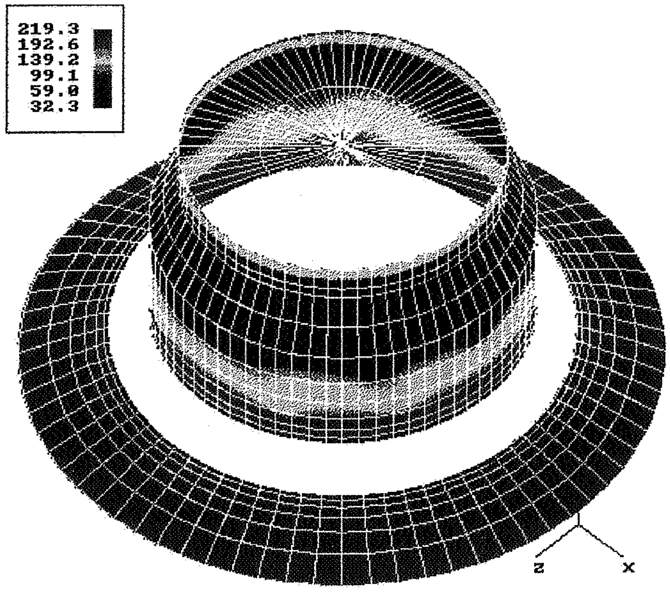
Finite Element Model



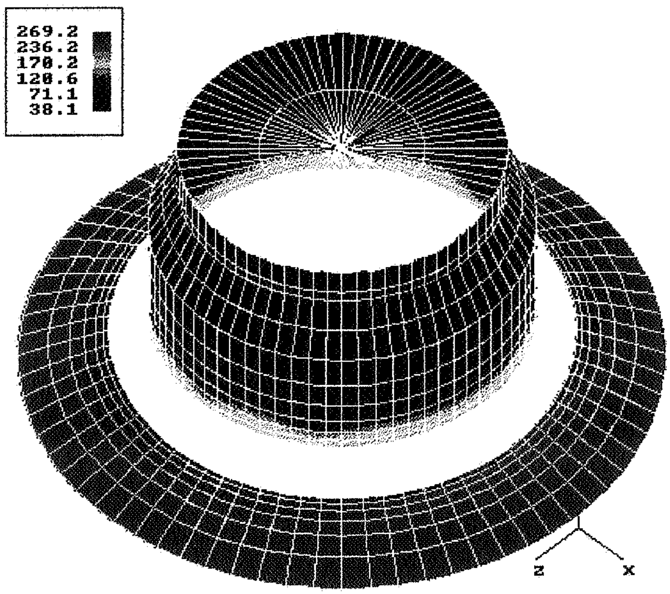
1) Pl < 1.5(k)Smh (SUS Membrane) Case 2



4) Pl+Pb+Q < 3(Smavg) (OPE Inside) Case 4



5) Pl+Pb+Q < 3(Smavg) (OPE Outside) Case 4



CONCENTRATED LOADS ON NOZZLE :NOZZLE E

Stress Analysis acc. to ASME VIII Div. 2, Sect. 4

USER DEFINED NOZZLE LOADS

(1)	P	VL	-VC	MT	MC	-ML
(1)	FX	FY	FZ	MX	MY	MZ
	N	*N*	*N*	*N·m*	*N·m*	*N·m*
Allowable Loads	20000	20000	-20000	25000	12500	-12800

(1) Loads are applied at the nozzle-to-shell intersection.

FEA REPORT

Model Notes

```
Model Type                    : Cylindrical Shell

Parent Outside Diameter       :    4828.400 mm.
       Thickness              :     260.000 mm.

       Parent Properties:
       Cold Allowable         :       169.0 MPa
       Hot  Allowable         :       169.0 MPa
       Material ID #2         :  Low Alloy Steel
       Ultimate Tensile (Amb) :       506.6 MPa
       Yield Strength (Amb)   :       337.9 MPa
       Yield Strength (Hot)   :       337.9 MPa
       Elastic Modulus (Amb)  :    179600.0 MPa
       Poissons Ratio         :       0.300
       Weight Density         :  0.0000E+00  N /cu.mm.(NOT USED)

Nozzle Reinforced OD          :     435.000 mm.
       Reinforced Thickness   :     115.900 mm.
       Reinforced Length      :     318.900 mm.
       Transition Length      :      65.100 mm.
       Neck OD                :     304.800 mm.
       Neck Thickness         :      50.800 mm.
       Neck Length            :      83.500 mm.
       Nozzle Tilt Angle      :       0.000 deg.
       Distance from Top      :    3500.000 mm.
       Distance from Bottom   :    3500.000 mm.

       Nozzle Properties
       Cold Allowable         :       169.0 MPa
       Hot  Allowable         :       169.0 MPa
       Material ID #2         :  Low Alloy Steel
```

```
Ultimate Tensile (Amb)  :      506.6 MPa
Yield Strength (Amb)    :      337.9 MPa
Yield Strength (Hot)    :      337.9 MPa
Elastic Modulus (Amb)   :   179600.0 MPa
Poissons Ratio          :      0.300
Weight Density          :  0.0000E+00  N /cu.mm. (NOT USED)
```

The following temperatures have been specified for the analysis:

```
Nozzle Inside  Temperature    :      454.00 deg.
Nozzle Outside Temperature    :      454.00 deg.
Vessel Inside  Temperature    :      454.00 deg.
Vessel Outside Temperature    :      454.00 deg.
Nozzle Pressure               :      19.150 MPa
Vessel Pressure               :      19.150 MPa
```

User Defined Loads:
- Loads are given at the End of Nozzle
- Loads are defined in Global Coordinates

Forces(N) Moments (N-m)

Load Case	FX	FY	FZ	MX	MY	MZ
WEIGHT:	20000.0	20000.0	-20000.0	25000.0	12500.0	-12800.0
OPER:	20000.0	20000.0	-20000.0	25000.0	12500.0	-12800.0

Both ends of the model are "fixed," except that one end is free axially so that longitudinal pressure stresses may be developed in the geometry.

Stresses ARE nodally AVERAGED.

No weld dimensions have been given for the nozzle connection to the shell. This will produce conservative results for external loads and may tend to produce more realistic inside surface pressure stresses.

Load Case Report

Inner and outer element temperatures are the same throughout the model. No thermal ratcheting calculations will be performed.

THE LOAD CASES ANALYZED ARE:

2 SUSTAINED
Sustained case run to satisfy Pl<1.5Sm limit, as per 04 ASME Section VIII Div 2 Table 4-120.1 and 2.
Loads in Case 2
Loads due to Weight
Pressure Case 1

4 OPERATING
Operating case run to compute the extreme operating stress state to be used in the shakedown and peak stress calculations per ASME Section VIII Div 2.
By assuming both uniform temperature and Operating Loads identical to

Weight Loads, the Operating Case run to satisfy Pl+Pb+Q<3Smavg limit, as per 04 ASME Section VIII Div 2 Table 4-120.1 and 2.
Loads in Case 4
Pressure Case 1
Temperature Case 1 (Uniform Temperature)
Loads from (Operating)

Solution Data

Number of Nodes = 7796
Number of Elements = 2544

Summation of Loads per Case

Case #	FX	FY	FZ
2	405211957.	64340158.	-20060.
4	405211957.	64340158.	-20060.

ASME Code Stress Output Plots

1) Pl < 1.5(k)Smh (SUS,Membrane) Case 2
4) Pl+Pb+Q < 3(Smavg) (OPE,Inside) Case 4
5) Pl+Pb+Q < 3(Smavg) (OPE,Outside) Case 4

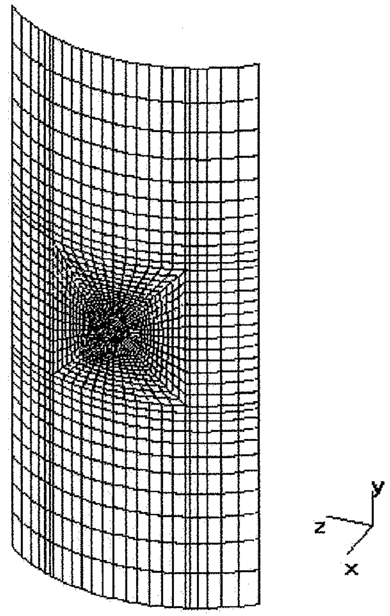
ASME Overstressed Areas

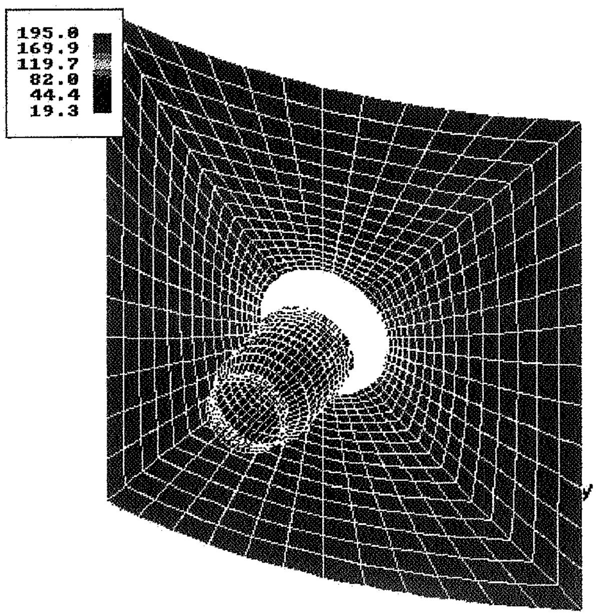
*** NO OVERSTRESSED NODES IN THIS MODEL ***

Stress Summary Table

Location	ASME Category	Stress	Allowable Stress	Percent of Allowable
Header Next to Nozzle	Pl+Pb < 1.5(k)Smh [Pb=0]	194.97	253.56	77
Branch Next to Header	Pl+Pb < 1.5(k)Smh [Pb=0]	60.05	253.56	24
Header Next to Nozzle	Pl+Pb+Q < 3(k)Smavg	250.69	507.12	49
Branch Next to Header	Pl+Pb+Q < 3(k)Smavg	128.37	507.12	25

Figures


Finite Element Model
y
z
x


1> Pl < 1.5(k)Smh (SUS Membrane) Case 2
195.0
169.9
119.7
82.0
44.4
19.3

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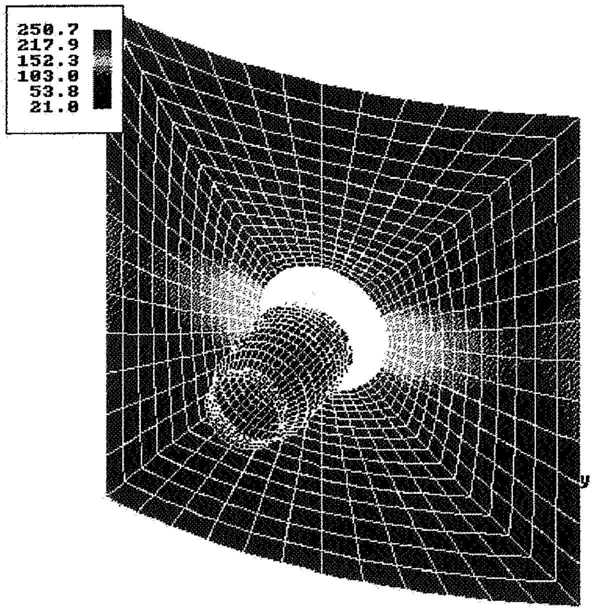
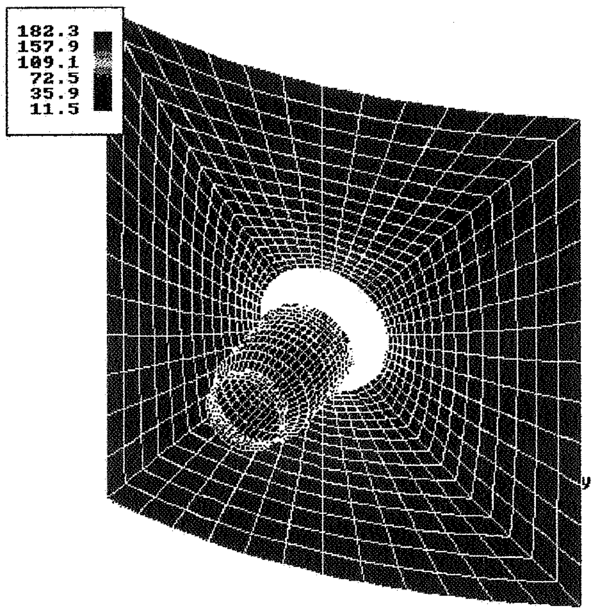
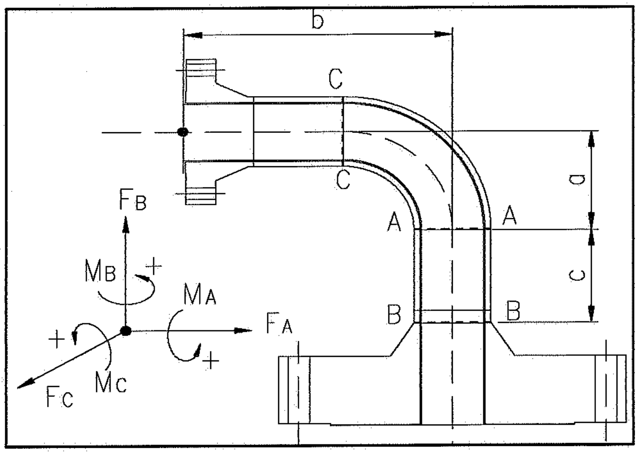
4) Pl+Pb+Q < 3(Smavg) (OPE Inside) Case 4



5) Pl+Pb+Q < 3(Smavg) (OPE Outside) Case 4



UPPER SPOOL VERIFICATION <3>



UPPER SPOOL VERIFICATION

(Load A_{max})

F_A =	-38,85	KN	
F_B =	-37,20	KN	
F_C =	22,80	KN	
M_A =	198,00	KN*m	
M_B =	-119,70	KN*m	
M_C =	-57,75	KN*m	
a =	762	mm	Vertical arm
b =	2500	mm	Horizontal arm
c =	223,8	mm	Vertical arm
D =	508	mm	Pipe external diameter
d =	419,1	mm	Pipe internal diameter
b_i =	1,250		from DIN 2413 fig. 4 = (2*a - D/2)/(2*a - D)
K_I =	1,3		Factor from Roark cap. 8 TABLE 16 case 11
p =	19,15	Mpa	Design pressure
	SA 182 F22V		Spool material
$_{am}$ =	169,00	Mpa	Allowable stress at design temperature
T =	454	°C	Design temperature

$I = * ((D/2)^4 - (d/2)^4) / 4 =$	1,755E+09	mm^4	Inertia moment
$I_o = 2 * I =$	3,509E+09	mm^4	Polar moment
$A = * (D^2 - d^2) / 4 =$	64.732	mm^2	Area of pipe section
$t = (D - d) / 2 =$	44,45	mm	Pipe thickness

SECTION A-A

$_1 = 4 * F_C / (3 * A) =$	0,47	Mpa	Stress due to F_C load
$_2 = 4 * F_A / (3 * A) =$	-0,80	Mpa	Stress due to F_A load
$_3 = F_C * b * D / (2 * I_o) =$	4,13	Mpa	Stress due to F_C load
$_4 = M_B * D / (2 * I_o) =$	-8,66	Mpa	Stress due to M_B moment
$_1 = F_B / A =$	-0,57	Mpa	Stress due to F_B load
$M_{A\ tot} = M_A + F_C * a =$	215.374	KN*mm	Tot bending moment M_A
$M_{C\ tot} = M_C - F_A * a - F_B * b =$	64.854	KN*mm	Tot bending moment M_C
$M = (M_{A\ tot}^2 + M_{C\ tot}^2)^{0,5} =$	224.926	KN*mm	Tot bending moment
$_{m1} = +M * D * K_i / (2 * I) =$	42,33	Mpa	Stress due to M_A and M_C moment
$_{m2} = - M * D * K_i / (2 * I) =$	-42,33	Mpa	Stress due to M_A and M_C moment

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Stress due to internal pressure

$_p = p * d * b_i / (4 * t) =$	56,42	Mpa	Longitudinal Stress
$_p = p * d / (2 * t) =$	90,28	Mpa	Tangential Stress

Principal stress calculation (ASME VIII Div. 2 Par. 4-120)

$_{z1} = {}_{m1} + {}_{1} + {}_{p} =$	98,18	Mpa
$_{z2} = {}_{m2} + {}_{1} + {}_{p} =$	13,52	Mpa
$_t = {}_p + \| {}_3 \| + \| {}_4 \| =$	103,07	Mpa
$= ({}_1{}^2 + {}_2{}^2)^{0,5} =$	0,93	Mpa

$S_{1\text{-}a} = 0,5 * ({}_t + {}_{z1} + (({}_t - {}_{z1})^2 + 4*{}^2)^{0,5} =$	103,24	Mpa
$S_{1\text{-}b} = 0,5 * ({}_t + {}_{z1} + (({}_t - {}_{z2})^2 + 4*{}^2)^{0,5} =$	103,08	Mpa
$S_{2\text{-}a} = 0,5 * ({}_t + {}_{z1} - (({}_t - {}_{z1})^2 + 4*{}^2)^{0,5} =$	98,01	Mpa
$S_{2\text{-}b} = 0,5 * ({}_t + {}_{z1} - (({}_t - {}_{z2})^2 + 4*{}^2)^{0,5} =$	13,51	Mpa
$S_3 = 0,5 * p =$	9,58	Mpa

$S_1 - S_2$	$1 = S_{1\text{-}a} - S_{2\text{-}a} =$	5,23	Mpa
	$2 = S_{1\text{-}b} - S_{2\text{-}b} =$	89,56	Mpa
$S_1 + S_3$	$3 = S_{1\text{-}a} + 0,5*p =$	112,81	Mpa
	$4 = S_{1\text{-}b} + 0,5*p =$	112,65	Mpa
$S_2 + S_3$	$5 = S_{2\text{-}a} + 0,5*p =$	107,58	Mpa
	$6 = S_{2\text{-}b} + 0,5*p =$	23,09	Mpa

S (max 1-6) S =	112,81	Mpa	largest absolute value
$3 * {}_{am} =$	507,00	Mpa	Stress intensity limit at design temperature (ASME VIII Div. 2 Par. 4-134)

S = **112,81** Mpa < $3 * \sigma_{am} =$ **507,00** Mpa

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SECTION B-B

$_1 = 4 * F_C / (3 * A) =$	0,47	Mpa	Stress due to F_C load
$_2 = 4 * F_A / (3 * A) =$	-0,80	Mpa	Stress due to F_A load
$_3 = F_C * b * D / (2 * I_o) =$	4,13	Mpa	Stress due to F_C load
$_4 = M_B * D / (2 * I_o) =$	-8,66	Mpa	Stress due to M_B moment
$_1 = F_B / A =$	-0,57	Mpa	Stress due to F_B load
$M_{A\ tot} = M_A + F_C*(a+c) =$	220.476	KN*mm	Tot bending moment M_A
$M_{C\ tot} = M_C - F_A*(a+c) - F_B*b =$	73.548	KN*mm	Tot bending moment M_C
$M = (M_{A\ tot}^2 + M_{C\ tot}^2)^{0,5} =$	232.420	KN*mm	Tot bending moment
$_{m1} = +M * D / (2 * I) =$	33,64	Mpa	Stress due to M_A and M_C moment
$_{m2} = -M * D / (2 * I) =$	-33,64	Mpa	Stress due to M_A and M_C moment

Stress due to internal pressure

$_p = p * d / (4 * t) =$	45,14	Mpa	Longitudinal Stress
$_p = p * d / (2 * t) =$	90,28	Mpa	Tangential Stress

Principal stress calculation (ASME VIII Div. 2 Par. 4-120)

$_{z1} = {}_{m1} + {}_1 + {}_p =$	78,21	Mpa
$_{z2} = {}_{m2} + {}_1 + {}_p =$	10,92	Mpa
$_t = {}_p + \lvert {}_3 \rvert + \lvert {}_4 \rvert =$	103,07	Mpa
$= ({}_1^2 + {}_2^2)^{0,5} =$	0,93	Mpa

$S_{1-a} = 0,5 * ({}_t + {}_{z1} + (({}_t - {}_{z1})^2 + 4 * {}^2)^{0,5} =$	103,10	Mpa
$S_{1-b} = 0,5 * ({}_t + {}_{z1} + (({}_t - {}_{z2})^2 + 4 * {}^2)^{0,5} =$	103,08	Mpa
$S_{2-a} = 0,5 * ({}_t + {}_{z1} - (({}_t - {}_{z1})^2 + 4 * {}^2)^{0,5} =$	78,17	Mpa
$S_{2-b} = 0,5 * ({}_t + {}_{z1} - (({}_t - {}_{z2})^2 + 4 * {}^2)^{0,5} =$	10,91	Mpa
$S_3 = 0,5 * p =$	9,58	Mpa

$S_1 - S_2$	$1 = S_{1-a} - S_{2-a} =$	24,93	Mpa
	$2 = S_{1-b} - S_{2-b} =$	92,17	Mpa
$S_1 + S_3$	$3 = S_{1-a} + 0,5*p =$	112,68	Mpa
	$4 = S_{1-b} + 0,5*p =$	112,65	Mpa
$S_2 + S_3$	$5 = S_{2-a} + 0,5*p =$	87,75	Mpa
	$6 = S_{2-b} + 0,5*p =$	20,49	Mpa

S (max 1-6) S =	112,68	Mpa	largest absolute value
$1,5 * {}_{am} =$	253,50	Mpa	Stress intensity limit at design temperature (ASME VIII Div. 2 Par. 4-134)

S = **112,68** Mpa < $1,5 * \sigma_{am} =$ **253,50** Mpa

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SECTION C-C

$_1 = 4 * F_C / (3 * A) =$	0,47	Mpa	Stress due to F_C load
$_2 = 4 * F_B / (3 * A) =$	-0,77	Mpa	Stress due to F_B load
$_3 = M_A * D / (2 * I_o) =$	14,33	Mpa	Stress due to M_A moment
$_1 = F_A / A =$	-0,60	Mpa	Stress due to F_A load
$M_{B\ tot} = M_B + F_C*(b-a) =$	-80.074	KN*mm	Tot bending moment M_B
$M_{C\ tot} = M_C - F_B*(b-a) =$	6.904	KN*mm	Tot bending moment M_C
$M = (M_{B\ tot}^2 + M_{C\ tot}^2)^{0,5} =$	80.371	KN*mm	Tot bending moment
$_{m1} = +M * D * K_i / (2 * I) =$	15,12	Mpa	Stress due to M_B and M_C moment
$_{m2} = - M * D * K_i / (2 * I) =$	-15,12	Mpa	Stress due to M_B and M_C moment

Stress due to internal pressure

$_p = p * d * b_i / (4 * t) =$	56,42	Mpa	Longitudinal Stress
$_p = p * d\ / (2 * t) =$	90,28	Mpa	Tangential Stress

Principal stress calculation (ASME VIII Div. 2 Par. 4-120)

$_{z1} = {}_{m1} + {}_1 + {}_p =$	70,95	Mpa
$_{z2} = {}_{m2} + {}_1 + {}_p =$	40,70	Mpa
$_t = {}_p + \vert {}_3 \vert =$	104,61	Mpa
$= ({}_1^2 + {}_2^2)^{0,5} =$	0,90	Mpa

$S_{1-a} = 0,5 * ({}_t + {}_{z1} + (({}_t - {}_{z1})^2 + 4*{}^2)^{0,5} =$	104,63	Mpa
$S_{1-b} = 0,5 * ({}_t + {}_{z1} + (({}_t - {}_{z2})^2 + 4*{}^2)^{0,5} =$	104,62	Mpa
$S_{2-a} = 0,5 * ({}_t + {}_{z1} - (({}_t - {}_{z1})^2 + 4*{}^2)^{0,5} =$	70,92	Mpa
$S_{2-b} = 0,5 * ({}_t + {}_{z1} - (({}_t - {}_{z2})^2 + 4*{}^2)^{0,5} =$	40,69	Mpa
$S_3 = 0,5 * p =$	9,58	Mpa

$S_1 - S_2$	$1 = S_{1-a} - S_{2-a} =$	33,71	Mpa
	$2 = S_{1-b} - S_{2-b} =$	63,94	Mpa
$S_1 + S_3$	$3 = S_{1-a} + 0,5*p =$	114,21	Mpa
	$4 = S_{1-b} + 0,5*p =$	114,20	Mpa
$S_2 + S_3$	$5 = S_{2-a} + 0,5*p =$	80,50	Mpa
	$6 = S_{2-b} + 0,5*p =$	50,26	Mpa

S (max 1-6) S =	114,21	Mpa	largest absolute value
$3 * {}_{am} =$	507,00	Mpa	Stress intensity limit at design temperature (ASME VIII Div. 2 Par. 4-134)

S = **114,21** Mpa < $3 * \sigma_{am} =$ **507,00** Mpa

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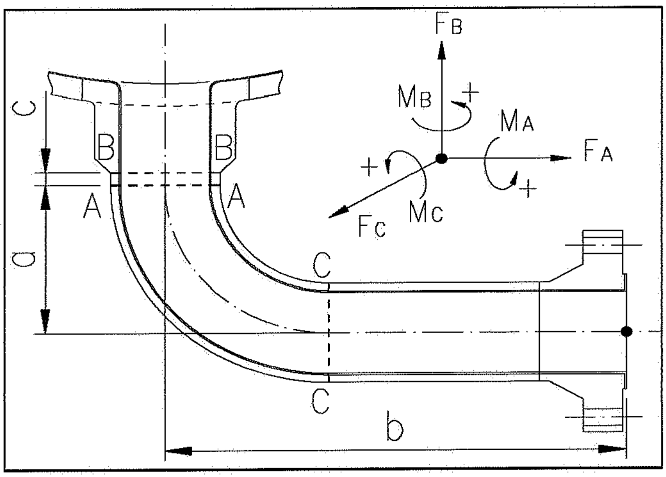
LOWER SPOOL VERIFICATION



LOWER SPOOL VERIFICATION

F_A =	140,007	KN	
F_B =	158,40	KN	
F_C =	140,007	KN	
M_A =	220,427	KN*m	
M_B =	285,12	KN*m	
M_C =	220,427	KN*m	
a =	914,4	mm	Vertical arm
b =	3300	mm	Horizontal arm
c =	60,3	mm	Vertical arm
D =	609,6	mm	Pipe external diameter
d =	504,8	mm	Pipe internal diameter
b_i =	1,250		from DIN 2413 fig. 4 = (2*a - D/2)/(2*a - D)
K_i =	1,3		Factor from Roark cap. 8 TABLE 16 case 11
p =	19,150	Mpa	Design pressure
	SA 182 F22V		Spool material
$_{am}$ =	169,00	Mpa	Allowable stress at design temperature
T =	454	°C	Design temperature

I = * ((D/2)^4 - (d/2)^4) / 4 =	3,591E+09	mm^4	Inertia moment
I_o = 2 * I =	7,183E+09	mm^4	Polar moment
A = * (D^2 - d^2) / 4 =	91.726	mm^2	Area of pipe section
t = (D - d) / 2 =	52,4	mm	Pipe thickness

SECTION A-A

$_1$ = 4 * F_C / (3 * A) =	2,04	Mpa	Stress due to F_C load
$_2$ = 4 * F_A / (3 * A) =	2,04	Mpa	Stress due to F_A load
$_3$ = F_C * b * D / (2 * I_o) =	19,61	Mpa	Stress due to F_C load
$_4$ = M_B * D / (2 * I_o) =	12,10	Mpa	Stress due to M_B moment
$_1$ = F_B / A =	1,73	Mpa	Stress due to F_B load
$M_{A\ tot}$ = M_A - F_C * a =	92.405	KN*mm	Tot bending moment M_A
$M_{C\ tot}$ = M_C + F_A * a - F_B * b =	-174.271	KN*mm	Tot bending moment M_C
M = ($M_{A\ tot}^2$ + $M_{C\ tot}^2$)^{0,5} =	197.253	KN*mm	Tot bending moment
$_{m1}$ = +M * D * K_i / (2 * I) =	21,76	Mpa	Stress due to M_A and M_C moment
$_{m2}$ = - M * D * K_i / (2 * I) =	-21,76	Mpa	Stress due to M_A and M_C moment

Stress due to internal pressure

$_{p} = p * d * b_i / (4 * t) =$	57,65	Mpa	Longitudinal Stress
$_{p} = p * d / (2 * t) =$	92,24	Mpa	Tangential Stress

Principal stress calculation (ASME VIII Div. 2 Par. 4-120

$_{z1} = {}_{m1} + {}_{1} + {}_{p} =$	81,14	Mpa
$_{z2} = {}_{m2} + {}_{1} + {}_{p} =$	37,61	Mpa
$_{t} = {}_{p} + \lvert {}_{3} \rvert + \lvert {}_{4} \rvert =$	123,95	Mpa
$= ({}_{1}{}^{2} + {}_{2}{}^{2})^{0,5} =$	2,88	Mpa

$S_{1\text{-}a} = 0,5 * ({}_{t} + {}_{z1} + (({}_{t} - {}_{z1})^2 + 4 * {}^2)^{0,5} =$	124,14	Mpa
$S_{1\text{-}b} = 0,5 * ({}_{t} + {}_{z1} + (({}_{t} - {}_{z2})^2 + 4 * {}^2)^{0,5} =$	124,04	Mpa
$S_{2\text{-}a} = 0,5 * ({}_{t} + {}_{z1} - (({}_{t} - {}_{z1})^2 + 4 * {}^2)^{0,5} =$	80,95	Mpa
$S_{2\text{-}b} = 0,5 * ({}_{t} + {}_{z1} - (({}_{t} - {}_{z2})^2 + 4 * {}^2)^{0,5} =$	37,52	Mpa
$S_3 = 0,5 * p =$	9,58	Mpa

$S_1 - S_2$	$1 = S_{1\text{-}a} - S_{2\text{-}a} =$	43,19	Mpa
	$2 = S_{1\text{-}b} - S_{2\text{-}b} =$	86,53	Mpa
$S_1 + S_3$	$3 = S_{1\text{-}a} + 0,5*p =$	133,72	Mpa
	$4 = S_{1\text{-}b} + 0,5*p =$	133,62	Mpa
$S_2 + S_3$	$5 = S_{2\text{-}a} + 0,5*p =$	90,52	Mpa
	$6 = S_{2\text{-}b} + 0,5*p =$	47,09	Mpa

S (max 1-6) S =	133,72	Mpa	largest absolute value
$3 * {}_{am} =$	507,00	Mpa	Stress intensity limit at design temperature (ASME VII Div. 2 Par. 4-134)

S = **133,72** Mpa < $3 * \sigma_{am} =$ **507,00** Mpa

3	MODIFIED WHERE INDICATED <3>	ITEM	
2	MODIFIED WHERE INDICATED <2>	D-6212/ D-6232	
1	REVISIONE GENERALE	N. SOU0107840/4	
0	EMISSIONE-ISSUE	LINGUA-LANG.	PAGINA-SHEET
REV.	DESCRIZIONE - DESCRIPTION	A	126 / 127

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SOSTITUITO DA - REPLACED BY

SECTION B-B

$_1 = 4 * F_C / (3 * A) =$	2,04	Mpa	Stress due to F_C load
$_2 = 4 * F_A / (3 * A) =$	2,04	Mpa	Stress due to F_A load
$_3 = F_C * b * D / (2 * I_o) =$	19,61	Mpa	Stress due to F_C load
$_4 = M_B * D / (2 * I_o) =$	12,10	Mpa	Stress due to M_B moment
$_1 = F_B / A =$	1,73	Mpa	Stress due to F_B load
$M_{A\ tot} = M_A - F_C*(a+c) =$	83.962	KN*mm	Tot bending moment M_A
$M_{C\ tot} = M_C + F_A*(a+c) - F_B*b =$	-165.828	KN*mm	Tot bending moment M_C
$M = (M_{A\ tot}^2 + M_{C\ tot}^2)^{0,5} =$	185.873	KN*mm	Tot bending moment
$_{m1} = +M * D / (2 * I) =$	15,78	Mpa	Stress due to M_A and M_C moment
$_{m2} = - M * D / (2 * I) =$	-15,78	Mpa	Stress due to M_A and M_C moment

Stress due to internal pressure

$_p = p * d / (4 * t) =$	46,12	Mpa	Longitudinal Stress
$_p = p * d / (2 * t) =$	92,24	Mpa	Tangential Stress

Principal stress calculation (ASME VIII Div. 2 Par. 4-120

$_{z1} = {}_{m1} + {}_1 + {}_p =$	63,62	Mpa
$_{z2} = {}_{m2} + {}_1 + {}_p =$	32,07	Mpa
$_t = {}_p + \| {}_3 \| + \| {}_4 \| =$	123,95	Mpa
$= ({}_1{}^2 + {}_2{}^2)^{0,5} =$	2,88	Mpa

$S_{1-a} = 0,5 * ({}_t + {}_{z1} + (({}_t - {}_{z1})^2 + 4 * {}^2)^{0,5} =$	124,08	Mpa
$S_{1-b} = 0,5 * ({}_t + {}_{z1} + (({}_t - {}_{z2})^2 + 4 * {}^2)^{0,5} =$	124,04	Mpa
$S_{2-a} = 0,5 * ({}_t + {}_{z1} - (({}_t - {}_{z1})^2 + 4 * {}^2)^{0,5} =$	63,49	Mpa
$S_{2-b} = 0,5 * ({}_t + {}_{z1} - (({}_t - {}_{z2})^2 + 4 * {}^2)^{0,5} =$	31,98	Mpa
$S_3 = 0,5 * p =$	9,58	Mpa

$S_1 - S_2$	$1 = S_{1-a} - S_{2-a} =$	60,60	Mpa
	$2 = S_{1-b} - S_{2-b} =$	92,06	Mpa
$S_1 + S_3$	$3 = S_{1-a} + 0,5*p =$	133,66	Mpa
	$4 = S_{1-b} + 0,5*p =$	133,61	Mpa
$S_2 + S_3$	$5 = S_{2-a} + 0,5*p =$	73,06	Mpa
	$6 = S_{2-b} + 0,5*p =$	41,56	Mpa

S (max 1-6) S =	133,66	Mpa	largest absolute value
$1,5 * {}_{am} =$	253,50	Mpa	Stress intensity limit at design temperature (ASME VII Div. 2 Par. 4-134)

S = **133,66** Mpa < $1,5 * \sigma_{am} =$ **253,50** Mpa

3	MODIFIED WHERE INDICATED <3>
2	MODIFIED WHERE INDICATED <2>
1	REVISIONE GENERALE
0	EMISSIONE-ISSUE
REV.	DESCRIZIONE - DESCRIPTION

ITEM
D-6212/ D-6232
N. SOU0107840/4
LINGUA-LANG. **A**
PAGINA-SHEET 127 / 128

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249A

SECTION C-C

$_1 = 4 * F_C / (3 * A) =$	2,04	Mpa	Stress due to F_C load
$_2 = 4 * F_B / (3 * A) =$	2,30	Mpa	Stress due to F_B load
$_3 = M_A * D / (2 * I_o) =$	9,35	Mpa	Stress due to M_A moment
$_1 = F_A / A =$	1,53	Mpa	Stress due to F_A load
$M_{B\ tot} = M_B - F_C*(b-a) =$	-48.881	KN*mm	Tot bending moment M_B
$M_{C\ tot} = M_C - F_B*(b-a) =$	-157.452	KN*mm	Tot bending moment M_C
$M = (M_{B\ tot}^2 + M_{C\ tot}^2)^{0,5} =$	164.865	KN*mm	Tot bending moment
$_{m1} = +M * D * K_i / (2 * I) =$	18,19	Mpa	Stress due to M_B and M_C moment
$_{m2} = -M * D * K_i / (2 * I) =$	-18,19	Mpa	Stress due to M_B and M_C moment

Stress due to internal pressure

$_p = p * d * b_i / (4 * t) =$	57,65	Mpa	Longitudinal Stress
$_p = p * d / (2 * t) =$	92,24	Mpa	Tangential Stress

Principal stress calculation (ASME VIII Div. 2 Par. 4-120

$_{z1} = {}_{m1} + {}_1 + {}_p =$	77,37	Mpa
$_{z2} = {}_{m2} + {}_1 + {}_p =$	40,99	Mpa
$_t = {}_p + \| {}_3 \| =$	101,60	Mpa
$= ({}_1{}^2 + {}_2{}^2)^{0,5} =$	3,07	Mpa

$S_{1\text{-}a} = 0,5 * ({}_t + {}_{z1} + (({}_t - {}_{z1})^2 + 4 * {}^2)^{0,5} =$	101,98	Mpa
$S_{1\text{-}b} = 0,5 * ({}_t + {}_{z1} + (({}_t - {}_{z2})^2 + 4 * {}^2)^{0,5} =$	101,75	Mpa
$S_{2\text{-}a} = 0,5 * ({}_t + {}_{z1} - (({}_t - {}_{z1})^2 + 4 * {}^2)^{0,5} =$	76,98	Mpa
$S_{2\text{-}b} = 0,5 * ({}_t + {}_{z1} - (({}_t - {}_{z2})^2 + 4 * {}^2)^{0,5} =$	40,83	Mpa
$S_3 = 0,5 * p =$	9,58	Mpa

$S_1 - S_2$	$1 = S_{1\text{-}a} - S_{2\text{-}a} =$	25,00	Mpa
	$2 = S_{1\text{-}b} - S_{2\text{-}b} =$	60,92	Mpa
$S_1 + S_3$	$3 = S_{1\text{-}a} + 0,5*p =$	111,55	Mpa
	$4 = S_{1\text{-}b} + 0,5*p =$	111,33	Mpa
$S_2 + S_3$	$5 = S_{2\text{-}a} + 0,5*p =$	86,56	Mpa
	$6 = S_{2\text{-}b} + 0,5*p =$	50,41	Mpa

S (max 1-6) S =	111,55	Mpa	largest absolute value
$3 * {}_{am} =$	507,00	Mpa	Stress intensity limit at design temperature (ASME VII Div. 2 Par. 4-134)

S = **111,55** Mpa < $3 * \sigma_{am} =$ **507,00** Mpa

SOSTITUISCE IL - REPLACES

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249|B

EXTERNAL PRESSURE CALCULATION

SPHERICAL HEAD POS. HEAD

================ (ASME VIII div.2 / Edition 2004 D-3) =================

```
* DESIGN TEMPERATURE                        T =  177.0  C     =  350.6  F

* MATERIAL:                                   SA 542 Gr.D Cl.4a

* ALLOWABLE STRESS                          S = 195.1213 Mpa = 28300.0 Psi

External pressure                           P =   0.1030 Mpa =    14.9 Psi
Head outside crown radius                  Ro =   2351.2 mm  =   92.57 "
Elastic Modulus                             E =  196459 Mpa = 2.849E+07Psi
Adopted thickness                           t =   134.00 mm  =   5.276 "
Corrosion Allowance                         c =     0.00 mm  =   0.000 "
Min thickness for internal pressure-  tmin =   129.30 mm  =   5.091 "

Ro/(t-c)                                      =   17.546
A = 0.125/(Ro/(t-c))                          = 0.00712402
B (Fig. -CS-2        )                        = 111.6994 Mpa = 16200.7 Psi
Pa1= 0.0625*E/(Ro/(t-c))^2                    =  39.8825 Mpa =  5784.5 Psi
Pa2= B/(Ro/(t-c))                             =   6.3660 Mpa =   923.3 Psi
Pa =   min (Pa1,Pa2)                          =   6.3660 Mpa =   923.3 Psi


Min. thickness for design pressure     tr =    6.485 mm  =  0.2553 "
```


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249/C

CYLINDRICAL SHELL POS. SHELL

=============== (ASME VIII div.2 / Edition 2004 D-3) ===============

```
* DESIGN TEMPERATURE                          T =  177.0  C    =  350.6  F

* MATERIAL:                                     SA 336 F22V

* ALLOWABLE STRESS                            S = 195.1213 Mpa = 28300.0 Psi

External pressure                             P =   0.1030 Mpa =    14.9 Psi
External diameter                            Do =   4828.4 mm  =  190.09 "
Elastic Modulus                               E =  196459 Mpa = 2.849E+07Psi
Length between reinforcements                 L =  40135.0 mm  = 1580.12 "
Adopted thickness                             t =   260.00 mm  =  10.236 "
Corrosion Allowance                           c =     0.00 mm  =   0.000 "
Min thickness for internal pressure-       tmin =   258.80 mm  =  10.189 "

L/Do                                            =    8.312
Do/(t-c)                                        =   18.571
A (Fig.G Part D Subpart 3)                      = 0.00328873
B (Fig. -CS-2        )                          = 104.1835 Mpa = 15110.6 Psi
Pa1= 2*A*E/3/(Do/(t-c))                         =  23.1942 Mpa =  3364.0 Psi
Pa2= 4*B/3/(Do/(t-c))                           =   7.4801 Mpa =  1084.9 Psi
Pa =   min (Pa1,Pa2)                            =   7.4801 Mpa =  1084.9 Psi


Min. thickness for design pressure           tr =   36.635 mm  =  1.4423 "
```

CYLINDRICAL SHELL POS. PIPE A-347

```
================ (ASME VIII div.2 / Edition 2004 D-3 ) ================

* DESIGN TEMPERATURE                        T =  177.0  C    =  350.6  F

* MATERIAL:                                   SA 182 F347 <=5 H.S.

* ALLOWABLE STRESS                          S = 137.8949 Mpa = 20000.0 Psi

External pressure                           P =   0.1030 Mpa =    14.9 Psi
External diameter                          Do =    508.0 mm  =   20.00 "
Elastic Modulus                             E =  180958 Mpa = 2.625E+07Psi
Length between reinforcements               L =    500.0 mm  =   19.69 "
Adopted thickness                           t =    50.00 mm  =   1.969 "
Corrosion Allowance                         c =     0.00 mm  =   0.000 "
Min thickness for internal pressure-     tmin =    36.75 mm  =   1.447 "

L/Do                                          =    0.984
Do/(t-c)                                      =   10.160
A (Fig.G Part D Subpart 3)                    = 0.04604863
B (Fig. -HA-2        )                        =  97.8591 Mpa = 14193.3 Psi
Pa1= 2*A*E/3/(Do/(t-c))                       = 546.7764 Mpa = 79303.4 Psi
Pa2= 4*B/3/(Do/(t-c))                         =  12.8424 Mpa =  1862.6 Psi
Pa =   min (Pa1,Pa2)                          =  12.8424 Mpa =  1862.6 Psi


Min. thickness for design pressure        tr =    1.505 mm  =  0.0593 "
```


249/E

CYLINDRICAL SHELL POS. PIPE A

================ (ASME VIII div.2 / Edition 2004 D-3) ================

* DESIGN TEMPERATURE	T =	177.0	C	=	350.6	F
* MATERIAL:		SA 182 F22V				
* ALLOWABLE STRESS	S =	195.1213	Mpa	=	28300.0	Psi
External pressure	P =	0.1030	Mpa	=	14.9	Psi
External diameter	Do =	508.0	mm	=	20.00	"
Elastic Modulus	E =	196459	Mpa	=	2.849E+07	Psi
Length between reinforcements	L =	1369.0	mm	=	53.89	"
Adopted thickness	t =	44.45	mm	=	1.750	"
Corrosion Allowance	c =	0.00	mm	=	0.000	"
Min thickness for internal pressure-	tmin =	25.17	mm	=	0.991	"
L/Do	=	2.694				
Do/(t-c)	=	11.429				
A (Fig.G Part D Subpart 3)	=	0.03823294				
B (Fig. -CS-2)	=	119.8541	Mpa	=	17383.4	Psi
Pa1= 2*A*E/3/(Do/(t-c))	=	438.1534	Mpa	=	63548.9	Psi
Pa2= 4*B/3/(Do/(t-c))	=	13.9830	Mpa	=	2028.1	Psi
Pa = min (Pa1,Pa2)	=	13.9830	Mpa	=	2028.1	Psi
Min. thickness for design pressure	tr =	1.475	mm	=	0.0581	"

CYLINDRICAL SHELL POS. PIPE B 347

================ (ASME VIII div.2 / Edition 2004 D-3) ================

* DESIGN TEMPERATURE	T =	177.0	C	=	350.6	F
* MATERIAL:		SA 182 F347 <=5 H.S.				
* ALLOWABLE STRESS	S =	137.8949	Mpa	=	20000.0	Psi
External pressure	P =	0.1030	Mpa	=	14.9	Psi
External diameter	Do =	609.6	mm	=	24.00	"
Elastic Modulus	E =	180958	Mpa	=	2.625E+07	Psi
Length between reinforcements	L =	500.0	mm	=	19.69	"
Adopted thickness	t =	59.60	mm	=	2.346	"
Corrosion Allowance	c =	0.00	mm	=	0.000	"
Min thickness for internal pressure-	tmin =	44.19	mm	=	1.740	"
L/Do	=	0.820				
Do/(t-c)	=	10.228				
A (Fig.G Part D Subpart 3)	=	0.05708532				
B (Fig. -HA-2)	=	99.2637	Mpa	=	14397.0	Psi
Pa1= 2*A*E/3/(Do/(t-c))	=	673.3061	Mpa	=	97655.0	Psi
Pa2= 4*B/3/(Do/(t-c))	=	12.9399	Mpa	=	1876.8	Psi
Pa = min (Pa1,Pa2)	=	12.9399	Mpa	=	1876.8	Psi
Min. thickness for design pressure	tr =	1.675	mm	=	0.0659	"

CYLINDRICAL SHELL POS. PIPE B

```
================ (ASME VIII div.2 / Edition 2004 D-3 ) ================

* DESIGN TEMPERATURE                     T =  177.0  C     =  350.6  F

* MATERIAL:                                SA 182 F22V

* ALLOWABLE STRESS                       S = 195.1213 Mpa = 28300.0 Psi

External pressure                        P =   0.1030 Mpa =    14.9 Psi
External diameter                       Do =    609.6 mm  =   24.00 "
Elastic Modulus                          E =  196459 Mpa = 2.849E+07Psi
Length between reinforcements            L =   1925.4 mm  =   75.80 "
Adopted thickness                        t =    52.40 mm  =   2.063 "
Corrosion Allowance                      c =     0.00 mm  =   0.000 "
Min thickness for internal pressure- tmin =    30.32 mm  =   1.194 "

L/Do                                       =    3.158
Do/(t-c)                                   =   11.634
A (Fig.G Part D Subpart 3)                 = 0.04650080
B (Fig. -CS-2         )                    = 119.8541 Mpa = 17383.4 Psi
Pa1= 2*A*E/3/(Do/(t-c))                    = 523.5126 Mpa = 75929.2 Psi
Pa2= 4*B/3/(Do/(t-c))                      =  13.7366 Mpa =  1992.3 Psi
Pa =    min (Pa1,Pa2)                      =  13.7366 Mpa =  1992.3 Psi


Min. thickness for design pressure     tr =     1.645 mm  =  0.0648 "
```

CYLINDRICAL SHELL POS. PIPE D1-2

```
================ (ASME VIII div.2 / Edition 2004 D-3 ) ================

* DESIGN TEMPERATURE                        T =  177.0  C    =  350.6  F

* MATERIAL:                                   SA 182 F22V

* ALLOWABLE STRESS                          S = 195.1213 Mpa = 28300.0 Psi

External pressure                           P =   0.1030 Mpa =    14.9 Psi
External diameter                          Do =    219.1 mm  =    8.63 "
Elastic Modulus                             E =  196459 Mpa = 2.849E+07Psi
Length between reinforcements               L =   2795.0 mm  =  110.04 "
Adopted thickness                           t =    18.24 mm  =   0.718 "
Corrosion Allowance                         c =     0.00 mm  =   0.000 "
Min thickness for internal pressure-    tmin =    10.95 mm  =   0.431 "

L/Do                                          =   12.758
Do/(t-c)                                      =   12.011
A (Fig.G Part D Subpart 3)                    = 0.00772965
B (Fig. -CS-2          )                      = 112.1752 Mpa = 16269.7 Psi
Pa1= 2*A*E/3/(Do/(t-c))                       =  84.2873 Mpa = 12224.9 Psi
Pa2= 4*B/3/(Do/(t-c))                         =  12.4525 Mpa =  1806.1 Psi
Pa =    min (Pa1,Pa2)                         =  12.4525 Mpa =  1806.1 Psi


Min. thickness for design pressure      tr =    1.655 mm  =  0.0652 "
```


249/1

OPENINGS IN SHELL AND FORMED HEADS

The required reinforcement area for openings in shell and formed heads under external pressure
shall be not less than:

$$A=(d*t_{er}*F)/2$$

where:

d = diameter in the given plane of the finished opening in mm.
ter = wall thickness required by the rules for vessel under external pressure(see article D-3 of Section VIII div.2 of ASME BAPV Code).
F = the value determined from figure AD-520.1 of article D-3 of Section VIII div.2 of ASME BAPV Code.

Since the required area for openings under internal pressure shall be not less than:

$$A=d*t_{ir}*F$$

where:

t_{ir}= minimum thickness wich meets the requirements of article D-2 of Section VIII div.2 of ASME BAPV Code in the absence of openings.

and since:

$$t_{er} < t_{ir}$$

(for all openings, indeed the internal pressure is governing in present case)

We may affirm that the reiforcement areas, calculated in condition of internal pressure are always greater than the areas required for the external pressure conditions.
Therefore further calculations are not necessary for reinforcement area of openings in
conditions of external pressure.

2491

COVER A FOR HYDRAULIC TEST

ELLIPTICAL HEAD POS. CAP A
=============== (ASME VIII div.2 / Edit. 2004 D-2) ===================

* DESIGN TEMPERATURE	T =	21.1	C	=	70.0 F
* HEAD MATERIAL :		SA234 WPB			
* ALLOW. STRESS (Case 1489-2)	S =	137.9000	Mpa	=	20000.7 Psi
* ALLOW. STRESS,room temp.(Case 1489-2)	Sa=	137.9000	Mpa	=	20000.7 Psi
* YIELD STRENGTH at room temp.	Syh=	241.3000	Mpa	=	34997.7 Psi
Internal design pressure	P =	19.1500	Mpa	=	2777.5 Psi
Internal hydrostatic test pressure	PHy =	28.2000	Mpa	=	4090.1 Psi
Internal diameter	D =	517.0	mm	=	20.35 "
Inside Crown Radius	L =	462.6	mm	=	18.21 "
Inside Knuckle Radius	r =	87.4	mm	=	3.44 "
Corrosion allowance	c =	0.00	mm	=	0.0000 "

* MINIMUM REQUIRED THICKNESS , DESIGN CONDITION

P/S =	=	0.13887			
tr = (D+2c)/2(EXP(P/S)-1)	=	38.29	mm	=	1.5073 "
tr+c =	=	38.29	mm	=	1.5073 "

* MINIMUM REQUIRED THICKNESS , HYDROSTATIC TEST CONDITION

Phy/(0.9*Syh)	=	0.12985			
tr' = D/2(EXP(Phy/(0.9*Syh))-1)	=	35.64	mm	=	1.4030 "
Adopted thickness	t =	46.00	mm	=	1.8110 "

CAPS A

* CHECK OF WELDING

Internal hydro. test pressure	PHy =	28,20	Mpa	=	4.090,0 Psi
Internal diamater	D =	517,00	mm	=	20,354 in
Weld joint thickness	t =	30,00	mm	=	1,181 in
Welding efficiency	E =	0,85			

* WELDING SECTION AREA

tw = 0.707*t=	=	21,21	mm	=	0,835 in
Aw = *(D+tw)*tw =	=	35.863	mm^2	=	55,59 in^2

* STRSS ON WELD

FHy = $*D^2/4*PHy$ =	=	5.919.978	N	=	1.330.842 Lb
= FHy/Aw =	=	165,1	MPa	=	23.941 Psi
$_{al}$= 0.9*Syh*E =	=	184,6	MPa	=	26.773 Psi

2649/M

Nuovo Pignone MASSA	**PRESSURE PARTS CALCULATION OF STAGE 1, HYDROCRACKING REACTORS ITEMS: D-6212 / D-6232**

COVER B FOR HYDRAULIC TEST

```
                        ELLYPTICAL  HEAD  POS. CAP B
 ================ (ASME VIII div.2 / Edit. 2004  D-2) ===================

 * DESIGN TEMPERATURE                              T =   21.1  C    =   70.0  F

 * HEAD  MATERIAL :                                  SA234 WPB

 * ALLOW. STRESS            (Case 1489-2) S = 137.9000 Mpa = 20000.7 Psi

 * ALLOW. STRESS,room temp.(Case 1489-2) Sa= 137.9000 Mpa = 20000.7 Psi

 * YIELD STRENGTH at room temp.           Syh= 241.3000 Mpa = 34997.7 Psi

 * MINIMUM ULTIMATE TENSILE STRENGTH     UTSh= 241.3000 Mpa = 34997.7 Psi


 Internal design pressure                  P =  19.1500 Mpa =  2777.5 Psi
 Internal hydrostatic test pressure      PHy =  28.2000 Mpa =  4090.1 Psi
 Internal diameter                         D =    616.0 mm  =   24.25 "
 Inside Crown Radius                       L =    554.4 mm  =   21.83 "
 Inside Knuckle Radius                     r =    104.7 mm  =    4.12 "
 Corrosion allowance                       c =     0.00 mm  =  0.0000 "

 * MINIMUM REQUIRED THICKNESS , DESIGN CONDITION
 P/S =                                        =  0.13887
 tr     = (D+2c)/2(EXP(P/S)-1)                =    45.88 mm  =   1.8064 "
 tr+c   =                                     =    45.88 mm  =   1.8064 "

 * MINIMUM REQUIRED THICKNESS , HYDROSTATIC TEST CONDITION
 Phy/(0.9*Syh)                                =  0.12985
 tr'    = D/2(EXP(Phy/(0.9*Syh))-1)           =    42.71 mm  =   1.6814 "

 Adopted thickness                         t =     48.00 mm  =  1.8898 "


* CHECK OF WELDING
Internal hydro. test pressure      PHy =       28,20 Mpa    =      4.090,0 Psi
Internal diamater                    D =      616,00 mm     =       24,252 in
Weld joint thickness                 t =       35,00 mm     =        1,378 in
Welding efficiency                   E =        0,85

* WELDING SECTION AREA
tw =     0.707*t=                        =      24,75 mm    =        0,974 in
Aw =      *(D+tw)*tw =                   =     49.811 mm^2  =        77,21 in^2

* STRSS ON WELD
FHy =     *D^2/4*PHy =                   =  8.404.278 N     =  1.889.325 Lb
  =      FHy/Aw =                        =      160,3 MPa   =     23.247 Psi
 al=     0.9*Syh*E =                     =      184,6 MPa   =     26.773 Psi
```

3	MODIFIED WHERE INDICATED <3>	ITEM D-6212/ D-6232	
2	MODIFIED WHERE INDICATED <2>		
1	REVISIONE GENERALE	N. SOU0107840/4	
0	EMISSIONE-ISSUE	LINGUA-LANG. A	PAGINA-SHEET 138 / 138
REV.	DESCRIZIONE - DESCRIPTION		

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SOSTITUITO DA - REPLACED BY

249/N

Nuovo Pignone MASSA	CLIENTE – CUSTOMER **CONOCO PHILLIPS**
	LOCALITA' - PLANT LOCATION **WILHELMSHAVEN, GERMANY**
COMMESSA - JOB **3100276-277**	IMPIANTO - PROJECT **WRG – DEEP CONVERSION PROJECT**

TITOLO - TITLE

STRUCTURAL PARTS CALCULATION OF STAGE 2 , HYDROCRACKING REACTORS

ITEMS: D-6212/ D-6232

TOTAL SHEETS 58

REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
3	MODIFIED WHERE SHOW <3>	Larrezini	Ricci S.	Ronchieri A.	11/03/10
2	MODIFIED WHERE SHOW <2>	Larrezini	Ricci	Ronchieri	16/11/06
1	MODIFIED WHERE SHOW <1>	Larrezini	Ricci	Ronchieri	20/06/06
0	EMISSIONE-ISSUE	Larrezini	Ricci	Ronchieri	06/03/06

ITEM **D-6212/ D-6232**

N. SOU0107841/4

LINGUA-LANG.	PAGINA-SHEET
A	1 / 2

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

250

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APPLICABLE CODE AND STANDARD <1>

- NUOVO PIGNONE – DRAWING – SUO0269057/1 and SUO0269058/1
- AD-2000-Merkblatt S3
- DIN 1055-4 2005-03
- BROWNELL & YOUNG

Nuovo Pignone

MASSA

STRUCTURAL PARTS CALCULATION OF
STAGE 2 , PRETREATING REACTORS
ITEMS: D-6212 / D-6232

WEIGHT & GRAVITY CENTER CALCULATION <2>

Pos	Q.ty	ITEM	W N	W tot N	V int dm^3	V tot dm^3	Yg mm
1	1	Top Head Ri. 2213 thk. 137,2	199.253	**199.253**	9.359,5	**9.359,5**	**38.620**
2	1	Bottom Head Ri. 2213 thk. 137,2	207.261	**207.261**	9.359,5	**9.359,5**	**-1.737**
3	1	Belt O Di. 4300 thk.264,2 H 2220	653.788	**653.788**	31.948,4	**31.948,4**	**180**
4	1	Belt N Di. 4300 thk.264,2 H 3300	980.781	**980.781**	47.922,6	**47.922,6**	**2.930**
5	1	Belt M Di. 4300 thk.264,2 H 3400	1.010.501	**1.010.501**	49.374,8	**49.374,8**	**6.280**
6	1	Belt L Di. 4300 thk.264,2 H 2990	888.647	**888.647**	43.420,8	**43.420,8**	**9.475**
7	1	Belt I Di. 4300 thk.264,2 H 3050	906.479	**906.479**	44.292,1	**44.292,1**	**12.495**
8	1	Belt H Di. 4300 thk.264,2 H 3457	1.027.442	**1.027.442**	50.202,6	**50.202,6**	**15.749**
9	1	Belt G Di. 4300 thk.264,2 H 3457	1.027.442	**1.027.442**	50.202,6	**50.202,6**	**19.206**
10	1	Belt F Di. 4300 thk.264,2 H 3050	906.479	**906.479**	44.292,1	**44.292,1**	**22.459**
11	1	Belt E Di. 4300 thk.264,2 H 2655	789.083	**789.083**	38.555,9	**38.555,9**	**25.312**
12	1	Belt D Di. 4300 thk.264,2 H 2220	659.798	**659.798**	32.238,9	**32.238,9**	**27.749**
13	1	Belt C Di. 4300 thk.264,2 H 3400	1.010.501	**1.010.501**	49.374,8	**49.374,8**	**30.559**
14	1	Belt B Di. 4300 thk.264,2 H 3400	1.010.501	**1.010.501**	49.374,8	**49.374,8**	**33.959**
15	1	Belt A Di. 4300 thk.264,2 H 2260	577.246	**577.246**	32.819,7	**32.819,7**	**36.670**
16	1	FLANGE A	11.254	**11.254**	48,0	**48,0**	**41.813**
17	16	Bolt dia. 3 1/4" L= 680	286	**4.568**			**41.813**
18	32	Nut 3 1/4" M	57	**1.825**			**41.813**
19	1	FLANGE A	11.254	**11.254**	48,0	**48,0**	**41.813**
20	1	Pipe Dia. 508,4 thk. 50,7 L=1370	7.836	**7.836**	178,2	**178,2**	**41.813**
21	1	Elbow Dia. 508,4 thk. 50,7 R. 762	6.846	**6.846**	155,7	**155,7**	**41.432**
22	1	Pipe Dia. 508,4 thk. 50,7 L=174	995	**995**	22,6	**22,6**	**40.964**
23	1	FLANGE NOZZLE M	43.303	**43.303**	76,4	**76,4**	**40.540**
24	20	Bolt dia. 4" L= 990	630	**12.594**			**40.330**
25	40	Nut 4" H	120	**4.789**			**40.330**
26	1	NOZZLE M	92.780	**92.780**	945,2	**945,2**	**39.622**
27	1	FLANGE B	26.793	**26.793**	87,8	**87,8**	**-3.727**
28	16	Bolt dia. 3 3/4" L= 900	503	**8.050**			**-3.727**
29	32	Nut 3 3/4" M	87	**2.781**			**-3.727**
30	1	FLANGE B	26.793	**26.793**	87,8	**87,8**	**-3.727**
31	1	Pipe Dia. 609,6 thk. 58,4 L=1925	15.273	**15.273**	367,2	**367,2**	**-3.727**
32	1	Elbow Dia. 609,6 thk. 58,4 R. 914,4	11.396	**11.396**	274,0	**274,0**	**-3.270**
33	1	NOZZLE B	6.736	**6.736**	111,8	**111,8**	**-2.451**
34	2	BLIND FLANGE D1-2	2.352	**4.704**			**-5.040**
35	24	Bolt dia. 1 5/8" L= 330	35	**831**			**-5.050**
36	48	Nut 1 5/8" H	9	**421**			**-5.050**
37	2	FLANGE D1-2	2.570	**5.140**	7,6	**15,2**	**-4.909**
38	2	Pipe Dia. 219,08 thk. 24,24 L=2793	3.251	**6.502**	63,8	**127,7**	**-3.322**

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE

ITEM **D-6212/ D-6232**

N. SOU0107841/4

LINGUA-LANG. **A**

PAGINA-SHEET **4 / 5**

SOSTITUISCE IL - REPLACES

PARI NUMERO

SOSTITUITO DA - REPLACED BY

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MASSA

STRUCTURAL PARTS CALCULATION OF STAGE 2 , PRETREATING REACTORS ITEMS: D-6212 / D-6232

Pos	Q.ty	ITEM	W N	W tot N	V int dm^3	V tot dm^3	Yg mm	
39	2	NOZZLE D1-2	2.902	5.805	10,8	21,6	-2.082	
40	2	NOZZLE D3-4	13.101	26.201	20,8	41,5	25.575	
41	16	Bolt dia. 2" L= 350	56	890			25.575	
42	32	Nut 2" H	16	510			25.575	
43	2	BLIND FLANGE D3-4	1.558	3.116			25.575	
44	2	NOZZLE D5-6	11.968	23.936	20,8	41,5	12.215	
45	16	Bolt dia. 2" L= 350	56	890			12.215	
46	32	Nut 2" H	16	510			12.215	
47	2	BLIND FLANGE D5-6	1.558	3.116			12.215	
48	1	NOZZLE T1	2.832	2.832	2,7	2,7	33.045	
49	1	NOZZLE T2	2.832	2.832	2,7	2,7	29.450	
50	1	NOZZLE T3	2.832	2.832	2,7	2,7	19.685	
51	1	NOZZLE T4	2.832	2.832	2,7	2,7	16.090	
52	1	NOZZLE T5	2.832	2.832	2,7	2,7	6.320	
53	1	NOZZLE T6	2.832	2.832	2,7	2,7	2.725	
54	1	NOZZLE T7	2.832	2.832	2,7	2,7	25.855	
55	1	NOZZLE T8	2.832	2.832	2,7	2,7	23.280	
56	1	NOZZLE T9	2.832	2.832	2,7	2,7	12.495	
57	1	NOZZLE T10	2.832	2.832	2,7	2,7	9.915	
58	1	NOZZLE T11	2.832	2.832	2,7	2,7	300	
59	1	NOZZLE E1	11.217	11.217	25,5	25,5	25.025	
60	12	Bolt dia. 1 5/8" L= 330	35	416			25.025	
61	24	Nut 1 5/8" H	9	211			25.025	
62	1	BLIND FLANGE E1	2.352	2.352			25.025	
63	1	NOZZLE E2	11.217	11.217	25,5	25,5	11.665	
64	12	Bolt dia. 1 5/8" L= 330	35	416			11.665	
65	24	Nut 1 5/8" H	9	211			11.665	
66	1	BLIND FLANGE E2	2.352	2.352			11.665	
67	1	FLANGE D7	777	777	2,5	2,5	-3.485	
68	8	Bolt dia. 1 1/2" L= 260	20	156			-3.485	
69	16	Nut 1 1/2" M	6	98			-3.485	
70	1	BLIND FLANGE D7	2.352	2.352			-3.485	
71	1	Skirt Belt Di. 4738,4 thk.45 H 1180	62.603	62.603			-1.440	
72	1	Skirt Belt Di. 4738,4 thk.45 H 3000	159.159	159.159			-3.530	
73	1	Skirt Belt Di. 4738,4 thk.45 H 2750	145.896	145.896			-6.405	<2>
74	1	Base Ring dia. 5158,6 / 4558,6 thk. 70	24.485	24.485			-7.815	<2>
75	1	Upper Ring dia. 5158,6 / 4828,4 thk. 7	13.561	13.561			-7.530	<2>

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE

ITEM D-6212/ D-6232

N. SOU0107841/4

LINGUA-LANG. A

PAGINA-SHEET 5 / 6

SOSTITUISCE IL - REPLACES PARI NUMERO

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MASSA

STRUCTURAL PARTS CALCULATION OF STAGE 2 , PRETREATING REACTORS ITEMS: D-6212 / D-6232

Pos	Q.ty	ITEM	W N	W tot N	V int dm^3	V tot dm^3	Yg mm	
76	48	Plate 165,1 x 215 thk. 20	56	2.673			-7.673	<2>
77	2	skirt opening Dia. 609,6 thk. 35 L=304	1.511	3.022			-6.230	<2>
78	1	Opening B Dia. 1425 thk. 45 L=200	3.061	3.061			-3.726	
79	2	Opening D1-2 Dia. 617,5 thk. 45 L=40	2.540	5.080			-4.100	
		-						

	TOTAL VESSEL WEIGHT		12.716.110	N	2.857.671	Lb	
<2>	**ALLOWANCE**	**3,0%**	13.132.594	N	2.951.267	Lb	
	ASSUMED WEIGHT		**13.135.000**	**N**	**2.951.807**	**Lb**	
	TOTAL INTERNAL CAPACITY		**585.473**	**dm^3**	**20.676**	**ft^3**	
	GRAVITY CENTER FROM B.T.L.		**17.820**	**mm**	**701,57**	**in**	<2>
	SKIRT HEIGHT		**7.850**	**mm**	**309,06**	**in**	<2>
	GRAVITY CENTER FROM BASE		**25.670**	**mm**	**1010,63**	**in**	<2>

W - Item single weight
W_{tot} - Total items weight (W x Q.ty)
V - Item internal capacity
V_{tot} - Total items internal capacity (V x Q.ty)
Y_g - Item gravity center from bottom tangent line

REV.	DESCRIZIONE - DESCRIPTION	
3	MODIFIED WHERE SHOW <3>	ITEM D-6212/ D-6232
2	MODIFIED WHERE SHOWN <2>	N. SOU0107841/4
1	MODIFIED WHERE SHOWN <1>	LINGUA-LANG. A
0	EMISSIONE-ISSUE	PAGINA-SHEET 6 / 7

SOSTITUISCE IL - REPLACES PARI NUMERO
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WEIGHT SUMMARY <1>

		WEIGHT				
1)	VESSEL METAL WEIGHT	13.135.000	N	2.951.807	Lb	<1>
2)	EXTERNAL ATTACHMENTS	20.000	N	4.495	Lb	
3)	INSULATION	154.000	N	34.608	Lb	
4)	FIRE PROOFING	206.000	N	46.294	Lb	
5)	TOTAL INTERNAL WEIGHT	(*) 6.828.000	N	1.534.445	Lb	
6)	TEST FLUID	5.742.000	N	1.290.390	Lb	

(*) from dwg 939031-304-02-A1-0 note 4
total internal weight 605400 Kg plus 15% due to operating fluid

The following assumptions have been made to perform the calculation:

Density of metal =	78,45	KN/m^3	499,42	Lb/ft^3	
Density of insulation =	0,8	KN/m^3	5,09	Lb/ft^3	<1>
Density of fire proofing =	22,0	KN/m^3	140,05	Lb/ft^3	
Density of test fluid =	9,806	KN/m^3	62,42	Lb/ft^3	

		WEIGHT				
OPERATING CONDITION	Wo =	**20.343**	**KN**	**4.571.652**	Lb	<1>
ERECTION CONDITION	We =	**13.135**	**KN**	**2.951.809**	Lb	<1>
HYDROTEST CONDITION	Wh =	**19.963**	**KN**	**4.486.255**	Lb	<1>
LIFTING CONDITION	Wl =	**13.515**	**KN**	**3.037.206**	Lb	<1>

- Operating weight includes the following items: 1 , 2 , 3 , 4 , 5
- Erection weight includes the following items: 1
- Hydrotest weight includes the following items: 1 , 6
- Lifting weight includes the following items: 1 , 2 , 3 , 4

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE

ITEM D-6212/ D-6232
N. SOU0107841/4
LINGUA-LANG. A
PAGINA-SHEET 7 / 8

SOSTITUISCE IL - REPLACES PARI NUMERO
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SNOW LOAD CALCULATION <2>

SNOW LOAD CALCOLATION ACCORTING TO DIN 1055-5

NORMAL SNOW LOAD

Para 4

D =	4.828,4 mm	Vessel diameter
T =	200,0 mm	Insulation thickness
x =	1.000,0 mm	Extra dimensione due to nozzle and piping
w =	0,75 KN/m^2	Snow static pressure

D_o =	D + 2*(T+x) =	7228,4 mm	Vessel outer diameter
A =	$\pi * D_o^2 / 4$ =	41,04 m^2	Vessel project area
F =	A * w =	**30,78** KN	**SNOW LOAD**

WIND LOAD CALCULATION <2>

WIND CALCULATION ACCORDING TO DIN 1055-4 2005-03 **JOB 3100276-277**

TABLE B.2 **WIND DESIGN FACTOR** **OPERATING CONDITION**

Zone	I	II	III	IV		Wind zone
z_{min} =	2	4	8	16	m	Minimum building height
z_e =	48,14	48,14	48,14	48,14	m	Max vessel height
v_{ref} =	22,5	25	27,5	30	m/s	Reference wind velocity **(A.1)**
v_m =	32,06	32,15	29,92	26,92	m/s	Design wind velocity
I_v =	0,116	0,148	0,198	0,268		Importance Wind factor
q_{ref} =	0,32	0,39	0,47	0,56	kN/m^2	Reference wind pressure **(A.1)**
q =	1,122	1,194	1,224	1,155	kN/m^2	Design wind pressure
v =	42,06	43,77	44,56	43,13	m/s	

Para C.2 (1) **WIND ZONE III**

F_w =	$G * c_f * q_m(z_e) * A_{ref}$ =	**254,7**	**KN**	**Equation C.1**
where				
G =		**1,231**		
c_f =		**1,06**		Force coefficient
A_{ref} =		347,98	m^2	Vessel section area
q_m =		0,56	KN/m^2	Wind pressure at z_e elevation
z_e =		48.140	mm **<2>**	Max vessel height

Para 12.6

C_f =	$\psi * C_{fo}$ =	**1,063**		**Equation 28**
where :				
C_{fo} =		1,25		See Table **10**
ψ =		0,850		See Para 12.13

Para C.2 (3)

q_m =	$1/2 * \rho * v_m^2$ =	**559,54**	N/m^2	**Equation C.3**
		0,56	KN/m^2	
where				
ρ =		1,25	Kg/m^3	Air density
v_m =		29,92	m/s	Wind velcoty

Para C.3 (1)

G =	$1+2*g*I_v(z_e)*(Q_o^2+R_x^2)^{0.5}$ =	**1,231**		**Equation C.4**
where :				
I_v =	From table **B2**	**0,198**		
g =	$(2*\ln(\nu_E*t)^{0.5} + 0,6*/(2*\ln(\nu_E*t)^{0.5}$ =	**3,782**		**Equation C.5**
where :				
t =		**600**	sec	
$_E$ =	$((\nu^2_{E,0}*Q_o^2+ n^2_{1,x}*R_x^2)/(Q_o^2+R_x^2))^{0.5}$ =	**1,1527**		**Equation C.6**
$_{E,0}$ =	$(\nu_m(z_e) / L_i(z_e) * 1/1,11*S^{0,615}$=	**1,8838**		**Equation C.7**
S =	$0,46*(b+h)/L_i(z_e)+1,58*(b*h)^{0.5}/L_i(z_e)$ =	**0,3604**		**Equation C.8**
where:				
b =	Max vessel wind exposed width	7,2284	m	See Sketch **C.1**
h =	Max vessel height	48,14	m **<2>**	See Sketch **C.1**
$v_m(z_e)$=	From Table **B2**	29,92	m/s	Wind velcoty

$L_i(z_e)$=	$300*(z/300)^{\varepsilon}$ =	**152,45** m		**Equation C.9**
where :				
ε =		0,37		Form table **C.1**
z =		48,14 m	**<2>**	Vessel height
Q_o^2 =	$1 / (1+0{,}9*((b+h)/L_i(z_e))^{0.63})$=	**0,6777**		**Equation C.10**
R_x^2 =	$\pi^2/(2*\delta)* R_N *R_h*R_b$ =	**0,03508**		**Equation C.11**
where :				
R_N =	$6{,}8*N_{1,x}/(1+10{,}2*N_{1,x})^{5/3}$ =	**0,0456**		**Equation C.12**
where :				
$N_{1,x}$ =	$n_{1,x} * L_i(z_e)/v_m(z_e)$ =	**5,2390**		**Equation C.13**
where :				
$n_{1,x}$ =	1 / T =	1,0283 Htz		Vessel frequency
T =	See calculation	0,9725 sec	**<2>**	Vessel period
$L_i(z_e)$=		152,45 m		Equation C.9
$v_m(z_e)$=	From Table B2	29,92 m/s		Wind velcoty
R_h =	$R_{l\,(h)}$=	**0,1228**		**Equation C.15**
R_b =	$R_{l\,(b)}$=	**0,5491**		**Equation C.16**
where :				
$R_{l\,(h)}$=	$1/\eta_{(h)} - 1/(2\cdot\eta_{(h)}^2)*(1-e^{-2*\eta(h)})$ =	**0,12277**		**Equation C.14**
$R_{l\,(h)}$=	$1/\eta_{(b)} - 1/(2\cdot\eta_{(b)}^2)*(1-e^{-2*\eta(b)})$ =	**0,54910**		**Equation C.14**
where :				
$\eta(h)$=	$4{,}6*N_{1,x}*h/L_i(ze)$ =	7,610		
$\eta(b)$=	$4{,}6*N_{1,x}*b/L_i(ze)$ =	1,143		
$N_{1,x}$ =		5,2390		Equation C.13
h =	Max vessel height	48,14 m		See Sketch **C.1**
b =	Max vessel wind exposed width	7,2284 m		See Sketch **C.1**
$L_i(z_e)$=		152,45 m		Equation C.9

Para F.5 (1)

=	$\delta_s + \delta_a + \delta_d$ =	**0,432**		**Equation F.7**
where :				
$_s$ =	$a_1 * n_1 + b_1 > \delta_{min}$ = Max(0,096:0,1)=	**0,100**		**Equation F.8**
where :				
a_1=		0,045		From table **F.2**
b_1 =		0,05		From table **F.2**
δ_{min} =		0,1		From table **F.2**
n_1 =	1 / T =	1,0283 Htz		Vessel frequency
$_a$ =	$\rho * b * c_f / (2 * n_{1,x} * m_{1,x}) * v_m(z_e)$ =	**0,2321**		
where :				
ρ =		1,25 Kg/m^3		Air density
b =	Max vessel wind exposed width	7,2284 m		See Sketch **C.1**
c_f =	$\psi * C_{fo}$ =	1,063		Equation 28
$m_{1,x}$ =	Operating weight	601,8 Kg/m		
$v_m(z_e)$ =	From Table B2	29,92 m/s		Wind velcoty
z_e =		48,140 m	<2>	Max vessel height
$_d$ =		**0,1**		**Assumed**

VESSEL SECTION AREA

A_{ref} =	(D+ 2*(T+ x) * H =	**347,98** m^2		
D =		4.828,4 mm		Vessel outer diameter
T =		200 mm		Insulation thickness
x =		1.000 mm		Extra dimensione due to nozzle and piping
H =		48.140 mm		Vessel height
F =		**255** KN	<2>	**WIND SHEAR LOAD**
M =	F * H/2 =	**6.130** KN*m	<2>	**WIND BENDING MOMENT**

WIND AND SNOW LOAD COMBINATION <2>

q_m =		0,56 KN/m^2	Wind pressure
w =	(see snown load calculation)	0,75 KN/m^2	Snow pressure
q =	Max (q_1 : q_2) =	**1,030** KN/m^2	Combined wind and snow pressure
q_1 =	q_m + w/2 =	0,935 KN/m^2	
q_2 =	w + q_m/2 =	1,030 KN/m^2	
F =	$G * c_f * q_m(z_e) * A_{ref}$ =	**468,7 KN**	**TOTAL SHEAR LOAD**
M =	F * H/2 =	**11.282 KN*m**	**TOTAL BENDING MOMENT**

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STRUCTURAL PARTS CALCULATION OF STAGE 2 , PRETREATING REACTORS ITEMS: D-6212 / D-6232

WIND CALCULATION ACCORDING TO DIN 1055-4 2005-03 **JOB 3100276-277**

TABLE B.2 **WIND DESIGN FACTOR** **ERECTION CONDITION**

Zone	I	II	III	IV		Wind zone
z_{min} =	2	4	8	16	m	Minimum building height
z_e =	48,14	48,14	48,14	48,14	m	Max vessel height
v_{ref} =	22,5	25	27,5	30	m/s	Reference wind velocity **(A.1)**
v_m =	32,06	32,15	29,92	26,92	m/s	Design wind velocity
I_v =	0,116	0,148	0,198	0,268		Importance Wind factor
q_{ref} =	0,32	0,39	0,47	0,56	kN/m^2	Reference wind pressure **(A.1)**
q =	1,122	1,194	1,224	1,155	kN/m^2	Design wind pressure
v =	42,06	43,77	44,56	43,13	m/s	

Para C.2 (1) **WIND ZONE** **III**

F_w = $G * c_f * q_m(z_e) * A_{ref}$ = **170,8** **KN** **Equation C.1**

where
- G = **1,236**
- c_f = **1,06** Force coefficient
- A_{ref} = 232,44 m^2 Vessel section area
- q_m = 0,56 KN/m^2 Wind pressure at z_e elevation
- z_e = 48.140 mm <2> Max vessel height

Para 12.6

C_f = $\psi * C_{fo}$ = **1,063** **Equation 28**

where :
- C_{fo} = 1,25 See Table **10**
- ψ = 0,850 See Para 12.13

Para C.2 (3)

q_m = $1/2 * \rho * v_m^2$ = **559,54** N/m^2 **Equation C.3**
0,56 KN/m^2

where
- ρ = 1,25 Kg/m^3 Air density
- v_m = 29,92 m/s Wind velcoty

Para C.3 (1)

G = $1+2*g*I_v(z_e)*(Q_o^2+R_x^2)^{0.5}$ = **1,236** **Equation C.4**

where :
- **I_v =** From table **B2** **0,198**
- **g =** $(2*\ln(\nu_E*t)^{0.5} + 0,6*/(2*\ln(\nu_E*t)^{0.5}$ = **3,795** **Equation C.5**

where :
- **t =** **600** sec
- $_E$ = $((\nu^2_{E,O}*Q_o^2+ n^2_{1,x}*R_x^2)/(Q_o^2+R_x^2))^{0.5}$ = **1,2095** **Equation C.6**
- $_{E,0}$ = $(v_m(z_e) / L_i(z_e) * 1/1,11*S^{0,615}$= **2,0194** **Equation C.7**
- **S =** $0,46*(b+h)/L_i(z_e)+1,58*(b*h)^{0.5}/L_i(z_e)$ = **0,3178** **Equation C.8**

where:
- b = Max vessel wind exposed width 4,8284 m See Sketch **C.1**
- h = Max vessel height 48,14 m <2> See Sketch **C.1**
- $v_m(z_e)$= From Table **B2** 29,92 m/s Wind velcoty

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE

ITEM **D-6212/ D-6232**

N. SOU0107841/4

LINGUA-LANG. **A** PAGINA-SHEET **12 / 13**

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$L_i(z_e)$=	$300*(z/300)^{\varepsilon}$ =	**152,45** m		**Equation C.9**
where :				
ε =		0,37		Form table **C.1**
z =		48,14 m	**<2>**	Vessel height
Q_o^2 =	$1 / (1+0{,}9*((b+h)/L_i(z_e))^{0.63})$=	**0,6838**		**Equation C.10**
R_x^2 =	$\pi^2/(2*\delta)* R_N *R_h*R_b$ =	**0,03605**		**Equation C.11**
where :				
R_N =	$6{,}8*N_{1,x}/(1+10{,}2*N_{1,x})^{5/3}$ =	**0,0396**		**Equation C.12**
where :				
$N_{1,x}$ =	$n_{1,x} * L_i(z_e)/v_m(z_e)$ =	**6,5186**		**Equation C.13**
where :				
$n_{1,x}$ =	1 / T =	1,2794 Htz		Vessel frequency
T =	See calculation	0,7816 sec	**<2>**	Vessel period
$L_i(z_e)$=		152,45 m		Equation C.9
$v_m(z_e)$=	From Table B2	29,92 m/s		Wind velcoty
R_h =	$R_{l\,(h)}$=	**0,1000**		**Equation C.15**
R_b =	$R_{l\,(b)}$=	**0,6123**		**Equation C.16**
where :				
$R_{l\,(h)}$=	$1/\eta_{(h)} - 1/(2\text{-}\eta_{(h)}^2)*(1-e^{-2*\eta(h)})$ =	**0,10003**		**Equation C.14**
$R_{l\,(h)}$=	$1/\eta_{(b)} - 1/(2\text{-}\eta_{(b)}^2)*(1-e^{-2*\eta(b)})$ =	**0,61226**		**Equation C.14**
where :				
$\eta(h)$=	$4{,}6*N_{1,x}*h/L_i(ze)$ =	9,469		
$\eta(b)$=	$4{,}6*N_{1,x}*b/L_i(ze)$ =	0,950		
$N_{1,x}$ =		6,5186		Equation C.13
h =	Max vessel height	48,14 m		See Sketch **C.1**
b =	Max vessel wind exposed width	4,8284 m		See Sketch **C.1**
$L_i(z_e)$=		152,45 m		Equation C.9

REV.	DESCRIZIONE - DESCRIPTION	
3	MODIFIED WHERE SHOW <3>	ITEM D-6212/ D-6232
2	MODIFIED WHERE SHOWN <2>	N. SOU0107841/4
1	MODIFIED WHERE SHOWN <1>	LINGUA-LANG. A
0	EMISSIONE-ISSUE	PAGINA-SHEET 13 / 14

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SOSTITUITO DA - REPLACED BY

Para F.5 (1)

=	$\delta_s + \delta_a + \delta_d$ =		**0,332**	**Equation F.7**
where :				
$_s$ =	$a_1 * n_1 + b_1 > \delta_{min}$ =	Max(0,108:0,1)=	**0,108**	**Equation F.8**
where :				
a_1=			0,045	From table **F.2**
b_1 =			0,05	From table **F.2**
δ_{min} =			0,1	From table **F.2**
n_1 =	1 / T =		1,2794 Htz	Vessel frequency
$_a$ =	$\rho * b * c_f / (2 * n_{1,x} * m_{1,x}) * v_m(z_e)$ =		**0,1246**	
where :				
ρ =			1,25 Kg/m^3	Air density
b =	Max vessel wind exposed width		4,8284 m	See Sketch **C.1**
c_f =	$\psi * C_{fo}$ =		1,063	Equation 28
$m_{1,x}$ =	Operating weight		601,8 Kg/m	
$v_m(z_e)$ =	From Table B2		29,92 m/s	Wind velcoty
z_e =			48,140 m <2>	Max vessel height
$_d$ =			**0,1**	**Assumed**

VESSEL SECTION AREA

A_{ref} =	(D+ 2*(T+ x) * H =	**232,44** m^2	
D =		4.828,4 mm	Vessel outer diameter
T =		0 mm	Insulation thickness
x =		0 mm	Extra dimensione due to nozzle and piping
H =		48.140 mm	Vessel height
F =		**171** KN **<2>**	**WIND SHEAR LOAD**
M =	F * H/2 =	**4.112** KN*m **<2>**	**WIND BENDING MOMENT**

WIND AND SNOW LOAD COMBINATION <2>

q_m =		0,56 KN/m^2	Wind pressure
w =	(see snown load calculation)	0,75 KN/m^2	Snow pressure
q =	Max (q_1 : q_2) =	**1,030** KN/m^2	Combined wind and snow pressure
q_1 =	q_m + w/2 =	0,935 KN/m^2	
q_2 =	w + q_m/2 =	1,030 KN/m^2	
F =	$G * c_f * q_m(z_e) * A_{ref}$ =	**314,4 KN**	**TOTAL SHEAR LOAD**
M =	F * H/2 =	**7.567 KN*m**	**TOTAL BENDING MOMENT**

Nuovo Pignone

MASSA

STRUCTURAL PARTS CALCULATION OF STAGE 2 , PRETREATING REACTORS ITEMS: D-6212 / D-6232

WIND CALCULATION ACCORDING TO DIN 1055-4 2005-03 **JOB 3100276-277**

TABLE B.2 **WIND DESIGN FACTOR**

HYDROTEST CONDITION
60% OF WIND LOAD

Zone	I	II	III	IV		Wind zone
z_{min} =	2	4	8	16	m	Minimum building height
z_e =	48,14	48,14	48,14	48,14	m	Max vessel height
v_{ref} =	22,5	25	27,5	30	m/s	Reference wind velocity **(A.1)**
v_m =	32,06	32,15	29,92	26,92	m/s	Design wind velocity
I_v =	0,116	0,148	0,198	0,268		Importance Wind factor
q_{ref} =	0,32	0,39	0,47	0,56	kN/m^2	Reference wind pressure **(A.1)**
q =	1,122	1,194	1,224	1,155	kN/m^2	Design wind pressure
v =	42,06	43,77	44,56	43,13	m/s	

Para C.2 (1) **WIND ZONE** **III**

F_w = $G * c_f * q_m(z_e) * A_{ref} * 0,6$ = **105,6 KN** **Equation C.1**

where
G = **1,274**
c_f = **1,06** Force coefficient
A_{ref} = 232,44 m^2 Vessel section area
q_m = 0,56 KN/m^2 Wind pressure at z_e elevation
z_e = 48.140 mm **<2>** Max vessel height

Para 12.6

C_f = $\psi * C_{fo}$ = **1,063** **Equation 28**

where :
C_{fo} = 1,25 See Table **10**
ψ = 0,850 See Para 12.13

Para C.2 (3)

q_m = $1/2 * \rho * v_m^2$ = **559,54** N/m^2 **Equation C.3**
0,56 KN/m^2

where
ρ = 1,25 Kg/m^3 Air density
v_m = 29,92 m/s Wind velcoty

Para C.3 (1)

G = $1+2*g*I_v(z_e)*(Q_o^2+R_x^2)^{0.5}$ = **1,274** **Equation C.4**

where :
I_v = From table **B2** **0,198**
g = $(2*\ln(v_E*t)^{0.5} + 0,6*/(2*\ln(v_E*t)^{0.5}$ = **3,795** **Equation C.5**

where :
t = **600** sec
$_E$= $((v^2_{E,O}*Q_o^2+ n^2_{1,x}*R_x^2)/(Q_o^2+R_x^2))^{0.5}$ = **1,2083** **Equation C.6**
$_{E,0}$ = $(v_m(z_e) /L_i(z_e) * 1/1,11*S^{0,615}$= **2,0194** **Equation C.7**
S = $0,46*(b+h)/L_i(z_e)+1,58*(b*h)^{0.5}/L_i(z_e)$ = **0,3178** **Equation C.8**

where:
b = Max vessel wind exposed width 4,8284 m See Sketch **C.1**
h = Max vessel height 48,14 m **<2>** See Sketch **C.1**
$v_m(z_e)$= From Table **B2** 29,92 m/s Wind velcoty

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE

ITEM **D-6212/ D-6232**

N. SOU0107841/4

LINGUA-LANG. **A** PAGINA-SHEET **15 / 16**

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$L_i(z_e)$=	$300*(z/300)^{\varepsilon}$ =	**152,45** m		**Equation C.9**
where :				
ε =		0,37		Form table **C.1**
z =		48,14 m	**<2>**	Vessel height
Q_o^2 =	$1 / (1+0,9*((b+h)/L_i(z_e))^{0.63})$=	**0,6838**		**Equation C.10**
R_x^2 =	$\pi^2/(2*\delta)* R_N *R_h*R_b$ =	**0,04852**		**Equation C.11**
where :				
R_N =	$6,8*N_{1,x}/(1+10,2*N_{1,x})^{5/3}$ =	**0,0438**		**Equation C.12**
where :				
$N_{1,x}$ =	$n_{1,x} * L_i(z_e)/v_m(z_e)$ =	**5,5695**		**Equation C.13**
where :				
$n_{1,x}$ =	1 / T =	1,0931 Htz		Vessel frequency
T =	See calculation	0,9148 sec	**<2>**	Vessel period
$L_i(z_e)$=		152,45 m		Equation C.9
$v_m(z_e)$=	From Table B2	29,92 m/s		Wind velcoty
R_h =	$R_{l\ (h)}$=	**0,1160**		**Equation C.15**
R_b =	$R_{l\ (b)}$=	**0,6691**		**Equation C.16**
where :				
$R_{l\ (h)}$=	$1/\eta_{(h)} - 1/(2\text{-}\eta_{(h)}^2)*(1-e^{-2*\eta(h)})$ =	**0,11597**		**Equation C.14**
$R_{l\ (h)}$=	$1/\eta_{(b)} - 1/(2\text{-}\eta_{(b)}^2)*(1-e^{-2*\eta(b)})$ =	**0,66911**		**Equation C.14**
where :				
η(h)=	$4,6*N_{1,x}*h/L_i(ze)$ =	8,090		
η(b)=	$4,6*N_{1,x}*b/L_i(ze)$ =	0,811		
$N_{1,x}$=		5,5695		Equation C.13
h =	Max vessel height	48,14 m		See Sketch **C.1**
b =	Max vessel wind exposed width	4,8284 m		See Sketch **C.1**
$L_i(z_e)$=		152,45 m		Equation C.9

Nuovo Pignone MASSA	**STRUCTURAL PARTS CALCULATION OF STAGE 2 , PRETREATING REACTORS ITEMS: D-6212 / D-6232**

Para F.5 (1)

=	$\delta_s + \delta_a + \delta_d$ =		**0,346**	**Equation F.7**
where :				
$_s$ =	$a_1 * n_1 + b_1 > \delta_{min}$ =	Max(0,099:0,1)=	**0,100**	**Equation F.8**
where :				
a_1=			0,045	From table **F.2**
b_1 =			0,05	From table **F.2**
δ_{min} =			0,1	From table **F.2**
n_1 =	1 / T =		1,0931 Htz	Vessel frequency
$_a$ =	$\rho * b * c_f / (2 * n_{1,x} * m_{1,x}) * v_m(z_e)$ =		**0,1458**	
where :				
ρ =			1,25 Kg/m^3	Air density
b =	Max vessel wind exposed width		4,8284 m	See Sketch **C.1**
c_f =	$\psi * C_{fo}$ =		1,063	Equation 28
$m_{1,x}$ =	Operating weight		601,8 Kg/m	
$v_m(z_e)$ =	From Table B2		29,92 m/s	Wind velcoty
z_e =			48,140 m **<2>**	Max vessel height
$_d$ =			**0,1**	**Assumed**

VESSEL SECTION AREA

A_{ref} =	(D+ 2*(T+ x) * H =	**232,44** m^2	
D =		4.828,4 mm	Vessel outer diameter
T =		0 mm	Insulation thickness
x =		0 mm	Extra dimensione due to nozzle and piping
H =		48.140 mm	Vessel height
F =		**106** KN **<2>**	**WIND SHEAR LOAD**
M =	F * H/2 =	**2.542** KN*m **<2>**	**WIND BENDING MOMENT**

WIND AND SNOW LOAD COMBINATION <2>

q_m =		0,56 KN/m^2	Wind pressure
w =	(see snown load calculation)	0,75 KN/m^2	Snow pressure
q =	Max (q_1 : q_2) =	**1,030** KN/m^2	Combined wind and snow pressure
q_1 =	q_m + w/2 =	0,935 KN/m^2	
q_2 =	w + q_m/2 =	1,030 KN/m^2	
F =	G * c_f * $q_m(z_e)$ * A_{ref} =	**194,4 KN**	**TOTAL SHEAR LOAD**
M =	F * H/2 =	**4.679 KN*m**	**TOTAL BENDING MOMENT**

REV.	DESCRIZIONE - DESCRIPTION		
3	MODIFIED WHERE SHOW <3>	ITEM	
2	MODIFIED WHERE SHOWN <2>	**D-6212/ D-6232**	
1	MODIFIED WHERE SHOWN <1>	**N. SOU0107841/4**	
0	EMISSIONE-ISSUE	LINGUA-LANG. **A**	PAGINA-SHEET 17 / 18

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PERIOD OF VIBRATION <2>

PERIOD OF VIBRATION CALCULATION

The fundamental period of vibration of the vessel under proper weight, is calculated using the Rayleigh method of approximation by the numerical integration of the following formulae

T = $2 \times \pi \times (\Sigma m_i \times u_i^2 / (g \times \Sigma m_i \times u_i))^{0,5}$ sec

where :

m_i =	Weight of each section	**<2>**	To =	0,9725	sec	**Operating**
u_i =	Horizontal displacement at the top of section	**<2>**	Te =	0,7816	sec	**Erection**
g =	Gravity acceleratior 9,80665 m/s^2	**<2>**	Th =	0,9148	sec	**hydrotest**

OPERATING CONDITION **(hot and corroded)** Wo = 20.343.000 N **<1>**

	Sect.	h_i	m_i	de_i	di_i	t	cor	I_i	E_i	F_i	u_i	Hs	
		mm	N	mm	mm	mm	mm	mm^4	Mpa	N	mm	mm	
		48.140											
1	Top head	44.850	1.390.288	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	1.390.288	359,3	3290,00	
2	Belt A	43.510	566.257	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	566.257	329,0	1340,00	
3	Belt B	40.110	1.436.772	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	1.436.772	316,6	3400,00	
4	Belt C	36.710	1.436.772	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	1.436.772	285,3	3400,00	
5	Belt D	34.490	938.128	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	938.128	254,0	2220,00	
6	Belt E	31.835	1.121.950	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	1.121.950	233,7	2655,00	
7	Belt F	28.785	1.288.869	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	1.288.869	209,6	3050,00	
8	Belt G	25.328	1.461.070	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	1.461.070	182,1	3457,50	
3	Belt H	21.870	1.461.070	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	1.461.070	151,5	3457,50	
4	Belt I	18.820	1.288.869	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	1.288.869	121,7	3050,00	
5	Belt L	15.830	1.263.514	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	1.263.514	96,2	2990,00	
6	Belt M	12.430	1.436.772	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	1.436.772	72,1	3400,00	
7	Belt N	9.130	1.394.514	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	1.394.514	46,1	3300,00	
8	Belt O	7.850	540.902	4.828,4	4.738,4	45,0	0,0	1,93E+12	178.923	540.902	22,6	1280,00	
9	Skirt #1	5.820	857.837	4.828,4	4.738,4	45,0	3,2	1,93E+12	178.923	857.837	14,6	2030,00	
10	Skirt #2	2.820	1.267.740	4.828,4	4.738,4	45,0	3,2	1,93E+12	180.160	1.267.740	5,4	3000,00	
11	Skirt #3	0	1.191.676	4.828,4	4.738,4	45,0	3,2	1,93E+12	180.160	1.191.676	5,4	2820,00	**<2>**

ERECTION CONDITION (cold and corroded) We = 13.135.000 N <1>

	Sect.	h_i mm	m_i N	de_i mm	di_i mm	t mm	cor mm	I_i mm^4	E_i Mpa	F_i N	u_i mm	Hs mm	
		48.140											
1	Top head	44.850	897.677	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	897.677	232,0	3290,000	
2	Belt A	43.510	365.619	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	365.619	212,4	1340,000	
3	Belt B	40.110	927.690	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	927.690	204,4	3400,000	
4	Belt C	36.710	927.690	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	927.690	184,2	3400,000	
5	Belt D	34.490	605.727	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	605.727	164,0	2220,000	
6	Belt E	31.835	724.417	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	724.417	150,9	2655,000	
7	Belt F	28.785	832.193	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	832.193	135,3	3050,000	
8	Belt G	25.328	943.379	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	943.379	117,6	3457,500	
3	Belt H	21.870	943.379	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	943.379	97,8	3457,500	
4	Belt I	18.820	832.193	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	832.193	78,6	3050,000	
5	Belt L	15.830	815.822	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	815.822	62,1	2990,000	
6	Belt M	12.430	927.690	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	927.690	46,6	3400,000	
7	Belt N	9.130	900.405	4.828,4	4.308,4	260,0	0,0	9,77E+12	178.923	900.405	29,8	3300,000	
8	Belt O	7.850	349.248	4.828,4	4.738,4	45,0	0,0	1,93E+12	178.923	349.248	14,6	1280,000	
9	Skirt #1	5.820	553.886	4.828,4	4.738,4	45,0	3,2	1,93E+12	178.923	553.886	9,4	2030,000	
10	Skirt #2	2.820	818.550	4.828,4	4.738,4	45,0	3,2	1,93E+12	180.160	818.550	3,5	3000,000	
11	Skirt #3	0	769.437	4.828,4	4.738,4	45,0	3,2	1,93E+12	180.160	769.437	0,0	2820,000	<2>
12													

HYDROTEST CONDITION (cold and corroded) Wh = 19.963.000 N <1>

	Sect.	h_i mm	m_i N	de_i mm	di_i mm	t mm	cor mm	I_i mm^4	E_i Mpa	F_i N	u_i mm	Hs mm	
	0	48.140											
1	Top head	44.850	1.364.318	4.828,4	4.308,4	260,0	0,0	9,77E+12	209.800	1.364.318	317,5	3290,00	
2	Belt A	43.510	555.680	4.828,4	4.308,4	260,0	0,0	9,77E+12	209.800	555.680	290,8	1340,00	
3	Belt B	40.110	1.409.934	4.828,4	4.308,4	260,0	0,0	9,77E+12	209.800	1.409.934	280,0	3400,00	
4	Belt C	36.710	1.409.934	4.828,4	4.308,4	260,0	0,0	9,77E+12	209.800	1.409.934	252,4	3400,00	
5	Belt D	34.490	920.604	4.828,4	4.308,4	260,0	0,0	9,77E+12	209.800	920.604	224,9	2220,00	
6	Belt E	31.835	1.100.992	4.828,4	4.308,4	260,0	0,0	9,77E+12	209.800	1.100.992	207,1	2655,00	
7	Belt F	28.785	1.264.793	4.828,4	4.308,4	260,0	0,0	9,77E+12	209.800	1.264.793	185,8	3050,00	
8	Belt G	25.328	1.433.778	4.828,4	4.308,4	260,0	0,0	9,77E+12	209.800	1.433.778	161,6	3457,50	
3	Belt H	21.870	1.433.778	4.828,4	4.308,4	260,0	0,0	9,77E+12	209.800	1.433.778	134,7	3457,50	
4	Belt I	18.820	1.264.793	4.828,4	4.308,4	260,0	0,0	9,77E+12	209.800	1.264.793	108,4	3050,00	
5	Belt L	15.830	1.239.912	4.828,4	4.308,4	260,0	0,0	9,77E+12	209.800	1.239.912	85,8	2990,00	
6	Belt M	12.430	1.409.934	4.828,4	4.308,4	260,0	0,0	9,77E+12	209.800	1.409.934	64,5	3400,00	
7	Belt N	9.130	1.368.465	4.828,4	4.308,4	260,0	0,0	9,77E+12	209.800	1.368.465	41,4	3300,00	
8	Belt O	7.850	530.799	4.828,4	4.738,4	45,0	0,0	1,93E+12	209.800	530.799	20,5	1280,00	
9	Skirt #1	5.820	841.813	4.822,0	4.738,4	45,0	3,2	1,79E+12	209.800	841.813	13,3	2030,00	
10	Skirt #2	2.820	1.244.059	4.822,0	4.738,4	45,0	3,2	1,79E+12	209.800	1.244.059	4,9	3000,00	
11	Skirt #3	0	1.169.415	4.822,0	4.738,4	45,0	3,2	1,79E+12	209.800	1.169.415	0,0	2820,00	<2>

FOUNDATION LOAD CALCULATION <2> <3>

OPERATING CONDITION <2> <3>
SEISMIC LOAD

F_o =	-	N	-	Lb	Shear load
M_o =	-	N*m	-	Lb*ft	Bending Moment

WIND LOAD <2>

F_o = 468700 * 1,05	**492.135**	N	**110.634**	Lb	Shear load
M_o = 11282000 * 1,05	**11.846.100**	N*m	**8.737.088**	Lb*ft	Bending Moment

ERECTION CONDITION
SEISMIC LOAD

F_e =	-	N	-	Lb	Shear load
M_e =	-	N*m	-	Lb*ft	Bending Moment

WIND LOAD <2>

F_e = 314400 * 1,05	**330.120**	N	**74.213**	Lb	Shear load
M_e = 7567000 * 1,05	**7.945.350**	N*m	**5.860.091**	Lb*ft	Bending Moment

HYDROTEST CONDITION <2>

F_h = 194400 * 1,05	**204.120**	N	**45.887**	Lb	Shear load
M_h = 4679000 * 1,05	**4.912.950**	N*m	**3.623.545**	Lb*ft	Bending Moment

- The foundation loads have been conservatively increased by 5%

OPERATING PIPING LOADS <1> <2> <3>

Qty	Nozzle	Vertical	Horizontal		Total	Horizontal		Total	Height	
		N	N	N	N	N*m	N*m	N*m	m	
	A	27600	18000	21600	28116,899	42000	68400	80265,56		CASE 1
	A	30000	26400	22800	34882,66	42000	75600	86483,29		CASE 2
	A	16800	16800	13200	21365,393	37200	38400	53464,01		CASE 3
	A	30000	27600	22800	35799,441	39600	75600	85343,54		CASE 4
	A	1200	37200	2400	37277,339	7200	1200	7299,315		CASE 5
	A	38850	28350	22050	35915,526	57750	119700	132902,8		CASE6
1	**A**	**38.850**	**37.200**	**22.800**	**37.277**	**57.750**	**119.700**	**132.903**	**49,663**	MAX
1	**B**	**158.400**	**140.000**	**140.000**	**197.990**	**220.427**	**220.427**	**311.731**	**4,365**	
1	**E1**	**20.000**	**20.000**	**20.000**	**28.284**	**25.000**	**12.500**	**27.951**	**32,874**	
1	**E2**	**20.000**	**20.000**	**20.000**	**28.284**	**25.000**	**12.500**	**27.951**	**19,514**	

Fv =	ΣF_{Vert}	**237,3 KN**	**53.334** Lb
Fh =	ΣF_{TotHor}	**291,8 KN**	**65.605** Lb
M tot =	$\Sigma M\ Tot + \Sigma F_{Tot^*h}$	**4.697,8 KN*m**	**3.465.114** Lb*ft

Note: All piping loads have been considered with absolute value.
For nozzle "A" the highest load value for each case has been conservatively applied.
Lateral forces and moments have been combined on the horizontal plane.
Height of piping loads application point is referred to nozzle flange face.

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE

ITEM **D-6212/ D-6232**

N. SOU0107841/4

LINGUA-LANG. **A** PAGINA-SHEET **20 / 21**

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

VESSEL WEIGHT

OPERATING CONDITION	W_o	20343	KN	4.571.652	Lb
ERECTION CONDITION	W_e	13135	KN	2.951.809	Lb
HYDROTEST CONDITION	W_h	19963	KN	4.486.255	Lb
SNOW LOAD	Ws	31	KN	6.967	Lb

LOADS COMBINATION <2> <3>

OPERATING:
- **Vertical load:** Operating weight + piping load
- **Bending moment:** Governing Wind-Seismic bending moment + piping load
- **Shear load:** Governing Wind-Seismic shear load + piping load

ERECTION:
- **Vertical load:** Erection weight + snow load
- **Bending moment:** Governing Wind-Seismic bending moment
- **Shear load:** Governing Wind-Seismic shear load

HYDROTEST:
- **Vertical load:** Hydrotest weight + snow load
- **Bending moment:** Wind bending moment
- **Shear load:** Wind shear load

TOTAL FOUNDATION LOADS <2> <3>

	VERTICAL LOAD		BENDING MOMENT		SHEAR LOAD	
	[KN]	[Lb]	[KN*m]	[Lb * ft]	[KN]	[Lb]
OPERATING	20.580	4.626.440	16.544	12.202.797	784	176.237
ERECTION	13.166	3.063.273	7.945	6.048.277	330	76.478
HYDROTEST	19.994	4.854.358	4.913	3.628.192	204	47.643

TOTAL FOUNDATION LOADS ASSUMED <2>

	VERTICAL LOAD		BENDING MOMENT		SHEAR LOAD	
	[KN]	[Lb]	[KN*m]	[Lb * ft]	[KN]	[Lb]
OPERATING	20.600	4.630.000	21.420	15.799.000	860	194.000
ERECTION	13.170	2.960.000	7.950	5.864.000	340	77.000
HYDROTEST	20.000	4.495.000	4.920	3.629.000	210	48.000

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SKIRT CALCULATION <2>

ALLOWABLE STRESS CALCULATION

The following values of Yield Strenght are in accordance with TABLE Y-1 from ASME II Part. D

DESIGN DATA <1>

SECTION	MATERIAL	Temperature		Yield Strenght		Elevation of sect. <2>	<2>
		°C	°F	MPa	Psi	mm	in
UPPER	SA-387 Gr.22 Cl.2	454,0	849,2	231,06	33.513	7.000	275,59
MIDDLE	SA-516 Gr.65	250,0	482,0	198,24	28.752	4.355	171,46
LOWER	SA-516 Gr.65	20,0	68,0	241,00	35.000	0	0,00

We assume that : Ts_{all} = Ys / 1,5

where Ys is the Yield Strenght and Tsall is allowable Tensile Stress , therefore :

SECTION	MATERIAL	Temperature		Ts_{all}	
		°C	°F	MPa	Psi
2-3	SA-387 Gr.22 Cl.2	454,0	849,2	154,04	22.342
4	SA-516 Gr.65	250,0	482,0	132,16	19.168
5	SA-516 Gr.65	20,0	68,0	160,67	23.303

According to ASME II D App. 3, the allowable Compressive Stress (Cs_{all}) is the lowest of the following values :

Cs_1 = 0,25 * 0,25 * 0,5 * E * t / R_o

Cs_2 = 0,5 * Ys

Cs_3 = Ts_{all}

Where :

E = Elasticity Modulus at design temperature

t = Thickness of skirt corroded 41,8 mm 1,65 in

R_o = Outer radius of skirt corroded 2412,6 mm 94,98 in

MATERIAL	Temp.	E		Cs_1	Cs_2	Cs_3
	°C	MPa	Psi	MPa	MPa	MPa
SA-516 Gr.65	20,0	202.775	29.410.000	109,79	120,50	160,67
SA-516 Gr.65	250,0	198.155	28.740.000	107,29	99,12	132,16
SA-387 Gr.22 Cl.2	454,0	178.953	25.955.000	96,89	115,53	154,04

Therefore we have :

SECTION	MATERIAL	Temp.	Cs_{all}		
		°C	MPa	Psi	
2	SA-387 Gr.22 Cl.2	454,0	96,89	14.053	<1>
3	SA-387 Gr.22 Cl.2	454,0	96,89	14.053	<1>
4	SA-516 Gr.65	250,0	99,12	14.376	<1>
5	SA-516 Gr.65	20,0	109,79	15.923	<1>

This value could be increased for 1,2 in accordance with ASME VIII Div 1 Par UG-23 (d)
Therefore we assume Ts_{all} the following values. The actual tensile stress (Ts_{actual}) on skirt is:

SECTION	MATERIAL	Temp.	Ts_{all}		Ts_{actual}		
		°C	[MPa]	[Psi]	[MPa]	[Psi]	
2	SA-387 Gr.22 Cl.2	454,0	184,85	26.810	36,35	5.272	<1>
3	SA-387 Gr.22 Cl.2	454,0	184,85	26.810	61,31	8.892	<1>
4	SA-516 Gr.65	250,0	158,59	23.001	97,97	14.209	<1>
5	SA-516 Gr.65	20,0	192,80	27.963	5,35	776	<1>

Therefore we assume Cs_{all} the following values The actual tensile stress (Cs_{actual}) on skirt is:

SECTION	MATERIAL	Temp.	Cs_{all}		Cs_{actual}		
		°C	[MPa]	[Psi]	[MPa]	[Psi]	
2	SA-387 Gr.22 Cl.2	454,0	116,27	16.863	36,35	5.272	<1>
3	SA-387 Gr.22 Cl.2	454,0	116,27	16.863	61,31	8.892	<1>
4	SA-516 Gr.65	250,0	118,94	17.251	97,97	14.209	<1>
5	SA-516 Gr.65	20,0	131,75	19.108	5,35	776	<1>

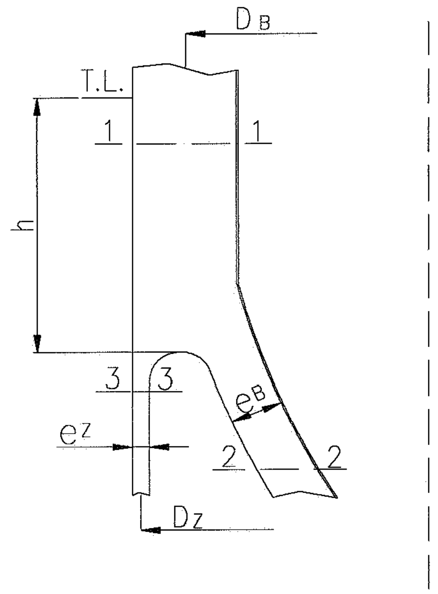
The stresses in the skirt are calculated supposing the reactor a cantilevered beam in which the base is the fixed end.
The most severe load condition for the skirt is **Operating Condition** therefore

Nuovo Pignone MASSA	STRUCTURAL PARTS CALCULATION OF STAGE 2 , PRETREATING REACTORS ITEMS: D-6212 / D-6232

UPPER SECTION VERIFICATION (ACCORDING TO AD-Merkblatt S3) <1>

MATERIAL : **SA-387 Gr.22 Cl.2**

T =	**454,0** °C	**849,2** °F	Design temperature	
H =	**7.000** mm	**275,59** in	Elevation of section from base	**<2>**
D_B =	**4.564,2** mm	**179,69** in	Mean vessel diameter	
D_E =	**4.828,4** mm	**190,09** in	External diameter of the skirt	
D_i =	**4.738,4** mm	**186,55** in	Internal diameter of the skirt	
D_Z =	**4.783,4** mm	**188,32** in	Mean skirt diameter	
e_Z =	**45,0** mm	**1,77** in	Skirt thickness	
Ce =	**1,6** mm	**0,06** in	External corrosion allowance	
Ci =	**1,6** mm	**0,06** in	Internal corrosion allowance	
e_Z =	**41,8** mm	**1,65** in	Skirt thickness corroded	
e_B =	**134,0** mm	**5,28** in	Head Thickness	
r =	**2.213,0** mm	**87,13** in	Head inner radius	
h =	**738,7** mm	**29,08** in	Support skirt height adopted	
P =	**19,15** Mpa		Internal pressure design	
W =	**20.600** KN	**4.629.405** Lb	Vertical load	**<2>**
M =	**21.420** KN*m	**15.792.921** Lb*ft	Bending moment	**<2>**
f_B =	**184,85** Mpa		Allowable tensile stress = Ys/S = Tsall	
S=	**1,25**		Safety factor	



N.B: skirt connection; see fig.1 AD-2000-Merkblatt S3

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE

ITEM **D-6212/ D-6232**

N. SOU0107841/4

LINGUA-LANG.	PAGINA-SHEET
A	24 / 25

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

MEMBRANE STRESS ANALYSIS (according to AD-2000-Merkblatt S3 parag. 6.1)

σ_{c2} = $(W+4*M/Dz)/(\pi*D_B*e_B) + P*D_B/(40*e_B)$= **36,35** **MPa** Compressive stress on section 2

σ_{c2} = **36,35** **<** **184,85** **= f_B** **MPa**

σ_{c3} = $(W+4*M/Dz)/(\pi*D_z*e_z)$= **61,31** **MPa** Compressive stress on section 3

σ_{c3} = **61,31** **<** **184,85** **= f_B** **MPa**

STABILITY VERIFICATION

σ_{c2} = **36,35** **<** **116,27** **= C_{Sall}** **MPa**

σ_{c3} = **61,31** **<** **116,27** **= C_{Sall}** **MPa**

BENDING STRESS ANALYSIS (according to AD-2000-Merkblatt S3 parag. 6.2.1)

$W_3 = \pi/4*[(D_Z+e_Z-D_B-e_B)*h^2 + 2*(e_B^2-e_{BMIN}^2)*D_B + 0,5*(e_Z^2-e_{ZMIN}^2)*D_Z]$ = **181.106.064** mm^3 Section Modulus

$e_{BMIN} = \sigma_{c2} * e_B/f_B$ = **26,4** mm Minimum head thickness required

e_B= **134,0** mm Head thickness adopted

$e_{ZMIN} = \sigma_{c3} * e_Z/f_B$ = **13,9** mm Minimum skirt thickness required

e_Z= **45,0** mm Skirt thickness adopted

σ_{f3} = M/W_3 = **118,3** **<** **184,85** **= f_B** **MPa** Bending stress on section 3

3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE
REV.	DESCRIZIONE - DESCRIPTION

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

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LOWER SECTION VERIFICATION (ACCORDING TO AD-Merkblatt S3) <1>

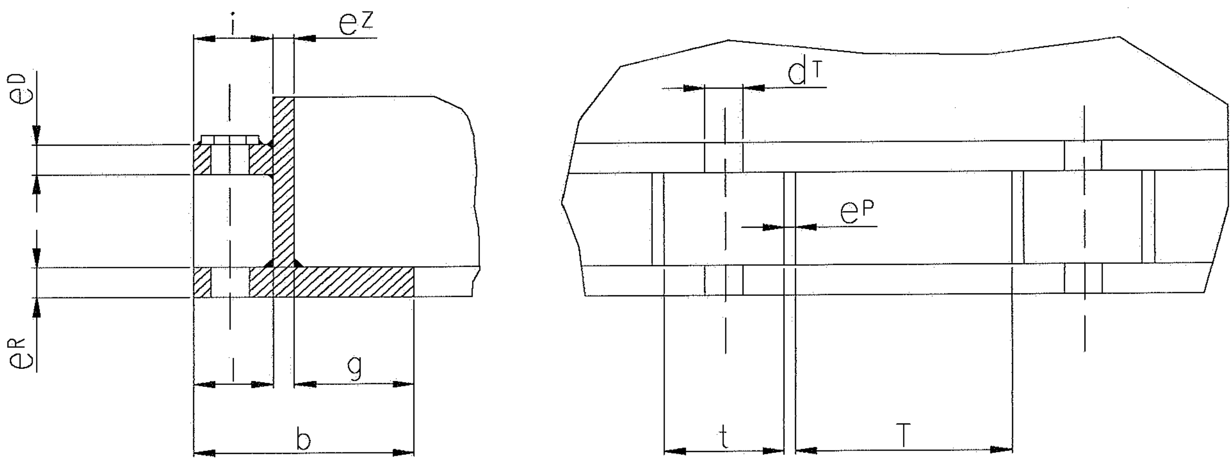
ANCHOR BOLTS STRESS ANALYSIS (according to AD-2000-Merkblatt S3 parag. 8.2)

n =	**20**		Number of bolts
D_T =	**5006,2** mm	**197,09** in	Bolts circle diameter
A_B =	**2471,2** mm^2	**3,83** in^2	Bolt corroded area

F_B = $1/n*(4*M/D_T-0,9*W)$ = **-71261,1** N **<** **0**

There is not tensile stress on anchor bolts!

DOUBLE RING WITH WEBS STRESS ANALYSIS (according to AD-2000-Merkblatt S3 parag. 8.3.2)



N.B: base ring design; see fig.6 AD-2000-Merkblatt S3

b =	**479,3** mm	**18,87** in	See fig.
T=	**616,4** mm	**24,27** in	Gusset span
g =	**269,2** mm	**10,60** in	See fig.
d_T =	**80** mm	**3,15** in	Base ring diameter hole
l =	**165,1** mm	**6,50** in	See fig.
i =	**165,1** mm	**6,50** in	See fig.
t=	**130** mm	**5,12** in	Gusset span between holes
f_R =	**192,80** Mpa		Allowable tensile stress = Ys/S = Tsall
f_P =	f_D = f_R		Allowable tensile stress = Ys/S = Tsall
S=	**1,25**		Safety factor

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GEOMETRICAL CONDITIONS see fig.6 AD-2000-Merkblatt S3

T/l=	**3,73**	>	**3,0**
e_R / e_Z =	**1,56**	>	**1,5**
e_D / e_Z =	**1,56**	>	**1,5**
b / l =	**2,90**	>	**1,5**
l / e_P =	**8,26**	<	**15,0**

σ_{CC} = $1/(\pi*D_Z*b)*(4*M/D_Z+W)$= **5,35** **MPa** Concrete compression stress

e_{RMIN}= $l*(3*\sigma_{CC}/f_R)^{0,5}$=	**47,62**	mm	Minimum base ring thickness required
e_R=	**70**	mm	Base ring thickness adopted
e_{PMIN}= $0,5*F_B/(l*f_P)$=	**1,12**	mm	Minimum base ring thickness required
e_P=	**20**	mm	Gusset thickness adopted
e_{DMIN}= MAX(e_{DMIN1}:e_{DMIN2})			Upper ring thickness required
e_{DMIN1}= $2*3^{0,5}*F_B/(\pi*d_T*f_D)$=	**5,09**	mm	
e_{DMIN2}= $0,72*\{(F_B*t)/[(i-d_T)*f_D]\}^{0,5}$=	**17,11**	mm	
e_D=	**70**	mm	Upper ring thickness adopted

MIDDLE SECTION VERIFICATION (ACCORDING TO AD-Merkblatt S3) <1>

MATERIAL :	**SA-516 Gr.65**	**<1>**		
T =	**250,0** °C	**482** °F	Design temperature	
D_B =	**4.828,4** mm	**190,09** in	External diameter of the skirt	
D_i =	**4.738,4** mm	**186,55** in	Internal diameter of the skirt	
D_Z =	**4.783,4** mm	**188,32** in	Mean skirt diameter	
e_Z =	**45,0** mm	**1,77** in	Skirt thickness	
Ce =	**1,6** mm	**0,06** in	External corrosion allowance	
Ci =	**1,6** mm	**0,06** in	Internal corrosion allowance	
e_Z =	**41,8** mm	**1,65** in	Skirt thickness corroded	
Y_{max} =	**2.753,8** mm	**108,42** in	Maximum distance between section and neutral axis	
W =	**20.600** KN	**4.630.986** Lb	Vertical load	**<2>**
M =	**21.420** KN*m	**15.798.315** Lb*ft	Bending moment	**<2>**
e =	**158,4** mm	**6,24** in	Displacement of the centre of gravity	
f_Z =	**158,59** Mpa		Allowable tensile stress = Ys/S = Tsall	
S=	**1,25**		Safety factor	

OPENINGS ON THE SKIRT: between ref. line -3400 and -4440 we have 3 openings:

N°	Nozzle	D_{op} [mm]	T_{hr} [mm]	H_r [mm]	y_{max} [mm]	A_{op} [mm^2]	A_r [mm^2]	J_{op} [mm^4]	J_r [mm^4]
2	**SO1-2**	**612,4**	**45,0**	**260,0**	**2.500,0**	55.116	46.800	6,31E+11	1,32E+11
1	**SO3**	**1.425,0**	**45,0**	**310,0**	**2.500,0**	64.125	27.900	3,67E+11	1,54E+11
						0	0	0,00E+00	0,00E+00
						0	0	0,00E+00	0,00E+00
						0	0	0,00E+00	0,00E+00
					TOT	119.241	74.700	9,97E+11	2,85E+11

where :

D_{op} = Diameter of opening
T_{hr} = Thickness of opening reinforcement
H_r = Effective lenght of reinforcement
y_{max} = Max. distance between reinforcement sect. and nutral axis
D_r = Distance of reinforcement from neutral axis = $Y_{max} - H_r / 2$

A_{op} = Area of opening = $D_{op} * t_h$
A_r = Area of reinfocement = $2 * T_{hr} * H_r$
J_{op} = Inertia moment of opening = $A_{op} * ((D_e + D_i) / 4)^2$
J_r = Inertia moment of reiforcement= $2*(T_{hr} * H_r^3 / 12) + A_r * D_r^2$

REV.	DESCRIZIONE - DESCRIPTION	ITEM	
3	MODIFIED WHERE SHOW <3>	D-6212/ D-6232	
2	MODIFIED WHERE SHOWN <2>	N. SOU0107841/4	
1	MODIFIED WHERE SHOWN <1>	LINGUA-LANG.	PAGINA-SHEET
0	EMISSIONE-ISSUE	A	28 / 29

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

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$A =$	$\pi * ((D_o\text{-}2*Ce)^2 - (D_i+2*Ci)^2) / 4 =$	628.149 mm^2	Cross sectional area of the skirt
$A_e =$	$A - A_{op\ tot} + A_r =$	583.608 mm^2	Residual area of the skirt
$J =$	$\pi * ((D_o\text{-}2*Ce)^4 - (D_i+2*Ci)^4) /64 =$	1,797E+12 mm^4	Inertia moment of skirt section
$J_e =$	$J - J_{op\ tot} + J_r =$	1,085E+12 mm^4	Residual inertia moment of the skirt

COMPRESSIVE STRESS

$\sigma_c =$	$W / A_e =$	**35,30 MPa**	Compressive stress due to the vertical load

BENDING STRESS

$M_{tot} =$	$M + W * e =$	24.683 KN*m	Total bending moment on section
$\sigma_b =$	$M_{tot} * Y_{max} / J_e =$	**62,67 MPa**	Bending stress due to the moment

IDEAL STRESS

$\sigma_{id} = \sigma_c + \sigma_b =$ **97,97 MPa** $<$ $f_z =$ **158,59 MPa**

COMPRESSIVE STRESS ASSESSMENT

$\sigma_{Cmax} = \sigma_b + \sigma_c =$ **97,97 MPa** $<$ $Cs_{all} =$ **118,94 MPa**

Nuovo Pignone MASSA	**STRUCTURAL PARTS CALCULATION OF STAGE 2 , PRETREATING REACTORS** **ITEMS: D-6212 / D-6232**

BASE RING AND ANCOR BOLTS CALCULATION <2>

(According to BROWNELL & YOUNG)

ANCHOR BOLTS MATERIAL SA 307 Gr.B

ϕ'_e =	**5158,6**	mm	**203,09**	in	Anchor boxes outside diameter	
ϕ_e =	**5158,6**	mm	**203,09**	in	Base ring outside diameter	
ϕ_i =	**4.200,0**	mm	**165,35**	in	Base ring inside diameter	
ϕ_b =	**5006,2**	mm	**197,09**	in	Bolts circle diameter	
D_e =	**4828,4**	mm	**190,09**	in	Skirt outside diameter	
t_4 =	**70,0**	mm	**2,76**	in	Base ring thickness	
t_5 =	**70,0**	mm	**2,76**	in	Upper plate thickness	
N =	**20**				Number of bolts	
Cor =	**3,0**	mm	**0,005**	in	Bolt corrosion allowance	
A_b =	**2.471,2**	mm^2	**3,830**	in^2	Bolt corroded area	**M64**
Sb_{all} =	**120,00**	MPa	**17.405**	Psi	Anchor bolts allowable stress	
Sc_{all} =	**5,00**	MPa	**725**	Psi	Concrete allowable stress on compression	
n =	**20**				ratio of base ring mat. and concrete modulus	
S_a =	**160,67**	MPa	**23.303**	Psi	Base ring allowable stress	
b =	**636,4**	mm	**25,05**	in	Gusset span	
b' =	**150,0**	mm	**5,91**	in	Gusset span	
s =	**80,0**	mm	**3,15**	in	Base ring diameter hole	
e =	**54,3**	mm	**2,14**	in	Minimum width of half nut	
H =	**216,0**	mm	**8,50**	in	Gusset height	
T =	**20,0**	mm	**0,79**	in	Gusset thickness	

CONDITION N° 1 (DURING ERECTION)

P =	**13.170**	KN	**2.960.684**	Lb	**<2>**	Total load on base ring
M =	**4.920**	KN*m	**3.628.745**	Lb*ft	**<2>**	Total moment on base ring

CONDITION N° 2 (DURING HYDROTEST)

P =	**20.000**	KN	**4.496.103**	Lb	**<2>**	Total load on base ring
M =	**4.920**	KN*m	**3.628.745**	Lb*ft	**<2>**	Total moment on base ring

CONDITION N° 3 (DURING OPERATING)

P =	**20.600**	KN	**4.630.986**	Lb	**<2>**	Total load on base ring
M =	**21.420**	KN*m	**15.798.315**	Lb*ft	**<2>**	Total moment on base ring

REV.	DESCRIZIONE - DESCRIPTION	
3	MODIFIED WHERE SHOW <3>	ITEM **D-6212/ D-6232**
2	MODIFIED WHERE SHOWN <2>	
1	MODIFIED WHERE SHOWN <1>	**N. SOU0107841/4**
0	EMISSIONE-ISSUE	LINGUA-LANG. **A** / PAGINA-SHEET **30 / 31**

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

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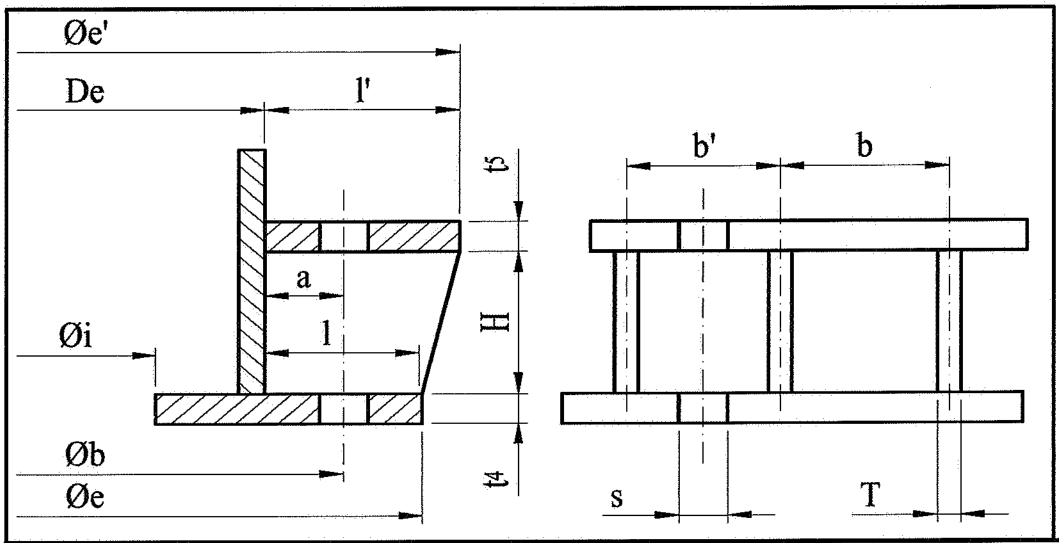
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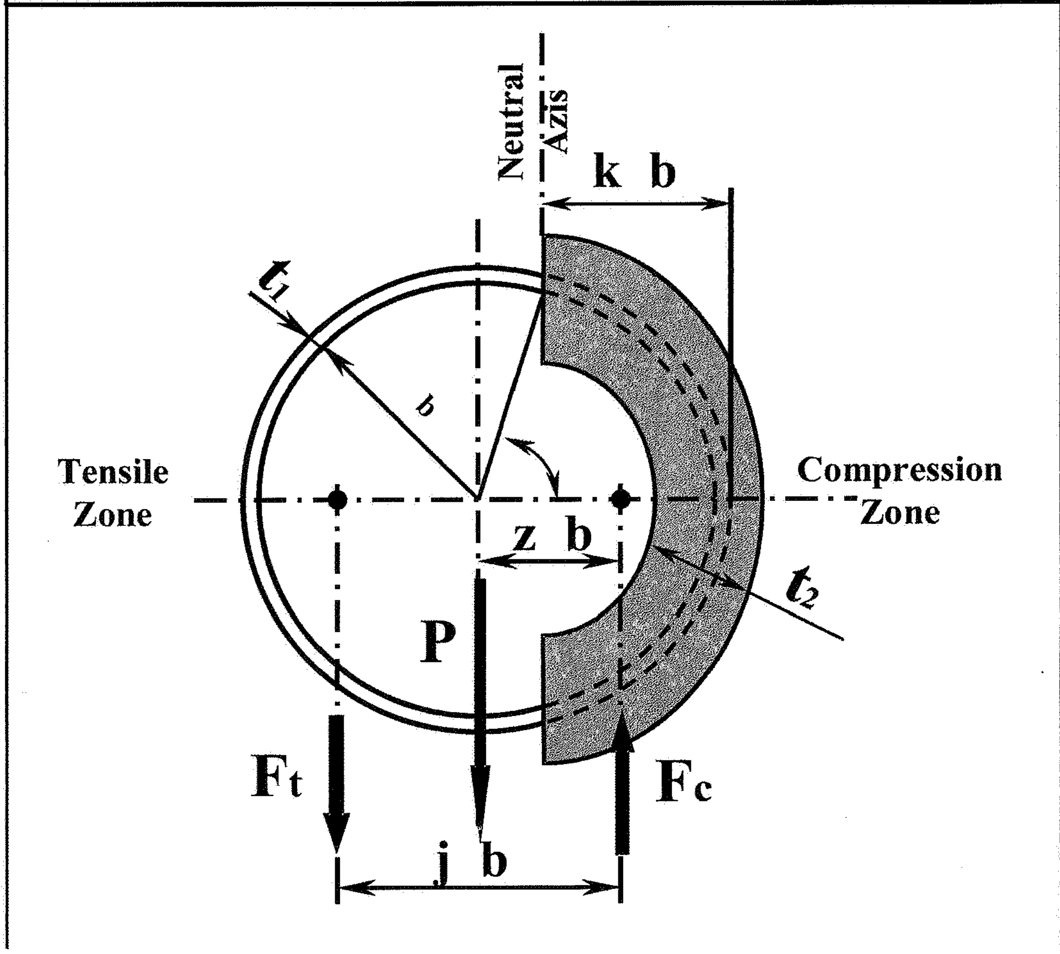
Neutral
Azis
k b
t1
b
Tensile
Zone
Compression
Zone
z b
t2
P
Ft
Fc
j b

280

CONDITION N° 1 - ERECTION

$Sc_{min} = 4xP/ \pi x(\phi_e^2 - \phi_i^2) - 32xMx\phi_b / \pi\ x(\phi_e^4 - \phi_i^4) =$ 1,24 MPa / 179 Psi — Minimum stress on concrete at bolt circle diameter

If Sc_{min} is > 0 the Neutral axis is outside of base ring surface then the compressive stress on concrete is :

Sc = $4xP/ \pi x(\phi_e^2 - \phi_i^2)+32xMx\phi_b / \pi\ x(\phi_e^4 - \phi_i^4) =$ **2,50 MPa** / **363 Psi** — Compressive stress at B.C.D.

Sc_{max} $= 4xP/ \pi x(\phi_e^2 - \phi_i^2)+32xMx\phi_e / \pi\ x(\phi_e^4 - \phi_i^4) =$ **2,52 MPa** / **366 Psi** — Compressive stress at outside edge of base ring

The anchor bolts are not stressed in tension for load due to wind , earthquake or piping load

Minimum required thickness of base ring

l =	$(\phi_e - D_e) / 2 =$	165,1 mm	6,50 in	
l / b =		0,2594		
	0,1			
t_{4min} =	$(6 \times M_a / S_a)^{0,5} =$	**32,31 mm**	**1,27 in**	**Minimum required thickness**
t_4 =		**70,00 mm**	**2,76 in**	**Actual base ring thickness**

M_a is the greater between M_x and M_y according to Table 1

TABLE 1

l / b	M_x	M_y
0	0,000 x Sc x b^2	0,5 x Sc x l^2
1 / 3	0,0078 x Sc x b^2	0,428 x Sc x l^2
1 / 2	0,0293 x Sc x b^2	0,319 x Sc x l^2
2 / 3	0,0558 x Sc x b^2	0,227 x Sc x l^2
1	0,0972 x Sc x b^2	0,119 x Sc x l^2
3 / 2	0,123 x Sc x b^2	0,124 x Sc x l^2
2	0,131 x Sc x b^2	0,125 x Sc x l^2
3	0,133 x Sc x b^2	0,125 x Sc x l^2
over	0,133 x Sc x b^2	0,125 x Sc x l^2

M_x = 6.149 N
1.382.351 Lb

M_y = 30.268 N
6.804.300 Lb

Note : linear interpolation is allowed

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CONDITION N° 2 - HYDROTEST

$Sc_{min} = 4xP/\pi x(\phi_e^2 - \phi_i^2) - 32xMx\phi_b/\pi\, x(\phi_e^4 - \phi_i^4) =$ 2,21 MPa / 320 Psi — Minimum stress on concrete at bolt circle diameter

If Sc_{min} is > 0 the Neutral axis is outside of base ring surface then the compressive stress on concrete is :

Sc = $4xP/\pi x(\phi_e^2 - \phi_i^2)+32xMx\phi_b/\pi\, x(\phi_e^4 - \phi_i^4) =$ **3,47 MPa** / **503 Psi** — Compressive stress at B.C.D.

Sc_{max} $= 4xP/\pi x(\phi_e^2 - \phi_i^2)+32xMx\phi_e/\pi\, x(\phi_e^4 - \phi_i^4) =$ **3,49 MPa** / **506 Psi** — Compressive stress at outside edge of base ring

The anchor bolts are not stressed in tension for load due to wind , earthquake or piping load

Minimum required thickness of base ring

l =	$(\phi_e - D_e)/2 =$	165,1 mm	6,50 in	
l / b =		0,2594		
	0,1			
t_{4min} =	$(6 \times M_a / S_a)^{0,5} =$	**38,06 mm**	**1,50 in**	**Minimum required thickness**
t_4 =		**70,00 mm**	**2,76 in**	**Actual base ring thickness**

M_a is the greater between M_x and M_y according to Table 1

TABLE 1

l / b	M_x	M_y
0	0,000 x Sc x b^2	0,5 x Sc x l^2
1 / 3	0,0078 x Sc x b^2	0,428 x Sc x l^2
1 / 2	0,0293 x Sc x b^2	0,319 x Sc x l^2
2 / 3	0,0558 x Sc x b^2	0,227 x Sc x l^2
1	0,0972 x Sc x b^2	0,119 x Sc x l^2
3 / 2	0,123 x Sc x b^2	0,124 x Sc x l^2
2	0,131 x Sc x b^2	0,125 x Sc x l^2
3	0,133 x Sc x b^2	0,125 x Sc x l^2
over	0,133 x Sc x b^2	0,125 x Sc x l^2

M_x = 8.532 N
1.918.102 Lb

M_y = 41.998 N
9.441.407 Lb

Note : linear interpolation is allowed

CONDITION N° 3 - OPERATING

$Sc_{min} = 4xP/ \pi x(\phi_e^2 - \phi_i^2) - 32xMx\phi_b / \pi x(\phi_e^4 - \phi_i^4) =$ 0,17 MPa / 25 Psi — Minimum stress on concrete at bolt circle diameter

If Sc_{min} is > 0 the Neutral axis is outside of base ring surface then the compressive stress on concrete is :

Sc = $4xP/ \pi x(\phi_e^2 - \phi_i^2)+32xMx\phi_b / \pi x(\phi_e^4 - \phi_i^4) =$ **4,91 MPa** / **711 Psi** — Compressive stress at B.C.D.

$Sc_{max} = 4xP/ \pi x(\phi_e^2 - \phi_i^2)+32xMx\phi_e / \pi x(\phi_e^4 - \phi_i^4) =$ **5,00 MPa** / **725 Psi** — Compressive stress at outside edge of base ring

The anchor bolts are not stressed in tension for load due to wind , earthquake or piping load

Minimum required thickness of base ring

$l = (\phi_e - D_e) / 2 =$ 165,1 mm 6,50 in

$l / b =$ 0,2594

0,1

$t_{4min} = (6 \times M_a / S_a)^{0,5} =$ **48,66 mm** **1,92 in** **Minimum required thickness**

$t_4 =$ **70,00 mm** **2,76 in** **Actual base ring thickness**

M_a is the greater between M_x and M_y according to Table 1

TABLE 1

l / b	M_x	M_y
0	0,000 x Sc x b^2	0,5 x Sc x l^2
1 / 3	0,0078 x Sc x b^2	0,428 x Sc x l^2
1 / 2	0,0293 x Sc x b^2	0,319 x Sc x l^2
2 / 3	0,0558 x Sc x b^2	0,227 x Sc x l^2
1	0,0972 x Sc x b^2	0,119 x Sc x l^2
3 / 2	0,123 x Sc x b^2	0,124 x Sc x l^2
2	0,131 x Sc x b^2	0,125 x Sc x l^2
3	0,133 x Sc x b^2	0,125 x Sc x l^2
over	0,133 x Sc x b^2	0,125 x Sc x l^2

$M_x =$ 13.952 N
3.136.552 Lb

$M_y =$ 68.677 N
15.438.939 Lb

Note : linear interpolation is allowed

LIFTING DEVICES CALCULATION <2>

Nome
DESIGN DATA
SINGLE PIECE BY FORGING

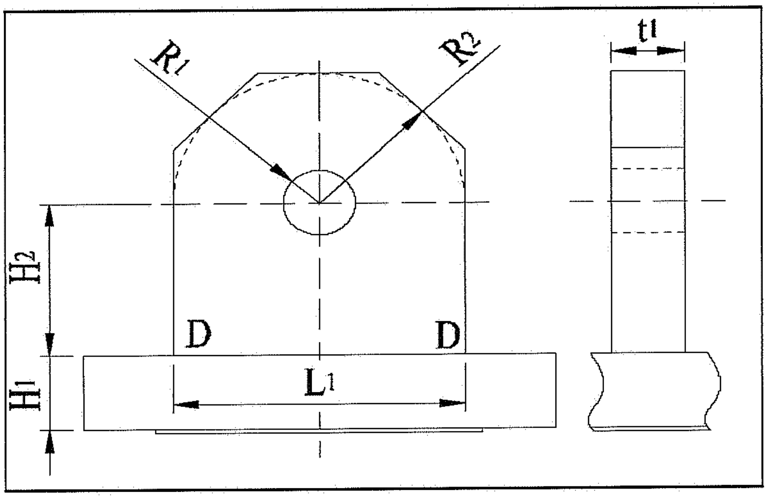
MATERIAL : **SA-508 Gr.3 Cl.2**

	MPa	Psi
Yield strenght Y_s =	448,16	65.000
σ_{all} = Y_s / 1,5 =	298,77	43.333
τ_{all} = σ_{all} / 2 =	149,39	21.667

	mm	in	
R_1 =	161,0	6,339	
R_2 =	520,0	20,472	
$t_{1(*)}$=	450,0	17,717	
L_1 =	830,8	32,709	<2>
H_1 =	300,0	11,811	
H_2 =	600,0	23,622	

(*) = 460 mm - 10 mm for tolerances

SKETCH N°1
DESIGN FOR GREEN PIN
TYPE P-6033, WEIGHT 1500 TONS



RETENTION LUG
DESIGN DATA

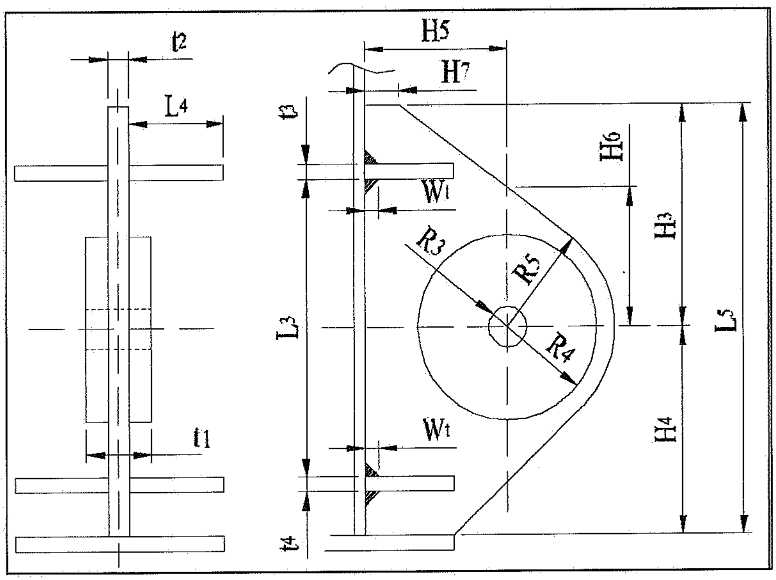
MATERIAL : **SA-516 Gr.65** <1>

	MPa	Psi	
Yield strenght Y_s =	241,32	35.000	<1>
σ_{all} = Y_s / 1,5 =	160,88	23.333	<1>
τ_{all} = σ_{all} / 2=	80,44	11.667	<1>

	mm	in	
R_3 =	108,0	4,252	
R_4=	530,0	20,866	<1>
R_5 =	630,0	24,803	<1>
$t_{1(*)}$ =	290,0	11,417	<2>
t_2 =	100,0	3,937	
t_3 =	70,0	2,756	
t_4 =	70,0	2,756	
H_3 =	850,0	33,465	
H_4 =	1000,0	39,370	
H_5 =	500,0	19,685	
H_6 =	682,8	26,882	<1>
H_7 =	100,0	3,937	
L_3=	1300,0	51,181	
L_4=	750,0	29,528	
L_5=	1850,0	72,835	
W_t =	30,0	1,181	

(*) = 300 mm - 10 mm for tolerances

SKETCH N°2
DESIGN FOR GREEN PIN
TYPE P-6033, WEIGHT 700 TONS



For the lenght L_3 the retention lug is welded by full penetration

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE

ITEM **D-6212/ D-6232**

N. SOU0107841/4

LINGUA-LANG.	PAGINA-SHEET
A	35 / 36

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

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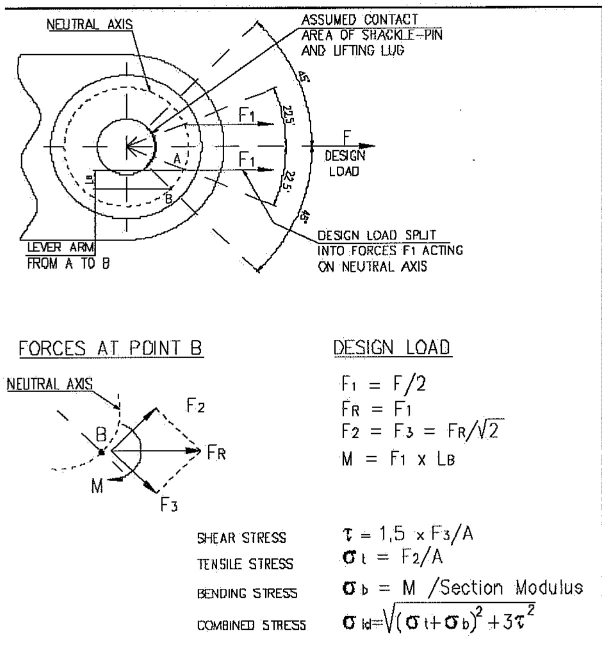
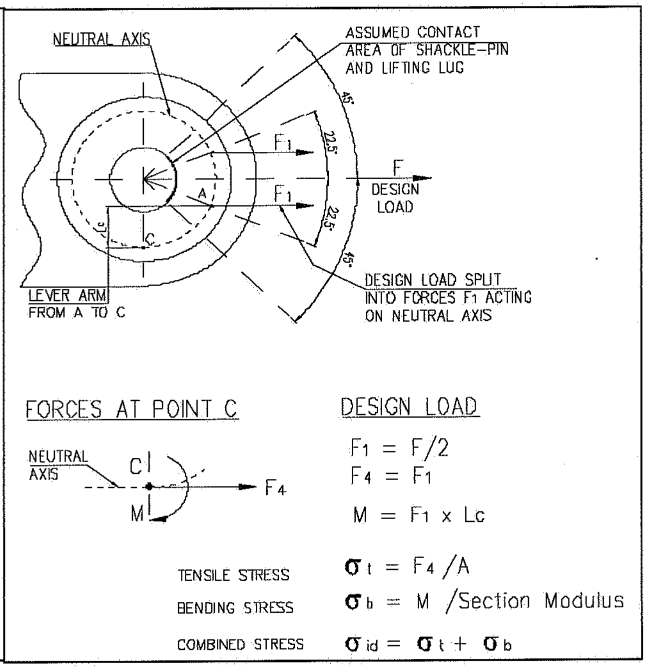




SKETCH N°3

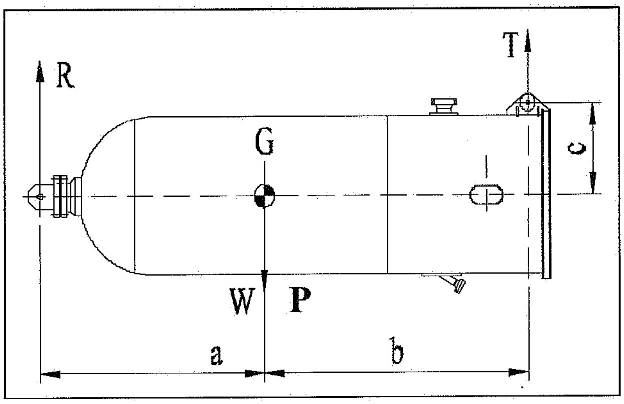
SKETCH N°4

N° 1 LIFTING POSITION (=0°)

a =	**23.348** mm	**<1>**	**919,213** in	
b =	**24.600** mm	**<1>**	**968,504** in	
c =	**2.914** mm		**114,732** in	

Kd = **1,5** Dimamic coef.

	N	Lb	
P =	**13.515.000**	**3.038.242**	**<1>**
$W = P * K_d =$	**20.272.500**	**4.557.363**	**<1>**
R =W*b/(a+b) =	**10.400.924**	**2.338.181**	**<1>**
T = W - R =	**9.871.576**	**2.219.181**	**<1>**



REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE

ITEM D-6212/ D-6232
N. SOU0107841/4
LINGUA-LANG. A
PAGINA-SHEET 36 / 37

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

LIFTING LUG VERIFICATION

DESIGN FORCES

		N	Lb
F_1 =	R / 2 =	**5.200.462**	**1.169.091**
F_R =	F_1 =	**5.200.462**	**1.169.091**
F_2 =	F_3=$F_R/(2)^{0,5}$=	**3.677.282**	**826.672**
F_4 =	F_1 =	**5.200.462**	**1.169.091**

	mm	in	
R_1 =	**161,0**	**6,339**	Inner radius
R_2 =	**520,0**	**20,472**	Outer radius
R_m =	**340,5**	**13,406**	Mean radius
t =	**450,0**	**17,717**	Thickness

A = $t * (R_2 - R_1)$ = 161.550 mm² — Section area

W = $t * (R_2 - R_1)^2/6$ = 9.666.075 mm³ — Section modulus

STRESS AT POINT B — **With reference to sketch 3**

L_b = R_m * (sen 45° - sen 22,5°) = 110,47 mm — Lever arm from A to B

M_b = $F_1 * L_b$ = 574.475.012 N*mm — Bending moment

SHEAR STRESS

τ = $1,5 * F_3 / A$ = **34,14 MPa** / **4.952 Psi** < τ_{all} = **149,39 MPa** / **21.667 Psi**

TENSILE STRESS

σ_t = F_2 / A = 22,76 MPa

BENDING STRESS

σ_b = M_b / W_b = 59,43 MPa

IDEAL STRESS

σ_{id} = $((\sigma_t+\sigma_b)^2 + 3*\tau^2)^{0,5}$ = **101,26 MPa** / **14.686 Psi** < σ_{all} = **298,77 MPa** / **43.333 Psi**

STRESS AT POINT C — **With reference to sketch 4**

L_c = R_m + (1 - sen 22,5°) = 210,2 mm — Lever arm from A to C

M_c = $F_1 * L_c$ = 1.093.117.817 N*mm — Bending moment

TENSILE STRESS

σ_t = F_4 / A = 32,19 MPa

BENDING STRESS

σ_b = M_c / W_c = 113,09 MPa

IDEAL STRESS

σ_{id} = $\sigma_t + \sigma_b$ = **145,28 MPa** / **21.071 Psi** < σ_{all} = **298,77 MPa** / **43.333 Psi**

SECTION " D-D "

$A_D =$	$t * L_1 =$	373.860	mm^2	Section area
$W_D =$	$L_1^2 * t / 6 =$	51.767.148	mm^3	Section modulus

SHEAR STRESS

$\tau =$	$1{,}5 * R / A_D =$	**41,73 MPa**	<	$\tau_{all} =$	**149,39 MPa**
		6.053 Psi			**21.667 Psi**

BENDING STRESS

$\sigma =$	$R * H_2 / W_D =$	120,55 MPa

IDEAL STRESS

$\sigma_{id} =$	$(\sigma^2 + 3 * \tau^2)^{0,5} =$	**140,56 MPa**	<	$\sigma_{all} =$	**298,77 MPa**
		20.386 Psi			**43.333 Psi**

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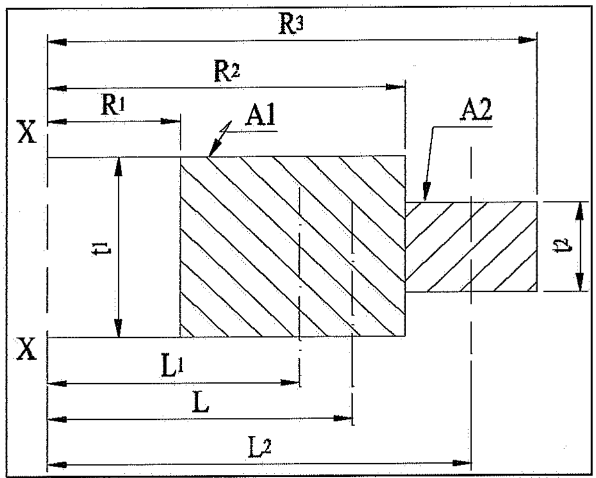
Nuovo Pignone

MASSA

STRUCTURAL PARTS CALCULATION OF STAGE 2 , PRETREATING REACTORS ITEMS: D-6212 / D-6232

RETENTION LUG VERIFICATION



DESIGN FORCES

		N	Lb
F_1 =	$T / 2$ =	**4.935.788**	**1.109.591**
F_R =	F_1 =	**4.935.788**	**1.109.591**
F_2 =	$F_3=F_R/(2)^{0,5}$=	**3.490.129**	**784.599**
F_4 =	F_1 =	**4.935.788**	**1.109.591**

	mm	in	
R_1 =	**108,0**	**4,252**	
R_2 =	**530,0**	**20,866**	<1>
R_3 =	**630,0**	**24,803**	<1>
t_1 =	**290,0**	**11,417**	<2>
t_2 =	**100,0**	**3,937**	

A_1 =	$t_1 * (R_2 - R_1)$ =	122.380 mm^2	
A_2 =	$t_2 * (R_3 - R_2)$ =	10.000 mm^2	
A =	$A_1 + A_2$ =	132.380 mm^2	Total section area
L_1 =	$(R_1 + R_2) / 2$ =	319,0 mm	Gravity center Area 1 from X-X axis
L_2 =	$(R_3 + R_2) / 2$ =	580,0 mm	Gravity center Area 2 from X-X axis
L =	$(A_1 * L_1 + A_2 * L_2) / A_a$ =	338,7 mm	Section gravity center from X-X axis
J_1 =	$t_1 * (R_2 - R_1)^3 / 12$ =	1,816E+09 mm^4	Moment of inertia of area 1
J_{T1} =	$A_1 + (L - L_1)^2$ =	4,757E+07 mm^4	Transfer moment of area 1
J_2 =	$t_2 + (R_3 - R_2)^3 / 12$ =	8,333E+06 mm^4	Moment of inertia area 2
J_{T2} =	$A_2 * (L_2 - L)^2$ =	5,822E+08 mm^4	Transfer moment of area 2
J_{tot} =	$J_1 + J_{T1} + J_2 + J_{T2}$ =	2,454E+09 mm^4	Section inertia moment
Y_{max}=		291,3 mm	Max of : $R_3 - L$ = 291,3; $L - R_1$ = 230,7

STRESS AT POINT B **With reference to sketch 3**

L_b =	$L * (sen\ 45° - sen\ 22,5°)$ =	109,89 mm	Lever arm from A to B
M_b =	$F_1 * L_b$=	542.380.762 N*mm	Bending moment

SHEAR STRESS

τ = $1,5 * F_3 / A$ = **39,55 MPa** / **5.736 Psi** < τ_{all} = **80,44 MPa** / **11.667 Psi**

TENSILE STRESS

σ_t = F_2 / A = 26,36 MPa

BENDING STRESS

σ_b = $M_b * Y_{max} / J_{tot}$ = 64,37 MPa

IDEAL STRESS

σ_{id} = $((\sigma_t+\sigma_b)^2 + 3*\tau^2)^{0,5}$ = **113,69 MPa** / **16.489 Psi** < σ_{all} = **160,88 MPa** / **23.333 Psi**

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE

ITEM **D-6212/ D-6232**

N. SOU0107841/4

LINGUA-LANG. **A** PAGINA-SHEET **39 / 40**

SOSTITUISCE IL - REPLACES PARI NUMERO

SOSTITUITO DA - REPLACED BY

STRESS AT POINT C **With reference to sketch 4**

$L_c =$	$L * (1 - sen\ 22{,}5°) =$	209,09 mm	Lever arm from A to C
$M_c =$	$F_1 * L_c =$	1.032.048.499 N*mm	Bending moment

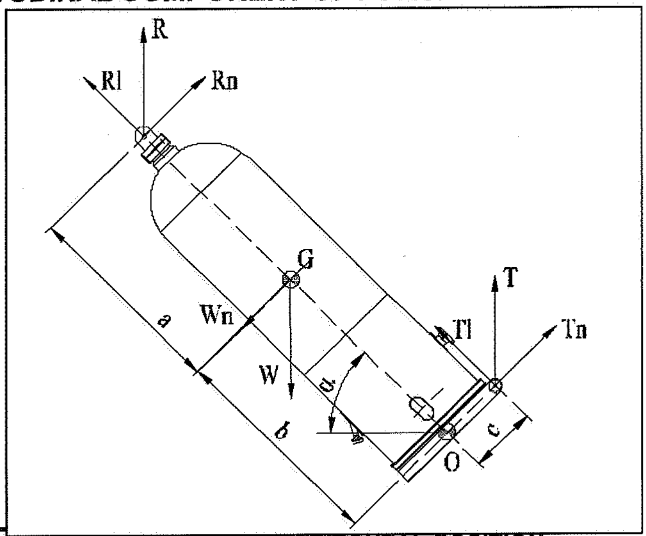
TENSILE STRESS
$\sigma_t =$ $F_4 / A =$ 37,28 MPa
BENDING STRESS
$\sigma_b =$ $M_c * Y_{max} / J_{tot} =$ 122,49 MPa
IDEAL STRESS
$\sigma_{id} =$ $\sigma_t + \sigma_b =$ **159,77 MPa** < $\sigma_{all} =$ **160,88 MPa**
23.173 Psi **23.333 Psi**

WELDED JOINT **(According to CNR-UNI 10011)**

$A_w =$ $L_3 * t_2 + 0{,}7 * 8 * W_t * L_4 =$ 256.000 mm^2 Weld joint area
NORMAL STRESS
$\sigma =$ $T / A_w =$ **38,56 MPa** < $\sigma_{all} * 0{,}85 =$ **136,75 MPa**
5.593 Psi **19.833 Psi**

CALCULATION OF THE ANGLE GIVING THE HIGHEST VALUE OF LONGITUDINAL COMPONENT OF FORCE "T"

a=	**23.348,0** mm	**<3>**	**919,21**	in
b=	**24.600,0** mm	**<3>**	**968,50**	in
c=	**2.914,2** mm		**114,73**	in
W =	**20.272.500** N		**937.691**	Lb



VERTICAL EQUILIBRIUM OF LOAD

1) R + T = W

ROTATION EQUILIBRIUM (POINT "O")

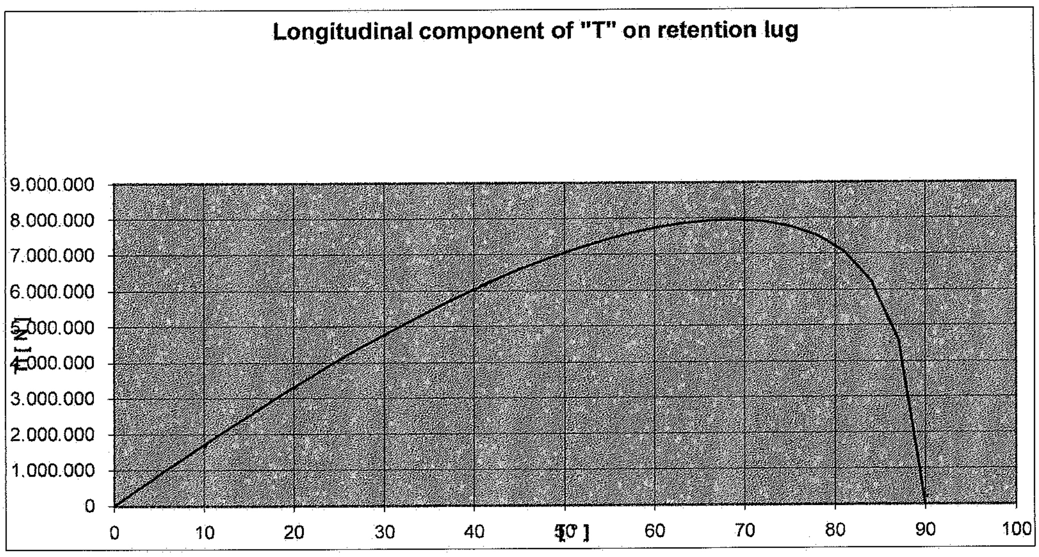
2) R*(a+b)*cosα - W*b*cosα - S*c*senα = 0

T = W*a*cosα / ((a+b)*cosα + c*senα)

Tl = W*a*cosα ∗ senα / ((a+b)*cosα + c*senα)

	Tl
0	0
3	514.998
6	1.025.311
9	1.529.531
12	2.026.239
15	2.514.010
18	2.991.410
21	3.457.002
24	3.909.344
27	4.346.984
30	4.768.461
33	5.172.296
36	5.556.981
39	5.920.970
42	6.262.650
45	6.580.318
48	6.872.134
51	7.136.059
54	7.369.761
57	7.570.476
60	7.734.786
63	7.858.271
66	7.934.933
69	7.956.184
72	7.908.997
75	7.772.248
78	7.508.796
81	7.046.154
84	6.220.428
87	4.564.503
90	0

α =	**0**	°	**HORIZONTAL POSITION**	
α =	**90**	°	**VERTICAL POSITION**	
α =	**69**	°	**INTERMEDIATE POSITION**	
$T_{l\,max}$ =	**7.956.184**	N	**N**	**Lb**
T_n =	$T_{l\,max}$ / tanα =		**3.054.093**	**686.576**
T =	$(T_l^2 + T_n^2)^{0,5}$ =		**8.522.226**	**1.915.840**
R =	W - T =		**11.750.274**	**2.641.522**
R_n =	R * cosα =		**4.210.921**	**946.637**
R_l =	R * senα =		**10.969.825**	**2.466.073**



3	MODIFIED WHERE SHOW <3>	ITEM **D-6212/ D-6232**
2	MODIFIED WHERE SHOWN <2>	
1	MODIFIED WHERE SHOWN <1>	**N. SOU0107841/4**
0	EMISSIONE-ISSUE	LINGUA-LANG. **A** / PAGINA-SHEET **41 / 42**
REV.	DESCRIZIONE - DESCRIPTION	

SOSTITUISCE IL - REPLACES PARI NUMERO

SOSTITUITO DA - REPLACED BY

N° 2 LIFTING POSITION (= 69 °)
LIFTING LUG VERIFICATION

DESIGN FORCES

		N	Lb
F_1 =	$R_l / 2$ =	**5.484.913**	**1.233.037**
F_R =	F_1 =	**5.484.913**	**1.233.037**
F_2 =	$F_3 = F_R/(2)^{0,5}$ =	**3.878.419**	**871.889**
F_4 =	F_1 =	**5.484.913**	**1.233.037**

	mm	in	
R_1 =	**161,0**	**6,339**	Inner radius
R_2 =	**520,0**	**20,472**	Outer radius
R_m =	**340,5**	**13,406**	Mean radius
t =	**450,0**	**17,717**	Thickness

$A = t * (R_2 - R_1) =$ 161.550 mm^2 Section area
$W = t * (R_2 - R_1)^2 / 6 =$ 9.666.075 mm^3 Section modulus

STRESS AT POINT B **With reference to sketch 3**

$L_b = R_m * (\text{sen } 45° - \text{sen } 22,5°) =$ 110,47 mm Lever arm from A to B
$M_b = F_1 * L_b =$ 605.897.191 N*mm Bending moment

SHEAR STRESS
$\tau = 1,5 * F_3 / A =$ **36,01 MPa** < τ_{all} = **149,39 MPa**
5.223 Psi **21.667 Psi**

TENSILE STRESS
$\sigma_t = F_2 / A =$ 24,01 MPa
BENDING STRESS
$\sigma_b = M_b / W_b =$ 62,68 MPa
IDEAL STRESS
$\sigma_{id} = ((\sigma_t + \sigma_b)^2 + 3 * \tau^2)^{0,5} =$ **106,80 MPa** < σ_{all} = **298,77 MPa**
15.490 Psi **43.333 Psi**

STRESS AT POINT C **With reference to sketch 4**
$L_c = R_m * (1 - \text{sen } 22,5°) =$ 210,20 mm Lever arm from A to C
$M_c = F_1 * L_c =$ 1.152.908.309 N*mm Bending moment

TENSILE STRESS
$\sigma_t = F_4 / A =$ 33,95 MPa
BENDING STRESS
$\sigma_b = M_c / W_c =$ 119,27 MPa
IDEAL STRESS
$\sigma_{id} = \sigma_t + \sigma_b =$ **153,23 MPa** < σ_{all} = **298,77 MPa**
22.223 Psi **43.333 Psi**

SECTION " D-D "

A_D =	$t * L_1$ =	373.860	mm^2	Section area
W_D =	$L_1^2 + t / 6$ =	51.767.148	mm^3	Section modulus

SHEAR STRESS

τ =	$1,5 + R_n / A_D$ =	**16,90 MPa**	<	τ_{all} =	**149,39 MPa**
		2.450 Psi			**21.667 Psi**

TENSILE STRESS

σ_t = R_l / A = 29,34 MPa

BENDING STRESS

σ_b = $R_l * H_2 / W_D$ = 127,14 MPa

IDEAL STRESS

σ_{id} =	$((\sigma_t+\sigma_b)^2 + 3*\tau^2)^{0,5}$ =	**159,20 MPa**	<	σ_{all} =	**298,77 MPa**
		23.090 Psi			**43.333 Psi**

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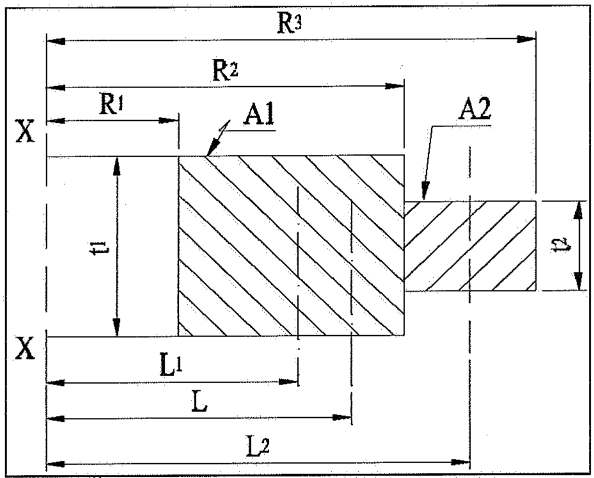
Nuovo Pignone MASSA	**STRUCTURAL PARTS CALCULATION OF STAGE 2 , PRETREATING REACTORS ITEMS: D-6212 / D-6232**

RETENTION LUG VERIFICATION



DESIGN FORCES

		N	Lb
F_1 =	$T_l / 2$ =	**3.978.092**	**894.296**
F_R =	F_1 =	**3.978.092**	**894.296**
F_2 =	$F_3=F_R/(2)^{0,5}$=	**2.812.936**	**632.362**
F_4 =	F_1 =	**3.978.092**	**894.296**

	mm	in	
R_1 =	**108,0**	**4,252**	
R_2 =	**530,0**	**20,866**	<1>
R_3 =	**630,0**	**24,803**	<1>
t_1 =	**290,0**	**11,417**	<2>
t_2 =	**100,0**	**3,937**	

A_1 =	$t_1 * (R_2 - R_1)$ =	122.380 mm^2	
A_2 =	$t_2 * (R_3 - R_2)$ =	10.000 mm^2	
A =	$A_1 + A_2$ =	132.380 mm^2	Total section area
L_1 =	$(R_1 + R_2) / 2$ =	319,0 mm	Gravity center Area 1 from X-X axis
L_2 =	$(R_3 + R_2) / 2$ =	580,0 mm	Gravity center Area 2 from X-X axis
L =	$(A_1*L_1 + A_2*L_2) / A_a$ =	338,7 mm	Section gravity center from X-X axis
J_1 =	$t_1 * (R_2 - R_1)^3 / 12$ =	1,816E+09 mm^4	Moment of inertia of area 1
J_{T1} =	$A_1 + (L - L_1)^2$ =	4,757E+07 mm^4	Transfer moment of area 1
J_2 =	$t_2 + (R_3 - R_2)^3 / 12$ =	8,333E+06 mm^4	Moment of inertia area 2
J_{T2} =	$A_2 * (L_2 - L)^2$ =	5,822E+08 mm^4	Transfer moment of area 2
J_{tot} =	$J_1 + J_{T1} + J_2 + J_{T2}$ =	2,454E+09 mm^4	Section inertia moment
Y_{max}=		291,3 mm	Max of : $R_3 - L$ = 291,3
			$L - R_1$ = 230,7

STRESS AT POINT B **With reference to sketch 3**

L_b =	L * (sen 45° - sen 22,5°) =	109,89 mm	Lever arm from A to B
M_b =	$F_1 * L_b$=	437.142.052 N*mm	Bending moment

	SHEAR STRESS				
τ =	$1,5 * F_3 / A$ =	**31,87 MPa**	<	τ_{all} =	**80,44 MPa**
	TENSILE STRESS	**4.623 Psi**			**11.667 Psi**
σ_t =	F_2 / A =	21,25 MPa			
	BENDING STRESS				
σ_b =	$M_b * Y_{max} / J_{tot}$ =	51,88 MPa			
	IDEAL STRESS				
σ_{id} =	$((\sigma_t+\sigma_b)^2 + 3*\tau^2)^{0,5}$ =	**91,63 MPa**	<	σ_{all} =	**160,88 MPa**
		13.290 Psi			**23.333 Psi**

3	MODIFIED WHERE SHOW <3>	ITEM	
2	MODIFIED WHERE SHOWN <2>	**D-6212/ D-6232**	
1	MODIFIED WHERE SHOWN <1>	**N. SOU0107841/4**	
0	EMISSIONE-ISSUE	LINGUA-LANG. **A**	PAGINA-SHEET **44 / 45**
REV.	DESCRIZIONE - DESCRIPTION		

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

Nuovo Pignone

MASSA

STRUCTURAL PARTS CALCULATION OF STAGE 2 , PRETREATING REACTORS
ITEMS: D-6212 / D-6232

STRESS AT POINT C **With reference to sketch 4**

$L_c =$	$L * (1 - \text{sen } 22{,}5°) =$	209,09 mm	Lever arm from A to C
$M_c =$	$F_1 * L_c =$	831.799.043 N*mm	Bending moment

TENSILE STRESS

$\sigma_t =$ $F_4 / A =$ 30,05 MPa

BENDING STRESS

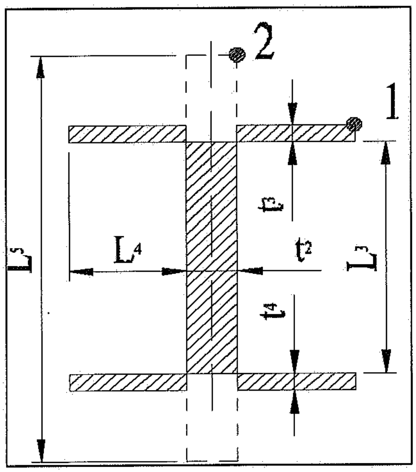
$\sigma_b =$ $M_c * Y_{max} / J_{tot} =$ 98,72 MPa

IDEAL STRESS

$\sigma_{id} =$ $\sigma_t + \sigma_b =$ **128,77 MPa** **18.677 Psi** $<$ $\sigma_{all} =$ **160,88 MPa** **23.333 Psi**

WELDED JOINT (According to CNR-UNI 10011)

$\sigma_{am} =$	$\sigma_{all} * 0{,}85 =$	**136,75 MPa** **19.833 Psi**	Allowable stress of welded joint
$T_l =$		7.956.184 N	Longitudinal load
$T_n =$		3.054.093 N	Normal load
$J_w =$	$(L_4*(L_3+t_3+t_4)^3-L_4*L_3^3)/6+ t_2*L_3^3/12=$	1,169E+11 mm^4	Moment of inertia of welded joint
$A_w =$	$8*L_4*W_t*0{,}7+ L_3*t_2 =$	256.000 mm^2	Total area of welded joint



SHEAR STRESS

$\tau =$ $T_l / A_w =$ 31,08 MPa

NORMAL STRESS

$\sigma =$ $T_n / A_w =$ 11,93 MPa

BENDING STRESS

$\sigma_m =$ $T_l * H_5 * ((L_3+t_3+t_4)/ 2)/ J_w =$ 24,49 MPa

STRESS VERIFICATION ON POINT 1 & 2

$\sigma_{id1} = ((\sigma + \sigma_m)^2+3 * \tau^2)^{0.5} =$	**65,00 Mpa** **9.427 Psi**	$<$	**136,75 MPa** **19.833 Psi**
$\sigma_{id2} = \sigma_{id1} \times L_5 / L_3 =$	**92,49 Mpa** **13.415 Psi**	$<$	**136,75 MPa** **19.833 Psi**

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE

ITEM **D-6212/ D-6232**

N. SOU0107841/4

LINGUA-LANG. **A** PAGINA-SHEET **45 / 46**

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

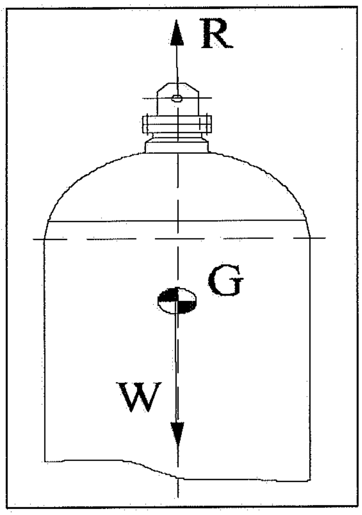
294

LIFTING POSITION N° 3 (=90°)

DESIGN FORCES

Kd = 1,5 Dimamic coef.

	N	Lb
P =	13.515.000	3.038.242
W = $P * K_d$ =	20.272.500	4.557.363
F_1 = W / 2 =	10.136.250	2.278.681
F_R = F_1 =	10.136.250	2.278.681
F_2 = F_3=$F_R/(2)^{0,5}$=	7.167.411	1.611.271
F_4 = F_1 =	10.136.250	2.278.681



	mm	in
R_1 =	161,0	6,339
R_2 =	520,0	20,472
R_m =	340,5	13,406
t =	450,0	17,717

A = $t * (R_2 - R_1)$ = 161.550 mm^2 Section area

W = $t * (R_2 - R_1)^2/6$ = 9.666.075 mm^3 Section modulus

LIFTING LUG VERIFICATION

STRESS AT POINT B **With reference to sketch 3**

L_b = R_m * (sen 45° - sen 22,5°) = 110,47 mm Lever arm from A to B

M_b = $F_1 * L_b$ = 1.119.712.516 N*mm Bending moment

SHEAR STRESS

τ = $1,5 * F_3 / A$ = **66,55 MPa** < τ_{all} = **149,39 MPa**

TENSILE STRESS **9.652 Psi** **21.667 Psi**

σ_t = F_2 / A = 44,37 MPa

BENDING STRESS

σ_b = M_b / W_b = 115,84 MPa

IDEAL STRESS

σ_{id} = $((\sigma_t+\sigma_b)^2 + 3*\tau^2)^{0,5}$ = **197,36 MPa** < σ_{all} = **298,77 MPa**

28.625 Psi **43.333 Psi**

295

STRESS AT POINT C **With reference to sketch 4**

$L_c =$	$R_m * (1 - \text{sen } 22{,}5°) =$	210,20 mm	Lever arm from A to C
$M_c =$	$F_1 * L_c =$	2.130.602.157 N*mm	Bending moment

TENSILE STRESS
$\sigma_t =$ $F_4 / A =$ 62,74 MPa
BENDING STRESS
$\sigma_b =$ $M_c / W_c =$ 220,42 MPa
IDEAL STRESS
$\sigma_{id} =$ $\sigma_t + \sigma_b =$ **283,16 MPa** < $\sigma_{all} =$ **298,77 MPa**
41.070 Psi **43.333 Psi**

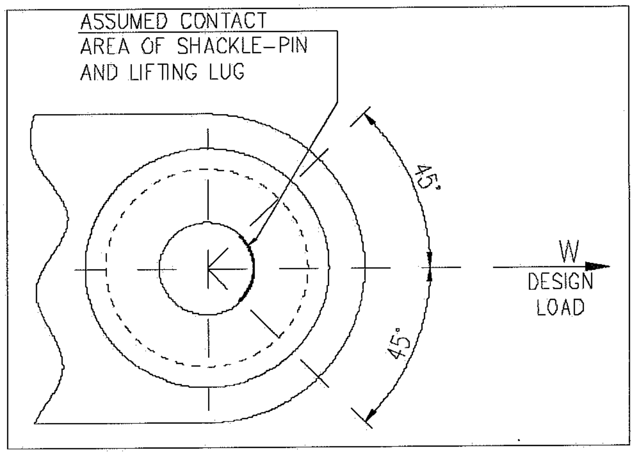
SECTION " D-D "
$A_D =$ $t * L =$ 373.860 mm^2 Section area

TENSILE STRESS
$\sigma =$ $W / A_D =$ **54,22 MPa** < $\sigma_{all} =$ **298,77 MPa**
7.865 Psi **43.333 Psi**

(*) In this configuration the retention lug is not loaded

BEARING STRESS ON PIN

DESIGN FORCES



Kd = 1,5 Dimamic coef.

	N	Lb
P =	13.515.000	3.038.242
$W = P * K_d =$	20.272.500	4.557.363

	mm	in
$R_1 =$	161,0	6,339
t =	450,0	17,717

$\alpha =$ **90 °**

$A =$ $\alpha_{[rad]} * R_1 * t =$ 113.804 mm^2 Total contact surface area

BEARING STRESS
$\sigma_b =$ $W / A =$ **178,13 MPa** < **$0{,}9*Y_s$ =** **403,34 MPa**
25.836 Psi **58.499 Psi**

II

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE

ITEM **D-6212/ D-6232**
N. SOU0107841/4
LINGUA-LANG. **A** PAGINA-SHEET **47 / 48**

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

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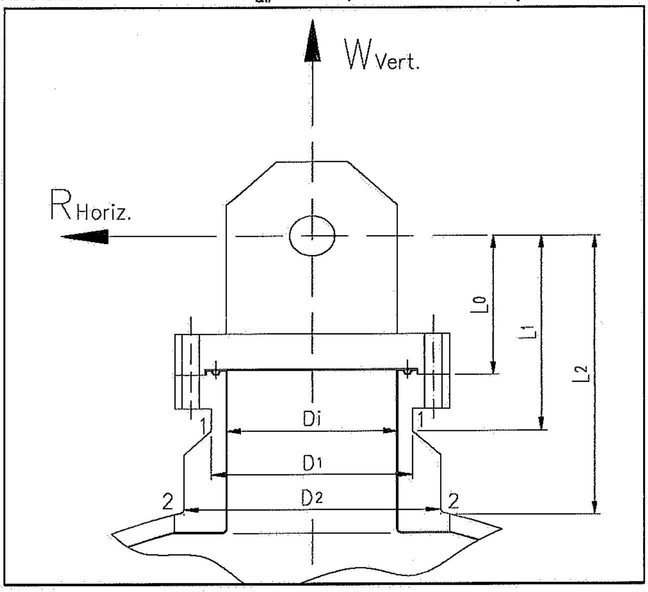
MANHOLE VERIFICATION <2>

MATERIAL OF NOZZLE : **SA 182 F22V** σ_{all} = Ys/1,5 = **275,8** MPa



D_i =	973,6 mm <2>	
	38,331 in	
D_1 =	1.134,0 mm <2>	
	44,646 in	
D_2 =	1.505,0 mm	
	59,252 in	
L_0 =	924,0 mm <2>	
	36,378 in	
L_1 =	1.360,0 mm <2>	
	53,543 in	
L_2 =	1.940,0 mm <2>	
	76,378 in	
K_d =	1,5 (Dinamic coeficent)	
R =	10.400.924 N <3>	in horizontal
	2.338.181 Lb <3>	
W =	20.272.500 N	in vertical
	4.557.363 Lb	

NOZZLE VERIFICATION IN LIFTING CONDITION

SECTION " 1-1 " VERIFICATION WITH THE REACTOR IN HORIZONTAL POSITION

M_1 =	$R \times L_1$ =	1,415E+10	N*mm		Bending moment on section "1-1"		
A_1 =	$\pi \times (D_1^2 - Di^2) / 4$ =	265.511	mm^2		Area of section "1-1"		
W_1 =	$\pi / 32 \times (D_1^4 - Di^4) / D_1$ =	65.378.353	mm^3		Section modulus of section "1-1"		
	BENDING STRESS						
σ_1 =	M_1 / W_1 =	216,36	MPa				
		31.380	Psi				
	SHEAR STRESS						
τ_1 =	$4 / 3 \times R / A_1$ =	52,10	MPa				
		7.556	Psi				
	IDEAL STRESS						
σ_{id} =	$(\sigma_1{}^2 + 4x\tau_1{}^2)^{0,5}$ =	**240,14**	**MPa**	<	σ_{all} =	**275,80**	**MPa**
		34.829	**Psi**			**40.000**	**Psi**

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SECTION " 2-2 " VERIFICATION WITH THE REACTOR IN HORIZONTAL POSITION

$M_2 =$	$R \times L_2 =$	2,01778E+10	N*mm	Bending moment on section "2-2"
$A_2 =$	$\pi \times (D_2^2 - Di^2) / 4 =$	1.034.470	mm^2	Area of section "2-2"
$W_2 =$	$\pi / 32 \times (D_2^4 - Di^4) / D_1 =$	366.365.873	mm^3	Section modulus of section "2-2"

BENDING STRESS

$\sigma_2 =$	$M_2 / W_2 =$	55,08	MPa
		7.988	Psi

SHEAR STRESS

$\tau_2 =$	$4 / 3 \times R / A_2 =$	13,37	MPa
		1.939	Psi

IDEAL STRESS

$\sigma_{id} =$	$(\sigma_2^{\ 2} + 4x\tau_2^{\ 2})^{0,5} =$	**61,23**	**MPa**	<	$\sigma_{all} =$	**275,80**	**MPa**
		8.880	**Psi**			**40.000**	**Psi**

SECTION " 1-1 " VERIFICATION WITH THE REACTOR IN VERTICAL POSITION

TENSILE STRESS

$\sigma =$	$W / A_1 =$	**76,35**	**MPa**	<	$\sigma_{all} =$	**275,80**	**MPa**
		11.074	**Psi**			**40.000**	**Psi**

SECTION " 2-2 " VERIFICATION WITH THE REACTOR IN VERTICAL POSITION

TENSILE STRESS

$\sigma =$	$W / A_2 =$	**19,60**	**MPa**	<	$\sigma_{all} =$	**275,80**	**MPa**
		2.842	**Psi**			**40.000**	**Psi**

BOLT VERIFICATION ACCORDING TO BROWNELL & YOUNG

BOLTS MATERIAL **SA 193 B16**

ϕ_e =	1.554,0	mm	61,181	in	Flange outside diameter
ϕ_i =	973,6	mm	38,331	in	Flange inside diameter
ϕ_b =	1.370	mm	53,937	in	Bolts circle diameter
N =	20	4" 8UN-2A			Number of bolts
A_b =	7.462	mm^2	11,566	in^2	Cross sect. area of one bolt
Sb_{all} =	436,7	MPa	63.335	Psi	Bolts allowable stress (Sy / 1.5)
Sc_{all} =	275,8	MPa	40.001	Psi	Flange allowable stress (Sy / 1.5)
n =	1				Elasticity modulus ratio of lug and flange
S_a =	298,7	MPa	43.322	Psi	Lifting lug allowable stress (Sy / 1.5)
s =	104,0	mm	4,094	in	Bolts holes

HORIZONTAL POSITION (N° 1)

M = $R \times L_o$ = 9,610E+09 N*mm Total moment on flange

VERTICAL POSITION (N° 2)

W = 2,027E+07 N Tensile load on flange

CONDITION N° 1

$Sc_{min} = 4xP/\pi x(\phi_e^2 - \phi_i^2) - 32xMx\phi_b/\pi\, x(\phi_e^4 - \phi_i^4) =$ -27,18 MPa Minimum stress on flange at bolt circle diameter

Check the position of neutral axis

$K = 1 / (1 + Sb_{max} /(n \times Sc)) =$ 0,198

As per linear interpolation, the value of Constants are the follows

C_c = 1,21124 **C_t** = 2,6654 **j** = 0,7758 **z** = 0,4594

k	C_c	C_t	j	z
0	0	3,14	0,75	0,5
0,05	0,6	3,08	0,76	0,49
0,1	0,852	2,887	0,766	0,48
0,15	1,049	2,772	0,771	0,469
0,2	1,218	2,661	0,776	0,459
0,25	1,37	2,551	0,779	0,448
0,3	1,51	2,442	0,781	0,438
0,35	1,64	2,333	0,783	0,427
0,4	1,765	2,224	0,784	0,416
0,45	1,884	2,113	0,785	0,404
0,5	2	2	0,785	0,393
0,55	2,113	1,884	0,785	0,381
0,6	2,224	1,765	0,784	0,369
0,65	2,333	1,64	0,783	0,357
0,7	2,442	1,51	0,781	0,344
0,75	2,551	1,37	0,779	0,331
0,8	2,661	1,218	0,776	0,316
0,85	2,772	1,049	0,771	0,302
0,9	2,887	0,852	0,766	0,286
0,95	3,08	0,6	0,76	0,27
1	3,14	0	0,75	0,25

Maximum tensile stress induced on bolts

$t_1 =$	$(A_b \times N) / (\pi \times \phi_b) =$	34,67	mm	
$F_t =$	$(M - Pxzx\phi_b) / (j \times \phi_b) =$	9.042.188	N	Tension load
$Sb_{max} =$	$(2 \times F_t) / (t_1 \times \phi_b \times C_t) =$	142,82	MPa	Max. induced stress on bolting
$F_c =$	$F_t + P =$	9.042.188	N	Compressive load on flange
$t_3 =$	$(\phi_e - \phi_i) / 2 =$	290,2	mm	Width of flange
$t_2 =$	$t_3 - t_1 =$	255,53	mm	Actual width of flange
$Sc =$	$(2 \times F_c)/((t_2 + nx\, t_1)x\, C_c \times \phi_b) =$	37,55	MPa	Stress on flange at B.C.D.
$Sc_{max} =$	$Sc\, x(1 + t_3 / (2xK\, x\phi_b)) =$	57,64	MPa	Max. compressive stress on flange

Minimum required cross sect. area of anchor bolts

$A_{min} =$	$(2 \times \pi \times F_t) / (C_t x\, Sb_{all}) =$	48.809	mm^2	
$A_{tot} =$	$A_b \times N =$	149.240	mm^2	Actual cross sect. area

CONDITION N° 2

TENSILE STRESS

$\sigma =$ $W / A_{tot} =$ **135,84** **MPa** < $\sigma_{all} =$ **436,70** **MPa**
19.701 **Psi** **63.336** **Psi**

REV.	DESCRIZIONE - DESCRIPTION
3	MODIFIED WHERE SHOW <3>
2	MODIFIED WHERE SHOWN <2>
1	MODIFIED WHERE SHOWN <1>
0	EMISSIONE-ISSUE

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

300

THICKNESS FLANGE VERIFICATION WITH THE REACTOR IN HORIZONTAL POSITION ACCORDING TO "ROARK'S FORMULA FOR STRESS & STRAIN" CHAPTER 10 TABLE 24 CASE 20b

MATERIAL OF NOZZLE : **SA 508 Gr.3 Cl.2** σ_{all} = Ys/1,5 = **298,78 MPa**
43.333 Psi

Comments :

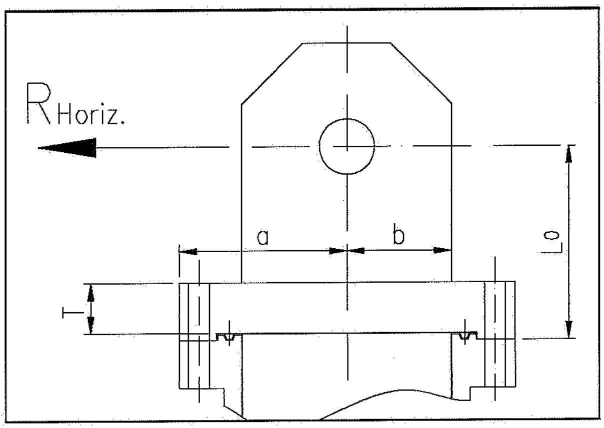
Table 24 case 20b Roark & Young (6° ed.), formulas for flat circular plates of constant thickness.
Central couple on an annular plate with simply supported outer edge .

θ = $(\alpha \times M_o)/(E \times t^3)$ = **0,000149** rad

σ_{max} = $(\beta \times M_o)/(a \times t^2)$ = **103,20 MPa** < **298,78 MPa**
14.967 Psi **43.333 Psi**

where :

θ =	Slope angle at center		
α =	0,0850		
β =	0,7509		
E =	Young's modulus =	203.400	MPa
Mo =	Moment = R x L_o =	9,61E+09	KN*mm
a =	radius of the flange =	777	mm
		30,591	in
b =	radius of the lug =	520	mm
		20,472	in
t =	flange thickness =	300	mm
		11,811	in



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SKIRT VERIFICATION IN LIFTING CONDITION <2>

MATERIAL <2>	Temp. T (°C)	Yield Stren. (MPa)	Tensile Allowable Stress (MPa)	Comp. allowable Stress (MPa)
		<2>	<2> Ys / 1,5	Acc. to ASME II D App. 3
SA 516 Gr.65	20	241	160,67	109,79
SA 387 22 Cl.2	20	310	206,67	115,20

T	9.872	Force KN **<2>**	Hs	5.430	mm <2> (see sketch)
th	45,0	Skirt thickness (mm)	H_1	550	mm <2> (see sketch)
De	4.828,4	Ext. Diam. (mm)	H_2	2.098	mm <2> (see sketch)
Di	4.738,4	Int. Diam. (mm)	D_1	1.219,2	mm (Dia of SA1+ SA2 openings)
Rm	2.391,7	Mean Radius. (mm)	D_2	2.650	mm **<1>** (Dia of SO1+2+3 openings)

BOTTOM HEAD-SKIRT JUNCTION VERIFICATION IN LIFTING CONDITION

MATERIAL SA 387 22 Cl.2

$A = \pi \times (De^2 - Di^2) / 4 =$ 676.237 mm^2 Area of skirt

$J = \pi \times Rm^3 \times th =$ 1,93E+12 mm^4 Moment of Inertia of skirt section

BENDING STRESS

$\sigma =$ T x Hs x De / 2 x J = **66,91 MPa** < **115,20 MPa**

SHEAR STRESS

$\tau =$ 4 / 3 x T / A = 19,46 MPa

IDEAL STRESS

$\sigma_{id} = (\sigma^2 + 4 \times \tau^2)^{0,5} =$ **77,41 MPa** < **206,67 MPa**

SA 1-2 OPENING SECTION VERIFICATION IN LIFTING CONDITION

MATERIAL SA 516 Gr.65

$A = \pi \times (De^2 - Di^2) / 4 =$ 676.237 mm^2 Area of skirt

$Ao = D_1 \times th =$ 54.864 mm^2 Area of opening

$Ar = A - Ao =$ 621.373 mm^2 Residual Area

$J = \pi \times Rm^3 \times th =$ 1,93E+12 mm^4 Moment of Inertia of skirt section

$Jo = Ao \times Rm^2 =$ 3,14E+11 mm^4 Moment of Inertia of opening

$Jr = J - Jo =$ 1,62E+12 mm^4 Residual Moment of Inertia

BENDING STRESS

$\sigma =$ T x H_1 x De / 2 x Jr = **8,09 MPa** < **109,79 MPa**

SHEAR STRESS

$\tau =$ 4 / 3 x T / Ar = 21,13 MPa

IDEAL STRESS

$\sigma_{id} = (\sigma^2 + 4 \times \tau^2)^{0,5} =$ **43,03 MPa** < **160,67 MPa**

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SO1,SO2 & SO3 OPENING SECTION VERIFICATION IN LIFTING CONDITION
MATERIAL SA 516 Gr.65

$A = \pi \times (De^2 - Di^2) / 4 =$	676.237	mm^2	Area of skirt
$Ao = D_2 \times th =$	119.250	mm^2	Area of opening
$Ar = A - Ao =$	556.987	mm^2	Residual Area
$J = \pi \times Rm^3 \times th =$	1,93E+12	mm^4	Moment of Inertia of skirt section
$Jo = Ao \times Rm^2 =$	6,82E+11	mm^4	Moment of Inertia of opening
$Jr = J - Jo =$	1,25E+12	mm^4	Residual Moment of Inertia

BENDING STRESS

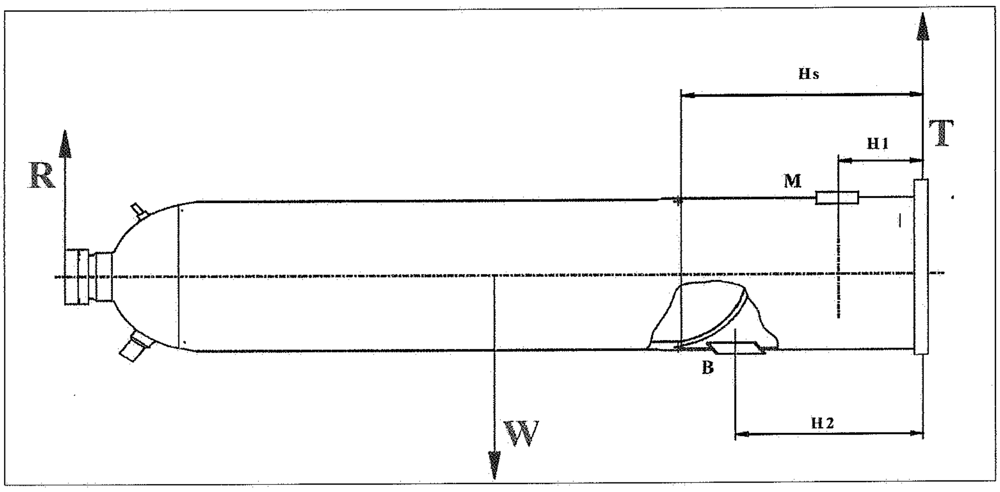
$\sigma = T \times H_2 \times De / 2 \times Jr =$ **39,94 MPa** < **109,79 MPa**

SHEAR STRESS

$\tau = 4 / 3 \times T / Ar =$ 23,57 MPa

IDEAL STRESS

$\sigma_{id} = (\sigma^2 + 4 \times \tau^2)^{0,5} =$ **61,79 MPa** < **160,67 MPa**



H_S = distance from retention lug center to top of skirt <2>
H_1 = distance from retention lug center to SA1-2 opening center <2>
H_2 = distance from retention lug center to SO1-2 opening center <2>

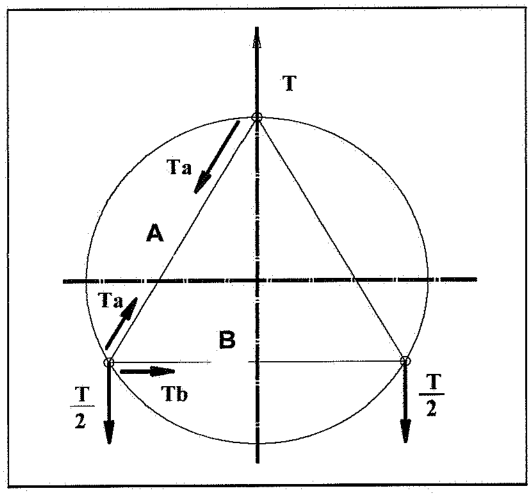
REINFORCING BEAM CALCULATION <2>

THIS VERIFICATION IS CARRIED OUT IN HORIZONTAL POSITION AT 0° ONLY
BECAUSE THIS POSITION IS THE MOST SEVERE

MATERIAL : ASTM A 36

				h =	**24,409**	in
Sy =	36.000	Psi		b =	**12,008**	in
E =	29.500.000	Psi		a =	**0,827**	in
σ_{all} =	Sy * 0,9 =	32.400	Psi	t =	**1,575**	in
Beam type:	**HEM-600**			Ix =	**10,079**	in
				Iy =	**2,843**	in

D =	4.738,2 mm	186,543	in	Skirt inner diameter
L =	D xcos 30 =	161,55	in	Beam lenght
T =	9.872,0 KN <2>	2.219.277	Lb	Static load



A = 2 x b x t + a x(h - 2xt)= 55,41 in^2

Beam "A" is loaded by tensile stress

T_a = T / (2*cos 30°) = 1.281.300 Lb

NORMAL STRESS

$\sigma = T_a / A =$ 23.125 Psi $< \sigma_{all}$

Beam "B" is loaded by compressive stress

T_b = T_a * cos 60°) = 640.650 Lb

NORMAL STRESS

$\sigma_{bx} = T_b * \omega_x / A =$ 11.563 Psi $< \sigma_{crx}$

$\sigma_{bx} = T_b * \omega_y / A =$ 15.610 Psi $< \sigma_{cry}$

where :

$\omega_x =$ 1,00 (from CNR-UNI 10011-73 tab 4-III c)

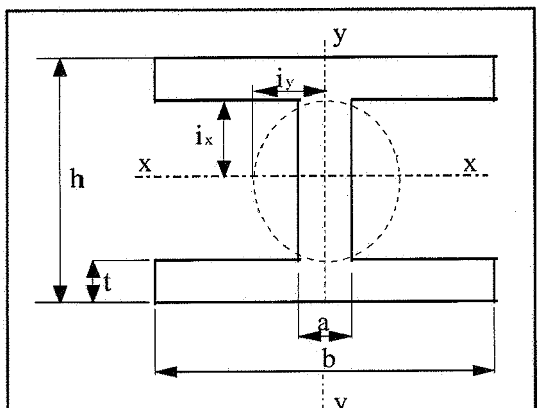
$\omega_y =$ 1,35 (from CNR-UNI 10011-73 tab 4-III c)

$\lambda_x = L / I_x =$ 16,03

$\lambda_y = L / I_y =$ 56,83

$\sigma_{crx} = \pi^2 * E / \lambda_x^2 =$ 1.133.218 Psi

$\sigma_{cry} = \pi^2 * E / \lambda_y^2 =$ 90.138 Psi



Beam A - B section

3	MODIFIED WHERE SHOW <3>	ITEM	
2	MODIFIED WHERE SHOWN <2>	D-6212/ D-6232	
1	MODIFIED WHERE SHOWN <1>	N. SOU0107841/4	
0	EMISSIONE-ISSUE	LINGUA-LANG.	PAGINA-SHEET
REV.	DESCRIZIONE - DESCRIPTION	A	55 / 56

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

NOZZLE LUGS CALCULATION <1>

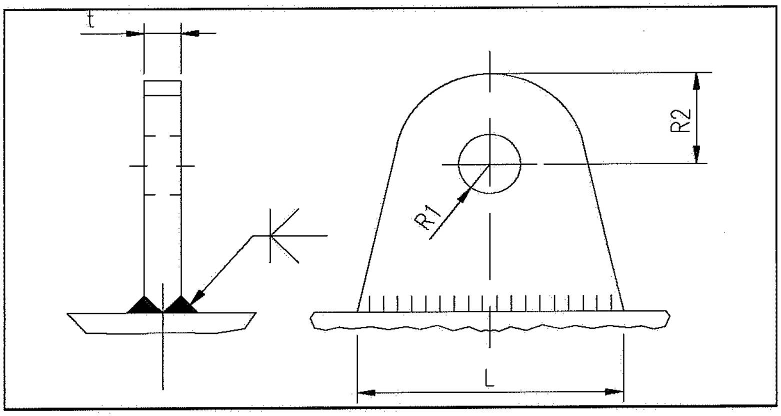
LIFTING LUG FOR COVER NOZZLE D1-D2

MATERIAL : SA 387 Gr.22 Cl.2

Yield stren. Sy = **310,00** Mpa

σ_{all} = Sy / 1,5 = 206,67 Mpa

τ_{all} = Sy / 3 = 103,33 Mpa



R_1 = **10** mm
R_2 = **30** mm
t = **12** mm
L = **127** mm

P = **2500** N Vessel weight
K_d = **1,5** Impact factor
n = **1** Number of lug
N = $P * K_d / n$ = 3750 N

SECTION " A-A "

$A_a = t * (R_2 - R_1) =$ 240 mm^2 Area of section "A-A"

SHEAR STRESS
$\tau = 1,5 * N / A_a =$ **23,44** Mpa < τ_{all} = **103,33** Mpa

SECTION " B-B "

$A_b = t * (R_2 - R_1) =$ 240 mm^2 Area of section "B-B"
$W_b = t * (R_2 - R_1)^2 / 6 =$ 800 mm^3 Section modulus of section "B-B"
T = R / 2 = 1.875 N Normal load acting on section "B-B"
M = $T * (R_2 + R_1) / 2$ = 37.500 N*mm Bending moment acting on section "B-B"

NORMAL STRESS
$\sigma = T / A_b + M / W_b =$ **54,69** Mpa < σ_{all} = **206,67** Mpa

SECTION " C-C "
$A_c = t * L =$ 1.524 mm^2 Area of section "C-C"

NORMAL STRESS

$\sigma = N / A_c =$ **2,46** Mpa < σ_{all} = **206,67** Mpa

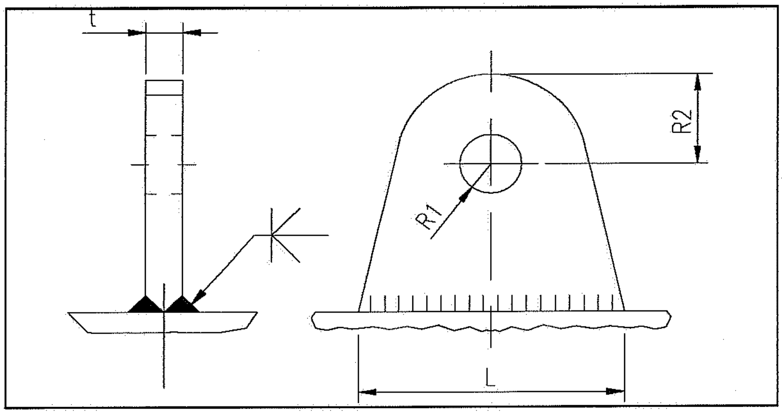
LIFTING LUG FOR COVER NOZZLE D3-D6

MATERIAL : SA 387 Gr.22 Cl.2

Yield stren. Sy = **310,00** Mpa

σ_{all} = Sy / 1,5 = 206,67 Mpa

τ_{all} = Sy / 3 = 103,33 Mpa



R_1 =	**10**	mm
R_2 =	**30**	mm
t =	**12**	mm
L =	**108**	mm

P =	**2500**	N	Vessel weight
K_d =	**1,5**		Impact factor
n =	**1**		Number of lug
N = P * K_d / n =	3750	N	

SECTION " A-A "

$A_a = t * (R_2 - R_1) =$ 240 mm^2 Area of section "A-A"

SHEAR STRESS

$\tau =$ 1,5 * N / A_a = **23,44** Mpa < τ_{all} = **103,33** Mpa

SECTION " B-B "

$A_b = t * (R_2 - R_1) =$	240	mm^2	Area of section "B-B"
$W_b = t * (R_2 - R_1)^2 / 6 =$	800	mm^3	Section modulus of section "B-B"
T = R / 2 =	1.875	N	Normal load acting on section "B-B"
$M = T * (R_2 + R_1) / 2 =$	37.500	N*mm	Bending moment acting on section "B-B"

NORMAL STRESS

$\sigma =$ T / A_b + M / W_b = **54,69** Mpa < σ_{all} = **206,67** Mpa

SECTION " C-C "

A_c = t * L = 1.296 mm^2 Area of section "C-C"

NORMAL STRESS

$\sigma =$ N / A_c = **2,89** Mpa < σ_{all} = **206,67** Mpa

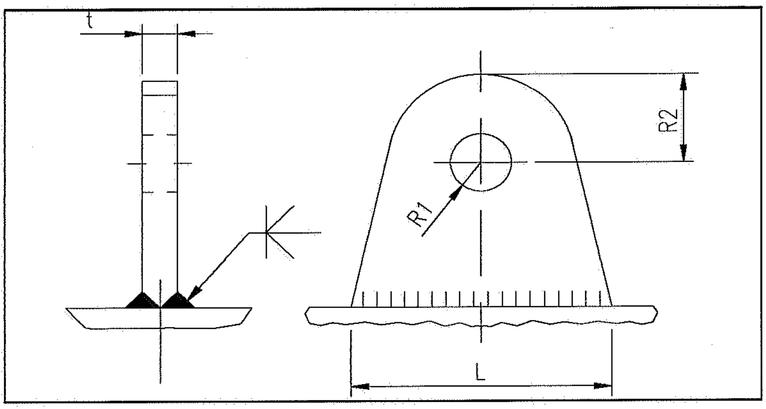
LIFTING LUG FOR TOP SPOOL

MATERIAL : SA 387 Gr.22 Cl.2

Yield stren. S_y = **310,00** Mpa

$\sigma_{all} = S_y / 1,5 =$ 206,67 Mpa

$\tau_{all} = S_y / 3 =$ 103,33 Mpa



R_1 =	**20**	mm	
R_2 =	**85**	mm	**<1>**
t =	**30**	mm	
L =	**350**	mm	

P =	**88000**	N	Vessel weight	**<1>**
K_d =	**1,5**		Impact factor	
n =	**1**		Number of lug	
N =	$P * K_d / n =$	132000	N	**<1>**

SECTION " A-A "

$A_a = t * (R_2 - R_1) =$ 1.950 mm^2 Area of section "A-A"

SHEAR STRESS

$\tau = 1,5 * N / A_a =$ **101,54** Mpa $< \tau_{all} =$ **103,33** Mpa

SECTION " B-B "

$A_b = t * (R_2 - R_1) =$	1.950	mm^2	Area of section "B-B"
$W_b = t * (R_2 - R_1)^2 / 6 =$	21.125	mm^3	Section modulus of section "B-B"
T = R / 2 =	66.000	N	Normal load acting on section "B-B"
$M = T * (R_2 + R_1) / 2 =$	3.465.000	N*mm	Bending moment acting on section "B-B"

NORMAL STRESS

$\sigma = T / A_b + M / W_b =$ **197,87** Mpa $< \sigma_{all} =$ **206,67** Mpa

SECTION " C-C "

$A_c = t * L =$ 10.500 mm^2 Area of section "C-C"

NORMAL STRESS

$\sigma = N / A_c =$ **12,57** Mpa $< \sigma_{all} =$ **206,67** Mpa

REV.	DESCRIZIONE - DESCRIPTION	
3	MODIFIED WHERE SHOW <3>	ITEM **D-6212/ D-6232**
2	MODIFIED WHERE SHOWN <2>	
1	MODIFIED WHERE SHOWN <1>	**N. SOU0107841/4**
0	EMISSIONE-ISSUE	LINGUA-LANG. **A** — PAGINA-SHEET **58 / 58**

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

Nuovo Pignone MASSA	CLIENTE – CUSTOMER CONOCO PHILLIPS
	LOCALITA' - PLANT LOCATION WILHELMSHAVEN (GERMANY)
COMMESSA - JOB 3100276	IMPIANTO - PLANT WRG-DEEP CONVERSION PROJECT

TITOLO - TITLE

TITLE

Stress Analysis on Belt "B" Under thickness area

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REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
1	GENERAL REVISION	Spadaccini	Lazzerini E.	Ronchieri A.	29/09/06
0	EMISSIONE-ISSUE	Spadaccini	Lazzerini	Ronchieri	19-09-06

ITEM D-6212

N. SOU0107862/4

LINGUA-LANG.	PAGINA-SHEET
A	1 / 2

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

1 GENERAL SUMMARY

This document shows the model (and the relative results) built to evaluate the effect of a material under thickness in belt "B". For reference see Creusot document Ner **NFC 06.050**. rev. 1.
The under thickness area has been modelled as shown in the sketch below.

All the analyses have been carried out using the software **ANSYS®** rel. *10.0*.
The mathematical model is based on the solid bodies showed in the following figures:

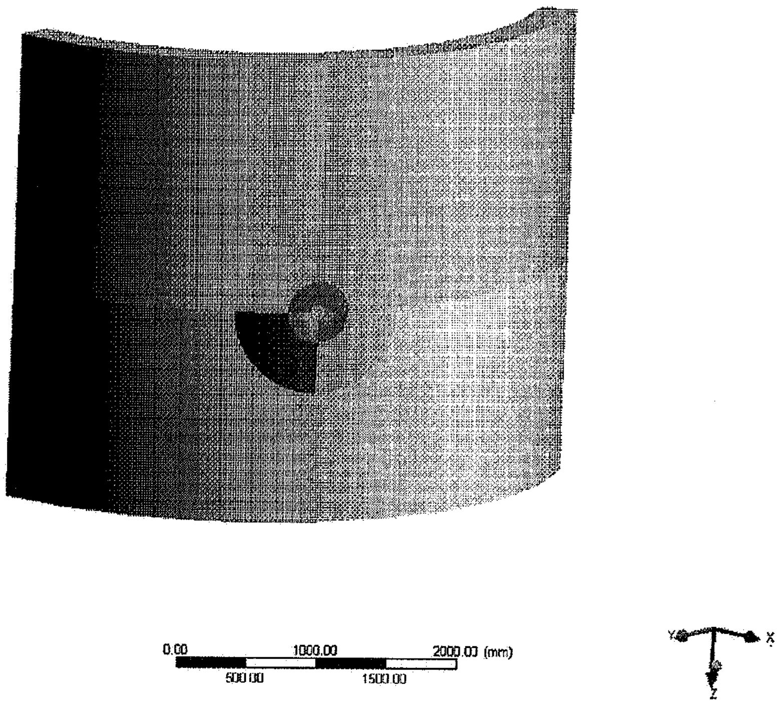

Figure 1 – *Model*

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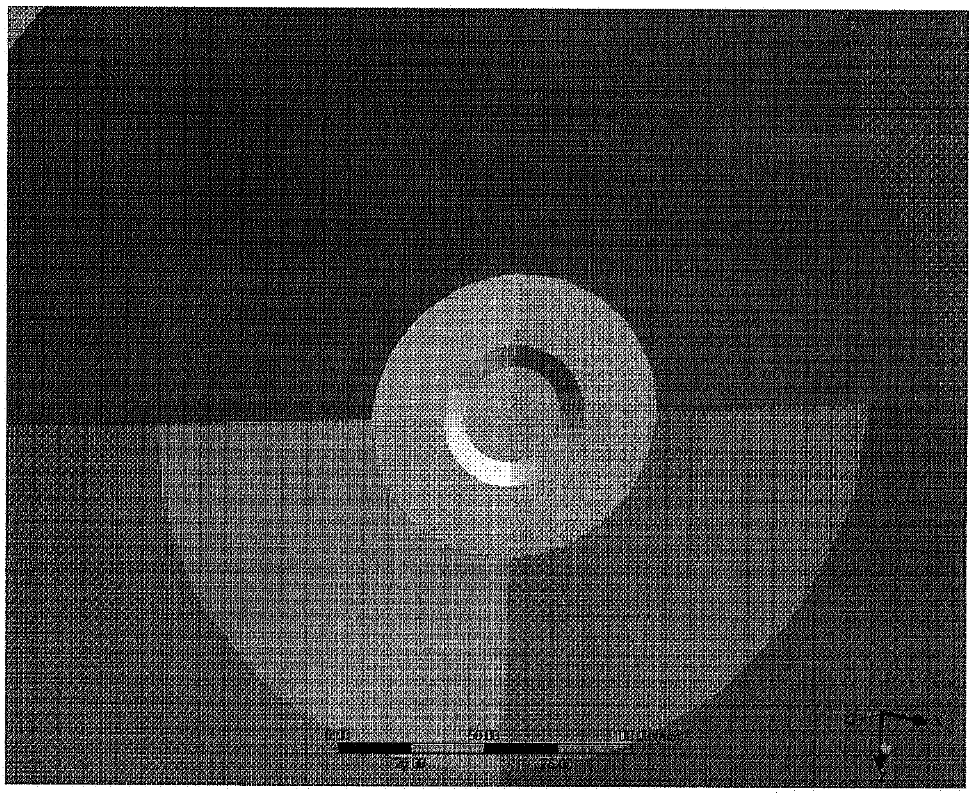

Figure 2 – *Under thickness area geometry*

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In the following figures, the finite elements mesh obtained is shown: during the mesh creation process, settings have been imposed to obtain a very refined mesh near the under thickness area. To correctly describe the stress field near the under thickness area (where the stress gradient is high), it is necessary to have sufficiently small elements.

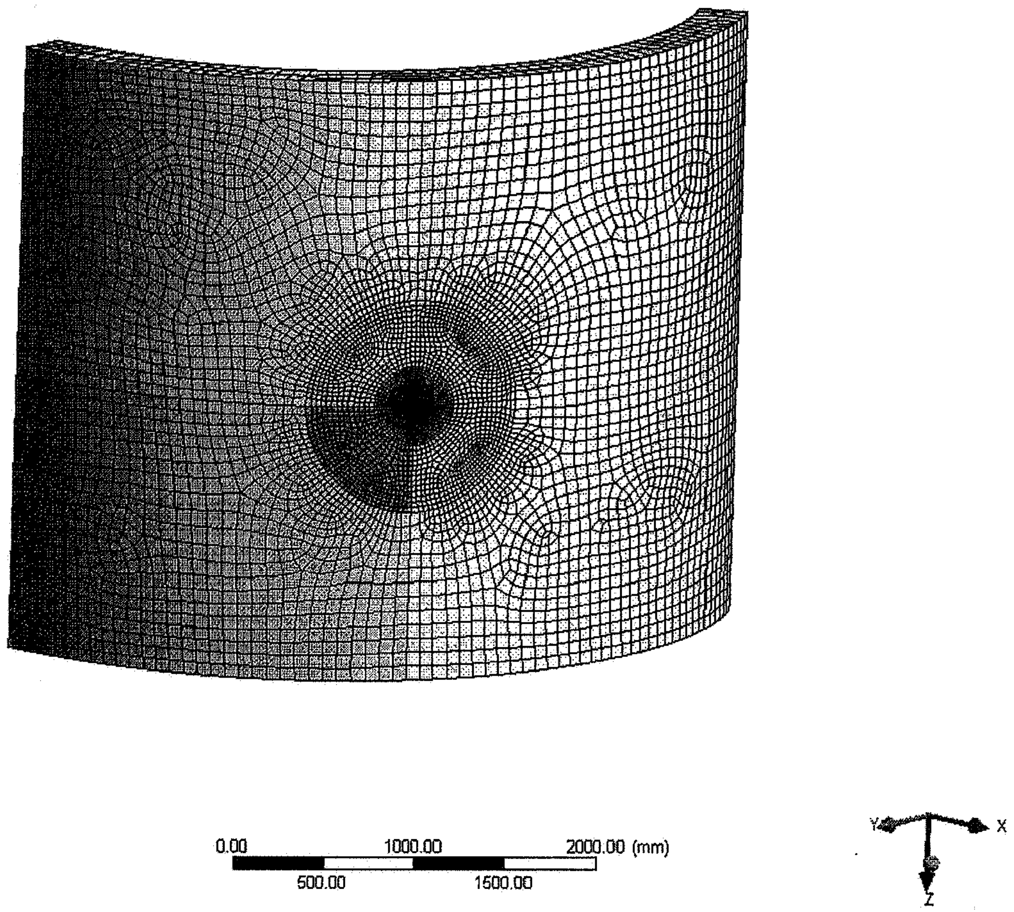

Figure 3 - *Mesh*

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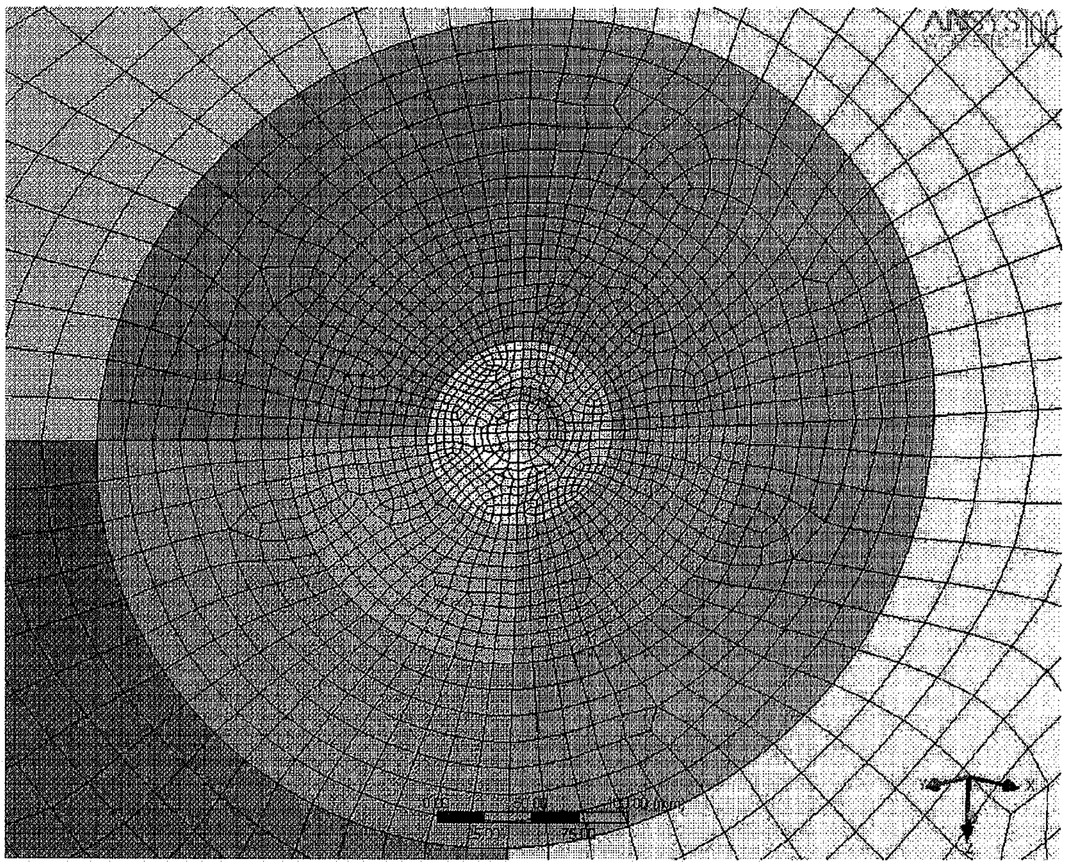

Figure 4 – *Mesh on the under thickness area*

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The element used for the mathematical model is ***Ansys SOLID186®***

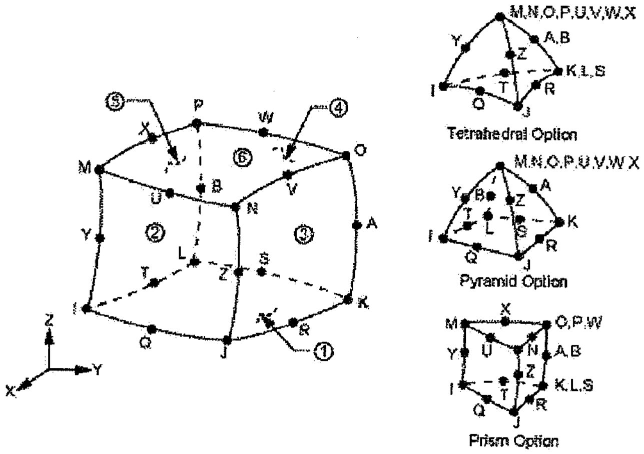

Figura 5 - *Solid186 element*

SOLID186 is a higher order 3-D 20-node solid element that exhibits quadratic displacement behaviour. The element is defined by 20 nodes having three degrees of freedom per node: translations in the nodal x, y, and z directions. The element supports plasticity, hyperelasticity, creep, stress stiffening, large deflection, and large strain capabilities. It also has mixed formulation capability for simulating deformations of nearly incompressible elastoplastic materials, and fully incompressible hyperelastic materials.
SOLID186 is well suited to model irregular meshes (such as those produced by various CAD/CAM systems).

SOLID186 Assumptions and Restrictions

- The element must not have a zero volume.
- An edge with a removed midside node implies that the displacement varies linearly, rather than parabolically, along that edge.
- Use at least two elements in each direction to avoid hourglass mode.
- When degenerated into a tetrahedron, wedge, or pyramid element shape, the corresponding degenerated shape functions are used. Degeneration to a pyramidal form should be used with caution. The element sizes, when degenerated, should be small to minimize the stress gradients. Pyramid elements are best used as filler elements or in meshing transition zones.

The part of the cylindrical shell included in the model has been forced and constrained with:

- A pressure of 19.15MP acting on the internal surface (*design pressure*)
- A force on the upper boundary to take account of the effect of the missing part on the modelled part.
- Simmetry constraints on lateral surfaces.
- Null vertical displacement on the bottom surface (*in-plane displacements allowed to permit the radial expansion*).

Constraints and forces are showed in the following figure:

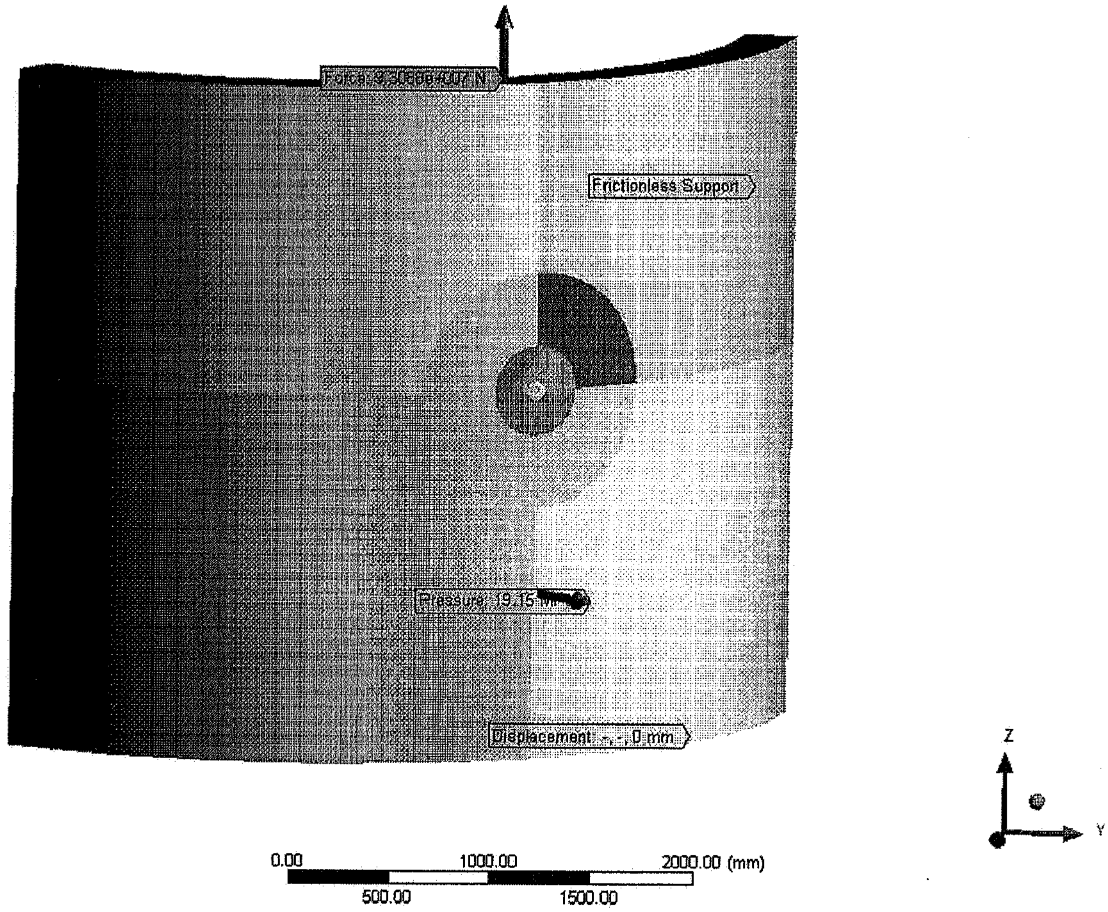

Figure 6 - *Constraints and forces*

The vessel has been considered to be an adiabatic system: all the material has the same temperature through the whole thickness. For this reason a *"thermal condition"* has been introduced in the model: according to this, the effect of thermal expansion on stresses is overlapped to the effect of forces and constraints.

The temperature considered in the model is 454°C (*design temperature*).

2 RESULTS

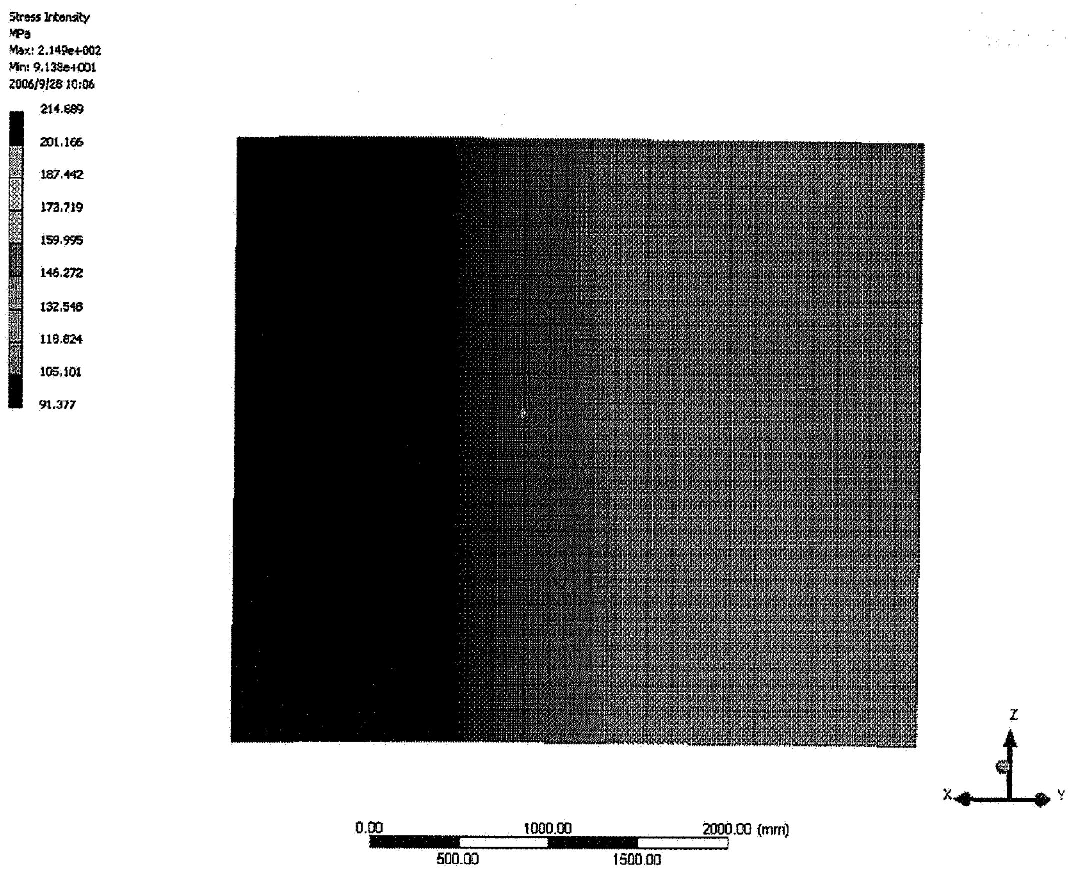

Figure 7 – *Stress Intensity*

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SOSTITUISCE IL - REPLACES PARI NUMERO
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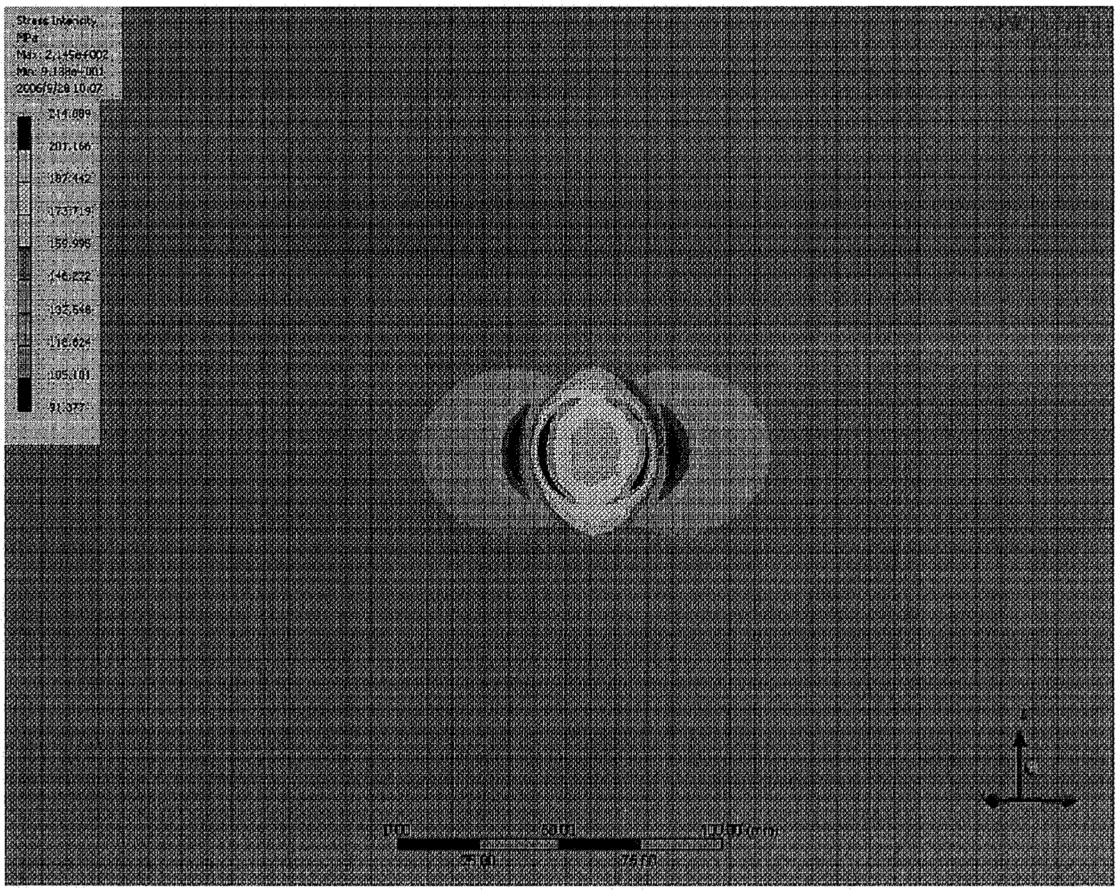

Figure 8 – *Stress Intensity (Under thickness area proximity)*

316

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

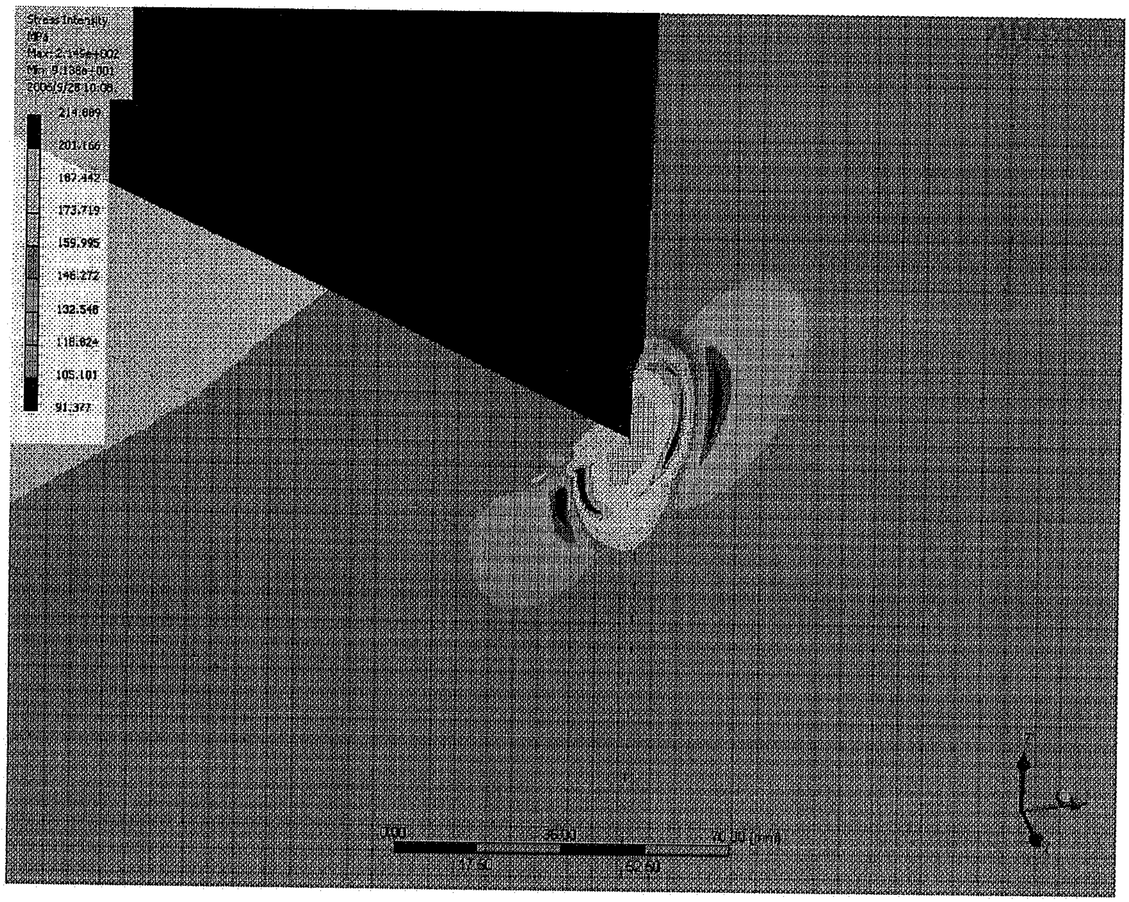

Figure 9 – *Stress Intensity (section)*

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2 LINEARIZATIONS

Stress linearizations have been evaluated along the following ***SCLs*** *(Stress Concentration Lines):*

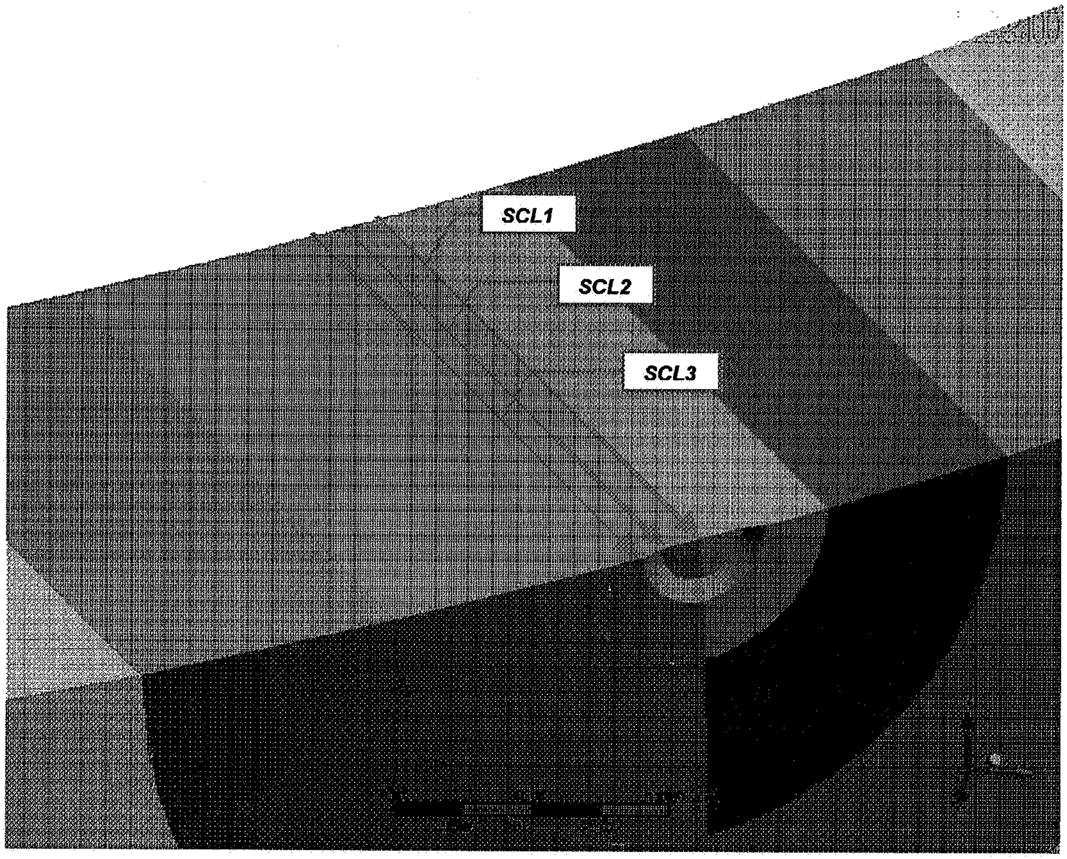

Figure 10 – *SCL near under thickness area (1-3)*

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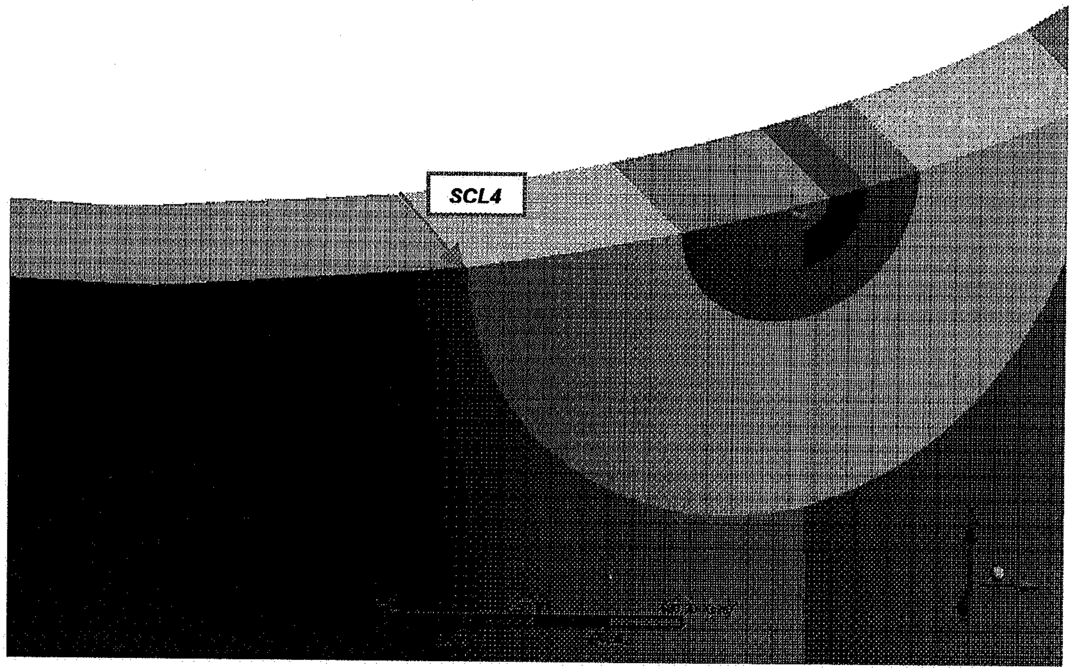

Figure 11 – *SCL far from the under thickness area (side)*

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SOSTITUISCE IL - REPLACES PARI NUMERO

SOSTITUITO DA - REPLACED BY

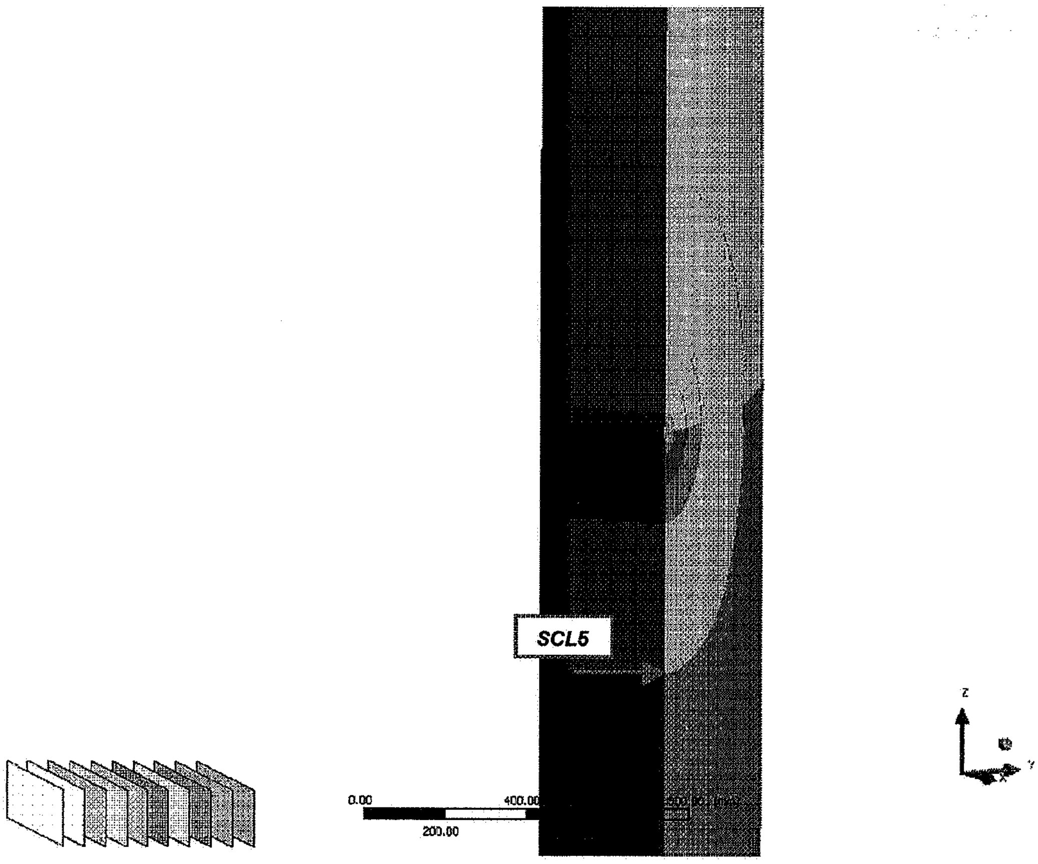

Figure 12 – *SCL far from the under thickness area (below)*

In the following table, all stresses maximum values are listed (Stress intensity):

- *"Membrane" (M)*
- *"Membrane+bending" (M+B)*

	M *[MPa]*	***M+B*** *[MPa]*
SCL1	167.9	186.2
SCL2	167.8	186.4
SCL3	167.1	187.7
SCL4	167.7	186.8
SCL5	167.8	187.0

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Table 1 – *Maximum stresses calculated along SCLs.*

3 ERROR ESTIMATION

The essentials of the method used by ***Ansys*** to estimate the error in the stress calculation are summarized below

The usual continuity assumption used in many displacement based finite element formulations results in a continuous displacement field from element to element, but a discontinuous stress field. To obtain more acceptable stresses, averaging of the element nodal stresses is done. Then, returning to the element level, the stresses at each node of the element are processed to yield:

$$\{\Delta\sigma_n^i\} = \{\sigma_n^a\} - \{\sigma_n^i\}$$

where:

$\{\Delta\sigma_n^i\}$= stress error vector at node n of element

$\{\sigma_n^a\}$= number of elements connecting to node n

$\{\sigma_n^i\}$= stress vector of node n of element i

Then, for each element:

$$e_i = \frac{1}{2}\int_{vol} \{\Delta\sigma\}^T [D]^{-1} \{\Delta\sigma\} d(vol)$$

where:

ei = energy error for element command.

vol = volume of the element.

[D] = stress-strain matrix evaluated at reference temperature.

{Δσ} = stress error vector at points as needed.

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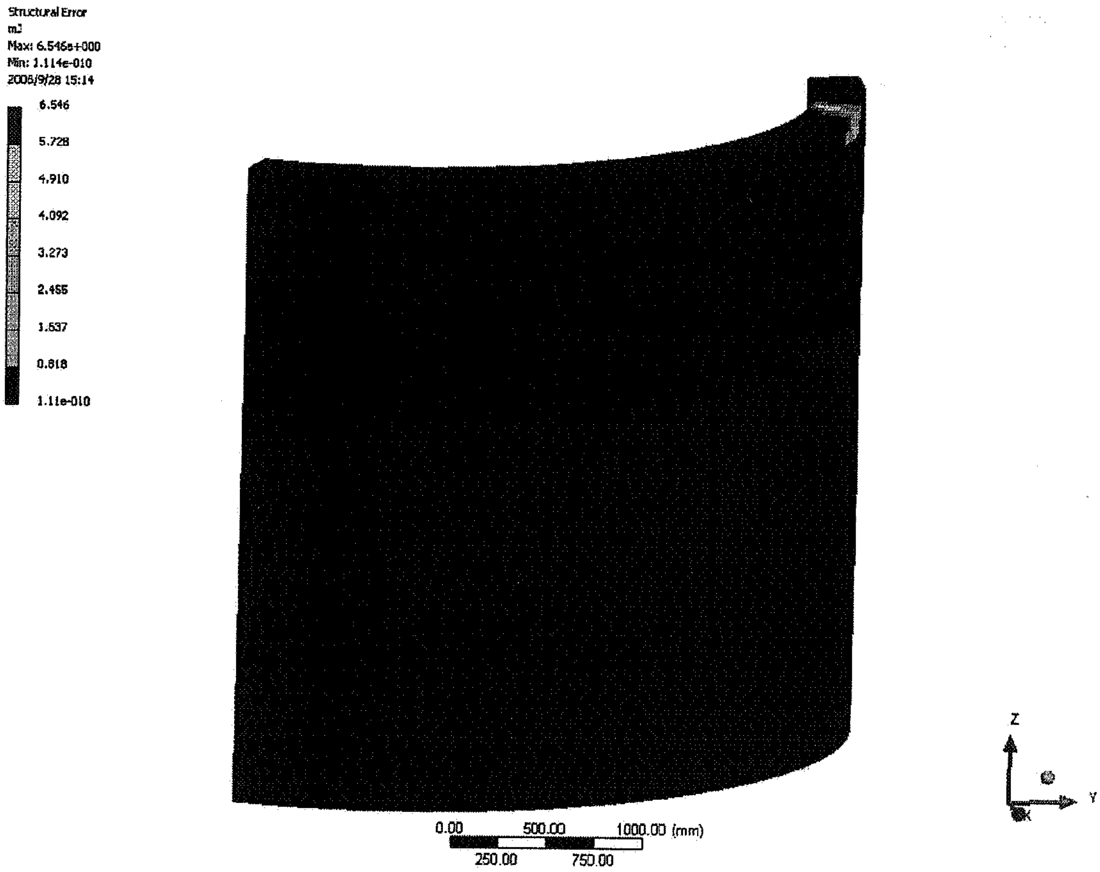

Figura 13 - *Structural error (as calculated by Ansys)*

It is important to notice that the error calculated and showed in the picture above is an energy (*measured in mJ*). To have an idea of how important it is, it should be compared to the total deformation energy of each element.

The situation in the under thickness area, where the mesh is very refined and the elements are small, is shown in the figures below:

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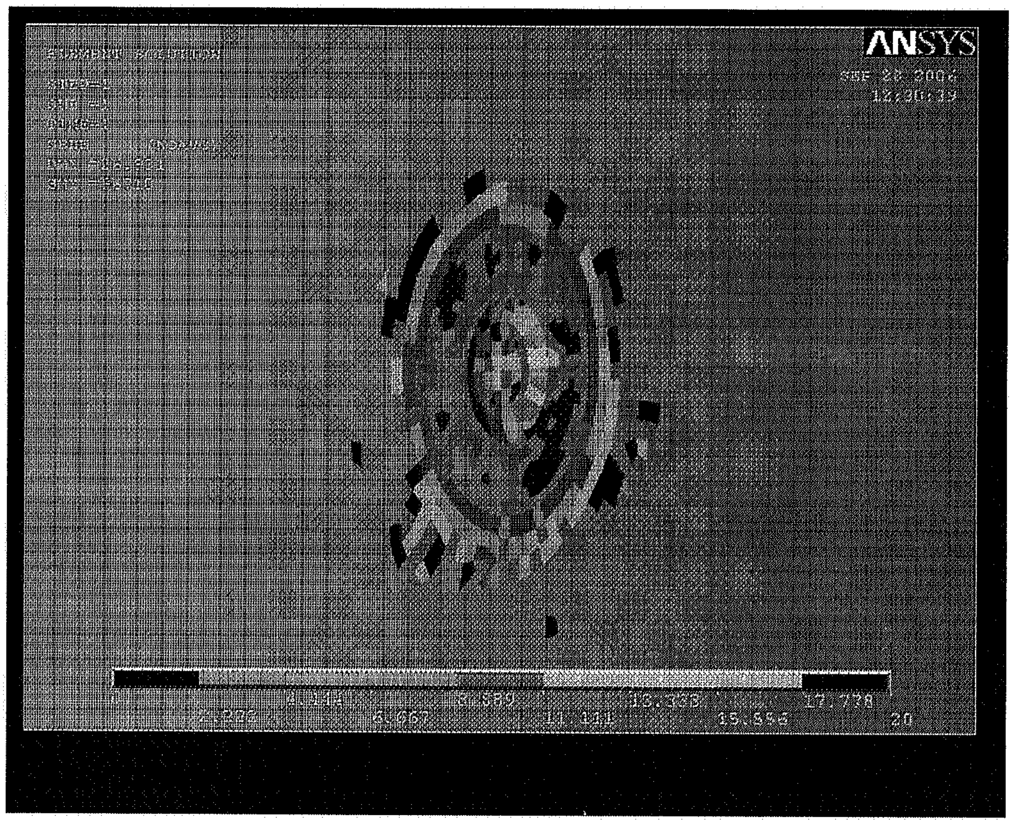

Figura 14 – *Element deformation energy (mJ)*

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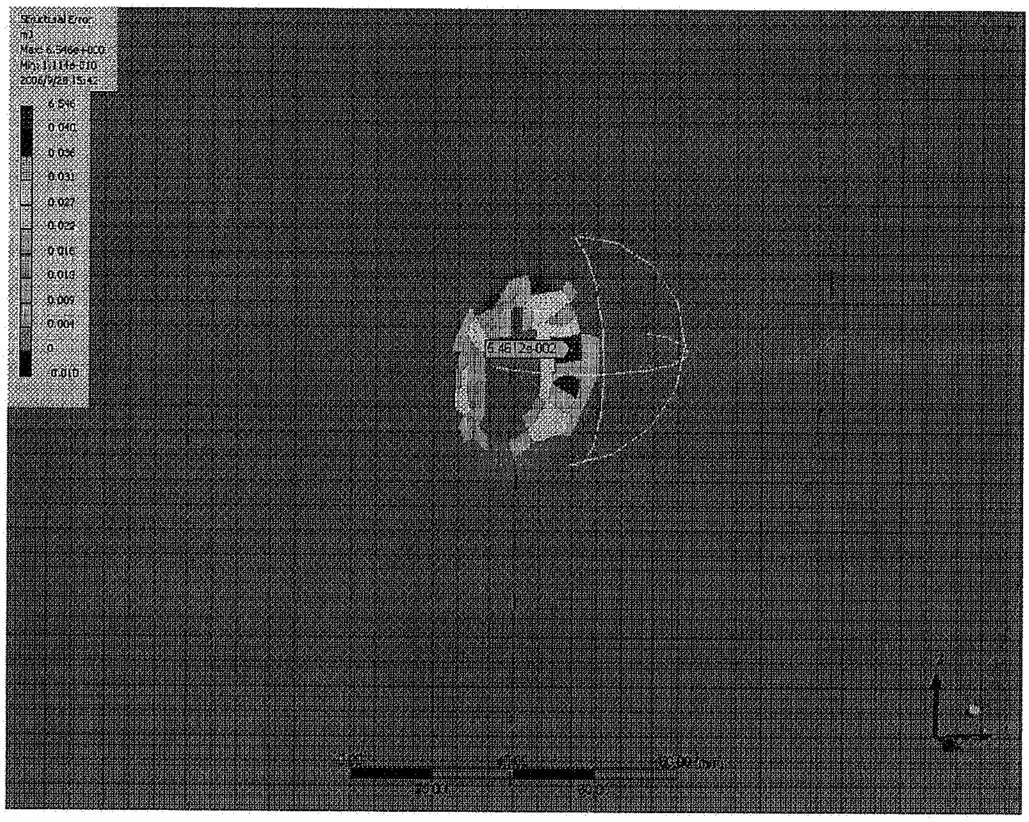

Figura 15 - *Structural error (mJ)*

In the under thickness area the highest error is about $5.5{\cdot}10^{-2}mJ$ while deformation energy is about 4÷5mJ.

The energy associated to the error for each element in the under thickness is always below the 1.4% of the energy associated to the deformation of the element.

Then it is possible to conclude that the error is very small.

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4 CONCLUSION

The calculated stresses shown in table 1 are within the following limits:

M is within S_m (169 MPa).
$M+B$ is within $1.5 \cdot S_m$ (253.5 MPa)

Considering that the thermal expansion effect is also considered in the model and that, according to ASME 4-134, the maximum allowable stress for M+B is $3 \cdot S_m$ (507 MPa), the values used in this analysis are strongly conservative.
NOTE: according to ASME CODE the linearization 1,2 and 3 should be compared with $1.5 \cdot S_m$ for the membrane and $3 \cdot S_m$ for membrane + bending.

ACCORDING TO THIS ANALYSIS, THE DETECTED UNDERTHICKNESS AREA IS ACCEPTABLE.

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Nuovo Pignone MASSA	CLIENTE – CUSTOMER **CONOCO PHILLIPS**
	LOCALITA' - PLANT LOCATION **WILHELMSHAVEN, GERMANY**
COMMESSA - JOB **3100276-277**	IMPIANTO - PLANT **WRG-DEEP CONVERSION PROJECT**

TITOLO - TITLE

SHIPPING SADDLE CALCULATION

ITEMS: D-6212; D-6232

326

REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
2	REVISED WHERE INDICATED <2>	LAZZERINI	Ricci S.	Ronchieri A.	07/02/07
1	GENERAL REVISION	LAZZERINI	RICCI	RONCHIERI	20/11/06
0	EMISSIONE-ISSUE	LAZZERINI	RICCI	RONCHIERI	20/07/06

ITEM **D-6212/D-6232**

N. SOU0107853/4

LINGUA-LANG.	PAGINA-SHEET
A	1 / 2

SOSTITUISCE IL - REPLACES

SOSTITUITO DA - REPLACED BY

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SHIPPING SADDLE CALCULATION – LIFTING BEAM	6
SHIPPING SADDLE CALCULATION – TILT VERIFICATION <2>	8
SHIPPING SADDLE CALCULATION – BASE SECTION <2>	10
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APPLICABLE CODE AND STANDARD

- **NUOVO PIGNONE –SUO 1429239/1: SHIPPING DRAWING;**
- **NUOVO PIGNONE –SUO 1429236/1: SHIPPING SADDLE;**

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SHIPPING SADDLE CALCULATION – BASE BEAM <2>

BASE BEAM VERIFICATION

W =	13.135.000 N	2.952.816 Lb	Vessel shipping weight without saddle	
K_{dV} =	1,20		Vertical acceleration	
A =	13.050,0 mm	513,78 in	Distance G.C. and left saddle	
B =	13.050,0 mm	513,78 in	Distance G.C. and right saddle	
W_s =	234.516,2 N	52.720 Lb	Weight of one saddle (higer)	
R_{AD} =	2.416,0 mm	95,12 in	Radius of craddle	
L_b =	7.600,0 mm	299,21 in	Beam length	<2>
L_{free} =	6.600,0 mm	259,84 in	Max beam unsupported length	<2>
L_t =	7.100,0 mm	279,53 in	Base beam inflection length	
H_s =	3.300,0 mm	129,92 in	Height of saddle center line	
n =	4 N° of base beam			
	S275 J2 G3 Beam Material			
Y_S =	275,0 MPa	39.885 Psi	Material Yield Strength	
K =	0,85		Safety factor (*)	
σ_{AMM} =	233,75 MPa	33.903 Psi	Allowable Stress	

(*) Considering that the saddles will be used just one time, 0,85 Ys is judge an adequate safety margin.

HEM 600 Beam type

	mm	in	
H =	620,0	24,41	Beam height
B =	305,0	12,01	Beam width
a =	21,0	0,83	Beam web thickness
e =	40,0	1,57	Beam flange thickness
c =	30,0	1,18	Reinforcing plate thickness
d =	540,0	21,26	Reinforcing plate height
n_p =	8		Total N° of reinforncing plate

R_A =	$W*K_{dV}* B /(A+B)$ =	7.881.000	N	Weight acting on left saddle
R_B =	$W*K_{dV} * A /(A+B)$ =	7.881.000	N	Weight acting on right saddle
P =	Max (R_A :R_B) +K_{dV}* W_s =	8.162.419	N	Saddle load
α =		37,5	°	Beam angle
R =	P / (2 * cos α)	5.144.252	N	Saddle split load
R_v =	R * cos α =	4.081.210	N	Vertical load
R_h =	R * sen α =	3.131.622	N	Horizontal load
b =	(B - a) / 2 =	142	mm	Beam flange widht
h =	H - 2 * e =	540	mm	Beam inteR. height
I_x =	($B*H^3$- $2*b*h^3$)/ 12 =	2,331E+09	mm^4	Beam Inertia moment X-X
A_B =	B*H - 2*b*h =	35.740	mm^2	Beam section area
I_{xp} =	$c*d^3$ /12 =	3,937E+08	mm^4	Reinf. plate Inertia moment X-X
A_p =	c*d =	16.200	mm^2	Reinf. plate section area
I_{tot} =	$I_x * n + I_{xp} * n_p$ =	1,247E+10	mm^4	Total section Inertia moment
A_{tot} =	$A_B * n + A_p * n_p$ =	272.560	mm^2	Total section area

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REV.	DESCRIZIONE - DESCRIPTION
2	REVISED WHERE INDICATED <2>
1	GENERAL REVISION
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ITEM **D-6212/D-6232**

N. SOU0107853/4

LINGUA-LANG.	PAGINA-SHEET
A	4 / 5

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Nuovo Pignone
MASSA

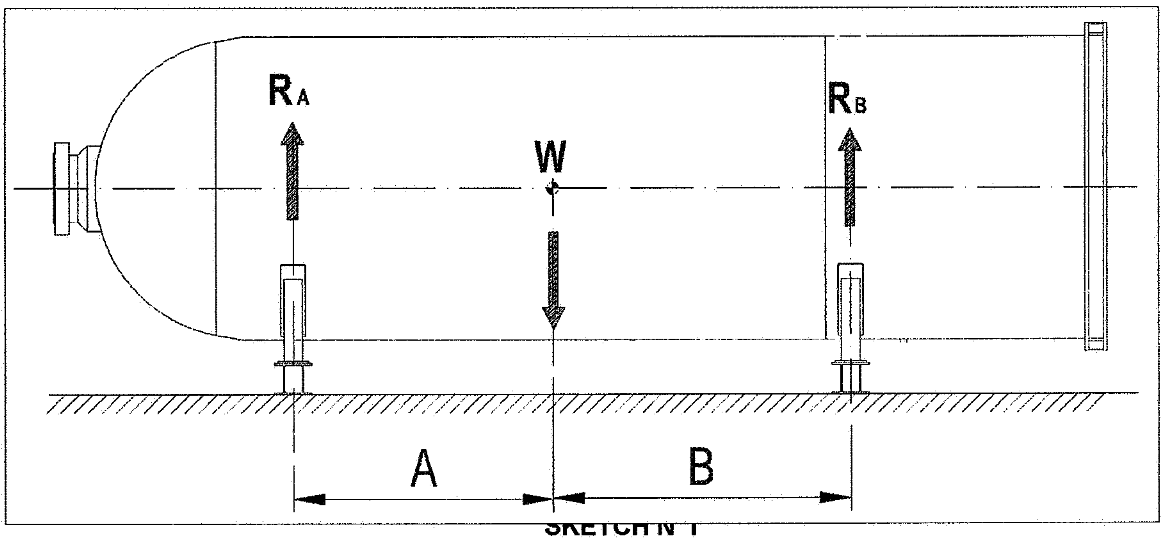
SHIPPING SADDLE CALCULATION

STRESS ON BASE BEAM VERIFICATION

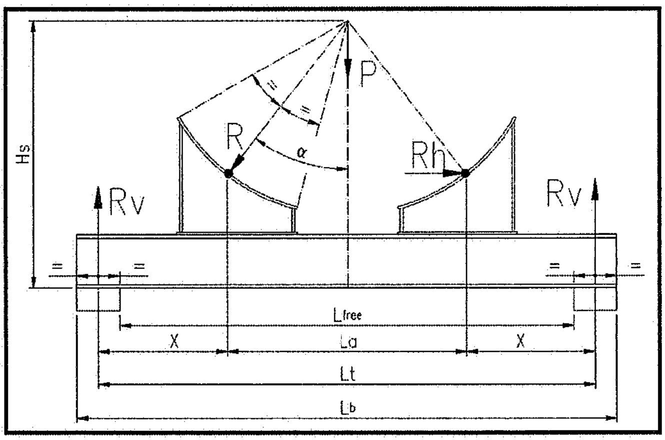
$L_a =$	$2 * R_{AD} * sen(\alpha) =$	**2.941,5**	mm	Reaction point distance
$X =$	$(L_t - L_a)/2 =$	**2.079**	mm	Load lever arm
$M_f =$	$R_v * X =$	**8,486E+09**	N*mm	Bending moment acting on section
$\sigma_b =$	$M_f * H / (2 * I_{tot}) =$	**210,91**	Mpa	Bending stress
$\sigma_t =$	$R_h / A_{tot} =$	**11,49**	Mpa	Tensile stress
$\tau =$	$1,5 * R_v / A_{tot} =$	**22,46**	Mpa	Shear stress

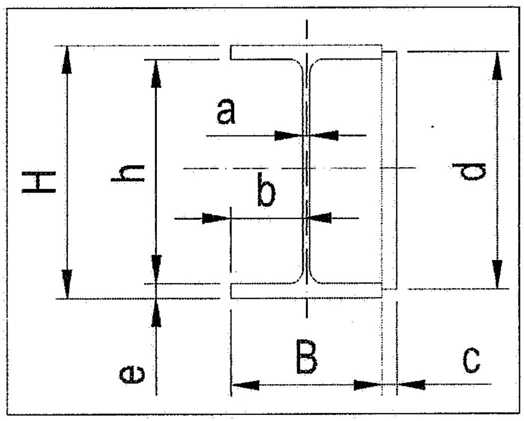
$\sigma_{id} = ((\sigma_b+\sigma_t)^2 + 3*\tau^2)^{0,5} =$

225,77 MPa	<	$\sigma_{AMM} =$	**233,75 Mpa**
32.746 Psi			**33.903 Psi**



SKETCH N°1





SKETCH N°2

SKETCH N°3

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REV.	DESCRIZIONE - DESCRIPTION	
2	REVISED WHERE INDICATED <2>	ITEM **D-6212/D-6232**
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SHIPPING SADDLE CALCULATION – LIFTING BEAM

LATERAL LIFTING BEAM VERIFICATION

$P =$	**8.162.419** N	**1.834.954** Lb		Saddle load
$K_{dv} =$	**1,20**			Vertical acceleration
$C =$	**1.545** mm	**60,83** in		Distance G.C. and left lateral lifting beam
$D =$	**1.545** mm	**60,83** in		Distance G.C. and right lateral lifting beam
$L_{b1} =$	**2.400,0** mm	**94,49** in		Lifting beam width
$L_{free} =$	**2.000,0** mm	**78,74** in		Max beam unsupported length
$L_{t1} =$	**2.200,0** mm	**86,61** in		Lifting beam inflection length
$L_{a1} =$	**436,0** mm	**17,17** in		Reaction point distance
$n =$	**2** N° of lifting beam			
$\sigma_{am} =$	**233,75** Mpa	Beam allowable stress		**S275 J2 G3**

HEM 400 Beam type

	mm	in		
$H =$	**432,0**	**17,01**	Beam height	See Sketch 6
$B =$	**307,0**	**12,09**	Beam width	See Sketch 6
$a =$	**21,0**	**0,83**	Beam web thickness	See Sketch 6
$e =$	**40,0**	**1,57**	Beam flange thickness	See Sketch 6
$c =$	**30,0**	**1,18**	Reinforcing plate thickness	See Sketch 6
$d =$	**352,0**	**13,86**	Reinforcing plate height	See Sketch 6
$n_p =$	**2,0**		Total N° of reinforncing plate	See Sketch 6
$t_1 =$	**30,0**	**1,18**	Reinforcing plate thickness	See Sketch 6
$h_1 =$	**432,0**	**17,01**	Reinforcing plate height	See Sketch 6
$t_2 =$	**30,0**	**1,18**	Reinforcing plate thickness	See Sketch 6
$h_2 =$	**186,0**	**7,32**	Reinforcing plate height	See Sketch 6

$R_C =$	$P * D / (C+D) =$	**4.897.452**	N	Weight acting on left lifting beam
$R_D =$	$P * C / (C+D) =$	**4.897.452**	N	Weight acting on rigth lifting beam
$P =$	$Max (R_C : R_D) + W_S =$	**4.897.452**	N	Saddle load
$R =$	$P/2 =$	**2.448.726**	N	Saddle sup. reac.
$b =$	$(B - a) / 2 =$	**143**	mm	Beam flange widht
$h =$	$H - 2 * e =$	**352**	mm	Beam inter. height
$I_x =$	$(B*H^3 - 2*b*h^3) / 12 =$	**1,023E+09**	mm^4	Beam Inertia moment X-X
$A_B =$	$B*H - 2*b*h =$	**31.952**	mm^2	Beam section area
$I_{xp} =$	$c*d^3 /12 =$	**1,090E+08**	mm^4	Reinf. plate Inertia moment X-X
$A_p =$	$c*d =$	**10.560**	mm^2	Reinf. plate section area
$I_1 =$	$t_1*h_1^3 /12 =$	**2,016E+08**	mm^4	Reinf. plate Inertia moment X-X
$A_1 =$	$t_1*h_1 =$	**12.960**	mm^2	Reinf. plate section area
$I_2 =$	$t_2*h_2^3 /12 =$	**1,609E+07**	mm^4	Reinf. plate Inertia moment X-X
$A_2 =$	$t_2*h_2 =$	**5.580**	mm^2	Reinf. plate section area
$I_{tot} =$	$I_x * n + I_{xp} * n_p + I_1 + I_2 =$	**2,482E+09**	mm^4	Total section Inertia moment
$A_{tot} =$	$A_B * n + A_p * n_p + A_1 + A_2 =$	**103.564**	mm^2	Total section area

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Nuovo Pignone MASSA	**SHIPPING SADDLE CALCULATION**

STRESS VERIFICATION

$X =$	$(L_{t1} - L_{a1})/2 =$	882 mm	Load lever arm	See sk n°5
$M_f =$	$R * X =$	2,160E+09 N*mm	Bending moment acting on section	

BENDING STRESS

$\sigma_b =$ $M_f * H / (2 * I_{tot}) =$ 187,97 Mpa

TENSILE STRESS

$\sigma_t =$ $R / A_{tot} =$ 23,64 Mpa

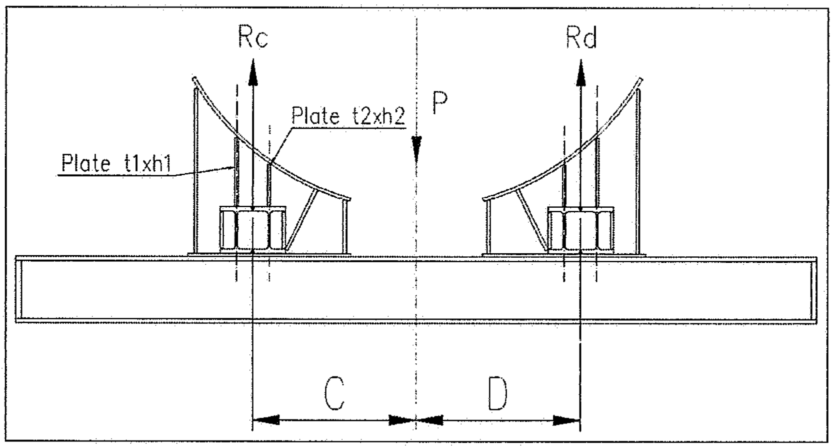
SHEAR STRESS

$\tau =$ $4/3 * R / A_{tot} =$ 31,53 Mpa

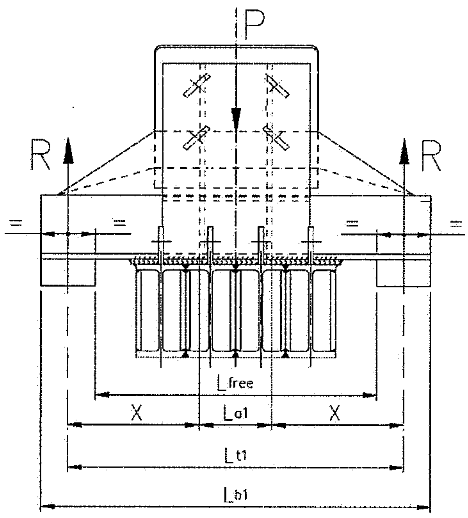
IDEAL STRESS

$\sigma_{id} =$ $((\sigma_b+\sigma_t)^2 + 3*\tau^2)^{0,5} =$ 218,54 Mpa < 233,75 Mpa

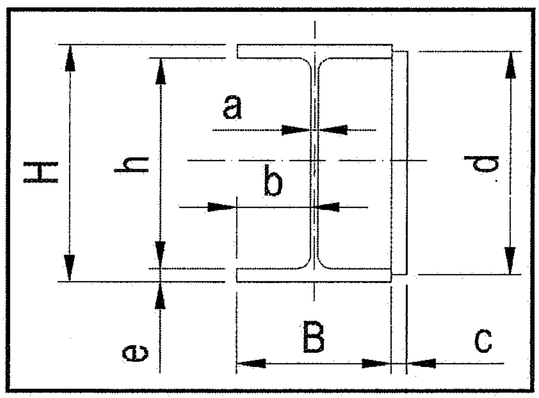
Verified



SKETCH N°4



SKETCH N°5



SKETCH N°6

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		ITEM **D-6212/D-6232**
2	REVISED WHERE INDICATED <2>	
1	GENERAL REVISION	**N. SOU0107853/4**
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REV.	DESCRIZIONE - DESCRIPTION	

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SHIPPING SADDLE CALCULATION – TILT VERIFICATION <2>

"TILT" VERIFICATION

alfa =	37,5 °	0,654 rad	Craddle contact angle
H_s =	3300,0 mm	129,92 in	Height of saddle center line
L_b =	7600,0 mm	299,21 in	Beam length
Y_1 =	1383,3 mm	54,46 in	Height between the base and point 1
Y_2 =	1916,7 mm	75,46 in	See sketch n° 9
Y_3 =	2329,2 mm	91,70 in	See sketch n° 9
Y_4 =	763,3 mm	30,05 in	See sketch n° 9
A_{R1} =	13050,0 mm	513,78 in	Distance G.C. and left saddle
A_{R2} =	13050,0 mm	513,78 in	Distance G.C. and right saddle
B_t =	1220,0 mm	48,03 in	Saddle base total width

C_T = **0,40** Transverse acceleration coeff. (conservative value) (*)

C_L = **0,20** Longitudinal acceleration coeff. (conservative value) (*)

W =		13.135.000 N	Vessel shipping weight
W_s =		234.516 N	Weight of one saddle
F_T =	$W^* C_T$ =	5.254.000 N	Tranverce force
F_L =	$W * C_L$ =	2.627.000 N	Longitudinal force
R_1 =	$W * A_{R2} /(A_{R1}+A_{R2})$ =	6.760.423 N	See sketch n° 7
R_2 =	$(W^*A_{R1} - F_L^*Y_2) /(A_{R1}+A_{R2})$ =	6.374.577 N	See sketch n° 7

TRANSVERSE "TILT" VERIFICATION

				SAFETY RATIO AGAINST TILT
$F_T * Y_1$	<	$R_1 * Y_3 + R_2 * Y_3$	Verified	
7.267.639.265		30.594.467.410	SADDLES DO NOT TILT	4,21

LONGITUDINAL"TILT" VERIFICATION

				SAFETY RATIO AGAINST TILT
F_L * Y1	<	$\mathrm{Min}(R_1:R_2)+Ws)^*B_t/2$	Verified	
3.633.819.633		4.031.547.101	SADDLES DO NOT TILT	1,11

(*) Conservatively it has been assumed that all the longitudinal force is applied at point 1 of saddle (lowest stabilizing moment due to weight).

VESSEL FASTENING VERIFICATION

(*) Usually the maximum longitudinal acceleration value during trasportation by trailers is 0,1.

η =	0,2		Friction coeff. (conservative value)
R_1 =	6.760.423 N		see sketch n° 7
R_2 =	6.374.577 N		see sketch n° 7
F_{max} =	$R_1{}^*\eta + R_2{}^*\eta$ =	2.627.000 N	Friction force

F_{max}/F_L = **1,000 Ratio** **FASTENING NOT REQUIRED**

(*) In the case $F_{max}/ F_L < 1$ the friction force is not suitable to withstand the longitudinal acceleration.

REV.	DESCRIZIONE - DESCRIPTION	
2	REVISED WHERE INDICATED <2>	ITEM D-6212/D-6232
1	GENERAL REVISION	N. SOU0107853/4
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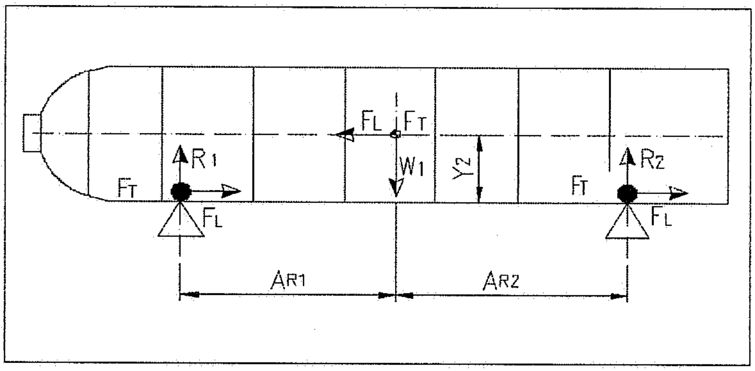
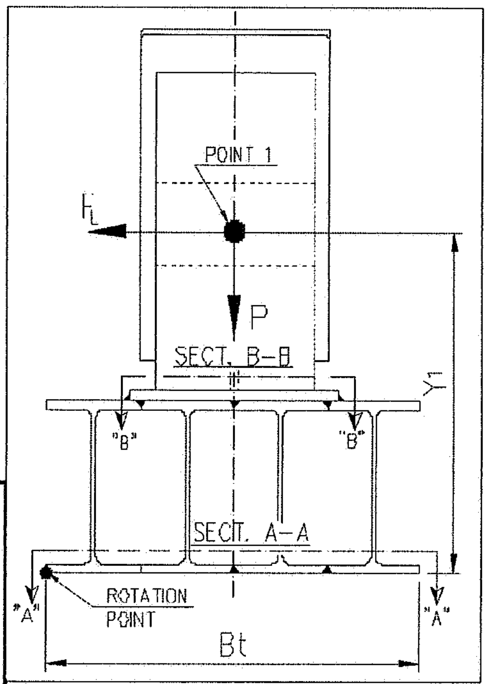
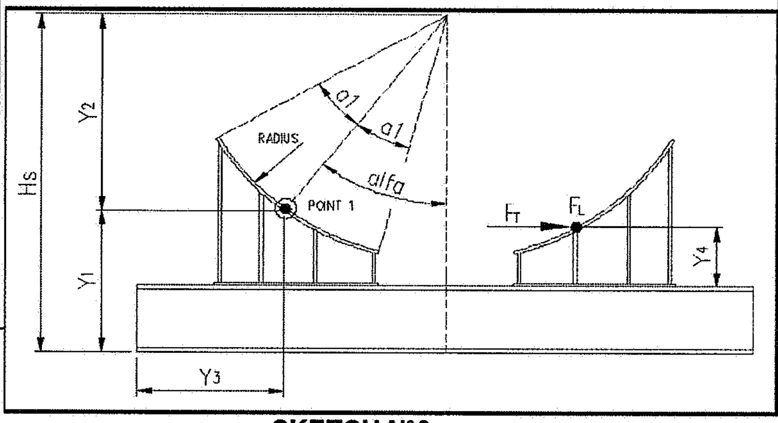


SKETCH N°7



SKETCH N° 8



SKETCH N°9

		ITEM
2	REVISED WHERE INDICATED <2>	*D-6212/D-6232*
1	GENERAL REVISION	N. SOU0107853/4
0	EMISSIONE-ISSUE	LINGUA-LANG. / PAGINA-SHEET
REV.	DESCRIZIONE - DESCRIPTION	A / 9 / 10

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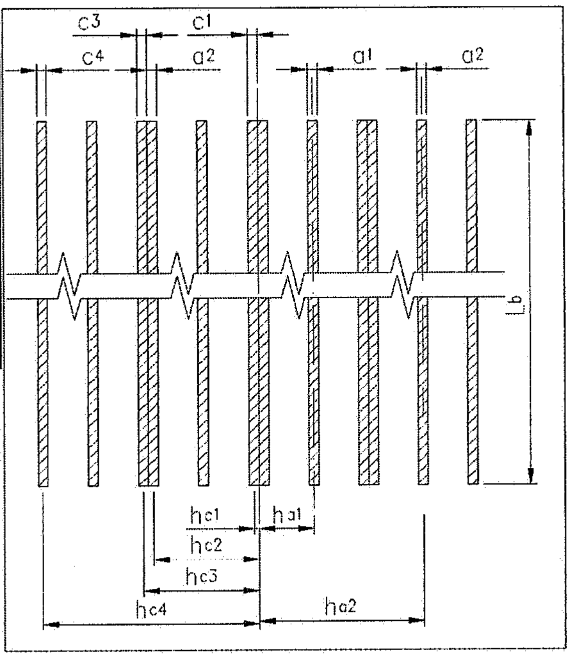
SHIPPING SADDLE CALCULATION – BASE SECTION <2>

SUPPORT SADDLE SECTION "A-A" VERIFICATION

GEOMETRICAL SECTION DATA

	t	h	$A = t^*L_b$	$I_X = A^*h^2$
a_1=	21,0	152,5	136500	3,174E+09
a_2=	21,0	457,5	136500	2,857E+10
c_1=	30,0	15	195000	4,388E+07
c_2=	30,0	290	195000	1,640E+10
c_3=	30,0	320	195000	1,997E+10
c_4=	30,0	595	195000	6,903E+10
		Σ =	1.053.000	1,372E+11

	mm	in	
L_b =	6500,0	255,906	Reinf plate length
a =	21,0	0,827	Beam web thickness
c =	30,0	1,181	Reinf. plate thickness
B	305,0	12,008	Single beam width
n =	4		N° of base beam
n_p =	8		N° of rinf. plate



SKETCH N° 10 (sect. A-A)

SECTIONAL PROPERTIES

A_{tot} = 2.106.000 mm^2 Total area (= 2*ΣA)

I_{Xtot}= 2,744E+11 mm^4 Total Long. Inertia moment (= $2^*\Sigma I_X$)

I_{Ytot}= 7,415E+12 mm^4 Total Transv. Inertia moment (= $n^*a_1^*L_b^3/12 + n_p^*c_1^*L_b^3/12$)

LOAD ON SECTION

P =		**8.162.419**	N	Saddle vertical load
F_T =	$W^* C_T$ =	**5.254.000**	N	Tranverce force
F_L =	$W^* C_L$ =	**2.627.000**	N	Longitudinal force
M_{FX} =	$F_T^* Y_1$ =	**7,268,E+09**	N*mm	Transverce bending moment
M_{FY} =	$F_L^* Y_1$ =	**3,634,E+09**	N*mm	Longitudinal bending moment

STRESS ON SECTION

Transverse Bending stress

$\sigma_{bT(c4)}$= $M_{FX}/I_{Xtot}^*h_{c4}$ = 15,76 MPa Stress on plate c_4

$\sigma_{bT(a2)}$= $M_{FX}/I_{Xtot}^*h_{a2}$ = 24,24 MPa Stress on web a_2

Longitudinal Bending stress

$\sigma_{bL(c)}$= $M_{FY}/I_{Ytot}^*L_b/2$ = 1,59 MPa Stress on reinf. plate

$\sigma_{bL(a)}$= $M_{FY}/I_{Ytot}^*L_b/2$ = 1,59 MPa Stress on beam web

REV.	DESCRIZIONE - DESCRIPTION
2	REVISED WHERE INDICATED <2>
1	GENERAL REVISION
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ITEM **D-6212/D-6232**
N. **SOU0107853/4**
LINGUA-LANG. A
PAGINA-SHEET 10 / 11

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Compressive stress

$\sigma_n =$	$P/A_{tot} =$	3,88 MPa	stress in section A-A

Total normal stress (compressive)

$\sigma_{c(c4)} =$	$\sigma_{bT(c4)}+\sigma_{bL(c)} + \sigma_n =$	21,23 MPa	stress on reinf. plate c_4
$\sigma_{c(a2)} =$	$\sigma_{b(a2)}+\sigma_n =$	29,70 MPa	stress on web a_2

Shear stress

$\tau =$	$1.5*(F_L+F_T)/A_{tot} =$	5,61 MPa	stress in section A-A

IDEAL STRESS ON BEAM WEB

$\sigma_{id(a)} =$	$(\sigma_{c(a2)}{}^2 + 3*\tau^2)^{0.5} =$	31,76 MPa	<	$\sigma_{AM} =$	233,75 Mpa
		4.606 Psi			33.903 Psi

IDEAL STRESS ON REINF. PLATE

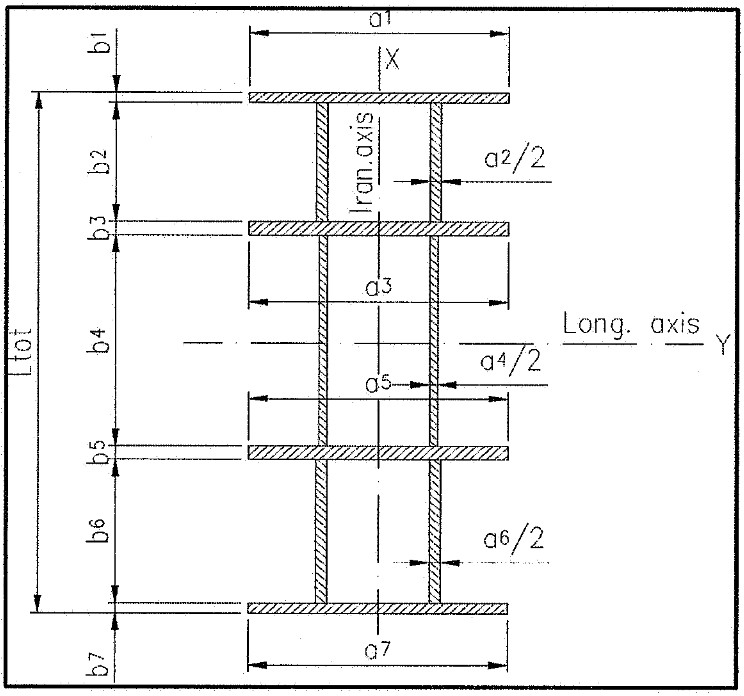
$\sigma_{id(c)} =$	$(\sigma_{c(c4)}{}^2 + 3*\tau^2)^{0.5} =$	24,01 MPa	<	$\sigma_{AM} =$	233,75 Mpa
		3.483 Psi			33.903 Psi

SHIPPING SADDLE CALCULATION – CRADDLE SECTION

SUPPORT SADDLE SECTION "B-B" VERIFICATION

GEOMETRICAL SECTION DATA

	mm	in
a_1 =	900,0	35,433
b_1 =	30,0	1,181
a_2 =	60,0	2,362
b_2 =	210,0	8,268
a_3 =	900,0	35,433
b_3 =	30,0	1,181
a_4 =	60,0	2,362
b_4 =	555,0	21,850
a_5 =	900,0	35,433
b_5 =	30,0	1,181
a_6 =	60,0	2,362
b_6 =	545,0	21,457
a_7 =	900,0	35,433
b_7 =	30,0	1,181
L =	1.430,0	56,299



SKETCH N° 11 (sect. B-B)

SECTIONAL PROPERTIES

A =	186.600 mm^2	Section area
Y_{1L} =	450,0 mm	Longitudinal Centroid Location
I_{xT} =	1,05E+10 mm^4	Transverse Inertia Moment
W_{xT} =	2,34E+07 mm^3	Transverse Section modulus
X_{1T} =	760,2 mm	Transverse Centroid Location
I_{yL} =	4,47E+10 mm^4	Longitudinal Inertia Moment
W_{yL} =	5,88E+07 mm^3	Longitudinal Section modulus

LOAD ON SECTION

P =		8.162.102	N	Saddle load
F_T =	$W * C_T$ =	5.254.000	N	Transverce force
F_L =	$W * C_L$ =	2.627.000	N	Longitudinal force
Y_4 =		762,3	mm	Load lever arm

STRESS ON SECTION

σ_c =	$W / (2*A)$ =	21,87	Mpa	Compressive stress
σ_{bT} =	$F_T * Y_4 / W_{YL}$ =	6,82E+01	Mpa	Transverse bending stress
σ_{bL} =	$F_L * Y_4 / W_{XT}$ =	85,67	Mpa	Longitudinal bending stress
τ =	$1/5 * (F_T + F_L)/A$ =	63,35	Mpa	Shear stress

IDEAL STRESS

σ_{ID}= $((\sigma_c+\sigma_{bL}+\sigma_{bT})^2 + 3*\tau^2)^{0,5}$ =

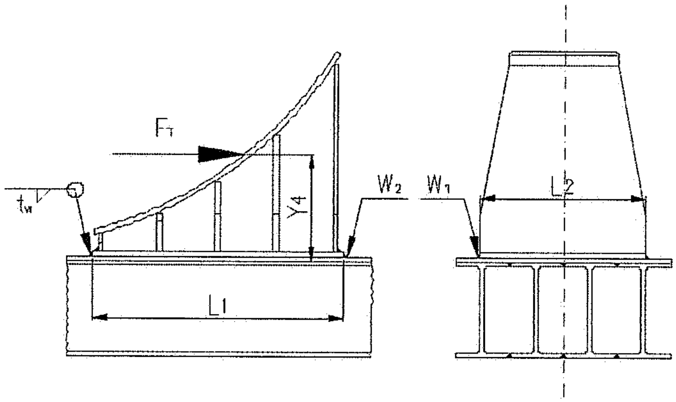
207,15 MPa	<	σ_{AMM}=	233,75 Mpa
30.045 Psi			33.903 Psi

SHIPPING SADDLE CALCULATION – CRADDLE WELD JOINT

CRADDLE WELD JOINT VERIFICATION - TRANSVERCE LOAD

GEOMETRICAL DATA

	mm	in
L_1 =	1.530,0	59,906
L_2 =	1.280,0	50,394
Y_4 =	762,3	30,012
t_w =	21,0	0,827
E =	0,85	



CROSS SECTIONAL PROPERTIES

A_{w1} =	$L_1 * t_w * 0{,}7$ =	22.491 mm^2	Weld joint section W_1
A_{w2} =	$L_2 * t_w * 0{,}7$ =	18.816 mm^2	Weld joint section W_2
I_T =	$2*[(t_w*0{,}7)*L_2^3/12 + Aw_1*(L_2/2)^2]$ =	2,356E+10 mm^4	Weld joint tran. inertia moment
I_L =	$2*[(t_w*0{,}7)*L_1^3/12 + Aw_2*(L_1/2)^2]$ =	3,080E+10 mm^4	Weld joint long. inertia moment
F_T =	$W/2 * C_T$ =	2.627.000 N	Transverce force
F_L =	$W * C_L$ =	2.627.000 N	Longitudinal force
F =	$(F_T^2+F_L^2)^{0,5}$	3.715.139 N	Total force
M_T =	F_T*Y_4 =	2,003E+09 N*mm	Transverce bending moment
M_L =	F_L*Y_4 =	2,003E+09 N*mm	Longitudinal bending moment

STRESS ON WELD

Bending stress

$\sigma_{bT|-}$ = $M_T* (L_1/2) / I_L$ = **49,74 MPa**

$\sigma_{bL|-}$ = $M_L* (L_2/2) / I_T$ = **54,39 MPa**

Shear stress

τ = $1{,}5*F / (2*(A_{w1}+A_{w2}))$ = **67,45 MPa**

Ideal stress

σ_{id} = $((\sigma_{bT|-} + \sigma_{bL|-})^2 + 3*\tau^2)^{0,5}$ =

156,51 MPa	$<$	$E*\sigma_{AM}$=	**198,69 MPa**
22.700 Psi			**28.817 Psi**

REV.	DESCRIZIONE - DESCRIPTION	
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2	REVISED WHERE INDICATED <2>	**N. SOU0107853/4**
1	GENERAL REVISION	LINGUA-LANG. A
0	EMISSIONE-ISSUE	PAGINA-SHEET 13 / 14

SOSTITUISCE IL - REPLACES | PARI NUMERO

SOSTITUITO DA - REPLACED BY

SHIPPING SADDLE CALCULATION – LIFTING LUG

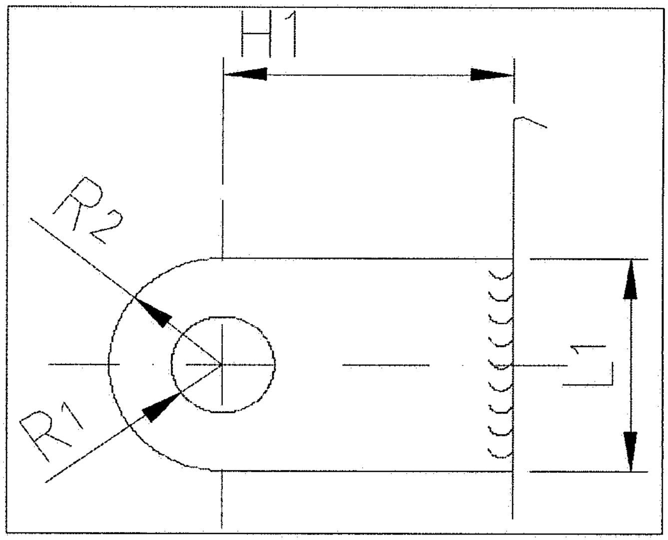
SADDLE LUG VERIFICATION

DESIGN DATA

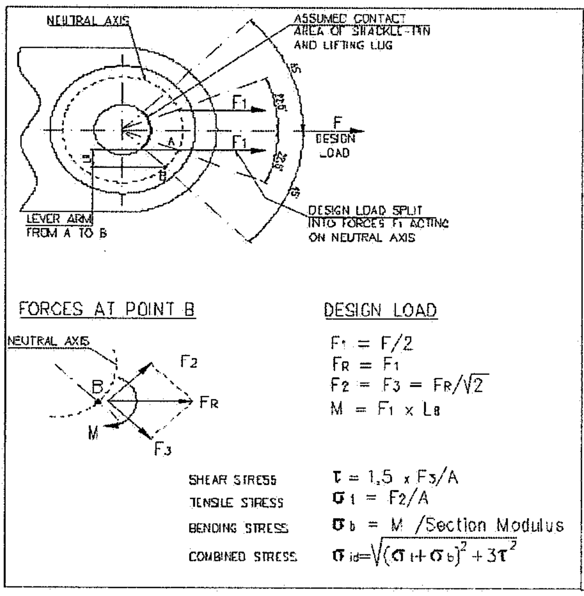
MATERIAL : **S275 J2 G3**

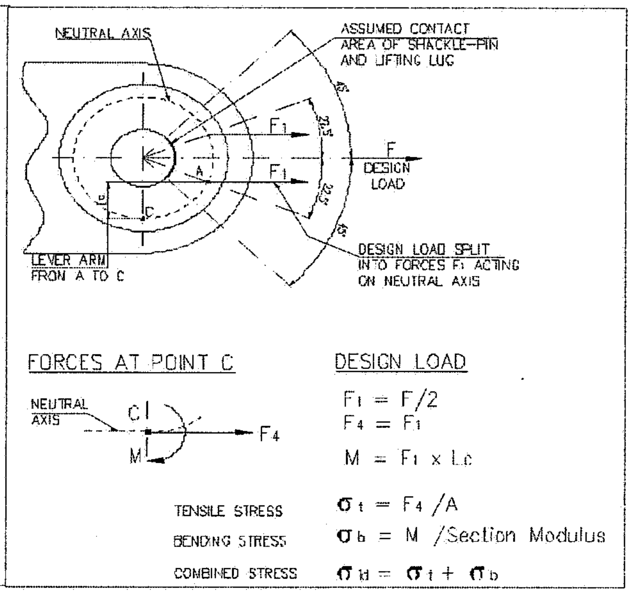
	MPa	Psi
Yield strenght Y_s =	275,00	39.885
σ_{all} = $Y_s / 1,5$ =	183,33	26.590
τ_{all} = $\sigma_{all} / 2$ =	91,67	13.295

	mm	in
R_1 =	40,0	1,575
R_2 =	100,0	3,937
t_1=	30,0	1,181
L_1 =	200,0	7,874
H_1 =	150,0	5,906



SKETCH N°1





SKETCH N°3 **SKETCH N°4**

REV.	DESCRIZIONE - DESCRIPTION
2	REVISED WHERE INDICATED <2>
1	GENERAL REVISION
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SHIPPING SADDLE CALCULATION

DESIGN FORCES

		N	Lb	
W_s =		234.251	52.661	Weight of one saddle
N =		8		Number of lugs per saddle
F_1 =	$W_s/(2*N)$ =	14.641	3.291	
F_R =	F_1 =	14.641	3.291	
F_2 =	$F_3=F_R/(2)^{0,5}$=	10.353	2.327	
F_4 =	F_1 =	14.641	3.291	

	mm	in	
R_1 =	40,0	1,575	Inner radius
R_2 =	100,0	3,937	Outer radius
R_m =	70,0	2,756	Mean radius
t =	30,0	1,181	Thickness

A = $t * (R_2 - R_1)$ = 1.800 mm^2 Section area

W = $t * (R_2 - R_1)^2 / 6$ = 18.000 mm^3 Section modulus

STRESS AT POINT B With reference to sketch 3

L_b = R_m * (sen 45° - sen 22,5°) = 22,71 mm Lever arm from A to B

M_b = $F_1 * L_b$ = 332.485 N*mm Bending moment

SHEAR STRESS

τ = $1,5 * F_3 / A$ = **8,63 MPa** < τ_{all} = **91,67 MPa**
1.251 Psi **13.295 Psi**

TENSILE STRESS

σ_t = F_2 / A = 5,75 MPa

BENDING STRESS

σ_b = M_b / W_b = 18,47 MPa

IDEAL STRESS

σ_{id} = $((\sigma_t+\sigma_b)^2 + 3*\tau^2)^{0,5}$ = **28,46 MPa** < σ_{all} = **183,33 MPa**
4.128 Psi **26.590 Psi**

STRESS AT POINT C With reference to sketch 4

L_c = R_m + (1 - sen 22,5°) = 43,2 mm Lever arm from A to C

M_c = $F_1 * L_c$ = 632.657 N*mm Bending moment

TENSILE STRESS

σ_t = F_4 / A = 8,13 MPa

BENDING STRESS

σ_b = M_c / W_c = 35,15 MPa

IDEAL STRESS

σ_{id} = $\sigma_t + \sigma_b$ = **43,28 MPa** < σ_{all} = **183,33 MPa**
6.277 Psi **26.590 Psi**

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2	REVISED WHERE INDICATED <2>
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Nuovo Pignone

MASSA

SHIPPING SADDLE CALCULATION

SECTION " D-D "

$A_D =$	$t * L_1 =$	8.250	mm^2			Section area
$W_D =$	$L_1^2 * t / 6 =$	200.000	mm^3			Section modulus
	SHEAR STRESS					
$\tau =$	$1{,}5 * F_1 / A_D =$	**2,66 MPa**		<	$\tau_{all} =$	**91,67 MPa**
		386 Psi				**13.295 Psi**
	BENDING STRESS					
$\sigma =$	$F_1 * H_1 / W_D =$	10,98 MPa				
	IDEAL STRESS					
$\sigma_{id} =$	$(\sigma^2 + 3 * \tau^2)^{0,5} =$	**11,91 MPa**		<	$\sigma_{all} =$	**183,33 MPa**
		1.727 Psi				**26.590 Psi**

REV.	DESCRIZIONE - DESCRIPTION	ITEM
2	REVISED WHERE INDICATED <2>	*D-6212/D-6232*
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STRESS INDUCED ON SHELL DURING TRANSPORTATION

STRESS INDUCED IN THE SHELL
HORIZONTAL POSITION
DURING TRANSPORTATION

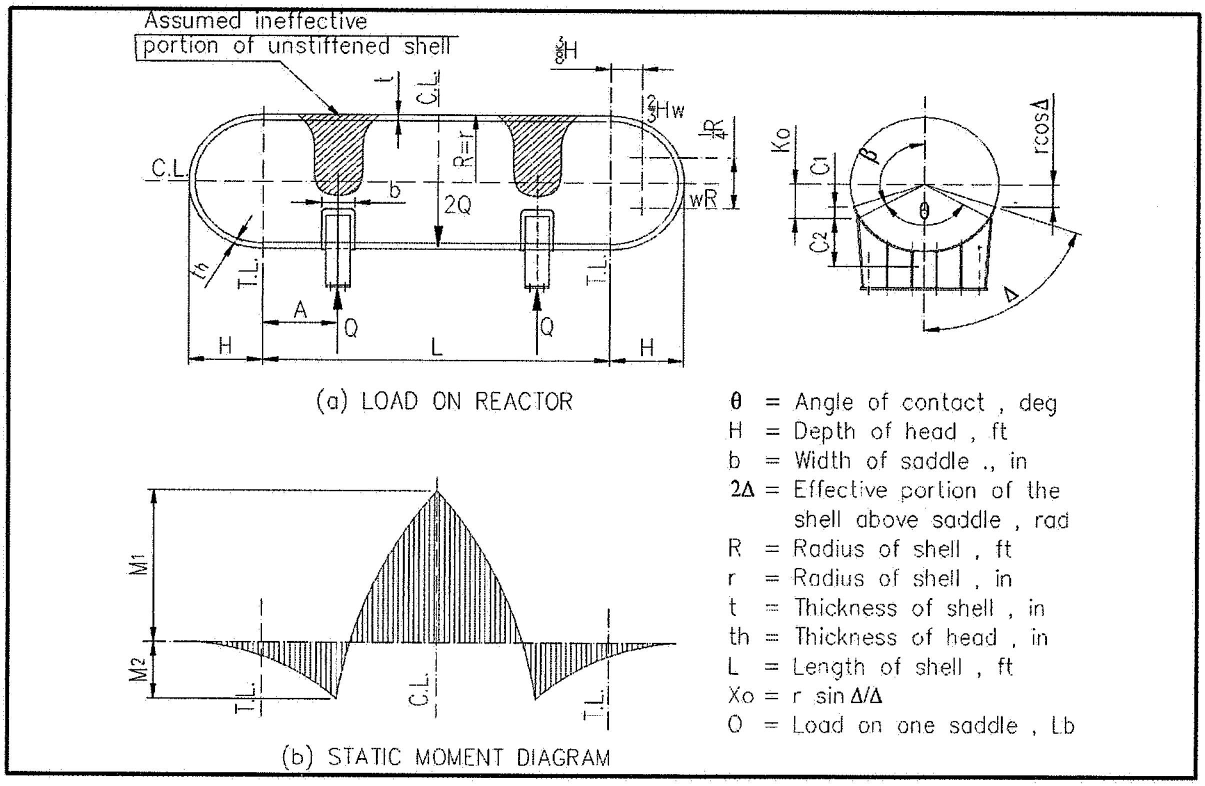

Figure 1

Maximum Longitudinal Bending Stress S1 in the shell at the Midspan

Geometry

L =	**121,391** ft	**37000,0** mm	see Figure 1
A =	**20,112** ft	**6130,0** mm	"
R =	**7,921** ft	**2414,2** mm	"
H =	**7,713** ft	**2351,0** mm	"
r =	**95,047** in	**2414,2** mm	"
t =	**10,402** in	**264,2** mm	"
b =	**39,370** in	**1000,0** mm	"
P =	**7,252** psi	**0,05** N/mm^2	[Different internal-external pressure]

NOTE 3:
the nitrogen pressure is negligible.

REV.	DESCRIZIONE - DESCRIPTION
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Loads

Q = **1.834.895 lb** **8.162.102 N** (Q = dynamic weight on the loadest saddle)

Material

S_y = **45.000 psi** = **310,26 Mpa**
S_m = **30.000 psi** = **206,84 Mpa**
E = **1** **(joint efficiency)**

The bending moment M_1 at midpan is:

$M_1 = K_1$*(Q*L/4) [lb-ft]
where:

K_1 = [(1+2*((R^2-H^2)/L^2))/(1+(4*H/3*L))]-(4*A/L)

K_1 = **0,2596**
M_1 = **14.455.770 [lb-ft]**

Stress

The maximum stress S1 is either in tension (shell bottom) or compression (shell top).

S_1 = 12*M_1/Z_1 ***[psi]*** where Z_1 = pi* r^2*t

		S_1 (t)	**587,62 psi**	=	**4,05 Mpa**
S_1 =	587,62 psi so				
		S_1 (c)	**-587,62 psi**	=	**-4,05 Mpa**

Sp* = *P*R/(2*t) ***[psi]***

Sp = 33,133 psi = 0,228 Mpa

S_{1t} (+) =	587,62 psi	4,28 Mpa	< Sm * E =	206,84	**Verified**
S_{1c} (-) =	-554,48 psi	-3,82 Mpa	< Sm	206,84	**Verified**

Allowable stress limits :

The tensile stress (+)S1 combined with the longitudinal pressure stress Sp should not execeed the allowable tensile stress of the shell material times the efficiency of the girth joints. The maximum compressive stress (-)S1 occurs when the vessel is filled with the operating liquid and under atmospheric pressure. It should not exceed the Code maximum compressive stress for cylindrical shells.

Maximum Longitudinal Bending stress S'1 in the shell in the plane of the saddle

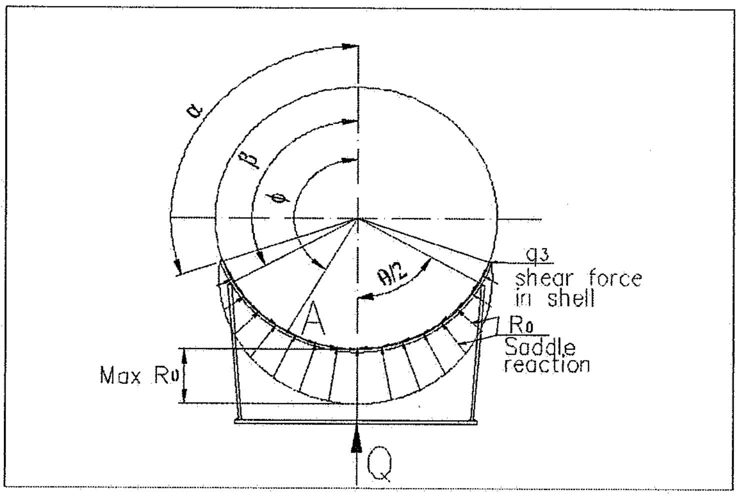

Figure 2

The bending moment in the plane of the saddle M_2 equals:

M_2 = 2Q/(L+4H/3)*[2HA/3+A^2/2-(R^2-H^2)/4] [lb-ft]

M_2 = 8.495.985 [lb-ft] = 5708980009 [N-mm]

If the shell section above the saddle is unstiffened and forced to deflect, the high local tangential bending moments at the horn of the saddle render this section ineffective in bending to some degree. the effective arc of the unstiffened shell in bending is assumed to be:

Δ = **[π/180*(θ/2+β/6)]** ***[rad]***

θ =	**120 grad**	=	**2,0944 rad**	See Figure2
β =	**120 grad**	=	**2,0944 rad**	
Δ =	**80 grad**	=	**1,3963 rad**	
sinΔ =	**0,9848**			
cosΔ =	**0,1736**			

S_1' = 12*M_2/Z_2 = ***[psi]*** where Z_2 =pi*r^2 *t * [F(delta)]

Z_2 = 31472,44 in^3

S_1' = 3239,40 psi so

S_1' (+) = **3239,40 psi = 22,33 Mpa**

S_1' (-) = **-3239,40 psi = -22,33 Mpa**

Sp = 33,13 psi 0,228 Mpa

S_1t (+) :	3272,53 psi	=	22,79 Mpa	< Sm*E =	206,84 Mpa		**Verified**
S_1c (-) :	-3239,40 psi	=	-22,33 Mpa	< Sm =	206,84 Mpa		**Verified**

Allowable stress limits:
The tensile stress S_1' combined with the pressure stress Sp should not exceed the allowable tensile stress for the shell material multiplied by the joint efficiency of the girth seam.Maximum compressive stress S_1' should be less than the Code allowable stress in compression.

Circunferential stress at the horn of the saddle

In the ring portion of uniform cross section fixed at the saddle horns, the circumferential moment $M\phi$ at any angle ϕ is given by:

$M(\phi) = (Q*r/\pi)* F(\phi;\beta)$

The moment $M(\phi)$ maximum at $\phi = \beta$ so:

$\phi = \beta$ **2,0944** rad
$\sin\beta$ = **0,8660**
$\cos\beta$ = **-0,5000**

$M(\phi=\beta) = K_6 \cdot Q \cdot r$

A/R = 2,54 then:

$M(\phi=\beta) =$ -41001597 lb in — max moment
$M(\phi=\beta) = K_3 \cdot Q \cdot r$ — where K_3 req. is given by interpolation:

K_3 =	0,0528		θ sup.	**150**
$M(\phi=\beta)$ =	9.208.409 lb-in		θ inf.	**120**
			θ req.	**120**
For case L > 8*R		L/R = 15,33		
Sb =	$(+/-)\ 3\ K_3Q / (2\ t^2)$	[psi]	K_3 sup.	**0,0316**
Sc =	$(-1)*Q / (4*t*(b+10*t))$	[psi]	K_3 inf.	**0,0528**
S_3 =	**Sc - Sb**	**[psi]**	K_3 req.	**0,0528**

Sb = 1343,19 psi = 9,26 Mpa
Sc = -307,57 psi = -2,12 Mpa
S_3 = -1650,76 psi = -11,38 Mpa <1,25*Sm = 258,55 Mpa **Verified**

Allowable stress limits :
The computed maximum stress S3 should not exceed 1,25 times the allowable stress for material with equal tensile and compressive yield strength.

Ring compression in the shell over the saddle

ϕ = **3,1416 rad**
α = **1,1519 rad**
S_5 = [Q /t*(b+10*t)]*[(1+cos(a))/(p-a+cos(a)*sen(a)] ***[psi]***

S_5 = 732,95 psi = 5,05 Mpa < 0,5*Sy = 155,13 Mpa **Verified**

Allowable stress limits:
The maximum compressive stress S_5 should not exceed one-half the yield strength and is not additive to the pressure stress. If wear plate is used the combined thickness with the shell thk. can be used for computing stress S_5, provided the wear plate extends r/10 in. Beyond the horn . and its minimum width is (b+10*t) in.

Maximum shear stresses in the plane of the saddle

Case 2: shell not stiffened by the head (A>R/2) or shell reinforced by two ring stiffeners adjacent to the saddle.

S_2 = (K$_2$' *Q/r * t) * [(L-2*A-H)/(L+H)] ***[psi]***

where $K_2' = \sin\phi_2/(\pi-\alpha+\sin\alpha *\cos\alpha)$
The maximum value of K_2' occurs at ϕ_2 = a, for θ = 120° and θ = 150° the value of K_2' are reported below.

θ	K_2'	*interpolation*	
120	**1,171**	θ sup.	**150**
150	**0,799**	θ inf.	**120**
		θ riquired	**120**
		K_2' sup	**0,799**
		k_2' inf	**1,171**
		K_2' riq.	**1,171**

S_2 = 1236,54 psi	8,53 Mpa	< 0,8*Sm =	165,47 Mpa	**Verified**

Allowable stress limits:
The tangential shear stress should not exceed 0,8 times the allowable stress in tension.

NOTE 4:
The situation of the vessel dressed in horizontal position is not considered because the dynamic weight applied in the above calculation is considered a conservative verification also for this particular case

CONCLUSIONS

According to the above verification, the saddles are suitable for transportation providing that the indicated limits are not exceded and the calculation hypotesis are met.

CONCLUSIONS <2>

During vessel loading / unloading on the trailer the vessel can be positioned on the saddles supported at each end in such way that a max free space of 6600 mm is left (for trailer insertion under the saddles).

During land transportation the following indications shall be met:

- The longitudinal acceleration shall not exceed 0.2g.
- The two saddles lead on the same set of joined trailers.
- The trailers floor shall remain always parallel to the leading surface of both saddles. (In other words the vessel axis shall be always parallel to the trailer floor)
  •8° ramp angle shall not be exceeded. (In this case longitudinal acceleration shall be avoided)

During sea shipping the following indications shall be met:

- The vessel shall be properly fastened in such way to avoid movements of the vessel on the saddles.
- The saddles shall be fixed to the ship floor and shall be supported at least at each end and at the middle section (suggested completely leading on the ship deck floor). The longitudinal acceleration shall not exceed 0.2g (suggested max 0.15g). Transversal acceleration shall not exceed 0.4g. Anyway, at freigth forwarder care, vessels shall be properly secured by an adequate lashing system.
- The vertical acceleration shall not exceed 1.2g (suggested max 1.15g)

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Sub-Section B 2

Specifications and Procedures

SOU 0111412/4 Rev.1 -Welding Repair Procedure for B.M.&W.M.
SOU 0111413/4 Rev.1 -Welding Repair Procedure for W.O. Tp.347
SOU 0111414/4 Rev.2 -Intermediate Stress Relieving Procedure
SOU 0113843/4 Rev.1 -P.W.H.T. and L.P.W.H.T. Procedure
SOU 0114168/4 Rev.3 -Painting Specification
SOU 0115194/4 Rev.1 -Hydrotest Test Procedure
SOU 0116552/4 Rev.2 -Liquid Penetrant Examination
SOU 0116553/4 Rev.1 -Magnetic Particle Examination
SOU 0116554/4 Rev.2 -Ultrasonic Examination
SOU 0116555/4 Rev.2 -Ultrasonic Examination of Weld Deposited Overlay
SOU 0116556/4 Rev.1 -Radiographic Examination
SOU 0116557/4 Rev.1 -Ultrasonic Inspection whith Time of Flight Diffraction Techique (TOFDT)
SOU 0116558/4 Rev.1 -B-C-SCAN Technique for Ultrasonic Examination of Welds
SOU 0116559/4 Rev.1 -Ferrite Check Specification
SOU 0116560/4 Rev.5 -Positive Material Identification
SOU 0116561/4 Rev.1 -Hardness Measurement Procedure for Production Welds
SOU 0116575/4 Rev.0 -Copper Sulphate Inspection
SOU 0120367/4 Rev.0 -Procedure for Nozzles Weld Overlay Removal and Restoring Nozzles "B" and "E2"

Nuovo Pignone MASSA	CLIENTE – CUSTOMER LOUIS DREYFUS
	LOCALITA' - PLANT LOCATION WILHELMSHAVEN (GERMAY)
COMMESSA - JOB 3100274-75-76-77-78-79	IMPIANTO - PLANT UNICRACKING REACTORS

TITOLO - TITLE

WELDING REPAIR PROCEDURE FOR B.M & W.M.
ITEM <1>:
D-6211 / D-6231
D-6212 / D-6232
D-6214 / D-6234

A PROCEED

AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

NAME:

02 OKT. 2006

FLUOR B.V.

A

W40-0056 REV1

REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
1	REVISIONE - REVISION	Chiappini	Casciaro	Chiappini	20/07/06
0	EMISSIONE - ISSUE	Chiappini	Casciaro	Chiappini	15/02/06

ITEM see UP

N. SOU0111412 /4

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SOSTITUISCE IL - REPLACES

SOSTITUITO DA - REPLACED BY

0. DOCUMENTI APPLICABILI
- ASME VIII Div. 2.
- ASME IX.

1. SCOPO
Scopo della seguente procedura è definire le modalità operative per la riparazione della saldatura e materiale base, del reattore prima e dopo esecuzione del trattamento termico sia in forno che localizzato.

I principali pezzi forgiati **e lamiere <1>** saranno forniti con assenza di riparazioni. Un difetto fuori dalle tolleranze definite da codici, norme o specifica del materiale indurrà lo scarto del pezzo forgiato **e lamiere <1>.**

La riparazione dei difetti maggiori in saldatura richiedono preventiva approvazione scritta da parte del cliente **(NP emetterà un NCR) <1>.**

Si considerano difetti maggiori quelli ecedenti a 3/8 " (9.525 mm) in prondità o ½ spessore, comunque il minore dei 2.

Sono da considerarsi difetti maggiori tutte le riparazioni dovute a perdite durante la prova idraulica.

(questo sarà fatto dopo PWHT) <1>

2. PROCEDURA (PRIMA DEL T.T. FINALE)
2.1 Asportazione difetti
Rimozione della saldatura difettosa o incisioni causate da ossitaglio mediante molatura o ARCAIR, verifica con NDT **(MT and UT) <1>**
Se usato ARCAIR preriscaldare a 200°C, interpass 300°C.

2.2 N.D.T.
Esame magnetoscopico, fino ad assicurarsi che il difetto sia stato completamente asportato.

2.3 Riparazione
La riparazione sarà eseguita utilizzando il procedimento (approvate WPS's/PQR's):
(1-0274-01 vedi welding book SOU0111416/4) <1>

a) SMAW
Se il tratto è lungo 400 mm Max, la riparazione sarà eseguita in accordo ai parametri indicati in una WPS qualificata che sarà scelta in funzione delle caratteristiche (spessore metallo base, spessore metallo depositato ecc..) del giunto da riparare.

b) SMAW
Se il tratto è lungo 400 mm Max, ma la riparazione non è accessibile per l'uso del procedimento SAW, la riparazione stessa sarà eseguita in accordo ai parametri indicati in una WPS qualificata che sarà scelta

in funzione delle caratteristiche (spessore metallo base, spessore metallo depositato etc) del giunto da riparare.

In riferimento ai due precedenti paragrafi, è inteso che la lunghezza della molatura dipenderà dalla dimensione del difetto e dalla sua posizione rispetto allo spessore. In particolare si utilizzeranno i seguenti criteri:

- Profondità del difetto ≤ 10 mm

Lunghezza molatura (Lm) = lunghezza difetto (Ld)+ 2 x profondità del difetto (Pd) [mm];

- Profondità del difetto 10÷50 mm

Lm = Ld + (2 x 20) + 2 x Pd [mm];

- Profondità del difetto ≥ 50 mm

Lm = Ld + (2 x 25) + 2 x Pd [mm].

c) SAW

Se il tratto da riparare è di lunghezza maggiore di 400 mm, in accordo ai parametri indicati in una WPS qualificata che sarà scelta in funzione delle caratteristiche (spessore metallo base, spessore metallo depositato etc) del giunto da riparare. La larghezza minima dello scavo dovrà essere ≥ 15 mm.

2.4 N.D.T.

Ripetizione dei controlli richiesti per la fabbricazione ed in particolare di quelli che hanno permesso la individuazione del difetto **(UT,MT e PMI). <1>**

3. PROCEDURA (DOPO IL T.T. FINALE)

3.1 Asportazione difetti

Rimozione della saldatura difettosa o incisioni causate da ossitaglio mediante molatura o ARCAIR, verifica con NDT **(MT e UT) <1>.**

Se usato ARCAIR preriscaldare a 200°C, interpass 300°C.

3.2 N.D.T.

Esame magnetoscopico , fino ad assicurarsi che il difetto sia stato completamente asportato.

3.3 Riparazione

La riparazione sarà eseguita utilizzando il procedimento:

(1-0274-01 vedi welding book SOU0111416/4) <1>

a) SMAW

Se il tratto è lungo 400 mm Max, la riparazione sarà eseguita in accordo ai parametri indicati in una WPS qualificata che sarà scelta in funzione delle caratteristiche (spessore metallo base, spessore metallo depositato etc) del giunto da riparare.

b) SMAW

Se il tratto è lungo 400 mm Max, ma la riparazione non è accessibile per l'uso del procedimento SAW, la riparazione stessa sarà eseguita in accordo ai parametri indicati in una WPS qualificata che sarà scelta in funzione delle caratteristiche (spessore metallo base, spessore metallo depositato etc) del giunto da riparare.

- Profondità del difetto ≤ 10 mm

Lunghezza molatura (Lm) = lunghezza difetto (Ld)+ 2 x profondità del difetto (Pd) [mm];

- Profondità del difetto 10÷50 mm

Lm = Ld + (2 x 20) + 2 x Pd [mm];

- Profondità del difetto ≥ 50 mm

Lm = Ld + (2 x 25) + 2 x Pd [mm].

c) SAW

Se il tratto da riparare è di lunghezza maggiore di 400 mm, in accordo ai parametri indicati in una WPS qualificata che sarà scelta in funzione delle caratteristiche (spessore metallo base, spessore metallo depositato etc) del giunto da riparare. La larghezza minima dello scavo dovrà essere ≥ 15 mm.

3.4 TRATTAMENTO TERMICO LOCALIZZATO

Esecuzione di trattamento termico localizzato secondo quanto indicato nella relativa procedura Nuovo Pignone applicabile e dovrà interessare tutta la giunzione saldata

3.5 N.D.T. dopo T.T.

Ripetizione dei controlli richiesti per la fabbricazione ed in particolare di quelli che hanno permesso la individuazione del difetto **(UT, MT e PMI).<1>**

4 CRITERI DI ACCETTABILITA'

I criteri di accettabilità dei difetti sono quelli indicati nelle sotto elencate spec. Nuovo Pignone:

- P.T.: SOU 0116552
- M.T.: SOU 0116553
- U.T.: SOU 0116554
- TOFD: SOU 0116557

0. SPECIFICATIONS AND CODES

- ASME VIII Div. 2.
- ASME IX.

1. SCOPE

The scope of this procedure is to define the method to carry out the repair of any defect on Weld Material and base material, type 2 ¼Cr 1Mo ¼ V <1> of the reactor before and after the PWHT execution.

Main forging **and plate** <1> shall be supplied with zero repairs. A defect out of the tolerances given by Code/Norm or Material Specification shall induce the reject of the forging **and plate** <1> .

<u>Repairs of major weld defects require Buyer's prior written approval. **(NP shall issue a NCR) <1>**</u>

<u>Repairs of weld defects are considered major when the defect size exceeds 3/8 inch in depth or one-half the wall thickness of the component, whichever is less or when the defect resulted in leakage during a hydrostatic test **(A repair that is required after PWHT execution) <1>.**</u>

2. PROCEDURE (BEFORE FINAL PWHT)

2.1 Defects removing

The defects shall be removed by grinding or ARCAIR plus grinding to sound metal, verified by NDT **(MT and UT) <1>.**
When arc gounging is used, the mandatory preheat & interpass temperature requirements apply.
Preheat: 200°C - Interpass:300°C

2.2 N.D.T.

Magnetic Particle Inspection

2.3 Repairing

Repair shall be done employing the following Welding Processes (approved WPS's/PQR's):
(1-0274-01 see welding book SOU0111416/4) <1>

a)b) <u>SMAW</u>

The process shall be applied up to 400 mm length of the removed areas at depth according to a qualified WPS.

With reference to the above consideration the length of the grinded area depend of the dimension of the defect and it positions referred to the dept also. The following criteria will be used:

- <u>Dept of defect ≤ 10 mm</u>

Grinded length (Lm) = defect length (Ld)+ 2 x defect dept (Pd) [mm];

- <u>Dept of defect 10÷50 mm</u>

Lm = Ld + (2 x 20) + 2 x Pd [mm];

- <u>Dept of defect ≥ 50 mm</u>

Lm = Ld + (2 x 25) + 2 x Pd [mm].

c) <u>SAW</u>

The process shall be applied for the length longer than 400 mm, according to a qualified WPS.

The minimum width of the grinded area shall be ≥ 15 mm.

2.4 **N.D.T.**

Repetition of the N.D.T. examination performed on weld seam during initial fabrication (UT, **MT and PMI**). <1>

3. PROCEDURE (AFTER FINAL PWHT)

3.1 **Defects removing**

The defects shall be removed by grinding or ARCAIR plus grinding to sound metal, verified by NDT. **(MT and UT) <1>.**

When arc gounging is used, the mandatory preheat & interpass temperature requirements apply.

Preheat: 200°C - Interpass:300°C

3.2 **N.D.T.**

Magnetic Particle Inspection .

3.3 **Repairing**

Repair shall be done employing the following Welding Processes:

(1-0274-01 see welding book SOU0111416/4) <1>

a)b) SMAW

The process shall be applied up to 400 mm length of the removed areas at depth according to a qualified WPS.

With reference to the above consideration the length of the grinded area depend of the dimension of the defect and it positions referred to the dept also. The following criteria will be used:

- Dept of defect ≤ 10 mm

Grinded length (Lm) = defect length (Ld)+ 2 x defect dept (Pd) [mm];

- Dept of defect 10÷50 mm

Lm = Ld + (2 x 20) + 2 x Pd [mm];

- Dept of defect ≥ 50 mm

Lm = Ld + (2 x 25) + 2 x Pd [mm].

c) SAW

The process shall be applied for the length longer than 400 mm, according to a qualified WPS.

The minimum width of the grinded area shall be ≥ 15 mm.

3.4 **LOCALIZED PWHT**

Localized PWHT shall be executed of complete weld seams according to approved Nuovo Pignone specification. **(SOU0113843/4)** <1>

3.5 **N.D.T. after PWHT**

Repetition of the N.D.T. examination performed on weld seam during initial fabrication (UT & MT **and PMI**). <1>

4 ACCETABLE CRITERIA

The criteria of acceptability of the defects are those indicated in the following Nuovo Pignone specifications:

- P.T.: SOU 0116552
- M.T.: SOU 0116553
- U.T.: SOU 0116554
- TOFD: SOU 0116557

Nuovo Pignone MASSA	CLIENTE – CUSTOMER *LOUIS DREYFUS*
	LOCALITA' - PLANT LOCATION *WILHELMSHAVEN (GERMAY)*
COMMESSA - JOB **3100274-75-76-77-78-79**	IMPIANTO - PLANT *UNICRACKING REACTORS*

TITOLO - TITLE

WELDING REPAIR PROCEDURE FOR W.O. TP 347
ITEM <1>:
D-6211 / D-6231
D-6212 / D-6232
D-6214 / D-6234

A PROCEED

AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

NAME:

02 OKT. 2006

FLUOR B.V.

W40-0057 REV1

1	REVISIONE - REVISION	Chiappini	Casciaro	Chiappini	20/07/06
0	EMISSIONE - ISSUE	Chiappini	Casciaro	Chiappini	15/02/06
REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE

ITEM see UP

N. SOU0111413 /4

LINGUA-LANG.	PAGINA-SHEET
IA	1 / 2

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

0. DOCUMENTI APPLICABILI

- ASME VIII Div. 2.
- ASME IX.

1. SCOPO

Scopo della seguente procedura è definire le modalità operative per la riparazione **di ogni difetto rilevato mediante VT, PT o UT aderenza placcato**, dei riporti di saldatura in acciaio inossidabile TP 347. <1>

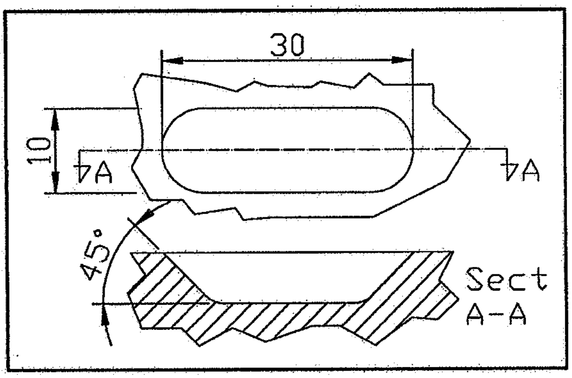
2. PROCEDURA

a) Esame visivo.
b) Esame con liquidi penetranti e controllo ultrasonoro. <1>
c) Rimuovere il difetto con molatura fino al metallo sano.
d) Esame visivo.
e) Esame con liquidi penetranti.
f) Ripristinare l'area difettosa con SMAW e/o FCAW overlay.
g) Esame visivo, liquidi penetranti finale, U.T. finale. <1>
h) Misurazione della ferrite.

2.1 Riparazione

Le dimensioni minime dello scavo dovranno essere le seguenti: larghezza 10 mm, lunghezza 30 mm ed inclinazione 45°.

<1>



Dopo la rimozione del difetto deve essere misurata e registrata la profondità. In particolare si dovrà operare come segue:

- Eseguire attacco acido tipo Nital 2% o similare;
- Se dall'esito dell'attacco acido non si evidenzia presenza di acciaio ferritico, si procede con una (FCAW) o due (SMAW) strati di SS. TP. 347; testare anche con ferritoscopio .
  (SOLO X OVERLAY MULTI LAYERS) <1>
  Questo punto di procedura potrà essere applicato solo nel caso in cui lo spessore misurato, con UT, sarà uguale o superiore a 3mm <1>.
- Se dall'esito dell'attacco acido si evidenzia la presenza di acciaio ferritico si procede con l'esecuzione del primo strato in SS. TP. 309L mantenendo il preriscaldo di 150°C e successive passate di completamento senza preriscaldo con SS. TP. 347.

Esecuzione del ripristino dell'Overlay in accordo a WPS's qualificate ed approvate. **(1-0274-05 e/o 1-0274-06, vedi welding book SOU0111416/4) <1>**

2.2 Criteri di accettabilità

I limiti di accettabilità saranno quelli stabiliti per la qualifica dei procedimenti, con le percentuali riferite ai valori misurati con il metodo magnetico. In particolare il valore di FN presente nel deposito dovrà essere compresa tra i 4÷8 FN. prima del PWHT .

- La zona riparata con riporto di saldatura dovrà essere controllata con liquidi penetranti in accordo alla specifica Nuovo Pignone (nel caso di difetti rilevati da U.T.) ed a tutte le altre prove previste per l'overlay in accordo a procedure approvate dal Cliente.

Nuovo Pignone MASSA	**WELDING REPAIR PROCEDURE FOR W.O. TP 347**

0. SPECIFICATIONS AND CODES

- ASME VIII Div. 2.
- ASME IX.

1. SCOPE

The scope of this procedure is to define the method to carry out the repair of any defect on the internal TP 347 Ss. weld overlay **detected during VT, PT or UT for lack of bond. <1>**

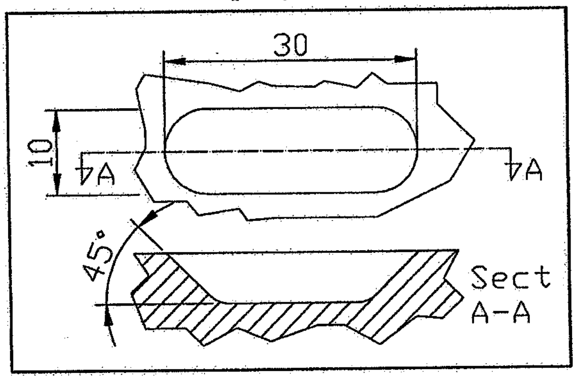
2. PROCEDURE

a) Visual examination.
b) Penetrant test examination and ultrasonic examination. <1>
c) Remove of the defect by grinding.
d) Visual examination.
e) Penetrant test examination.
f) Restoring the area with SMAW and/or FCAW processes overlay.
g) Final visual, dry penetrant, ultrasonic examinations. <1>
h) Ferrite measurements.

2.1 Repairing

The minimum dimension of the repair joint must be at least the follows: width 10 mm, length 30 mm, angle 45° .

<1>



The defect depth must be checked and recorded after their removal. In particular the follows indications must be follow:

- Chemical etching type Nital 2% or similar grade;
- If the chemical etching does not indicate the ferritic steel the weld will be carried out with two layers of Ss. Tp. 347 (SMAW and/or FCAW); Provide additional cross check method for ferritic steels with Ferritoscope. **(ONLY FOR MULTI LAYERS PROCESSES) <1>**
  For multi layers processes, it shall be measured (by UT instrument) that the remaining WO thk is ≥ 3mm <1>.
- If chemical etching indicate the ferritic steel the weld will be carried out at 150°C with a first layer in tp. 309L and others in tp. 347.

Overlay restoring according to qualified and approved WPS's **(1-0274-05 and/or 1-0274-06, see welding book SOU0111416/4) <1>**

2.2 Acceptable criteria

The acceptability limits will be those established for the procedures qualification, with the percentages reported to the values measured with the magnetic method. In particular the FN in the weld deposit shall be comprised between 4÷8 FN. before PWHT .

The repaired area must be checked with penetrant test examination according to Nuovo Pignone spec. (in case of major defect by U.T.) and all other tests required for overlay, **all testing** per Customer approved procedures. **<1>**

Nuovo Pignone MASSA	CLIENTE – CUSTOMER LOUIS DREYFUS
	LOCALITA' - PLANT LOCATION WILHELMSHAVEN (GERMAY)
COMMESSA - JOB 3100274-75-76-77-78-79	IMPIANTO - PLANT UNICRACKING REACTORS

TITOLO - TITLE

INTERMEDIATE STRESS RELIEVING PROCEDURE

ITEM <2>:

D-6211 / D-6231
D-6212 / D-6232
D-6214 / D-6234

Lloyd's Register EMEA
REVIEWED/ ~~WITNESSED~~
G.L. Frolla 4/1/07
Viareggio Office
Lloyd's Register

A PROCEED
AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER
NAME:
27 SEP. 2006
FLUOR B.V.

4545166-W40-0058 REV 1

REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
2	REVISIONE - REVISION	Chiappini	Casciaro C.	Chiappini F.	18/07/06
1	REVISIONE - REVISION	Chiappini	Casciaro	Chiappini	22/03/06
0	EMISSIONE - ISSUE	Chiappini	Casciaro	Chiappini	15/02/06

ITEM see UP

N. SOU0111414 /4

LINGUA-LANG.	PAGINA-SHEET
IA	1 / 2

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

1 SCOPO

1.1. Questa procedura descrive le operazioni e i fabbisogni per il trattamento termico intermedio in officina relativamente alle giunzioni delle connessioni saldate ai fondi *e alle virole* <2>. Deve essere applicata in congiunzione con la specifica di commessa (se emessa) e con lo schema intervento controllo. In caso di contrasto nelle istruzioni, la specifica di commessa o lo schema intervento controllo prevalgono.

2 PREPARAZIONE PER IL TRATTAMENTO TERMICO <2>

2.1. Il componente da trattare dovrà essere adeguatamente supportato per mantenere la sua linearità e rotondità.

3 FORNO

3.1. I componenti da trattare saranno distesi in forno a metano e ogni sforzo sarà fatto per assicurare una adeguata tenuta atmosferica e una corretta combustione durante tutto il ciclo di trattamento. Un diretto contatto della fiamma sull' apparecchio durante il trattamento non è ammessa. <2>

4 TRATTAMENTO TERMICO INTERMEDIO

4.0.1. Il pezzo sarà mantenuto alla temperatura di preriscaldo, fino all'inserimento dello stesso in forno. <2>

4.1. Il trattamento di ISR, sarà eseguito con i seguenti parametri:

4.1.1. La temperatura del pezzo dopo la saldatura o al momento della messa in forno non dovrà essere inferiore ai 200°C.

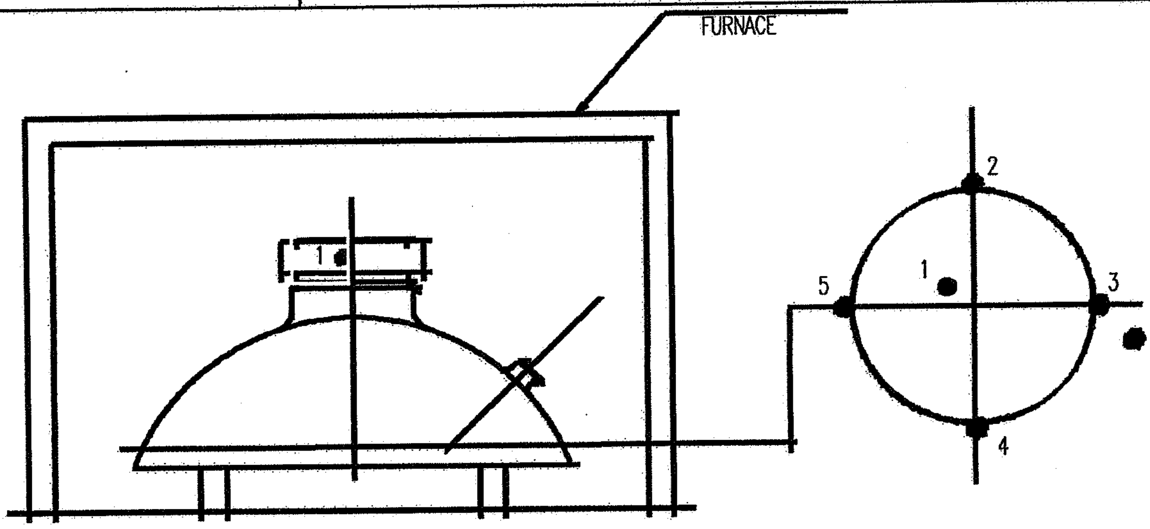
4.1.2. La velocità di riscaldamento non dovrà essere superiore a 56 °C/h.

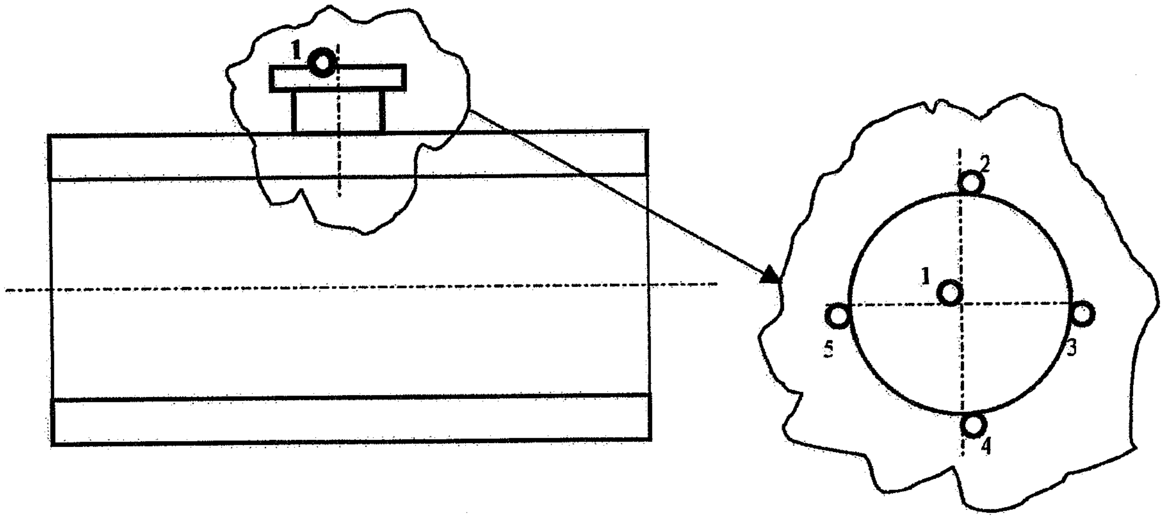
4.2. Temperatura di distensione 660^{+15}_{-0} °C per un tempo di 6 h. <1>

4.3. La velocità di raffreddamento non dovrà essere superiore a 56 °C/h.

4.4. Durante il riscaldamento e raffreddamento la differenza di temperatura tra i punti diversi deve essere minore di 30°C per metro di distanza e comunque non superiore a 80°C. Durante la permanenza alla temperatura di trattamento la differenza di temperatura tra i punti diversi deve essere quella indicata al punto 4.2.

4.5. Le termocoppie saranno disposte sull'apparecchio come sotto indicato:





5 TERMOCOPPIE

5.1. Tutte le termocoppie ed i relativi cavi (indicare la lunghezza delle termocoppie), usate durante il ciclo di trattamento termico dovranno essere corredate da un certificato di controllo. Il massimo errore dovrà essere dell' 1% alla temperatura di trattamento.

5.2. Ciascuna termocoppia dovrà essere fissata all' apparecchio per mezzo di una strisciolina inox a coprire la guarnizione (con un piccolo strato isolante interposto) saldata per punti a scarica capacitiva (vedasi allegato N.P. doc. SOU0119841/4 rev.1). Le striscioline saranno asportati di mola dopo T.T. e la superficie dovrà essere controllata con MFX o L.P. sulle superfici inossidabili. Termocoppie tipo "k" Ni/Cr a scarica capacitiva.

6 CERTIFICAZIONE

Il trattamento termico sarà certificato da ispettori del Nuovo Pignone.

1. SCOPE

1.1. This procedure describes the operations and requirements for intermediate stress relieving in shop for nozzle welding to head *and belt* <2>; it shall be applied in conjunction with the job PWHT specification (if issued) and with "Quality Plan". In case of conflict the job specification and the "Quality Plan" shall prevail.

2 PREPARATION FOR HEAT TREATMENT <2>

2.1. The component to be heat-treated shall be suitably supported to maintain their straightness and roundness.

3 FURNACE

3.1. The component to be heat treated shall be treated in methane gas furnace, every effort shall be made to insure adequate tightness and correct combustion to achieve a neutral or reducing atmosphere during the heating cycle. Direct contact of the flame with the vessel is not allowed.

4 INTERMEDIATE STRESS RELIEVING

4.0.1 The work piece shall be maintained at preheat temperature up until start of heating. <2>
Shall not permitted go below preheat temperature up until ISR is finished <2>

4.1. The ISR will be performed with the following parameters.

4.2.1. The temperature of the vessel at the charge time shall not be less than: 200°C.

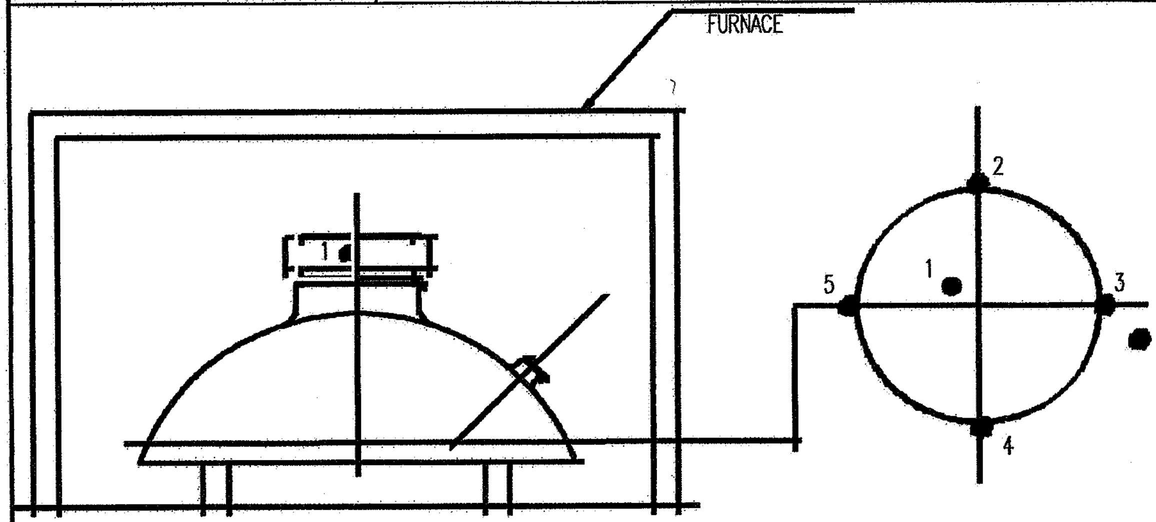
4.2.2. The heating must be not greater than: 56 °C/h.

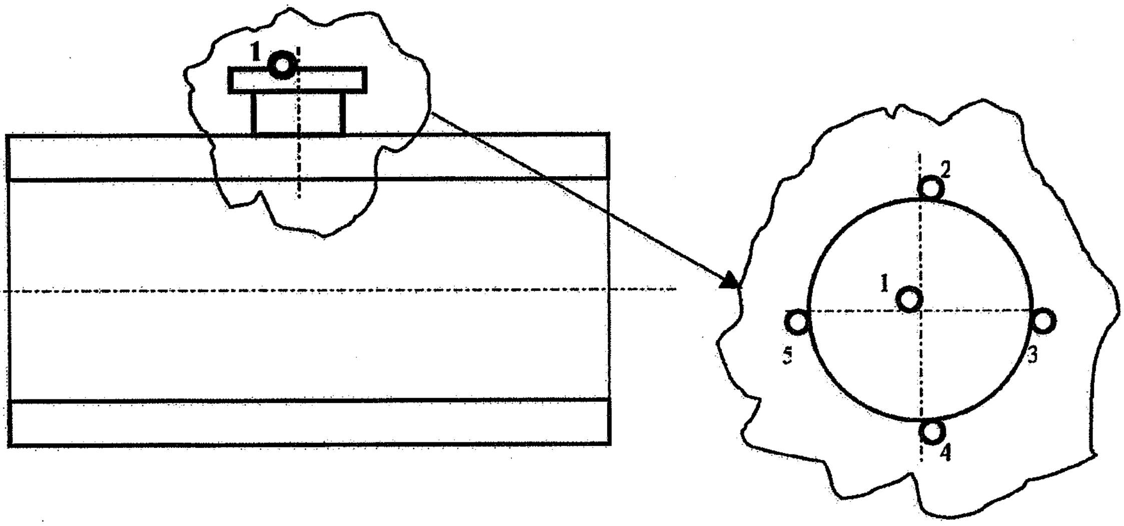
4.2. Holding temperature 660 $^{+15}_{-0}$ °C soaking time 6 h. <1>

4.3. Cooling rate must be not greater than: 56 °C/h.

4.4. During heating and cooling, the difference in temperature between different points shall not exceed 30°C per meter and any case 80°C. During soaking time at maximum temperature all points shall be kept within the temperature range as indicated at point 4.2.

4.5. The location of thermocouples on vessels shall be as indicated: (see sketch sheet 3).





5 THERMOCOUPLES SETTING

5.1. All thermocouples, along with the recorder a length of cable used during heat treatment cycle, shall have a calibration certificate. The maximum allowable error shall be ± 1 % at the PWHT temperature.

5.2. Each thermocouple shall be fixed on the vessel using capacitive discharge (see attached N.P. doc. SOU0119841/4 rev.1) spot welded S.S. cover strips (with a little insulation layer interposed). Care shall be taken to avoid any dilution to vessel material. Strips shall be removed by grinding, ground area shall be M.T. or P.T. inspected. Thermocouple type "k" Ni/Cr attached with capacitive discharge junctions.

6 CERTIFICATION

Nuovo Pignone Q.C. DPT. shall certify heat treatment.

Nuovo Pignone MASSA	CLIENTE – CUSTOMER CONOCOPHILLIPS LTD
	LOCALITA' - PLANT LOCATION WILHELMSHAVEN (GERMANY)
COMMESSA - JOB 3100274-75-76-77-78-79	IMPIANTO – PLANT RAFFINERIEGESELLSCHAFT MBH . WRG-DEEP CONV. PROJECT

TITOLO - TITLE

Titolo (Title):

POST WELD HEAT TREATMENT

LOCAL POST WELD HEAT TREATMENT

DHT

PROCEDURE

D ~~CONSIDERED FOR INFO ONLY~~

NAME: 15 JAN. 2007

~~FENOR B.V.~~

"A" Proceed KDS 1/2/07

Lloyd's Register EMEA
REVIEWED/~~WITNESSED~~
G.L. Frolla 4/1/07
Viareggio Office
Lloyd's Register

TOTAL PAGES: 6

4545166-P06-0097. REV01.

REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
1	MODIFIED WHERE INDICATED <1>	Lazzerini	Ricci S.	Ronchieri A.	24-08-06
0	EMISSIONE-ISSUE	Lazzerini	Ricci	Ronchieri	03-07-06

ITEMS: D-6211-12-14-31-32-34

N. SOU0113843/4

LINGUA-LANG.	PAGINA-SHEET
A	1 / 2

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

Electronically approved draw. GE NuovoPignone Internal DT-'N'

1. SCOPE

This procedure describes the operations and requirements for post weld heat treatments, Local Post weld heat treatment and DHT in shop.
Applicable documents are:

2. PREPARATION FOR HEAT TREATMENT

2.1. The materials and welds shall be free of machining fluids or debris, inspection residues such as couplant fluids, magnetic particles and other contaminants which, when heated, may be detrimental for the vessel material.

2.2. The completed vessels shall be suitably supported to maintain their straightness and roundness.

3. FURNACE

3.1. The vessels shall be treated in methane gas furnace, every effort shall be made to insure adequate tightness and correct combustion to achieve a neutral or reducing atmosphere during the heating cycle (as to avoid excessive oxidation of the surface of the vessel).
Direct contact of the flame with the vessel is not allowed.

4. FINAL POST WELD HEAT TREATMENT

4.1. Final PWHT of pieces of the vessel shall be performed in one single operation in furnace (the following pieces can be treated toghether or separately):

- UPPER SECTION as indicated in **sketch 1**.
- BOTTOM SECTION as indicated in **sketch 2**.
- BLIND FLANGE and COMPANION FLANGES as indicated in **sketch 4**.
- TOP SPOOL as indicated in **sketch 6**.

4.2. The vessel shall be heat treated with the following parameters:

4.2.1. The temperature of the furnace at the charge time shall not be greater than 300°C.

4.2.2. The heating rate above temperature indicated at para.4.2.1. shall be max 55° C/h

4.2.3. The cooling rate above temperature indicated at para 4.2.4. shall be max 55° C/h

4.2.4. The piece can be removed from the furnace at the temperature of 300 °C.

4.3. Holding time and temperature:

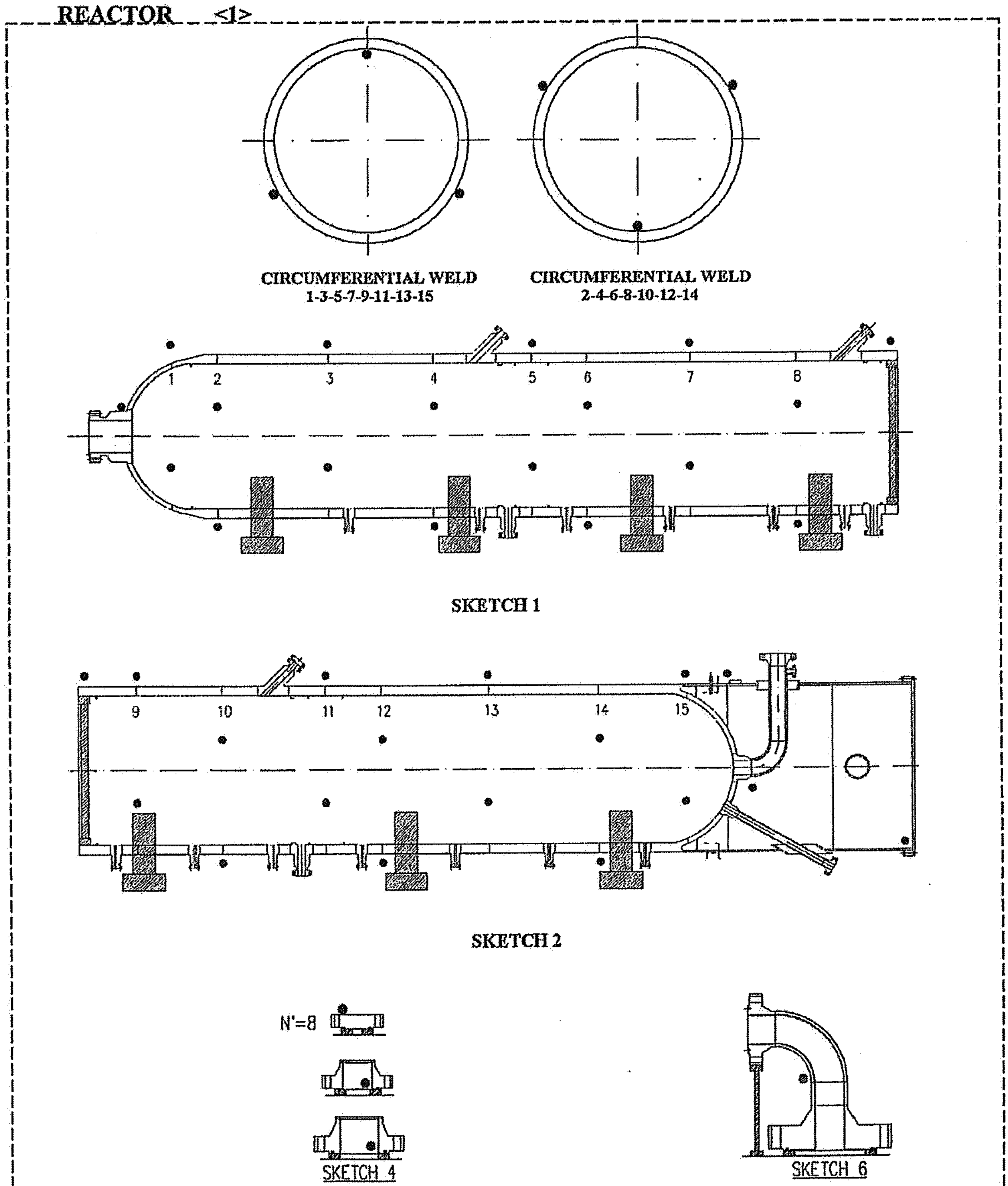
Temperature : 709 ±5°C.
Holding Time (Hours) : 8h $^{+15'}_{-0'}$ <1>

4.4. During heating and cooling, the difference in temperature between any of the used thermocouples shall not exceed the rate of 30°C per meter and in any case not more than 80°C.
During holding time at maximum temperature all points shall be kept within the temperature range as indicated at point 4.3.

Nuovo Pignone MASSA	POST WELD HEAT TREATMENT AND LOCAL POST WELD HEAT TREATMENT PROCEDURE

4.5. The location of thermocouples on pieces of the vessel shall be at least as below indicated:

THIS IS AN INDICATIVE SKETCH. THE NP WORKSHOP TECHNICAL DEPARTMENT SHALL STUDY THE ACTUAL CONFIGURATION FOR EACH REACTOR <1>



		ITEMS: D-6211-12-14-31-32-34	
1	MODIFIED WHERE INDICATED <1>	N. SOU0113843/4	
0	EMISSIONE - ISSUE	LINGUA-LANG.	PAGINA-SHEET
REV.	DESCRIZIONE - DESCRIPTION	A	3 / 4

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

● THERMOCOUPLE LOCATION FOR PWHT

5. LOCAL POST WELD HEAT TREATMENTS.

5.1. Weld P.W.H.T. will be performed in one single operation using electric sources resistance device.

5.2. The weld shall be heat treated with the following parameters:

5.2.1. The heating rate above 300°C shall be max 55°C/h

5.2.2. Holding time and temperature: 709±5°C for 8 h. $^{+15'}_{-0}$

5.2.3. The cooling rate above 300°C shall be max 55°C/h

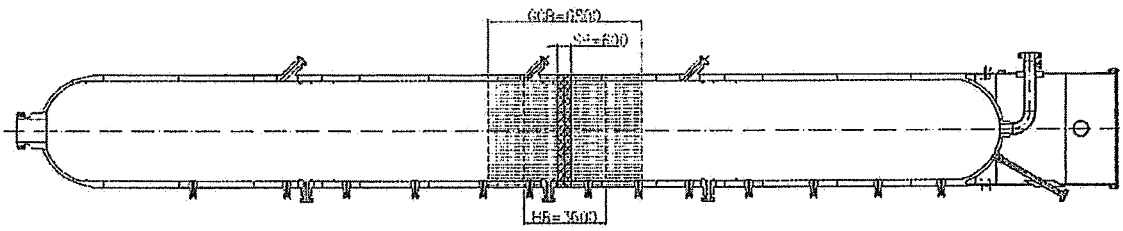
5.3. During heating and cooling, the difference in temperature between any of the used thermocouples shall not exceed the rate of 30°C per meter and in any case not more than 80°C.
During holding time at maximum temperature all points shall be kept within the temperature range as indicated at point 5.2.

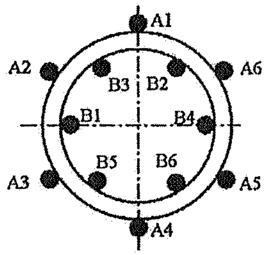
5.4. The heated band width shall extend on each side of the weld at least 1800 mm for external and internal side (3600 mm total width).

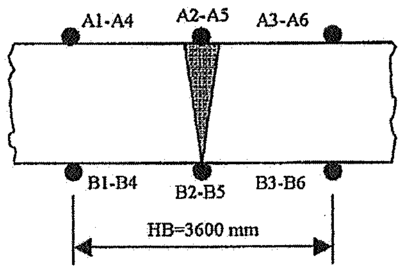
5.7. Insulation shall be provided inside and outside and shall extend at least 3400 mm beyond each side of the heated band (6800 mm total width).

5.8. The thermocouple number shall be minimum 12 as shown in the following sketch:

THIS IS AN INDICATIVE SKETCH. THE NP WORKSHOP TECHNICAL DEPARTMENT SHALL STUDY THE ACTUAL CONFIGURATION FOR EACH REACTOR (SEE ALSO WRC 452) <1>







SOSTITUISCE IL - REPLACES | PARI NUMERO
SOSTITUITO DA - REPLACED BY

369

BY WRC 452:

SB= SOAK BAND

HB= HEATING BAND

GCB= GRADIENT CONTROLL BAND (=MIN.INSULATED BAND)

6. THERMOCOUPLES SETTING

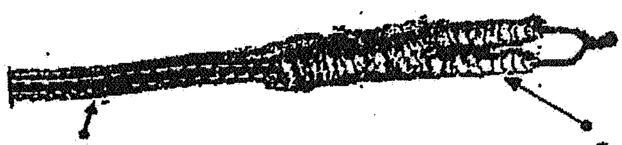
6.1. All thermocouples along with the recorder and length of cable used during heat treatment cycle shall have a calibration certificate. The maximum allowable error shall be ± 1% at the P.W.H.T. temperature.

6.2. The cycle of H.T. shall be continuously recorded.
Each reading shall be identified by the number of related thermocouple.
The H.T. chart shall indicate the serial number of thermocouples used during the treatment.

6.3. Each thermocouple shall be fixed on the vessel using capacitive discharge spot welded S.S. cover strips (with a little insulation layer interposed). Care shall be taken to avoid any dilution to the vessel material. Strips shall be removed by grinding, ground area shall be M.T. inspected.

6.4. A correspondance table shall be enclosed to the H.T. diagram indicating, for every T/C, its position on vessel and its related recorder pen.

Thermocouple with cable type CERIF S 20 KK



Strip Nichrome 0.1 mm thickness tack weld

7. CERTIFICATION

Post weld heat treatment shall be recorded on H.T. certificate signed by Nuovo Pignone Q.C. Dpt and Loyds Register.

8. REFERENCE DRAWING

SUO0269055-56-57-58-59-60/1 Sheet ¼ (General Assembly)

9. DHT (De-hydrogenation Heat Treatment)

DHT will be performed immediately after the welding execution by gas burners (avoiding temperature decrease under the preheat value).
During DHT, temperature shall be maintained in the range of 350 °C to 400 °C.
Minimum soaking time 4hours.
Temperature check and record shall be performed each 30 minutes by a special laser thermometer according to the fabrication inspection plan requirements.
Vessel is to be continuously turning in rolls during DHT. <1>
The following form shall be used to record the values.

DHT TEMPERATURE RECORDING TABLE

JOB	NOZZLE or CICULAR SEAM		DATE
TIME	TEMPERATURE °C	SIGNATURE	NOTES

Nuovo Pignone MASSA	CLIENTE – CUSTOMER **CONOCOPHILLIPS**
	LOCALITA' - PLANT LOCATION **WILHELMSHAVEN (GERMANY)**
COMMESSA - JOB <3> **3100274-75-76-77**	IMPIANTO - PLANT **WRG-DEEP CONVERSION PROJECT**

TITOLO - TITLE

PAINTING SPECIFICATION

TOTAL PAGES: 3

"A" Proceed
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KDS 23/04/07

REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
3	Modificato. dove indic. – Modif. where indic. <3>	Lazzerini	Ricci S.	Ronchieri A.	12-04-07
2	Modificato. dove indic. – Modif. where indic. <2>	Lazzerini	Ricci	Ronchieri	22-02-07
1	Modificato dove indic. – Modif. Where indic. <1>	Lazzerini	Ricci	Ronchieri	30-01-07
0	EMISSIONE-ISSUE	Lazzerini	Ricci	Ronchieri	27-07-06

ITEM **D-6211-31-12-32** <3>

N. SOU0114168/4

LINGUA-LANG.	PAGINA-SHEET
A	1 / 2

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0. FORWARD

The works, test and inspection, shall be performed according to the present specification and to the enclosed drawing and specifications.

Applicable documents

SUO0269055/1 Fabrication drawing ITEM D-6211
SUO0269056/1 Fabrication drawing ITEM D-6231
SUO0269057/1 Fabrication drawing ITEM D-6212
SUO0269058/1 Fabrication drawing ITEM D-6232
<3>

1. SCOPE <1>

This specification includes the information for surface preparation and painting of Reactors items **D-6211, D-6231, D-6212, D-6232. <3>**

PAINTING SYSTEM <3>

A) Vessel body (see sketch 1)

BLAST	SSPC-SP10
PRIMER	CARBOZINC 11 (or equivalent) 3 MILS (75µm) minimum (DFT) <2> **<3>**
INTERMEDIATE	NONE
FINISH	NONE

The maximum expected vessel surface temperature is 445 °C (Considering this temperature, supplier shall verify and confirm the suitability of the indicated painting cycles).

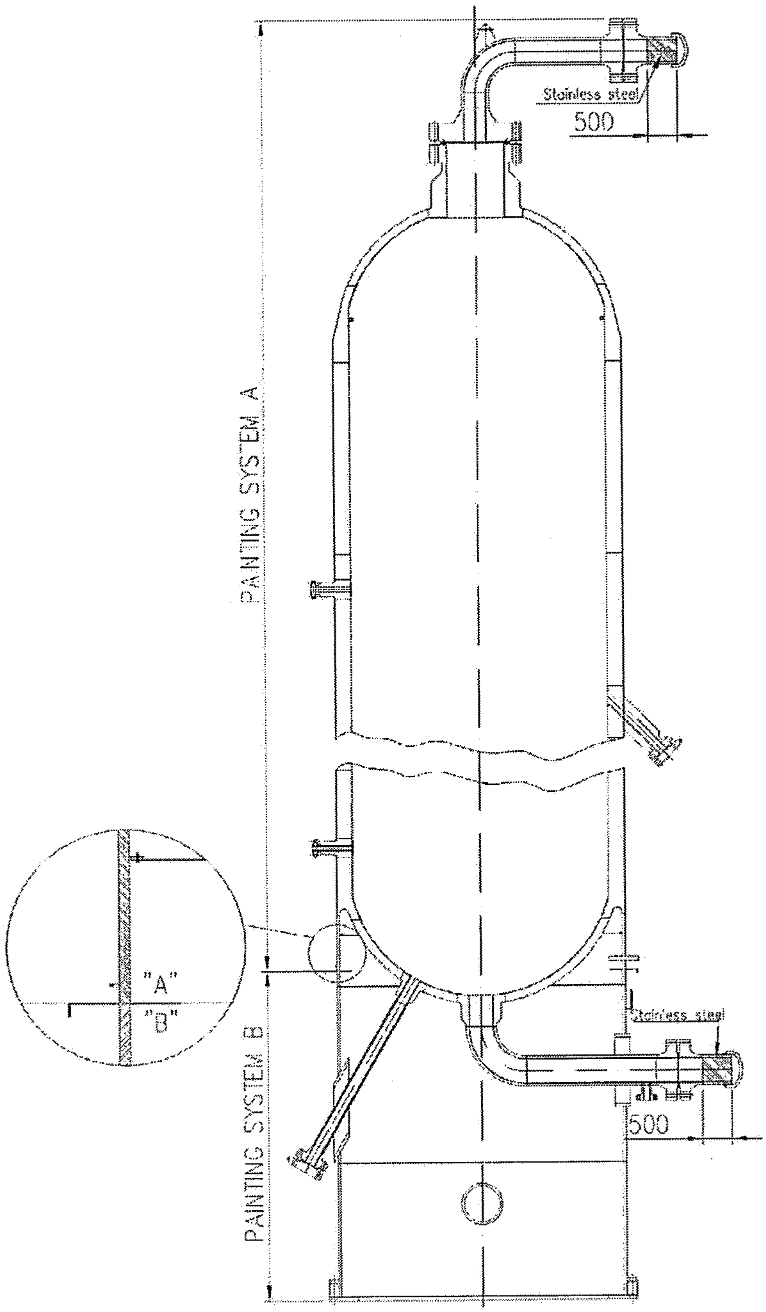
B) Skirt Internal/external (see sketch 1)

BLAST	SSPC-SP10
PRIMER	EPOXY MASTIC 4.5 MILS (114µm) minimum (DFT) <2> **<3>**
INTERMEDIATE	NONE
FINISH	NONE

The maximum expected skirt surface temperature is about 220 °C (Considering this temperature, supplier shall verify and confirm the suitability of the indicated painting system).

WARNING:
Stainless steel parts must not be sandblasted and/or painted.
Flanges mating surface must not be sandblasted and/or painted.

SKETCH 1 <1> <3>



REV.	DESCRIZIONE - DESCRIPTION
3	Modificato dove indic. – Modif. Where indic. <3>
2	Modificato dove indic. – Modif. Where indic. <2>
1	Modificato dove indic. – Modif. Where indic. <1>
0	ISSUE

ITEM D-6211-31-12-32 <3>

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Nuovo Pignone MASSA	CLIENTE – CUSTOMER CONOCOPHILLIPS
	LOCALITA' - PLANT LOCATION WILHELMSHAVEN (GERMANY)
COMMESSA - JOB 3100274÷79	IMPIANTO - PLANT W.R.G. DEEP CONVERSION PROJECT

TITOLO - TITLE

HYDRAULIC TEST PROCEDURE

A PROCEED

AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

NAME:

08 JAN. 2007

FLUOR B.V.

Lloyd's Register EMEA
REVIEWED/~~WITNESSED~~
G.L. Frolla 2/2/07
Viareggio Office
Lloyd's Register

TOTAL PAGES: 3

POS-0118 REV1

1	REV. DOVE INDIC. – REV. WHERE INDIC. <1>	Lazzerini	Ricci S.	Ronchieri A.	12-10-06
0	EMISSIONE-ISSUE	Lazzerini	Ricci S.	Ronchieri A.	28-08-06
REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE

ITEMS D-6211/31/12/32/14/34

N. SOU0115194/4

LINGUA-LANG.	PAGINA-SHEET
A	1 / 2

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(A)

1. SCOPE

This procedure describes the operations and requirements for hydrostatic test in shop of vessels ITEMS D-6211 , D-6231 , D-6212 , D-62321 , D-6214 , D-6234 and it shall be applied in conjunction with the following documents / codes:

SOU0110203/4	Quality plan item D-6211
SOU0110204/4	Quality plan item D-6231
SOU0110205/4	Quality plan item D-6212
SOU0110206/4	Quality plan item D-6232
SOU0110207/4	Quality plan item D-6214
SOU0110208/4	Quality plan item D-6234
SUO0269055/1	Setting Plan item D-6211
SUO0269056/1	Setting Plan item D-6231
SUO0269057/1	Setting Plan item D-6212
SUO0269058/1	Setting Plan item D-6232
SUO0269059/1	Setting Plan item D-6214
SUO0269060/1	Setting Plan item D-6234

ASME section VIII Div. 2, Ed. 2004 Article T-3
PED directive 97-23-EC paragraph 7.4.

2. TEST SEQUENCE

The test shall be conducted according to the procedure indicated in ASME VIII Div. 2 Article T3 (see paragraphs AT-353 and AT-355) at the pressure calculated according to PED 97-23-EC paragraph 7.4. (see table below and setting plan drawing) <1>

ITEMS D-6211 / D-6231
Test Pressure horizontal position (at top) 292 bar (g)

ITEMS D-6212 / D-6232
Test Pressure horizontal position (at top) 282 bar (g)

ITEMS D-6214 / D-6234
Test Pressure horizontal position (at top) 287 bar (g)

In addition, the following requirements shall be met.

- Hydrotest of vessel shall be performed after the completion of final PWHT, on completion of all inspections and tests as per applicable Code Specifications and satisfactory results of mechanical test on production test plates.
- The top spool has to be hydraulic tested together with the relevant vessel.
- The reactor shall be free of any kind of coating, soil and debris before testing. All dirt, scale, sands and foreign material shall be removed.

- Service gaskets shall not be used for hydraulic test. A dedicated set (identical to the service gaskets) shall be used.
- The vessel shall be fully vented prior to pressurising.
- The procedure for filling the vessels shall prevent the formation of air pockets or damage/dislocation of internals is installed during liquid filling.
- The test temperature shall be set in such way that it is greater than the ambient dew point temperature. In any case the min. test temperature shall be 15 °C.
- Maximum hydrostatic water temperature shall not exceed 50°C.
- The temperature of the vessel wall will be measured by contact thermocouples or thermometer.
- Heating of the vessel wall by direct flame impingement is strictly prohibited.
- The vessel shall be shop tested in horizontal position, supported on temporary saddles to prevent any deformation of the vessel.
- The pressure shall be gradually increased up to test pressure that shall be maintained at least for 1 (one) hour. <1>
- Vessel circumference shall be measured before and after hydrotest, measurement shall be recorded.

3. EQUIPMENT

- A centrifugal or reciprocating pump shall be used to fill the vessel.
- Hydrotest fluid: clean, fresh water, max. chloride content 50 ppm (see Assembly dwg. note 14).
- Dial indicating pressure gages used in testing shall be graduated over a range not less than 1,5 times but not more over 4 times the test pressure (pressure gage recorder shall be previously checked in laboratory for shop hydrotest).
- A second calibrated pressure gage, placed on the upper part of the vessel, will allow an additional check of pressure.
- The water shall be drained immediately after completion of the hydrostatic test.
- The vessels shall be dried immediately after draining, to prevent the possibility of evaporation and concentration of chlorides. HEAT DRYING IS NOT PERMITTED.

4. CERTIFICATION

Hydrotest shall be witnessed by the PED Notified Body Inspector. (Lloyd Register Hamburg) who will sign the pressure-time diagram. <1>

Nuovo Pignone MASSA	CLIENTE – CUSTOMER *CONOCO PHILLIPS*
	LOCALITA' - PLANT LOCATION *WILHELMSHAVEN, GERMANY*
COMMESSA - JOB 3100274÷3100279	IMPIANTO - PLANT *WRG-DEEP CORVERSION PROJECT*

TITOLO - TITLE

LIQUID PENETRANT EXAMINATION

A PROCEED

AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

NAME:

02 OKT. 2006

FLUOR B.V.

Lloyd's Register EMEA

REVIEWED/~~WITNESSED~~

G.L. Frolla 4/1/07

Viareggio Office

Lloyd's Register

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P05-C007 REV 2

REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
2	Revised where indicated ②	Zappavigna	Chiappini F.	Zappavigna G.	09.11.06
1	Revised where indicated ①	Zappavigna	Chiappini	Zappavigna	19.05.06
0	Emissione - Issue	Zappavigna	Chiappini	Zappavigna	30.01.06

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234

N. SOU0116552/4

LINGUA-LANG.	PAGINA-SHEET
AI	1 / 2

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Nuovo Pignone MASSA	**LIQUID PENETRANT EXAMINATION**

CUSTOMER	CONOCO PHILLIPS
JOB	3100274, 3100275, 3100276, 3100277, 3100278, 3100279
ITEM	D-6211, D-6231, D-6212, D-6232, D-6214, D-6234
MATERIALS	**SHELL:** ASME SA 336 F22V **HEADS:** ASME SA 542 Gr.D Cl.4a **NOZZLES and PIPE NECKS:** ASME SA 182 F22V **SPOOLS:** ASME SA 182 F22V **WELD OVERLAY:** S.S. TP 347 **SKIRT:** ASME SA 387 Gr.22 Cl.2 / SA 516 Gr.70
DOCUMENTS	UOP Specification 3-17-3 NP Fabrication and Inspection Plan. SOU0110203/4 NP GENERAL DRAWINGS SUO 0269055 ÷SUO 0269060 GENERAL PROCEDURE (from page 5/25).
PART TO BE EXAMINED	WELD OVERLAY - AUSTENITIC WELDS - INTERNAL ATTACHMENTS BACK GOUGED AREAS (high temperature surfaces)
EXTENT OF THE EXAMINATION ②	100 % before PWHT 100% after PWHT (including machined surfaces) SPOT (minimum 10%) after PRESSURE TEST
TECHNIQUES	COLOR CONTRAST WATER WASHABLE PROCESS COLOR CONTRAST SOLVENT REMOVABLE **(only for back gouged areas)**
SURFACE PREPARATION	AS WELDED GRINDED **(only for back gouged areas)**
TEMPERATURE OF THE SURFACE	> 10 °C < 52 °C > 180°C < 200 °C **(only for back gouged areas)**
CLEANING	BRUSHING VELEMULSIOR H_2O (CGM) **(only for back gouged areas)**
TIME PERIOD BETWEEN CLEANING AND PENETRANT APPLICATION	< 4h < 5 min **(only for back gouged areas)**
PENETRANT TYPE	ROTRIVEL AVIO B STICK of ROTVEL AVIO/ST **(only for back gouged areas)**
BRAND	CGM
PENETRANT APPLICATION	BRUSHING OR SPRAYING MELTING STICK **(only for back gouged areas)**

REV.	DESCRIZIONE - DESCRIPTION
2	Revised where indicated ②
1	Revised where indicated ①
0	Emissione - Issue

ITEM **D-6211, D-6231, D-6212, D-6232, D-6214, D-6234**

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PENETRATION TIME	15 min. ÷ 30 min. 15 sec ÷ 25 sec **(only for back gouged areas)**
EXCESS PENETRANT REMOVAL	WATER VELEMULSIOR H_20 (CGM) **(only for back gouged areas)**
DRYING	BY EXPOSURE TO AMBIENT TEMPERATURE OR COLD AIR BLAST
TIME PERIOD BETWEEN PENETRANT REMOVAL AND DEVELOPER APPLICATION	> 30 min and < 1h < 30 sec **(only for back gouged areas)**
DEVELOPER	NON AQUEOSUS
TYPE	ROTRIVEL U ROTRIVEL H_20 (CGM) **(only for back gouged areas)**
BRAND	CGM
DEVELOPER APPLICATION	SPRAYING
ILLUMINATION	> 1000 lux
INTERPRETATION TIME	7 min. ÷ 60 min. 1 min ÷ 10 min **(only for back gouged areas)**
CLEANING AFTER EXAMINATION	BRUSHING VELEMULSIOR H_20 (CGM) **(only for back gouged areas)**
PERSONNEL	PERSONNEL CONDUCTING EXAMINATION SHALL BE QUALIFIED AT LEAST AT LEVEL II ACCORDING TO EN 473
ACCEPTANCE CRITERIA ①	All surfaces to be examined shall be free of: (a) relevant linear indications; (b) relevant rounded indications greater than 5 mm; (c) four or more relevant rounded indications in a line separated by 1,5 mm or less, edge to edge (according to ASME VIII Div. 2 App. 9 Art.9-2)
ATTACHMENT	EXAMPLE OF LIQUID PENETRANT TEST REPORT

Nuovo Pignone
MASSA

LIQUID PENETRANT EXAMINATION

Nuovo Pignone
MASSA

CERTIFICATO di ESAME con LIQUIDI PENETRANTI
LIQUID PENETRANT TEST REPORT

Nr.: PTxxx-yy
Page / Pag.: 1 / 1

Purchaser / Cliente: ______ Order / Ordine N°: ______
Shop Job / Commessa: ______ Item / Sigla: ______ Serial N° / N° Fabbr.: ______ Dwg N° / Disegno N°: ______
Inspecting Authority / Ente di Collaudo: ______ Inspecting Plan / Piano di Collaudo N°: ______ Stage / Fase N°: ______

Specific Item Data / Dati Specifici del Prodotto	Specific Procedure / Specifica di Controllo	Tested Particular / Particolare Controllato	Material / Materiale	Extent Test / Esten. Contr.
	Details of the Test / Descrizione dell' esame			

Inspection Medium / Mezzo di Ispezione

Penetrant / Penetrante:
- ☐ Visible Penetrant by Color Contrast / Penetrante Visibile a Contrasto di Colore
- ☐ Fluorescent Penetrant / Penetrante fluorescente
- ☐ Water Washable / Lavabile con Acqua
- ☐ Post-Emulsifying / Post-Emulsionabile
- ☐ Solvent Removable / Rimovibile con Solvente

Marca / Brand: ______ Tipo / Type: ______ Lotto N° / Batch N°: ______

Removal / Rimozione: ☐ Acqua / Water ☐ Emulsionante / Emulsifier ☐ Solvente / Solvent
Marca / Brand: ______ Tipo / Type: ______ Lotto N° / Batch N°: ______

Developer / Rivelatore: ☐ Acquoso / Aqueous ☐ Non Acquoso / Non Aqueous ☐ Secco / Dry
Marca / Brand: ______ Tipo / Type: ______ Lotto N° / Batch N°: ______

Technical Test Conditions / Condizioni di Controllo

Surface Conditions / Stato delle Superfici: ☐ Lavorato di Macchina / Machined ☐ Come Saldato / As Welded ☐ Molato / Ground ☐

Surface Preparations / Preparaz. Superfici: ☐ Molato / Ground ☐ Con Detergente / By Detergent ☐ Spazzolato / Brushed ☐ Con Solvente / By Solvent

Test Carried Out / Esame Effettuato: ☐ Prima / Before ☐ Dopo / After
☐ Saldatura / Welding ☐ T.T. / P.W.H.T. ☐ T.T. Loc. / Loc. P.W.H.T. ☐ Prova Idraulica / Hydrotest

Test Results / Risultati d' Esame

☐ No indications to be recorded / Nessuna Indicazione da registrare ☐ Recorded Indications / Indicazioni Registrate — See page / Vedi pag. ______

Result Conforming to the Specified Requirements / RISULTATI CONFORMI AI REQUISITI DI SPECIFICA ☐ Yes / Sì ☐ No / No
☐ ASME VIII Div.1 App.8
☐ ASME VIII Div.2 App.9 Art.9-2
☐ ASME VIII Div.3

Examiner / Operatore ______ Level II / Livello II — Q.C. Department Level II / Controllo Qualità Livello II ______

Massa li ______ Inspectors / Ispettori ______

REV.	DESCRIZIONE - DESCRIPTION
2	Revised where indicated ②
1	Revised where indicated ①
0	Emissione - Issue

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234

N. SOU0116552/4

LINGUA-LANG.	PAGINA-SHEET
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SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

Titolo (Title):

PROCEDURA GENERALE:

CONTROLLO CON LIQUIDI PENETRANTI

LAVABILI CON ACQUA O ASPORTABILI CON SOLVENTE:

GENERAL PROCEDURE:

WATER-WASHABLE OR SOLVENT REMOVABLE

LIQUID PENETRANT EXAMINATION:

		ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234
2	Revised where indicated ②	
1	Revised where indicated ①	N. SOU0116552/4
0	Emissione - Issue	LINGUA-LANG. AI / PAGINA-SHEET 5 / 6
REV.	DESCRIZIONE - DESCRIPTION	

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2. DOCUMENTI DI RIFERIMENTO.
3. PRESCRIZIONI GENERALI.
4. PRESCRIZIONI SPECIFICHE.
5. TECNICHE.
6. VALUTAZIONE DELLE INDICAZIONI.
7. CRITERI DI ACCETTAZIONE.
8. PRESCRIZIONI PER LA RIPARAZIONE.
9. PULIZIA DOPO L'ESAME.
10. CERTIFICATO DI ESAME.
11. PERSONALE OPERATIVO.
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5. TECHNIQUES.
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7. ACCEPTANCE CRITERIA.
8. REPAIR REQUIREMENTS.
9. POST EXAMINATION CLEANING.
10. EXAMINATION REPORT.
11. QUALIFICATION OF PERSONNEL.
12. PROCEDURE FOR NONSTANDARD TEMPERATURE

1. SCOPO.

La presente Procedura Generale descrive i metodi e le prescrizioni per l'esame con Liquidi Penetranti, quando tale esame è richiesto dal Codice ASME, dal Contratto e dal Nuovo Pignone per rilevare discontinuità su superfici di parti metalliche.

1. SCOPE.

This general procedure describes the methods and the requirements to be applied for the liquid penetrant examination, when this examination is required by the referencing ASME Code Section or by the contract or by NUOVO PIGNONE, for detecting discontinuities open to the surface of metallic parts.

2. DOCUMENTI DI RIFERIMENTO. ①

- Codice ASME Sezione VIII Div. 2, Appendice 9, Articolo 9-2 - ultima edizione.
- Codice ASME Sezione V, SE 165 - ultima edizione.
- Codice ASME Sezione V, Articoli 6 e 24 - ultima edizione.

2. REFERENCE DOCUMENTS ①

- *ASME Code Section VIII Div. 2, Article 9-2, Appendix 9, latest edition and addenda*
- *ASME Code Section V, SE 165, latest edition and addenda*
- *ASME Code Section V, Art. 6 and 24, latest edition and addenda.*

3. PRESCRIZIONI GENERALI

3.1. Procedura Specifica

L'esame con Liquidi Penetranti sarà effettuato in accordo ad una Procedura Specifica, che dovrà:

- fare riferimento alla presente Procedura Generale;
- contenere almeno le informazioni seguenti considerate "variabili essenziali":
  - a) il tipo (con la designazione in numeri e lettere, se disponibile) del penetrante, dell'asportatore e del rivelatore;

b) i dettagli operativi per la pulizia preliminare e per l'asciugatura, includendo il tipo di materiali da usare per la pulizia ed il tempo minimo necessario per l'asciugatura;

c) i dettagli operativi per l'applicazione del penetrante, il periodo di tempo in cui il penetrante
deve rimanere sulla superficie (tempo di permanenza) e la temperatura della superficie e del penetrante durante l'esame se essa è al di fuori dell'intervallo fra 10°C e 52°C con relativa qualifica;

d) i dettagli operativi per l'asportazione dell'eccesso di penetrante dalla superficie e per l'asciugatura della stessa prima dell'applicazione del rivelatore;

e) i dettagli operativi per l'applicazione del rilevatore e tempo di sviluppo prima dell'interpretazione;

f) la minima intensità luminosa;

g) i criteri di accettazione.

- e contenere almeno le informazioni seguenti considerate "variabili non essenziali":

a) qualifica del personale

b) il materiale, la forma o le dimensioni dei particolari da esaminare e l'estensione dell'esame;

c) la tecnica di pulizia dopo l'esame

3. GENERAL REQUIREMENTS

3.1.<u>Specific Procedure</u>

The liquid penetrant examination shall be performed in accordance with a specific procedure that shall:

- *make reference to this procedure;*
- *include at least the following information considered "essential variable"*

a) type (number or letter designation if available) of each penetrant, penetrant remover and developer;

b) processing details for pre-examination cleaning and drying, including the cleaning materials used and minimum time allowed for drying;

c) processing details for applying the penetrant, the length of time that the penetrant will remain on the surfaces (Dwell time), and the temperature of the surface and penetrant during the examination if outside 50°F (10°C) to 125°F (52°C) range as previously qualified;
d) processing details for removing excess penetrant from the surface, and for drying the surface before applying the developer;
e) processing details for applying the developer and length of developing time before interpretation;
f) minimum light intensity
g) acceptance criteria.

- *and include at least the following information considered "nonessential variable"*
  a) personnel qualification requirements
  b) materials, shapes, or sizes to be examined and the extent of examination
  c) processing details for post-examination cleaning;

3.2. Qualifica della Procedura

Ogni Procedura Specifica dovrà essere dimostrata all'Ispettore Autorizzato per la sua accettazione.

Una revisione della Procedura Specifica o una nuova dimostrazione per accettazione possono essere richieste dall'Ispettore Autorizzato nei seguenti casi:

a) ogni volta che viene effettuato un cambiamento o una sostituzione nel tipo o nel gruppo della famiglia dei prodotti penetranti (compresi i rivelatori, gli emulsificanti, ecc.) o nelle tecniche operative;
b) ogni volta che viene effettuato un cambiamento o una sostituzione del tipo di materiali o nelle procedure usate per la pulizia preliminare;
c) per qualunque cambiamento nella preparazione del pezzo che possa otturare le aperture in superficie delle discontinuità o possa lasciare depositi che interferiscono con il controllo, come ad esempio l'uso di pulizia con granigliatura o di trattamenti con acidi.

3.2. Procedure Qualification

Each specific procedure shall be demonstrated to the satisfaction of the Authorized Inspector.

A revised specific procedure or a new demonstration for acceptance may be required:

a) whenever a change or substitution is made in the type of family group of penetrant materials (including developers, emulsifiers, etc.) or in the processing techniques;

b) whenever a change or substitution is made in the type of precleaning materials or processes;

c) for any change in part processing that can close surface openings of discontinuities or leave interfering deposits, such as the use of grit blast cleaning or acid treatments.

4. PRESCRIZIONI SPECIFICHE

4.1. Tecniche

Potrà essere usata una tecnica con penetranti visibili a contrasto di colore oppure fluorescenti con uno dei seguenti procedimenti:

a) Penetranti lavabili con acqua.

b) Penetranti asportabili con solvente

Una "famiglia" è la serie dei prodotti (penetrante, asportatore, solvente, rivelatore) della stessa marca necessari per effettuare un tipo specifico di esame con liquidi penetranti.

Non è permessa la mescolanza di prodotti di "famiglie" differenti o di fabbricanti differenti.

Un esame con penetranti fluorescenti non deve far seguito ad un esame con prodotti a contrasto di colore.

Un riesame con penetranti lavabili con acqua può causare perdita di indicazioni marginali causata da contaminazione.

4. SPECIFIC REQUIREMENTS

4.1. Techniques

Either a color contrast visible penetrant or a fluorescent penetrant technique shall be used with one of the following processes:

a) Water washable

b) Solvent removable

It is named "family" the complete group of penetrant material (penetrant, remover, solvent, developer) of the same brand necessary for performing a specific liquid penetrant examination.

Intermixing of penetrant materials from different "families" or different manufacturers is not permitted.

Fluorescent penetrant examination shall not follow a color contrast penetrant examination
A retest with washable penetrants may cause loss of marginal indications due to contaminants.

4.2.Prodotti

Tutti i prodotti (solventi, penetranti, rilevatori) usati per l'esame con liquidi penetranti di leghe a base di nickel, acciai inossidabili austenitici e titanio, dovranno essere conformi al controllo dei contaminanti indicato all'Appendice II, Articolo 6 del Codice ASME Sezione V ultima edizione.
I contenuti dei contaminanti (zolfo e alogeni) dovranno essere certificati per ciascun lotto ed il Nuovo Pignone dovrà ottenere il relativo certificato dal Fabbricante dei prodotti.

4.2.Penetrant materials

All liquid penetrants (solvents, penetrants, developers) used for the examination on nickel base alloys, austenitic stainless steels and titanium, shall comply with the control of contaminants as per Appendix II, Article 6, ASME Code Section V.
The contents of contaminants (sulphur and halogens) shall be certified for each batch number and NUOVO PIGNONE shall obtain the relevant certificate from the penetrant manufacturer.

4.3.Preparazione delle superfici

Condizione delle superfici

In generale possono ottenersi risultati soddisfacenti quando la superficie del pezzo è nella condizione come-saldata, come-laminata, come-fusa o come-forgiata. La preparazione delle superfici mediante molatura, lavorazione meccanica o altri metodi, può essere necessaria quando le irregolarità superficiali possono mascherare indicazioni di discontinuità inaccettabili.

Pulizia delle superfici.

Prima di ogni esame con liquidi penetranti, la superficie da esaminare e tutte le zone adiacenti per almeno 25 mm di larghezza dovranno essere asciutte ed esenti da polvere, grasso, sfilacciature, scoria, flusso di saldatura, spruzzi di saldatura, olio, vernici e altre sostanze che possano coprire le aperture in superficie o interferire altrimenti con l'esame.
Il metodo di pulizia è una fase importante del procedimento d'esame.
Agenti tipici che possono essere usati sono i detersivi, i solventi organici, le soluzioni disincrostanti, gli sverniciatori.

Possono pure essere usati metodi di sgrassaggio e pulitura con ultrasuoni.

I solventi per la pulitura devono soddisfare le prescrizioni all'Appendice II, Articolo 6 del Codice ASME Sezione V ultima edizione.

Dopo la pulizia, verrà effettuata l'asciugatura delle superfici da esaminare mediante normale evaporazione o con aria soffiata calda o fredda.

Si dovrà stabilire un periodo di tempo minimo per assicurarsi che la soluzione pulente sia evaporata prima dell'applicazione del penetrante.

4.3. Surfaces Preparation

Surface Condition

In general, satisfactory results may be obtained when the surface of the part is in the as-welded, as-rolled, as-cast, or as-forged condition.

Surface preparation by grinding, machining, or other methods may be necessary where surface irregularities could mask indications of unacceptable discontinuities.

Surface Cleaning

Prior to each liquid penetrant examination, the surface to be examined and all adjacent areas within at least 25 mm shall be dry and free of dirt, grease, lint, scale, welding flux, weld spatter, paint, oil and other extraneous matter that could obscure surface openings or otherwise interfere with the examination.

The cleaning method employed is an important part of the examination process.

Typical cleaning agents which may be used are detergents, organic solvents, descaling solutions, paint removers.

Degreasing and ultrasonic cleaning methods may also be used. The cleaning solvents shall meet the requirements of Appendix II, Article 6, ASME Code Section V.

After cleaning, drying of the surfaces to be examined shall be accomplished by normal evaporation or with forced hot or cold air.

A minimum period of time shall be established to ensure that cleaning solution has evaporated prior to application of the penetrant.

5. TECNICHE

5.1. Temperatura Standard

Nella tecnica standard la temperatura del penetrante e della superficie del pezzo da esaminare non dovrà essere inferiore a 10°C (50°F) né superiore a 52°C (125°F) durante l'effettuazione dell'esame.

Riscaldi o raffreddamenti localizzati sono permessi a condizione che la temperatura del pezzo rimanga fra 10°C (50°F) e 52°C (125°F) durante l'esame.

5. TECHNIQUE

5.1. Standard Temperature

In the standard technique, the temperature of the penetrant and the surface of the part to be examined shall not be examined below 50°F (10°C) nor above 125°F (52°C) throughout the examination period

Local heating or cooling is permitted provided the part temperature remains in the range 50°F (10°C) to 125°F (52°C) during the examination

5.2. Applicazione del penetrante

Il penetrante può essere applicato con ogni mezzo adatto, come ad esempio per immersione, con pennello o a spruzzo.

Se il penetrante viene applicato a spruzzo usando un impianto ad aria compressa, dovranno essere applicati dei filtri sul condotto dell'aria vicino al suo ingresso, per impedire contaminazione del penetrante con olio, acqua, polvere o sedimenti che possono essere raccolti lungo le tubazioni.

5.2. Penetrant application

The penetrant may be applied by any suitable means, such as dipping, brushing or spraying.

If applied by spraying using compressed-air-type apparatus, filters shall be placed on the upstream side near the air inlet to preclude contamination of the penetrant by oil, water, dirt or sediment that may have collected in the line.

5.3. Tempo di penetrazione

Il tempo di penetrazione è critico.

Il tempo minimo di penetrazione sarà quello raccomandato dal Fabbricante del penetrante, ma, come guida, non dovrà essere inferiore a quanto indicato nella tabella seguente:

Materiale da esaminare	**Tempo minimo di penetrazione (min.)**	**Tempo massimo di penetrazione (min.)**
Alluminio - Acciaio - Acciaio inossidabile - Bronzo e ottone -Titanio e leghe	15	30

Il tempo di penetrazione inizia dal momento in cui l'applicazione del penetrante è stata completata.

5.3. Penetration time

The penetration time is critical.

The minimum penetration time shall be those recommended by the penetrant manufacturer, but, as a guide, they shall be as indicated below:

Material to be examinated	***Minimum dwell time penetrant (min.)***	***Maximum dwell time penetrant (min.)***
Aluminium – Steel - Stainless austenitic steel - Titanium alloys	15	30

The penetration time begins after the penetrant application has been completed.

5.4. Asportazione dell'eccesso di penetrante

Dopo che è trascorso il tempo di penetrazione prescritto nella procedura specifica, tutto il penetrante rimasto sulla superficie deve essere asportato, avendo cura di rendere minima la rimozione del penetrante trattenuto dalle discontinuità.

Penetranti lavabili con acqua:

L'eccesso di penetrante lavabile con acqua dovrà essere asportato con spruzzo d'acqua. La pressione dell'acqua non dovrà superare 50 psi (345 KPa), e la sua temperatura non dovrà superare 110°F (43°C).

Penetranti asportabili con solvente:

L'eccesso di penetrante asportabile con solvente sarà rimosso strofinando la superficie con stracci o carta assorbente e ripetendo l'operazione fino a che la maggior parte delle tracce di penetrante sia stata rimossa.

Le rimanenti tracce di penetrante dovranno essere rimosse strofinando leggermente con stracci puliti o carta assorbente imbevuti di solvente.

Per rendere minima l'asportazione del penetrante dalle discontinuità, si dovrà avere cura di non usare troppo solvente.

È proibito sciacquare con solvente la superficie dopo l'applicazione del penetrante e prima dell'applicazione del rivelatore.

5.4. Excess Penetrant Removal

After the penetration time specified in the procedure has elapsed, any penetrant remaining on the surface shall be removed, taking care to minimize removal of penetrant from discontinuities.

Water washable penetrants:

Excess water washable penetrant shall be removed with a water spray. The water pressure shall not exceed 50 psi (345 KPa), and the water temperature shall not exceed 110°F (43°C).

Solvent removable penetrants:

Excess solvent removable penetrants shall be removed by wiping with a cloth or absorbent paper, repeating the operation until most traces of penetrant have been removed.

The remaining traces shall be removed lightly by wiping the surface with a cloth or absorbent paper moistened with solvent. To minimize removal of penetrant from discontinuities, care shall be taken to avoid the use of excess solvent.

Flushing the surface with solvent, following the application of the penetrant and prior to developing, is prohibited.

5.5. Asciugatura dopo l'asportazione dell'eccesso di penetrante

Per la tecnica lavabile con acqua, le superfici possono essere asciugate assorbendo con materiali puliti o usando circolazione d'aria, avendo cura che la temperatura della superficie non superi 125°F (52°C).

Per la tecnica di asportazione con solvente, la superficie può essere asciugata per normale evaporazione, con assorbenti o asciugando con aria soffiata.

5.5. Drying after excess penetrant removal

For the water washable or post-emulsifying technique, the surfaces may be dried by blotting with clean materials or by using circulating warm air, provided the temperature of the surface is not raised above 125°F (52°C).

For the solvent removable technique, the surface may be dried by normal evaporation, blotting, wiping, or forced air.

5.6. Applicazione del rivelatore

Il rivelatore sarà applicato subito dopo l'asportazione dell'eccesso di liquidi penetranti. L'intervallo di tempo non dovrà superare quello stabilito nella procedura specifica.

Un insufficiente spessore dello strato del rivelatore può non essere capace di richiamare il penetrante dalle discontinuità; al contrario un eccessivo spessore può mascherare le indicazioni.

Con i penetranti a contrasto di colore, deve essere usato soltanto un rivelatore umido.

Con i penetranti fluorescenti il rivelatore può essere a secco o a umido.

Rivelatore a secco

Il rivelatore a secco deve essere applicato soltanto su superficie asciutta, mediante un soffice pennello, uno spruzzatore manuale di polvere, una pistola lancia polvere o altri mezzi, facendo in modo che la polvere ricopra uniformemente l'intera superficie da esaminare.

Rivelatore umido

Prima di applicare il rivelatore del tipo a sospensione umida sulla superficie, il rivelatore deve essere agitato energicamente per assicurare una dispersione delle particelle in sospensione.

a) Applicazione del rivelatore acquoso.

Il rivelatore acquoso può essere applicato su una superficie umida o su una asciutta. Esso sarà applicato per immersione, con pennello, a spruzzo o con altri mezzi, avendo cura di distribuire uno strato sottile su tutta la superficie da esaminare.

Il tempo di asciugatura può essere ridotto usando aria calda, a condizione che la temperatura in superficie del pezzo non si innalzi al di sopra di 125°F (52°C). Non è ammesso asciugare strofinando.

b) Applicazione del rivelatore non-acquoso.

Il rivelatore non acquoso può essere applicato soltanto su superficie asciutta.

Esso dovrà essere applicato a spruzzo, a meno che ciò non sia impedito da motivi di sicurezza o di ristrettezza di accesso.

In queste situazioni il rivelatore può essere applicato con pennello.

L'asciugatura sarà ottenuta per evaporazione naturale

Il tempo di sviluppo per l'interpretazione finale ha inizio immediatamente dopo l'applicazione di un rivelatore a secco o subito dopo che lo strato di un rivelatore umido è asciugato.

5.6. *Developer application*

The developer shall be applied as soon as possible after penetrant removal; the time interval shall not exceed that established in the specific procedure. Insufficient coating thickness may not draw the penetrant out of discontinuities; conversely, excessive coating thickness may mask indications.

With color contrast penetrants, only a wet developer shall be used. With fluorescent penetrants, a wet or dry developer may be used.

Dry developer:

Dry developer shall be applied only to a dry surface by a soft brush, hand powder bulb, powder gun, or other means, provided the powder is dusted evenly over the entire surface being examined.

Wet developer:

Prior to applying suspension type wet developer to the surface, the developer must be thoroughly agitated to ensure adequate dispersion of suspended particles.

a) Aqueous Developer Application.

Aqueous developer may be applied to either a wet or dry surface.

It shall be applied by dipping, brushing, spraying, or other means, provided a thin coating is obtained over the entire surface being examined. Drying time may be decreased by using warm air, provided the surface temperature of the part is not raised above 125°F (52°C). Blotting is not permitted.

b) Nonaqueous Developer Application.

Nonaqueous developer shall be applied only to a dry surface. It shall be applied by spraying, except where safety or restricted access preclude it. Under such conditions, developer may be applied by brushing. Drying shall be by normal evaporation.

Developing time for final interpretation begins immediately after the application of a dry developer or as soon as a wet developer coating is dry.

5.7.Interpretazione

L'interpretazione finale dovrà essere effettuata fra 10 e 60 minuti dopo che sono soddisfatte le prescrizioni del punto 5.6.

Se la fuoriuscita del penetrante non altera i risultati dell'esame, sono ammessi anche periodi di tempo più lunghi.

Se la superficie da esaminare è troppo larga per consentire l'esame entro i tempi prescritti, essa sarà esaminata in porzioni successive.

I tipi di discontinuità sono difficili da valutare se il penetrante si diffonde troppo nel rivelatore. Se ciò accade, una attenta osservazione della formazione delle indicazioni durante l'applicazione del rivelatore può essere d'aiuto per caratterizzare e determinare l'estensione delle indicazioni

Penetranti a contrasto di colore:

Con un penetrante a contrasto di colore il rilevatore forma uno strato bianco ragionevolmente uniforme. Le discontinuità in superficie sono indicate dalla fuoriuscita del penetrante che di solito ha un colore rosso intenso che macchia il rivelatore.

Indicazioni che hanno un colore rosa tenue possono indicare eccessiva asportazione. Una insufficiente asportazione può lasciare un eccessivo sottofondo che rende difficile l'interpretazione.

È necessaria una illuminazione adeguata (>1000 lux) per assicurare una adeguata sensibilità durante l'esame e la valutazione delle indicazioni.

Penetranti fluorescenti

Con penetranti fluorescenti il procedimento è sostanzialmente uguale a quello del precedente Par. 5.7., con la sola differenza che l'esame è effettuato usando una lampada a luce ultravioletta, detta "A LUCE NERA"

a) Dovrà essere eseguito in una zona oscurata (< 32 lux).

b) L'operatore dovrà entrare nella zona oscurata almeno 5 minuti prima di effettuare l'esame, per abituare il suo occhio alla vista in ombra. Se l'operatore indossa lenti o occhiali, questi non dovranno essere fotosensibili.

c) La lampada a luce nera dovrà essere accesa almeno 10 minuti prima di usarla o di misurare l'intensità della luce ultravioletta emessa.

d) L'intensità della luce ultravioletta verrà misurata con un misuratore adatto. È richiesto un minimo di 1000 $\mu W/cm^2$ sulla superficie del pezzo da esaminare. L'intensità della luce nera dovrà essere misurata almeno una volta ogni 8 ore e ogni qualvolta viene cambiata la postazione di lavoro.

5.7.<u>Interpretation</u>

Final interpretation shall be made within 10 to 60 minutes after the requirements of Para. 5.6. are satisfied.

If bleed out does not alter the examination results, longer periods are permitted

If the surface to be examined is large enough to preclude complete examination within the prescribed time, the examination shall be perfomed in increments.

The type of discontinuities are difficult to evaluate if the penetrant diffuses excessively into the developer. If this condition occurs, close observations during application of the developer may assist in characterizing and determining the extent of the indications.

Color contrast penetrant.

With a color contrast penetrant, the developer forms a reasonably uniform white coating. Surface discontinuities are indicated by bleed-out of the penetrant which is normally a deep red color that stains the developer.

Indications with a light pink color may indicate excessive cleaning. Inadequate cleaning may leave an excessive background making interpretation difficult. Adequate illumination (>1000 lux) is required to ensure adequate sensitivity during the examination and evaluation of indications.

Fluorescent penetrants.

With fluorescent penetrants, the process is essentially the same as in Para 5.7. with the exception that the examination is performed using an ultraviolet light, called black light.

The examination shall be performed as follows:

a) It shall be performed in a darkened area (< 32 lux).

b) The examiner shall be in the darkened area for at least 5 min. prior to performing the examination to enable his eyes to adapt to dark viewing. If the examiner wears glasses or lenses, they shall not be photosensitive.

c) The black light shall be allowed to warm up for a minimum of 10 min. prior to use or measurement of the intensity of the ultraviolet light emitted.

d) The black light intensity shall be measured with a black light meter. A minimum of 1000 $\mu W/cm^2$ on the surface of the part being examined shall be required. The black light intensity shall be measured at least once every 8 hr, and whenever the work station is changed.

6. VALUTAZIONE DELLE INDICAZIONI

a) Tutte le indicazioni saranno valutate in termini di criteri di accettazione secondo la Procedura Specifica.

Soltanto indicazioni che hanno la loro dimensione maggiore più grande di 1/16" (1,6 mm) saranno considerate rilevanti.

Si dice lineare una indicazione che ha la lunghezza maggiore del triplo della larghezza.

Si dice tondeggiante una indicazione di forma circolare o ellittica con lunghezza uguale o inferiore al triplo della larghezza.

Tutte le indicazioni dubbie o incerte devono essere nuovamente esaminate per determinare se sono rilevanti o no.

b) Le discontinuità in superficie sono indicate dalla fuoriuscita del penetrante; comunque irregolarità localizzate della superficie dovute ad incisioni di lavorazione meccanica o altre condizioni superficiali possono produrre false indicazioni.

c) Ampie zone di fluorescenza o di pigmentazione che potrebbero mascherare indicazioni di discontinuità sono inaccettabili e tali zone dovranno essere pulite e riesaminate.

6. EVALUATION OF INDICATIONS

a) All indications shall be evaluated in terms of the acceptance criteria as per Specific Procedure.

Only indications which have any dimension greater than 1/16" (1,6 mm) shall be considered relevant.

A linear indication is one having a length greater than three times the width.

A rounded indication is one of circular or elliptical shape with a length equal to or less than three times its width.

All doubtful indications shall be re-examined to establish if they are relevant or not.

b) Discontinuities at the surface will be indicated by bleed-out of penetrant; however, localized surface irregularities due to machining marks or other surface conditions may produce false indications.

c) Broad areas of fluorescence or pigmentation which could mask indications of discontinuities are unacceptable, and such areas shall be cleaned and re-examined

7. CRITERI DI ACCETTAZIONE

I criteri di accettazione saranno stabiliti nella Procedura Specifica della commessa.

Quando tali criteri non sono specificati in un codice verranno adottati i seguenti (che sono in accordo al Codice ASME Sezione VIII, Div. 1, Appendice 8; al Codice ASME Sezione VIII, Div. 2 Art. 9-2 e al Codice ASME Sezione VIII, Div. 3 Art. KE-2):

a) Non sarà accettabile alcuna indicazione lineare rilevante, come definita nel punto 6 (a).

b) Non saranno accettabili indicazioni rotondeggianti > 1/8" (3,2 mm).

c) Indicazioni rotondeggianti se presenti in numero di 4 o più, allineate o raggruppate, distanti 1/16" (1,6 mm) o meno (da bordo a bordo) non saranno accettate.

d) Dieci o più indicazioni rotondeggianti in 6" sq. (3871 mm^2) di area la cui dimensione maggiore non è superiore a 6" (152,4 mm) con le dimensioni rilevate nella direzione meno favorevole in relazione alle indicazioni da valutare non saranno accettate.

7. ACCEPTANCE CRITERIA

The acceptance criteria shall be established in the Specific Procedure.

When the criteria are not specified in a Code the following one (in accordance with ASME Code Sect. VIII Div. 1, Appendix 8; ASME Code Sect. VIII Div. 2 Art. 9-2 and ASME Code Sect. VIII Div. 3 Art. KE-2), shall be adopted:

a) *No relevant linear indication as defined in 6a), shall be accepted.*

b) *No relevant rounded indication greater than 1/8" (3,2 mm), shall be accepted.*

c) *No rounded indications if present in number of four or more in a line, separated by 1/16" (1,6 mm) or less, edge-to edge, shall be accepted.*

d) *No rounded indications if present in number of ten or more in any 6 sq in. of area whose major dimension is no more than 6 in., with the dimensions taken in the most unfavourable location relative to the indications being evaluated.*

8. PRESCRIZIONI PER LA RIPARAZIONE

Imperfezioni non accettabili dovranno essere riparate e dovrà essere effettuato un nuovo esame per assicurarsi dell'eliminazione o della riduzione a dimensioni accettabili.

Ogni volta che un'imperfezione viene riparata mediante molatura senza che sia necessaria una successiva saldatura, la zona scavata verrà raccordata con la superficie circostante in modo da evitare intagli, fessure o spigoli vivi.

Quando è richiesta saldatura dopo la rimozione di una imperfezione, la zona dovrà essere pulita e la saldatura verrà effettuata secondo un procedimento di saldatura qualificato.

a) <u>Trattamento di indicazioni considerate non rilevanti</u>.

Ogni indicazione che è ritenuta non rilevante dovrà essere considerata come una imperfezione a meno che si possa dimostrare, con un riesame con lo stesso metodo e/o con un condizionamento della superficie, che nessuna imperfezione inaccettabile è presente.

b) <u>Esame di zone dalle quali sono stati asportati difetti</u>.

Dopo che si ritiene di aver eliminato il difetto e prima di effettuare riparazioni con saldatura, la zona dovrà essere esaminata con metodi adeguati per assicurarsi che il difetto sia stato effettivamente asportato o ridotto a imperfezione di dimensioni accettabili.

c) <u>Riesame di zone riparate</u>.

Dopo che sono state effettuate le riparazioni, la zona riparata sarà raccordata con la superficie circostante in modo da evitare intagli, fessure e spigoli vivi, e verrà riesaminata col metodo dei liquidi penetranti e con tutti gli altri metodi di esame che erano originariamente richiesti per la zona interessata, con l'eccezione che, quando la profondità della riparazione è inferiore alla sensibilità radiografica richiesta, può essere evitato il riesame radiografico.

8. REPAIR REQUIREMENTS

The defect shall be removed or reduced to an imperfection of acceptable size and a new examination will be performed. Whenever an imperfection is removed by chipping or grinding and subsequent repair by welding is not required, the excavated area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners. Where welding is required after removal of an imperfection, the area shall be cleaned and welding performed in accordance with a qualified welding procedure.

a) Treatment of indications believed non relevant.

Any indication which is believed to be non relevant shall be regarded as an imperfection unless it is shown by re-examination by the same method or by the use of other non destructive methods and/or by surface conditioning that no unacceptable imperfection is present.

b) Examination of areas from which imperfections have been removed.

After a defect is thought to have been removed and prior to making weld repairs, the area shall be examined by suitable methods to ensure it has been removed or reduced to an acceptably sized imperfection.

c) Re-examination of repair areas.

After repairs have been made, the repaired area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners and re-examined by the liquid penetrant method and by all other methods of examination that were originally required for the affected area, except that, when the depth of repairs is less than the radiographic sensitivity required, re-examination by radiography may be omitted.

9. PULIZIA DOPO L'ESAME

Dopo l'esame i pezzi verranno puliti secondo quanto indicato nella Procedura Specifica.

9. POST-EXAMINATION CLEANING

After examination, the part shall be cleaned as required in the Specific Procedure.

10. CERTIFICATO D'ESAME

Dovrà essere compilato un certificato di esame che dovrà comprendere come minimo le informazioni seguenti:

a) i materiali, la forma o le dimensioni dei pezzi da esaminare e l'estensione dell'esame;

b) il tipo (designazione con numeri e lettere se disponibili) di ciascun penetrante, asportatore del penetrante, rivelatore;

c) i dettagli operativi per la pulizia pre-esame e per l'asciugatura, inclusi i materiali usati per la pulizia ed il tempo minimo richiesto per l'asciugatura;

d) i dettagli operativi per applicare il penetrante, il tempo in cui il penetrante è rimasto sulla superficie (tempo di permanenza) e la temperatura della superficie e del penetrante durante l'esame se è al di fuori dell'intervallo fra 50°F e 125°F (fra 10°C e 52°C);

e) i dettagli operativi per l'asportazione dell'eccesso di penetrante dalla superficie e per l'asciugatura della superficie prima di applicare il rivelatore;

f) i dettagli operativi per l'applicazione del rivelatore e per il periodo di tempo di sviluppo prima dell'interpretazione;

g) i dettagli operativi per la pulizia dopo l'esame, se richiesta;

h) il nominativo e il livello di qualifica dell'operatore e del responsabile dell'esame;

i) i risultati dell'esame.

10. EXAMINATION REPORT

After completion, an examination report containing at least the following information, shall be prepared:

a) the materials, shapes, or sizes of the parts examined and the extent of the examination;

b) type (number or letter designation) of each penetrant, remover and developer;

c) processing details for pre-examination cleaning and drying, including the cleaning materials used and the time allowed for drying;

d) processing details for applying the penetrant, the time that the penetrant remained on the surface and the temperature of the surface and penetrant during the examination if outside 50°F to 125°F (10°C to 52°C) range;

e) processing details for removing excess penetrant and for drying the surface before applying the developer;

f) processing details for applying the developer and length of developing before interpretation;

g) processing details for post-examination cleaning, if require;.

h) name and qualification levels of the examiner and of the responsible of the examination;

h) result of the examination.

11. QUALIFICA DEL PERSONALE ①

Il personale che effettua l'esame con liquidi penetranti a fronte della presente procedura dovrà essere qualificato e certificato in accordo alla norma EN 473.

La valutazione del controllo con liquidi penetranti sarà eseguita da un operatore certificato al II livello.

11. QUALIFICATION OF PERSONNEL ①

The personnel performing the liquid penetrant examination according to this procedure shall be qualified and certified in accordance with EN 473.

Results of PT testing should be interpreted by a level II.

12. PROCEDURA PER LE TEMPERATURE FUORI STANDARD

Quando non è possibile effettuare un esame con liquidi penetranti entro il campo di temperatura fra 50°F (10°C) e 125°F (52°C) la procedura d'esame nel campo di temperatura proposto, più alto o più basso, richiede una qualifica. La procedura dovrà essere qualificata in accordo alla Appendice III, Articolo 6, Del Codice ASME Sezione V ultima edizione.

12. PROCEDURE FOR NONSTANDARD TEMPERATURE

When it is not practical to conduct a liquid penetrant examination within the temperature range of 50°F (10°C) to 125°F (52°C), the examination procedure at the proposed lower or higher temperature range requires qualification. The procedure shall be qualified in accordance with Appendix III, Article 6, ASME Code Section V latest edition.

Nuovo Pignone MASSA	CLIENTE – CUSTOMER **CONOCO PHILLIPS** ①
	LOCALITA' - PLANT LOCATION **WILHELMSHAVEN, GERMANY**
COMMESSA - JOB **3100274÷3100279**	IMPIANTO - PLANT **WRG-DEEP CONVERSION PROJECT** ①

TITOLO - TITLE

A PROCEED
AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER
NAME:
07 AUG. 2006
FLUOR B.V.

MAGNETIC PARTICLE EXAMINATION

A PROCEED
FLUOR
DATE: 10-7-'06
WELDING-ENGINEER
AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

Lloyd's Register EMEA
REVIEWED/~~WITNESSED~~
G.L. Frolla 4/1/07
Viareggio Office
Lloyd's Register

P05-0015 REV1

REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
1	Revised where indicated ①	Zappavigna	Chiappini	Zappavigna	19.05.06
0	Emissione - Issue	Zappavigna	Chiappini	Zappavigna	30.01.06

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①

N. SOU0116553/4

LINGUA-LANG. AI

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SOSTITUISCE IL - REPLACES

SOSTITUITO DA - REPLACED BY

Nuovo Pignone
MASSA

MAGNETIC PARTICLE EXAMINATION

CUSTOMER	CONOCO PHILLIPS ①
JOB	3100274, 3100275, 3100276, 3100277, 3100278, 3100279
ITEM	D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①
MATERIALS	**SHELL:** ASME SA 336 F22V **HEADS:** ASME SA 542 Gr.D Cl.4a **NOZZLES and PIPE NECKS:** ASME SA 182 F22V **SPOOLS:** ASME SA 182 F22V **WELD OVERLAY:** S.S. TP 347 **SKIRT:** ASME SA 387 Gr.22 Cl.2 / SA 516 Gr.70
DOCUMENTS	UOP Specification 3-17-3 NP Fabrication and Inspection Plan. SOU0110203/4 NP GENERAL DRAWINGS SUO 0269055 ÷SUO 0269060 GENERAL PROCEDURE (from page 5/26)
PART TO BE EXAMINED	BEVELS BACK GOUGED AREA (cold surfaces) SHELL and HEADS: CIRCUMFERENTIAL and LONGITUDINAL JOINTS NOZZLES TO SHELL AND TO HEADS SKIRT: ALL WELDED JOINTS TEMPORARY ATTACHMENT WELDS AREAS WHERE TEMPORARY ATTACHMENTS HAVE BEEN REMOVED
EXTENT OF THE EXAMINATION	100 %
SURFACE TEMPERATURE	< 40 °C
TECHNIQUES	ELECTROMAGNETIC YOKE Alternating Current
SURFACE PREPARATION	<u>BY GRINDING</u>: BEVELS SHELL AND HEADS WELDED JOINTS AREAS WHERE TEMPORARY ATTACHMENTS HAVE BEEN REMOVED <u>AS WELDED</u>: WELDS ON SKIRT TEMPORARY ATTACHMENTS
CLEANING	BRUSHING
TEST METHOD	WET FLUORESCENT PARTICLES

REV.	DESCRIZIONE - DESCRIPTION	
		ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①
1	Revised where indicated ①	N. SOU0116553/4
0	Emissione - Issue	LINGUA-LANG. AI — PAGINA-SHEET 2 / 3

SOSTITUISCE IL - REPLACES | PARI NUMERO
SOSTITUITO DA - REPLACED BY

MAGNETIZATION	**EQUIPMENT TYPE:** MINI SAMBA YOKE **CURRENTS TYPE :** ALTERNATING CURRENT
TYPE OF PARTICLES	K31-73 **BRAND:** CGM **COLOR:** FLUORESCENT GREEN
EXCESS PARTICLE REMOVAL	WITH A LIGHT AIR STREAM
ILLUMINATION	< 20 lux (DARKNED AREA)
DEMAGNETIZATION	NOT REQUIRED
PERSONNEL	PERSONNEL CONDUCTING EXAMINATION SHALL BE QUALIFIED AT LEAST AT LEVEL II ACCORDING TO EN 473
ACCEPTANCE CRITERIA ①	All surfaces to be examined shall be free of: (a) relevant linear indications; (b) relevant rounded indications greater than 5 mm; (c) four or more relevant rounded indications in a line separated by 1,5 mm or less, edge to edge (according to ASME VIII Div. 2 Appendix 9 Article 9-1)
ATTACHMENT	EXAMPLE OF MAGNETIC PARTICLE TEST REPORT

Nuovo Pignone
MASSA

MAGNETIC PARTICLE EXAMINATION

Nuovo Pignone
MASSA

CERTIFICATO di ESAME MAGNETOSCOPICO
MAGNETIC PARTICLE TEST REPORT

Nr. : MTxxx-yy
Page / Pag. : 1/1

Purchaser / Cliente : ______ Order / Ordine N° ______

Shop Job / Commessa : ______ Item / Sigla : ______ Serial N° / N° Fabbr. : ______ Dwg N° / Disegno N° : ______

Inspecting Authority / Ente di Collaudo : ______ Inspecting Plan / Piano di Collaudo N° : ______ Stage / Fase N° : ______

Specific Item Data / Dati Specifici del Prodotto	Specific Procedure / Specifica di Controllo	Tested Particular / Particolare Controllato	Material / Materiale	Extent Test / Esten. Contr.
	Details of the Test / Descrizione dell' esame			

Magnetization Method / Metodo di Magnetizzazione	Prods / PUNTALI ☐	Equipment Type / Tipo apparecchio	Current / Corrente: ☐ HWDC Continua ☐ A C Alternata	Intensity / Intensità	Prod spacing / Distanza poli
	Yoke / GIOGO ☐	Equipment Type / Tipo apparecchio: SILVER YOKE ☐ N° 6911 ☐ N° 6910	Current / Corrente: ☐ HWDC Continua ☐ A C Alternata	Tensione / Tension	Prod spacing / Distanza poli

Inspection Medium / Mezzo di Ispezione	Fluorescent / FLUORESCENTE ☐	Color Powder / Colore Polvere: ☐ Green Verde ☐ Yellow Giallo	Suspension / Sospensione: ☐ Water Acqua ☐ Oil Olio	Brand / Marca	Type / Tipo
	Wet / UMIDO ☐	Color Powder / Colore Polvere: ☐ Black Nero ☐ Red Rosso	Suspension / Sospensione: ☐ Water Acqua ☐ Oil Olio	Brand / Marca	Type / Tipo
	Dry / SECCO ☐	Color Powder / Colore Polvere: ☐ Gray Grigio ☐ Yellow Giallo	☐ Red Rosso ☐ Bleu Blu	Brand / Marca	Type / Tipo

Technical Test Conditions / Condizioni di Controllo

Surface Conditions / Stato delle Superfici: ☐ Lavorato di Macchina / Machined ☐ Molato / Ground ☐ Come Saldato / As Welded

Demagnetization / Smagnetizzazione ______

Test Carried Out / Esame Effettuato: ☐ Prima / Before ☐ Dopo / After

☐ Saldatura / Welding ☐ T.T. / P.W.H.T. ☐ T.T. Loc. / Loc. P.W.H.T. ☐ Prova Idraulica / Hydrotest

Test Results / Risultati d' Esame

☐ No indications to be recorded / Nessuna indicazione da registrare ☐ Recorded Indications / Indicazioni Registrate — See page / Vedi pag. ______

Result Conforming to the Specified Requirements / RISULTATI CONFORMI AI REQUISITI DI SPECIFICA ☐ Yes Si ☐ No No

☐ ASME VIII Div.1 App.6
☐ ASME VIII Div.2 Art.9-1
☐ ASME VIII Div.3 Par. KE334

Examiner / Operatore ______ Level II / Livello II — Q.C. Department Level II / Controllo Qualità Livello II ______

Massa li ______ Inspectors / Ispettori ______

REV.	DESCRIZIONE - DESCRIPTION	
		ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①
1	Revised where indicated ①	N. SOU0116553/4
0	Emissione - Issue	LINGUA-LANG. AI — PAGINA-SHEET 4 / 5

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SOSTITUITO DA - REPLACED BY

Titolo (Title)

PROCEDURA GENERALE:

CONTROLLO CON PARTICELLE MAGNETICHE CON PUNTALI O GIOGO

GENERAL PROCEDURE:

MAGNETIC PARTICLE EXAMINATION WITH PROD O YOKE TECHNIQUE

		ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①
1	Revised where indicated ①	N. SOU0116553/4
0	Emissione - Issue	LINGUA-LANG. AI / PAGINA-SHEET 5 / 6
REV.	DESCRIZIONE - DESCRIPTION	

SOSTITUISCE IL - REPLACES PARI NUMERO
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2. DOCUMENTI DI RIFERIMENTO.
3. SCOPO E APPLICABILITÀ.
4. PROCEDURA SPECIFICA.
5. TECNICHE.
6. PREPARAZIONE DELLE SUPERFICI.
7. MEZZI DI ESAME.
8. SMAGNETIZZAZIONE.
9. APPARECCHIATURE.
10. TARATURA DELLE APPARECCHIATURE.
11. PERSONALE.
12. VALUTAZIONE DELLE INDICAZIONI.
13. CRITERI DI ACCETTAZIONE.
14. PRESCRIZIONI PER LA RIPARAZIONE.
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ALLEGATO A: SEQUENZA OPERATIVA

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4. SPECIFIC PROCEDURE.
5. TECHNIQUE.
6. SURFACE PREPARATION.
7. EXAMINATION MEDIUM.
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13. ACCEPTANCE CRITERIA.
14. REPAIR REQUIREMENTS.
15. POST EXAMINATION CLEANING.

ANNEXE A: EXAMINATION SEQUENCE

1. GENERALITÀ.

Il metodo di esame con particelle magnetiche in accordo alla presente procedura verrà effettuato su parti o componenti a pressione o su recipienti completati quando tale esame è richiesto dalla sezione applicabile del Codice ASME o dal Contratto.

Questo metodo si applica per la ricerca di discontinuità sulla superficie, o in prossimità di essa, di materiali ferromagnetici, senza limitazioni di forma e dimensione.

1. GENERAL.

The magnetic particle examination method according to this procedure shall be carried out on parts or components of vessels when this examination is required by the referencing ASME Code Section or in the contract.

This method is applicable for detecting of discontinuities on or near the surface of ferromagnetic materials, without limitation in shape and dimensions.

2. DOCUMENTI DI RIFERIMENTO ①

Questa procedura è in accordo a:

- Codice ASME, Sezione V, Articolo 7- ultima edizione.
- Codice ASME, Sezione VIII Div. 2, Appendice 9, Articolo 9-1 - ultima edizione.

2. REFERENCE DOCUMENTS. ①

This procedure is in accordance with:

- *ASME Code Sect. V, Article 7 - latest edition and addenda.*
- *ASME Code Sect. VIII Div. 2, Appendix 9, Article 9-1 - latest edition and addenda.*

3. SCOPO E APPLICABILITÀ.

Lo scopo di questa procedura è quello di descrivere i metodi e le tecniche da usare per l'esame con particelle magnetiche e di fornire linee guida per la valutazione e l'interpretazione delle indicazioni rilevate.

Questa procedura si applica a giunti saldati, a preparazione di lembi da saldare, a superfici "come-fuso", "come-laminato", "come-forgiato" di materiali ferromagnetici, quando è richiesto l'esame con particelle magnetiche.

3. SCOPE AND APPLICATION.

The scope of this procedure is to describe the methods and the technique to be used in the magnetic particle examination and to provide guides for the evaluation and interpretation of the detected indications.

This procedure shall be applicable to welded joints, edge preparations for welding, as cast surfaces, as rolled surfaces, as forged surfaces of ferromagnetic materials, when the magnetic particle examination is required.

4. PROCEDURA SPECIFICA.

L'esame con polveri magnetiche sarà effettuato in accordo ad una procedura specifica che deve:

- fare riferimento alla presente procedura;
- essere specifica per il corrispondente tipo di applicazione;
- fornire almeno le informazioni seguenti considerate "variabili essenziali":
    a) tecnica di magnetizzazione;
    b) tipo di corrente di magnetizzazione;
    c) preparazione superficiale;
    d) tipo di particelle ferromagnetiche utilizzate (visibili o fluorescenti, colere, dimensioni, asciutte o in sospensione);
    e) metodo di applicazione delle particelle
    f) metodo di rimozione dell'eccesso di particelle;
    g) minima intensità di luce;
    h) spessore del rivestimento
    i) criteri di accettazione.
- e le seguenti informazioni considerate "variabili non essenziali"
    a) forma o dimensioni dell'oggetto da controllare

b) tipo di apparecchiatura
c) temperatura della superficie
d) tecnica di smagnetizzazione
e) tecnica di pulizia dopo l'esame
f) qualifica del personale

4. SPECIFIC PROCEDURE.

The magnetic particle examination shall be performed in accordance with a procedure that shall:

- *make reference to this procedure;*
- *be specific for the pertinent job;*
- *include at least the following information considered "essential variable":*
  - *a) magnetizing technique;*
  - *b) magnetizing current type;*
  - *c) surface preparation;*
  - *d) magnetic particle (fluorescent/visible, color, particle size, wet/dry)*
  - *e) method of particle application;*
  - *f) method of excess particle removal;*
  - *g) minimum light intensity;*
  - *h) coating thickness*
  - *i) acceptance criteria.*
- *and include at least the following information considered "nonessential variable"*
  - *a) shape or size of the examination object*
  - *b) equipment type*
  - *c) temperature*
  - *d) demagnetizing technique*
  - *e) post examination cleaning technique*
  - *f) personnel qualification requirements*

5. TECNICHE.

Per la magnetizzazione saranno utilizzati i puntali o il giogo.

L'esame sarà fatto con il metodo continuo cioè la corrente magnetizzante dovrà rimanere applicata mentre si applica il mezzo di esame e se ne asporta l'eccesso. Le particelle ferromagnetiche da usare saranno umide o asciutte, fluorescenti o non fluorescenti. In ogni area devono essere effettuati almeno due esami.

Durante il secondo esame le linee di flusso magnetico saranno approssimativamente perpendicolari a quelle del primo esame (vedi allegato A)

Nel secondo esame può essere usata una tecnica di magnetizzazione differente.

Tutti gli esami saranno effettuati con sovrapposizione sufficiente ad assicurare una copertura del 100% con la sensibilità richiesta.

5. TECHNIQUES.

For the magnetization, prod or yoke shall be used.

The examination shall be done by the continuous method, that is the magnetizing current remains on while the examination medium is being applied and while the excess of the examination medium is being removed.

The ferromagnetic particles used shall be either wet or dry, fluorescent or nonfluorescent.

At least two separate examinations shall be performed on each area.

During the second examination, the lines of magnetic flux shall be approximately perpendicular to those used during the first examination (see attachment A)

A different technique for magnetization may be used for the second examination.

All examinations shall be conducted with sufficient overlap to assure 100% coverage at the required sensitivity.

5.1. Tecnica con puntali.

Procedura di magnetizzazione.

Per la tecnica con puntali la magnetizzazione viene effettuata con contatti elettrici mobili del tipo a puntali messi a contatto contro la superficie nella zona da esaminare.

Per evitare scintillature d'arco, un pulsante per il controllo a distanza provvisto nelle maniglie dei puntali permette di far passare corrente dopo che i puntali sono stati adeguatamente posizionati e di interromperla prima che essi siano allontanati dalla superficie.

Corrente magnetizzante.

Verrà usata una corrente magnetizzante raddrizzata, trifase (raddrizzata ad onda intera) o monofase (raddrizzata a semionda).

L'amperaggio della corrente trifase sarà verificato misurando la corrente media, mentre l'amperaggio della corrente monofase sarà verificato misurando la corrente media durante l'effettuazione del semiciclo soltanto.

La corrente deve essere fra 100 Amp (minima) e 125 Amp (massima) per ogni pollice di spaziatura dei puntali, per spessori di 3/4" (19 mm) e superiori. Per spessori inferiore ai 3/4" (19 mm), la corrente sarà fra 90 Amp e 110 Amp per ogni pollice di spaziatura dei puntali.

Spaziatura dei puntali.

La spaziatura dei puntali non deve superare 8" (200 mm). Possono essere usate spaziature più piccole per adattarsi alle limitazioni geometriche della zona da esaminare, ma una spaziatura dei puntali inferiore a 3" (76 mm) non è di solito praticata a causa del raggruppamento delle particelle intorno ai puntali.

Le estremità dei puntali devono essere mantenute pulite.

Se il voltaggio a circuito aperto della sorgente di corrente magnetizzante è superiore a 25V, si raccomandano estremità dei puntali in piombo, acciaio o alluminio, piuttosto che in rame, per evitare depositi di rame sul pezzo da esaminare

5.1. Prod Technique.

Magnetic procedure.

For the prod technique, magnetization is accomplished by portable prod type electrical contacts pressed against the surface in the area to be examined.

To avoid arcing, a remote control switch, which may be built into the prod handles, shall be provided to permit the current to be turned on after the prods have been properly positioned and to be turned off before they are removed.

Magnetic current.

Rectified magnetizing current, either three-phase (full-wave rectified), or single-phase (half-wave rectified), shall be used.

The three-phase amperage shall be verified by measuring the average current, while the single-phase amperage shall be verified by measuring the average current during the conducting half cycle only.

The current shall be 100 Amp/in (minimum) to 125 Amp/in (maximum) of prod spacing for thickness 3/4" (19 mm) or greater.

For thickness less than 3/4" (19 mm), the current shall be 90 Amp/in to 110 Amp/in of prod spacing.

Prod Spacing.

Prod spacing shall not exceed 8" (200 mm).

Shorter spacing may be used to accomodate the geometric limitations of the area to be examined, but prod spacing of less than 3" (76 mm) are usually not practical due to banding of the particles around the prods.

The prod tips shall be kept clean.

If the open circuit voltage of the magnetizing current source is greater than 25 V, lead, steel or aluminum tipped prods are recommended Copper tipped prods are not to be used to avoid copper deposits on the part being examined.

5.2. Tecnica con giogo.

Questa tecnica deve essere applicata per rilevare soltanto discontinuità aperte in superficie.

Verrà usato un giogo elettromagnetico azionato da corrente continua o alternata. La forza magnetizzante del giogo dovrà essere verificata come richiesto al Par.10 della presente procedura.

Nel caso in cui l'esame sia eseguito su materiale ferritico rivestito da materiale non magnetico, le tecnica deve essere qualificata in accordo alle prescrizioni dell'Appendice I, Articolo 7, del codice ASME Sezione V..

5.2. Yoke Technique.

This method shall only be applied to detect discontinuities that are open to the surface of the part. Electromagnetic yokes operated by alternating or direct current, shall be used. The magnetizing force of yokes shall be checked as required in the following para. 10 of this procedure.

When magnetic particle examination is performed on ferritic materials coated with non magnetic coatings, the method shall be qualified in accordance with Appendix I, Article 7, ASME code Section V.

6. PREPARAZIONE DELLE SUPERFICI.

Risultati soddisfacenti si ottengono normalmente quando le superfici sono in condizioni "come saldata", "come laminata", "come fusa" o "come forgiata", tuttavia può essere necessario preparare le superfici con molatura o con lavorazione meccanica quando le irregolarità superficiali potrebbero mascherare indicazioni causate da discontinuità. Prima dell'esame con particelle magnetiche, la superficie da esaminare e tutte le zone adiacenti per una fascia di almeno 1" (25 mm), dovranno essere asciutte ed esenti da polvere, grasso, scorie, flusso e schizzi di saldatura, olio o altre sostanze estranee che possono interferire con l'esame.

La pulizia può essere effettuata usando detersivi, solventi organici, soluzioni svernicianti, sgrassaggio con vapore, sabbiatura o graniglatura o metodi di pulizia con ultrasuoni.

6. SURFACE PREPARATION.

Satisfactory results are normally obtained when the surfaces are in as-welded, as-rolled, as-cast or as-forged conditions, however surface preparation by grinding or machining may be necessary where surface irregularities could mask indications due to discontinuities.

Prior to magnetic particle examination, the surface to be examined and all adjacent areas within at least 1" (25 mm) shall be dry and free of all dirt, grease, lint, scale, welding flux and spatter, oil or other extraneous matter that could interfere with the examination.

Cleaning may be accomplished by detergents, organic solvents, paint removers, vapor degreasing, sand or grit blasting, or ultrasonic cleaning methods.

7. MEZZO DI ESAME.

Per l'esame con polveri magnetiche possono usarsi i seguenti tipi di particelle ferromagnetiche:

a) particelle asciutte

b) particelle in sospensione

c) particelle fluorescenti

Particelle asciutte.

Il colore scelto per le particelle dovrà fornire un contrasto adeguato con la superficie da esaminare.

L'esame con polveri magnetiche asciutte non dovrà essere effettuato se la temperatura della superficie del pezzo supera i 600°F (316°C).

L'intensità luminosa minima sulla superficie da esaminare deve essere 1000 lux.

Prescrizioni specifiche aggiuntive sull'uso delle particelle asciutte sono date nella SE-709 pratica raccomandata per l 'esame con polveri magnetiche.

Particelle in sospensione.

Il colore delle particelle dovrà fornire un contrasto adeguato con la superficie da esaminare.

La temperatura della sospensione delle particelle e della superficie del pezzo non deve superare 135°F (57°C).

L'intensità luminosa minima sulla superficie da esaminare deve essere 1000 lux.

Le particelle saranno in sospensione in un liquido adatto con la concentrazione raccomandata nella pratica standard SE-709, che contiene anche prescrizioni specifiche aggiuntive sull'uso delle particelle in sospensione.

Particelle fluorescenti.

Con le particelle fluorescenti l'esame deve essere effettuato in una postazione adeguatamente attrezzata per permettere l'uso di luce ultravioletta (luce nera).

L'esame verrà effettuato come segue:

a) sarà effettuato in una zona avente intensità luminosa < 20 lux.

b) L'esaminatore dovrà essere nella zona oscura almeno 5 minuti prima di effettuare l'esame, per adattare i suoi occhi alla visione in ambiente oscuro. Se l'esaminatore porta occhiali o lenti, essi non devono essere fotosensibili

c) La lampada a luce nera dovrà essere accesa almeno 10 minuti prima di usarla o di effettuare misure dell'intensità della luce ultravioletta emessa.

d) L'intensità della luce nera sarà misurata con un misuratore di luce nera. È richiesto sulla superficie da esaminare un minimo di 1000 $\mu W/cm^2$.
L'intensità della luce nera sarà misurata almeno ogni 8 ore e ogni qualvolta si cambia postazione di lavoro.

7. EXAMINATION MEDIUM.

For the magnetic examination the following ferromagnetic particles can be used:

a) Dry particles.
b) Wet particles.
c) Fluorescent particles.

Dry particles.

The colour of the particles shall provide adequate contrast with the surface being examined.

Dry magnetic particle examination shall not be performed if the surface temperature of the part exceeds 600°F (316°C)

A minimum light intensity of 1000 lux is required on the surface to be examined.

Additional specific requirements on the use of dry particles are given in the standard recommended practice SE-709.

Wet Particles.

The colour of the particles shall provide adequate contrast with the surface being examined.

The temperature of the wet particles suspension and the surface of the part shall not exceed 135°F (57°C).

A minimum light intensity of 1000 lux is required on the surface to be examined.

The particles shall be suspended in a suitable liquid medium in the concentration recommended in the standard practice SE-709, which contains additional specific requirements on the use of wet particles.

Fluorescent Particles.

The fluorescent particles shall be used in a properly equipped area to permit the use of an ultraviolet light (black light).

The examination shall be performed as follow:

a) it shall be performed in an area having light intensity < 20 lux.

b) The examiner shall be in the darkened area for at least 5 min. prior to performing the examination, to enable his eyes to adapt to dark viewing. If the examiner wears glasses or lenses, they shall not be photosensitive.

c) The black light shall be allowed to warm up for a minimum of 10 min. prior to use or measurement of the intensity of the ultraviolet light emitted.

d) The ultraviolet light intensity shall be measured with black light meter.

A minimum of 1000 $\mu W/cm^2$ on the surface of the part being examined shall be required.

The black light intensity shall be measured at least once every 8 hours and whenever the work station is changed.

<u>8. SMAGNETIZZAZIONE.</u>

Quando il magnetismo residuo nel pezzo può interferire con processi o impieghi successivi, il pezzo sarà smagnetizzato una volta completato l'esame.

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8. DEMAGNETIZATION.

When residual magnetism in the part could interfere with subsequent processing or usage, the part shall be demagnetized after completion of the examination.

9. APPARECCHIATURE.

L'esame con particelle magnetiche è effettuato usando due tipi di apparecchiature portatili per magnetizzare il pezzo da esaminare, cioè:

a) apparecchio a puntali

b) apparecchio a giogo elettromagnetico.

9. EQUIPMENT.

The magnetic particle examination is carried out by using two main types of portable equipment for magnetizing the part being examined.

a) Prod type-equipment.

b) Electromagnetic yoke type equipment.

10. TARATURA DELLE APPARECCHIATURE.

10.1. Apparecchio a puntali.

Frequenza.

Ciascun pezzo di un apparecchio magnetizzante provvisto di amperometro sarà tarato almeno una volta all'anno o ogni volta che l'apparecchio è stato sottoposto a riparazione elettrica importante o a danneggiamento.

Procedura.

La precisione del misuratore sull'apparecchio sarà verificata una volta all'anno mediante uno strumento riconducibile ad uno standard nazionale.

Verranno eseguite letture comparative per almeno tre valori diversi di corrente d'uscita che coprono il campo di impiego.

Le letture dello strumento sull'apparecchio non dovranno scostarsi più di ± 10% del valore di fondo scala, rispetto al valore effettivo della corrente indicato dallo strumento campione.

10. EQUIPMENT CALIBRATION.

10.1. Prod type equipment.

Frequency.

Each piece of magnetizing equipment shall be calibrated at least once a year, or whenever the equipment has been subjected to major electric repair, or damage. If the equipment has not been in use for a year or more, calibration shall be done prior to first use.

Procedure.

The accuracy of the unit's meter shall be verified annually by equipment traceable to a national standard. Comparative readings shall be taken for at least three different current output levels encompassing the usable range.

The unit's meter readings shall not deviate by more than ± 10% of full scale, relative to the actual current value as shown by the test meter.

10.2. Apparecchi a giogo.

Frequenza.

La forza magnetizzante del giogo sarà controllato almeno una volta all'anno, o ogni volta che il giogo è stato danneggiato.

Se il giogo non è stato usato per un anno o più, dovrà farsi un controllo prima del primo utilizzo.

Procedura.

Ogni giogo elettromagnetico a corrente alternata, dovrà avere una potenza di sollevamento di almeno 10 lb (4,5 Kg) alla massima distanza fra i poli che può essere impiegata in accordo al Par. T-762 del Codice ASME Sez. V.

Ogni giogo a corrente continua dovrà avere una potenza di sollevamento di almeno 40 lb (18.1) alla massima distanza fra i poli che può essere impiegata, pure in accordo a T-762 del Codice ASME Sez. V.

Ogni peso verrà pesato con una bilancia da parte di un fabbricante affidabile e verrà punzonato con il valore nominale applicabile prima del suo primo utilizzo.
Il peso deve essere verificato nuovamente soltanto se ha subito danni tali da produrre una perdita potenziale di materiale.

10.2. Yoke type equipment.

Frequency.

The magnetizing force of yoke shall be checked at least once a year, or whenever a yoke has been damaged.
If a yoke has not been in use for a year of more, a check shall be done prior to first use.

Procedure.

Each alternating current electromagnetic yoke shall have a lifting power of at least 10 lb (4,5 Kg) at the maximum pole spacing that will be used, according to T-762 of ASME Sect.V.
Each direct current yoke shall have a lifting power of at least 40 lb (18,1 Kg) at the maximum pole spacing that will be used, also according to T-762 of ASME Sect. V.
Each weight shall be weighed with a scale from a reputable manufacturer and stenciled with the applicable nominal weight prior to first use.
The weight need only be verified again if damaged in a manner that could have caused potential loss of material.

11. PERSONALE. ①

Il personale impiegato per l'esame con particelle magnetiche a fronte della presente procedura dovrà essere qualificato e certificato in accordo EN 473.
Gli operatori dovranno essere certificati come minimo al Livello II in accordo alla norma citata.

11. PERSONNEL. ①

The personnel employed for the magnetic particle examination according to EN 473, current Edition.

The examiners shall be certified as minimum as Level II, according to above norm.

12. VALUTAZIONE DELLE INDICAZIONI.

Le indicazioni saranno rivelate dalla ritenzione delle particelle magnetiche. Non tutte queste indicazioni sono necessariamente imperfezioni, comunque, poiché eccessiva rugosità superficiale, variazioni di permeabilità magnetica (come ad es. il bordo delle zone di transizione) ecc., possono produrre indicazioni simili.

Una indicazione è l'evidenza di una imperfezione meccanica. Soltanto indicazioni che hanno una qualunque dimensione più grande di 1/16" (1,6 mm) verranno considerate rilevanti.

a) Una indicazione è detta lineare quando ha la lunghezza maggiore del triplo della larghezza.

b) Una indicazione è detta rotondeggiante se è di forma circolare o ellittica con lunghezza uguale o inferiore al triplo della larghezza.

c) Tutte le indicazioni dubbie o incerte devono essere nuovamente esaminate per determinare se sono rilevanti o no.

12. EVALUATION OF INDICATIONS.

Indication will be revealed by retention of magnetic particles. All such indications are not necessarily imperfections, however, since excessive surface roughness, magnetic permeability variations (such as at the edge of heat affected zones), etc, may produce similar indications.

An indication is the evidence of a mechanical imperfection. Only indications which have any dimension greater than 1/16 in. shall be considered relevant.

a) A linear indication is one having a length greater than three times the width.

b) A rounded indication is one of circular or elliptical shape with a length equal to or less than three times its width.

c) Any questionable or doubtful indications shall be reexamined to determine whether or not they are relevant.

13. CRITERI DI ACCETTAZIONE.

I criteri di accettazione saranno definiti nella procedura specifica per ogni lavoro.

Quando i criteri non sono stati specificati in una norma verranno applicati i seguenti, che sono in accordo ad ASME Sez. VIII Div. 1,Appendice 6, ad ASME Sez. VIII Div. 2, Articolo 9-1 e ad ASME Sez. VIII Div. 3 Art. KE-2

Tutte le superfici devono essere esenti da:

a) indicazioni rilevanti lineari;

b) indicazioni rilevanti rotondeggianti più grandi di 1/8" (3,2 mm);

c) quattro o più indicazioni rilevanti allineate separate di 1/16" (1,6 mm) o meno, da bordo a bordo;

d) dieci o più indicazioni rotondeggianti in 6" sq. (3871 mm^2) di area la cui dimensione maggiore non è superiore a 6" (152,4 mm) con le dimensioni rilevate nella direzione meno favorevole in relazione alle indicazioni da valutare.

13. ACCEPTANCE CRITERIA.

The acceptance criteria shall be established in the specific procedure for each job.

When the criteria are not specified in a Code the following ones, in accordance with ASME Sect. VIII Div. 1 Appendix 6, ASME Sect. VIII Div. 2 Article 9-1 and ASME Sect. VIII Div. 3 Article KE-2, shall be applied.

All surface to be examined shall be free of:

a) relevant linear indications;

b) relevant rounded indication greater than 1/8" (3,2 mm);

c) four or more relevant rounded indications in a line separated by 1/16" (1,6 mm) or less, edge-to-edge;

d) ten or more rounded indications in any 6 sq in. of area whose major dimension is no more than 6 in., with the dimensions taken in the most unfavorable location relative to the indications being evaluated.

14. PRESCRIZIONI PER LA RIPARAZIONE.

I difetti dovranno essere asportati o ridotti ad imperfezioni di dimensione accettabile. Ogni volta che una imperfezione viene asportata mediante molatura o scalpellatura senza che sia necessaria la successiva riparazione mediante saldatura, la zona scavata verrà raccordata con la superficie circostante in modo da eliminare intagli, fessure o spigoli vivi.

Quando è richiesta la saldatura dopo la asportazione di una imperfezione, la zona dovrà essere pulita e la saldatura verrà effettuata secondo un procedimento di saldatura qualificato.

Trattamento di indicazioni considerate non rilevanti.

Ogni indicazione ritenuta non rilevante sarà considerata come una imperfezione a meno che si possa dimostrare con un riesame con lo stesso metodo o con altri metodi non distruttivi e/o con un condizionamento della superficie, che non è presente alcuna imperfezione non accettabile.

Esame delle zone dalle quali sono stati asportati difetti.

Dopo che si ritiene di aver eliminato un difetto e prima di effettuare riparazioni con saldatura, la zona dovrà essere esaminata con metodi adeguati per accertare che il difetto sia stato asportato o ridotto ad una imperfezione di dimensioni accettabili.

Riesame di zone riparate

Dopo che sono state effettuate le riparazioni, la zona riparata sarà raccordata con la superficie circostante in modo da evitare intagli, fessure e spigoli vivi, e verrà riesaminata col metodo delle particelle magnetiche e con tutti gli altri metodi di esame che erano originariamente richiesti per la zona interessata, con l'eccezione che, quando la profondità della riparazione è inferiore alla sensibilità radiografica, il riesame radiografico può essere evitato.

14. REPAIR REQUIREMENTS.

The defect shall be removed or reduced to an imperfection of acceptable size. Whenever an imperfection is removed by chipping or grinding and subsequent repair by welding is not required, the excavated area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners.

Where welding is required after removal of an imperfection, the area shall be cleaned and welding performed in accordance with a qualified welding procedure.

Treatment of indications believed nonrelevant.

Any indication which is believed to be nonrelevant shall be regarded as an imperfection unless it is shown by reexamination by the same method or by the use of other non destructive methods and/or by surface conditioning that no unacceptable imperfection is present.

Examination of areas from which imperfections have been removed.

After a defect is thought to have been removed and prior to making weld repairs, the area shall be examined by suitable methods to ensure it has been removed or reduced to an acceptably sized imperfection.

Reexamination of repair areas.

After repairs have been made, the repaired area shall be blended into the surrounding surface so as to avoid sharp notches, crevices, or corners and reexamined by the magnetic particle method and by all other methods of examination that were originally required for the affected area, except that, when the depth of repair is less than the radiographic sensitivity required, reexamination by radiography may be omitted.

15. PULIZIA DOPO ESAME.

Dopo l'esame il pezzo verrà pulito secondo quando indicato nella Procedura Specifica.

15. POST EXAMINATION CLEANING.

After examination the part shall be cleaned according to the Specific Procedure.

16. CERTIFICAZIONE

I risultati dell'esame saranno riportati in un rapporto. Il rapporto dovrà contenere almeno i seguenti dati:

- identificazione del pezzo,
- tipo di magnetizzazione,
- apparecchiatura usata,

- preparazione superficie,
- tecnica d'esame,
- tipo di particelle magnetiche e mezzo di contrasto usato,
- corrente magnetica e spaziatura dei puntali o dei poli,
- numero, tipo e dimensioni delle discontinuità riscontrate,
- procedura del controllo,
- risultato dell'esame,
- data dell'esame e nome dell'operatore,
- timbro e firma dell'Ispettore che ha presenziato.

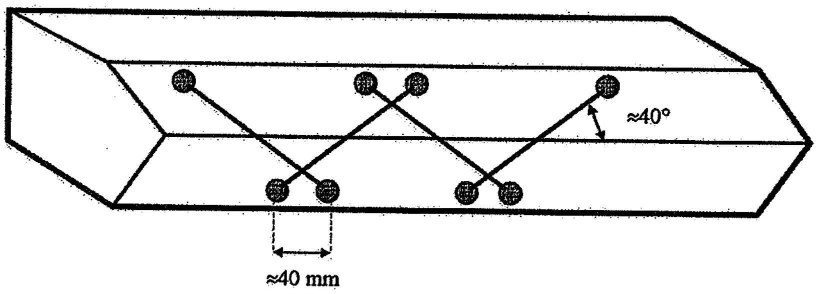
16. DOCUMENTATION

A magnetic particle examination report shall be issued, including the following data:

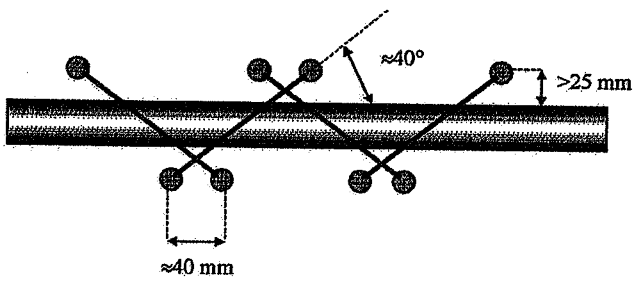
- *piece identification and examination coverage,*
- *type of magnetization,*
- *equipment used,*
- *surface preparation,*
- *technique,*
- *make and type of magnetic particles and contrast medium employed,*
- *magnetic current type and prod/pole spacing,*
- *number, type and size of the discontinuities detected,*
- *test procedure,*
- *examination results,*
- *examination date and name of the operator,*
- *stamp and sign of witnessing inspector.*

Allegato A: Sequenza operativa

Attachment A: Examination sequence



BASIC GRID PATTERN FOR EXAMINATION OF EDGES PREPARATION



BASIC GRID PATTERN FOR EXAMINATION OF WELD SEAM

Nuovo Pignone MASSA	CLIENTE – CUSTOMER CONOCO PHILLIPS
	LOCALITA' - PLANT LOCATION WILHELMSHAVEN, GERMANY
COMMESSA - JOB 3100274÷3100279	IMPIANTO - PLANT WRG-DEEP CONVERSION PROJECT

TITOLO - TITLE

ULTRASONIC EXAMINATION

A PROCEED

AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

NAME:

02 OKT. 2006

FLUOR B.V.

Lloyd's Register EMEA
REVIEWED/~~WITNESSED~~
G.L. Frolla 4/1/07
Viareggio Office
Lloyd's Register

AI

P05-0014 REV1

REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
2	Typewriting mistake	Zappavigna	Chiappini F.	Zappavigna G.	11.09.06
1	Revised where indicated ①	Zappavigna	Chiappini	Zappavigna	29.05.06
0	Emissione - Issue	Zappavigna	Chiappini	Zappavigna	30.01.06

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N. SOU0116554/4

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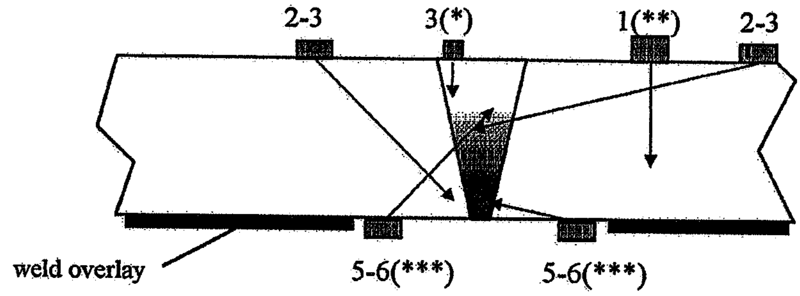
SOSTITUITO DA - REPLACED BY

Electronically approved draw. GE NuovoPignone Internal DT-'N'

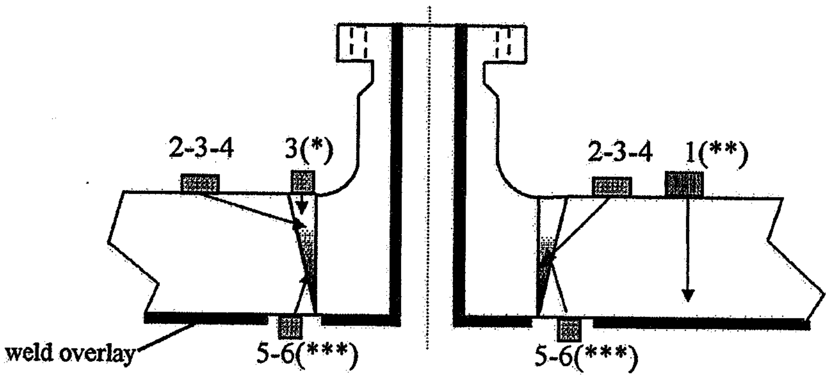
CUSTOMER	CONOCO PHILLIPS
JOB	3100274, 3100275, 3100276, 3100277, 3100278, 3100279
ITEM	D-6211, D-6231, D-6212, D-6232, D-6214, D-6234
MATERIALS	**SHELL:** ASME SA 336 F22V **HEADS:** ASME SA 542 Gr.D Cl.4a **NOZZLES and PIPE NECKS:** ASME SA 182 F22V **SPOOLS:** ASME SA 182 F22V **WELD OVERLAY:** S.S. TP 347 **SKIRT:** ASME SA 387 Gr.22 Cl.2 / SA 516 Gr.70
DOCUMENTS	UOP Specification 3-17-3 NP Fabrication and Inspection Plan. SOU0110203/4 NP GENERAL DRAWINGS SUO 0269055 ÷SUO 0269060 GENERAL PROCEDURE (from page 6/23).
THICKNESS	**SHELL**: 270 +4,2 mm; **HEADS**: 139+4,2 mm; **SKIRT**: 45 mm (items D-6211, D-6231) **SHELL**: 260 +4,2 mm; **HEADS**: 134+4,2 mm; **SKIRT**: 45 mm (items D-6212, D-6232) **SHELL**: 241 +4,2 mm; **HEADS**: 125+4,2 mm; **SKIRT**: 40 mm (items D-6214, D-6234)
PART TO BE EXAMINED	SHELL: CIRCUMFERENTIAL WELDED JOINTS. NOZZLES to BELTS and HEADS WELDED JOINTS. CIRCUMFERENTIAL WELDED JOINTS of SPOOL CIRCUMFERENTIAL and LONGITUDINAL WELDED JOINTS of SKIRT
EXTENT OF THE EXAMINATION	100 %
TESTING MACHINES	KRAUTKRAMER **TYPE:** USN52 or PANAMETRICS **TYPE:** EPOCH III
TRANSDUCERS	1. KRAUTKRAMER – B4SN – Angle 0° - Freq. 4 MHz – Size Ø 25 mm 2. KRAUTKRAMER – WB – Angle 45° - Freq. 2 MHz – Size 20 × 22 mm 3. KRAUTKRAMER – WB – Angle 70° - Freq. 2 MHz – Size 20 × 22 mm 4. KRAUTKRAMER – WB – Angle 60° - Freq. 2 MHz – Size 20 × 22 mm 5. KRAUTKRAMER – WB – Angle 45° - Freq. 4 MHz – Size 8 × 9 mm 6. KRAUTKRAMER – WB – Angle 70° - Freq. 4 MHz – Size 8 × 9 mm

METHOD OF SCANNING

BELT to BELT and to HEAD WELDED JOINT



NOZZLE to HEAD and to SHELL WELDED JOINT



Note:
(*) for trasversal flaws
(**) on base material in scanning area
(***) where accessible

REV.	DESCRIZIONE - DESCRIPTION	
		ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234
2	Typewriting mistake	
1	Revised where indicated ①	N. SOU0116554/4
0	Emissione - Issue	LINGUA-LANG. AI — PAGINA-SHEET 3 / 4

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SOSTITUITO DA - REPLACED BY

SURFACE CONDITION OF WELDED JOINTS	**FLUSH GROUND:** CIRCUMFERENTIAL WELDED JOINTS SHELL. NOZZLES to BELTS and HEADS WELDED JOINTS **AS WELDED:** CIRCUMFERENTIAL WELDED JOINTS SKIRT TO SHELL CIRCUMFERENTIAL and LONGITUDINAL WELDED JOINTS SKIRT
CONDITION OF SCANNING SURFACE	GROUND
SCANNING OVERLAP	> 10%
COUPLANT	U47 (CGM)
REFERENCE REFLECTOR	CYLINDRICAL HOLE 3 mm for T= 25 ÷ 50 mm CYLINDRICAL HOLE 5 mm for T= 50 ÷ 100 mm CYLINDRICAL HOLE 6.5 mm for T= 100 ÷ 150 mm CYLINDRICAL HOLE 8 mm for T= 150 ÷ 200 mm CYLINDRICAL HOLE 9,5 mm for T= 200 ÷ 250 mm CYLINDRICAL HOLE 11 mm for T= 250 ÷ 300 mm (On basic calibration block according ASME V Art. 4)
CALIBRATION OF THE SENSIBILITY	DAC METHOD IN ACCORDANCE ASME V Art. 4.
METHOD FOR SIZING INDICATIONS	6 dB DROP
METHOD TO CLASSIFY GEOMETRIC INDICATION	• Interpret the area containing the reflector • Plot and verify the reflector coordinates preparing a cross sectional sketch • Review fabrication or weld preparation drawing Note: Other NDE methods could be used in determining a reflector's true position, size and orientation
PERSONNEL	PERSONNEL CONDUCTING EXAMINATION SHALL BE QUALIFIED AT LEAST AT LEVEL II ACCORDING TO EN 473
INVESTIGATION LEVEL	ALL IMPERFERCTIONS THAT PRODUCE AN AMPLITUDE GREATER THAN 20% OF THE REFERENCE LEVEL SHALL BE INVESTIGATED.
ACCEPTANCE CRITERIA	ASME VIII Div. 2 App. 9 Art. 9-3 (see par. 10 of GENERAL PROCEDURE)
RECORDABLE INDICATION	ALL REFLECTIONS FROM UNCORRECTED AREAS HAVING RESPONSES THAT EXCEED 50 % OF THE REFERENCE LEVEL SHALL BE RECORDED
ATTACHMENT	EXAMPLE OF ULTRASONIC TEST REPORT

431

Nuovo Pignone
MASSA

ULTRASONIC EXAMINATION

Nuovo Pignone
MASSA

CERTIFICATO di ESAME con ULTRASUONI
ULTRASONIC TEST REPORT

Nr.: UTxxx-yy
Page / Pag.: 1/1

Purchaser / Cliente: ______ Order / Ordine N°: ______

Shop Job / Commessa: ______ Item / Sigla: ______ Serial N° / N° Fabbr.: ______ Dwg N° / Disegno N°: ______

Inspecting Authority / Ente di Collaudo: ______ Inspecting Plan / Piano di Collaudo N°: ______ Stage / Fase N°: ______

Specific Item Data / Dati Specifici del Prodotto

Specific Procedure / Specifica di Controllo	Tested Particular / Particolare Controllato	Material / Materiale	Extent Test / Esten. Contr.

Details of the Test / Descrizione dell' esame ______

Equipment / Strumentazione

Instruments Type / Tipo di Apparecchi		Sonde Usate / Used Probes					
EPOCH III PANAMETRICS	☐	Type / Tipo					
MG 15D GILARDONI	☐	Size / Misura mm					
USM 25 DAC KRAUTKRAMER: N°1754	☐	Angle / Angolo					
USN52R KRAUTKRAMER N°00DRKY	☐	Frequency / Frequenza MHz					

Technical Test Conditions / Condizioni di Controllo

Thickness / Spessori

Welding Procedure / Procedimento Saldatura: ☐ Automatic / Automatico ☐ Manual / Manuale

Coupling / Accoppiamento ______

Calibration blocks / Blocchi di Taratura

Calibration Sensitivity / Sensibilità di Calibrazione ______

Scanning Sensitivity / Sensibilità di Scansione ______

Reference Holes / Fori di Riferimento ϕ mm ______

Recording Level / Livello di Registrazione ______

Transfer Correction / Correzione di Trasferimento ☐ No / No ☐ Yes / Si dB ______

Surface Conditions / Stato delle Superfici: ☐ Lavorato di Macchina / Machined ☐ Come Saldato / As Welded ☐ Molato / Ground ☐

Scanning Surface / Superficie di Scansione: ☐ Lavorato di Macchina / Machined ☒ Molato / Ground

Test Carried Out / Esame Effettuato: ☐ Prima / Before ☐ Dopo / After

☐ Saldatura / Welding ☐ T.T. / P.W.H.T. ☐ T.T. Loc. / Loc. P.W.H.T. ☐ Prova Idraulica / Hydrotest

Test Results / Risultati d' Esame

☐ No indications to be recorded / Nessuna indicazione da registrare

☐ Recorded Indications / Indicazioni Registrate — See page / Vedi pag. ______

Result Conforming to the Specified Requirements / RISULTATI CONFORMI AI REQUISITI DI SPECIFICA ______ ☐ Yes / Si ☐ No / No

☐ ASME VIII Div.1 App.12
☐ ASME VIII Div.2 Art.9-3
☐ ASME VIII Div.3

Examiner / Operatore ______ Level II / Livello II

Q.C. Department Level II / Controllo Qualità Livello II ______

Massa li ______ Inspectors / Ispettori ______

REV.	DESCRIZIONE - DESCRIPTION
2	Typewriting mistake
1	Revised where indicated ①
0	Emissione - Issue

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234

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    PERSONNEL

APPENDICE I
APPENDIX I

1. SCOPO E APPLICABILITÀ

Questa specifica descrive la procedura da rispettare per l'esame ultrasonoro di saldature d'angolo e di testa e definisce i criteri di accettazione. Si applica a saldature di recipienti a pressione e ad altre saldature in acciai al carbonio e basso-legati.

L'esame verrà effettuato alle fasi operative precisate nel contratto.

L'esame deve essere effettuato almeno 48 ore dopo l'esecuzione del giunto saldato.

1. PURPOSE AND APPLICABILITY

This specification describes the procedure to be followed for ultrasonic examination of fillet welds and butt welds and defines acceptance criteria. It is applicable to the welds of pressure vessels and other welds in carbon steel and low-alloy steel.

The test shall be conducted in the operative steps as specified by the contract.

The test shall be conducted at least 48 hours after execution of the welded joint.

2. DOCUMENTI DI RIFERIMENTO

- ASME V, ultima edizione.
- ASME Sez. VIII Div. 1-2-3, ultima edizione.
- ASME Sez. I, ultima edizione.

2. REFERENCE DOCUMENTS

- *ASME V, latest edition and addenda.*
- *ASME VIII Div. 1-2-3, latest edition and addenda.*
- *ASME I, latest edition and addenda.*

3. PROCEDURA

L'esame ultrasonoro deve essere effettuato in accordo ad una procedura specifica che dovrà fare riferimento alla presente procedura generale e dovrà contenere come minimo le seguenti informazioni:

- saldatura e/o tipo del materiale e configurazione da esaminare, incluso lo spessore, le dimensioni e il tipo di prodotto (forgiato, lamiera, etc.);
- particolari requisiti del personale, quando richiesti;
- superficie da cui si effettua l'esame;
- tecnica da usare (fascio diritto, fascio angolato);
- angoli e modalità di propagazione dell'onda nel materiale;
- tipo di sonda, frequenza e dimensioni del trasduttore;
- tipo di strumento ultrasonoro;
- descrizione della taratura: blocchi e tecniche;
- direzione ed estensione della scansione;
- tipo di scansione (manuale o automatica);
- metodo per discriminare indicazioni geometriche da indicazioni di difetto;
- metodo di dimensionamento delle indicazioni;
- metodo di acquisizione dati al computer, quando utilizzato;
- sovrapposizione delle scansioni.

La variazione di una di queste ***variabili essenziali*** rispetto ad un valore specifico o ad un range di valori, richiede una riqualifica della procedura specifica.

3. PROCEDURE

Ultrasonic examination shall be performed in accordance with a specific procedure, that shall make reference to this general procedure and shall include at least the following information:

- *weld and/or material types and configurations to be examined, including thickness, dimensions and product form (forging, plate, etc.);*
- *personnel performance requirements, when required;*
- *technique (straight beam, angle beam);*
- *angles and mode of wave propagation in the material;*
- *search unit type, frequency and transducer size;*
- *ultrasonic instrument type;*
- *description of calibration: blocks and techniques;*
- *direction and extent of scanning;*

- *scanning (manual vs. automatic);*
- *method for discriminating geometric from flaw indications;*
- *method for sizing indications;*
- *computer enhanced data acquisition, when used;*
- *scan overlap.*

A change of these requirements identified as an ***essential variable*** *from the specified value, or range of values, shall require re-qualification of the written procedure.*

4. APPARECCHIATURE

4.1. Strumento

Verrà impiegato un apparecchio ad ultrasuoni che soddisfi alle prescrizioni della Sezione V del Codice ASME. La sua linearità orizzontale e verticale verrà verificata ogni tre mesi secondo i metodi prescritti dalla stessa Sezione V del Codice ASME (vedi anche Appendice I).

4. EQUIPMENT

4.1. Instrument

All ultrasonic instrument complying with the requirements of ASME Code, Sect. V, shall be checked every three months in accordance with the methods prescribed by ASME Code Sect. V (see also Appendix I).

4.2. Sonde e frequenza di esame

Per i vari spessori dei giunti saldati verranno usate generalmente le sonde come indicato di seguito:

4.2. Probes and examination frequency

For thickness of welded joints shall be used generally the probes shown below:

Welds thickness	Angle	Frequency	Probe size
< 20 mm (< 0,79 in.)	70°	4 MHz	8×9 mm (0,31×0,35 in.)
20÷30 mm (0,79÷1,18 in.)	60°-70°	4 MHz	8×9 mm (0,31×0,35 in.)
30÷50 mm (1,18÷1,97 in.)	45°-70°	4 MHz	8×9 mm (0,31×0,35 in.)
> 50 mm (>1,97 in.)	45°-70°	2 MHz	20×22 mm (0,79×0,87 in.)

Sonde a 0° con onde longitudinali, del tipo standard, e frequenze da 2 a 4 MHz, saranno usate per controllare il materiale base.

Quando si usano sonde angolate con onde trasversali, dovranno essere effettuati almeno i seguenti controlli:

- verifica del punto di emissione del fascio ultrasonoro, mediante l'impiego di un blocco universale V1 e/o V2, secondo il tipo di sonda usata. Mentre si irradia la superficie curva di 100 mm (3,94 in.) di raggio del blocco V1, o quella di 25 mm (0,98 in.) di raggio del blocco V2, cercare la posizione alla quale l'eco riflessa ha la massima ampiezza e marcarla sulla sonda.
- verifica dell'angolo di incidenza con il quale si propaga il fascio ultrasonoro. Mentre si irradia l'inserto di perspex nel blocco V1, cercare la posizione alla quale l'eco riflessa ha la massima ampiezza. In tale posizione il centro di emissione del fascio dovrebbe coincidere con l'intaglio di riferimento sul blocco. Se si rileva una deviazione maggiore di 2°, si dovrà correggere adeguatamente la superficie portante della sonda, oppure si dovrà usare una sonda nuova.

Longitudinal wave probes at 0° with frequency of 2 to 4 MHz of the standard type shall also be utilized to check base material.

When transverse wave angle-beam probes are utilized, the following checks at least must be carried out:

- *verification of point of emission of ultrasonic beam, with the aid of universal block V1 and/or V2, depending on the type of probe used. While irradiating the curved surface of the 100 mm (3,94 in.) radius of block V1, or the 25 mm (0,98 in.) radius of block V2, find the position at which the reflected echo has maximum amplitude, and mark it on the probe;*
- *verification of angle of incidence at which the ultrasonic beam is propagated. While irradiating the perspex insert in block V1, find the probe position at which the reflected echo has maximum amplitude. In this position, the center of emission of the beam should coincide with the reference notch on the block. If deviation of more than 2° is found, the inclination of the bearing surface of the probe should be appropriately corrected, or a new probe should be used.*

5. MEZZI DI ACCOPPIAMENTO

Per ottenere l'accoppiamento della sonda si potrà usare olio, olio di glicerina o pasta a base acquosa, a condizione che tali mezzi siano compatibili con il materiale del pezzo da esaminare. Non potrà essere usato altro mezzo di accoppiamento diverso da quelli citati.

Lo stesso mezzo di accoppiamento deve essere usato per l'esame che per la taratura.

5 COUPLING MEDIA

For coupling purpose, oil, glycerin, or a paste base of water shall be used, on condition that the media are compatible with the material of the piece to be tested.

No coupling means except those specified above may be used.

The same coupling media shall be used for both examination and calibration.

6. CONDIZIONI DELLE SUPERFICI

Per saldature di spessori fino a 85 mm (3,35 in.), la superficie del giunto può essere come saldata o raccordata, in ogni modo deve essere tale da permettere un corretto accoppiamento della sonda.

Da entrambi i lati della saldatura, per una fascia larga almeno quattro volte lo spessore della parete, la superficie di scansione esterna dovrà essere tale da consentire che la sonda si muova liberamente mentre rimane costantemente a contatto.

Per saldatura di parete con spessore superiore a 85 mm (3,35 in.), le superfici del giunto, inclusa una fascia ad esso adiacente larga almeno il doppio dello spessore di parete, da entrambi i lati della saldatura e sulla superficie esterna ed interna del recipiente, devono essere tali da permettere che la sonda si muova liberamente mentre rimane in contatto costante.

La rugosità delle superfici interessate dalla scansione dovrà essere di almeno 250 RMS, e qualunque irregolarità sarà raccordata in modo da assicurare che almeno l'80% della superficie di accoppiamento della sonda possa essere mantenuta in contatto costante con la superficie di scansione.

6. SURFACE CONDITION

For welds of walls up to 85 mm (3,35 in.) thick, the surface of the joints may be as welded or filleted, in any case such as to allow correct coupling of the probe.

On both sides of the weld, for a band at least four times the thickness of the wall, the outside scanning surface shall be such as to allow the probe to move freely while remaining constantly coupled.

For welds of walls thicker than 85 mm (3,35 in.) the surfaces of the joint, including an adjacent band at least twice the thickness of the wall, from both sides of the weld, on the outer surface and on the inner surface of the vessel, shall be such as to allow the probe to move freely while remaining constantly coupled.

The roughness of the surfaces involved in scanning shall be less than 250 RMS, with any irregularities filleted so as to ensure that at least 80% of the coupling surface of the probe may be kept constantly in contact with the scanning surface.

7. TARATURA DELLA SENSIBILITÀ

7.1. Blocchi di taratura

Per l'esame di pezzi che hanno una superficie piana oppure una superficie con diametro ≥ 508 mm (20 in.), saranno usati blocchi di taratura costruiti come in fig.1.

Per l'esame di pezzi che hanno superficie curva con diametro < 508 mm (20 in.), saranno usati blocchi di taratura con superficie curva uguale al componente costruito da esaminare.

Un blocco base di taratura con superficie curva unica può essere usato per tarare l'esame su superfici nel campo di curvatura fra 0,9 e 1.5 volte il diametro del blocco di taratura.

7 CALIBRATION OF SENSITIVITY

7.1 Calibration blocks

For examination of parts having flat surface or curved surfaces with diameter ≥ 508 mm (20 in.) calibration blocks constructed in accordance with fig. 1 shall be used.

For examination of parts having curved surfaces with diameter < 508 mm (20 in.) calibration blocks with curved surface similar to manufactured component to be examined, shall be used.

A single curved basic calibration block may be used to calibrate the examination on surfaces in the range of curvature from 0,9 to 1,5 times the basic calibration block diameter.

7.2. Prova con sonda angolata

Il livello di riferimento è quello fornito dalla curva distanza/ampiezza ottenuta tracciando sullo schermo dell'apparecchio (vedi fig. 2) una curva che unisce i picchi delle massime ampiezza d'eco riflesse dai fori, posizionando la sonda nelle varie posizioni sul blocco di taratura corrispondente allo spessore in esame (vedi fig. 1) e procedendo come segue:

- il foro di riferimento è quello dal quale si ottiene la massima altezza di eco sullo schermo;
- l'eco così ottenuta viene poi amplificata fino a portare il suo picco all'80% ± 5% dell'altezza totale dello schermo;
- senza variare l'amplificazione risultante dal foro di riferimento, procedere a determinare gli altri punti;
- tracciare la curva per il 100% ed il 50% del livello di riferimento.

7.2. Testing with angle-beam probe

The reference level is the one given by the distance/amplitude curve constructed by tracing on the detector screen (see fig. 2) a curve which joins the apexes of the maximum echo amplitude reflected from the holes, positioning the probe in the different position on the calibration block corresponding to the thickness under examination (see fig. 1), and proceeding as follows:

- *the reference hole is the one from which is obtained the maximum height of the echo on the screen;*
- *the echo thus obtained is then amplified to bring its apex to 80 ± 5% of the full screen height;*
- *without varying the resulting amplification for the reference hole, proceed to determine the other points;*
- *trace the curves for 100% and 50% of the reference level.*

7.3. Prova con sonda fascio diritto

Il livello di riferimento si ottiene allo stesso modo di quello descritto al paragrafo 7.2. per le sonde angolate (Ved. fig. 3).

7.3. Testing with straight-beam probe

The reference level is obtained in the same manner as described in paragraph 7.2. for angle-beam probes (see fig. 3).

7.4. Controllo della taratura

La taratura del sistema apparecchio/sonda deve essere verificata all'inizio e al termine di ciascun esame, e ogni volta che viene cambiato un cavo o una sonda, quando un nuovo operatore comincia ad usare l'apparecchiatura o quando si sospetta un malfunzionamento

7.4. Calibration check

The calibration of the instrument/probe system shall be checked at least at the beginning and end of each test, and always when a probe or cable is changed, when another operator starts to use the equipment, or any time that malfunctioning of the equipment is suspected.

8. ESAME

8.1. Sensibilità di scansione

La sensibilità della scansione è quella ottenuta per mezzo delle procedure di taratura descritte al par. 7, incrementata di 6 dB.

Questo incremento deve essere tenuto in considerazione e sottratto quando si devono valutare l'ampiezza e l'estensione di qualsiasi discontinuità agli effetti della registrazione.

8 EXAMINATION

8.1 Scanning sensitivity

The scanning sensitivity is the one obtained through the calibration procedures described in paragraph 7, increased by 6 dB.

This increase is to be taken into consideration and subtracted when the magnitude and extension of any discontinuity must be evaluated for recording purpose.

8.2. Tecnica di scansione

La traslazione laterale della sonda dovrà avvenire con una sovrapposizione di almeno il 10% fra un passaggio e il successivo, e con una velocità di movimento avanti/indietro non superiore a 150 mm/sec (6 in./sec).

La prova deve essere effettuata con sonde ad onde longitudinali e con sonde ad onde trasversali, a mezzo di percorsi di scansione prefissati che coprano l'intero volume della saldatura.

Per tutti gli spessori fino a 85 mm (3,35 in.) la tecnica usata per scansione con sonda angolata è quella del percorso a V completo della banda ultrasonora, da entrambi i lati della saldatura, solo dalla superficie esterna.

Per spessori maggiori di 85 mm (3,35 in.) la tecnica usata per scansione con sonde angolate, è quella del percorso a ½ V, da entrambi i lati della saldatura e da entrambe le superfici del pezzo in esame.

Se la superficie interna non è praticabile (per inaccessibilità, forma particolare del giunto saldato, etc.) la tecnica di scansione da usare è quella indicata per spessori fino a 85 mm (3,35 in.) e le superfici di scansione devono soddisfare le prescrizioni date al par. 6.2.

Nelle figure 4 e 5 sono illustrati i percorsi da seguire usando sonde angolate e sonde diritte in esame di saldature di testa.

Per saldature d'angolo non si applicano le posizioni 5, 6 e 9 della fig. 4 e le posizioni 5, 6, 7, 8, 9, 10 della fig. 5.

8.2. <u>Scanning technique</u>

Lateral translation of the probe shall take place with an overlap of at least 10% of one scanning on the next, and a speed of forward/backward motion not exceeding 150 mm/sec (6 in./sec).

Testing is to be conducted with longitudinal wave and transverse-wave probes, through specified scanning paths covering the entire welded volume.

For wall thickness up to 85 mm (3,35 in.) the technique used for scanning with angle beams is that of full V-path for ultrasonic band, from both sides of the weld, from the outer surface only.

For wall thickness over 85 mm (3,35 in.) the technique used for scanning with angle-beam probes is that of ½ V path for band, from both sides of the weld and from both surfaces, inside and outside, of the piece under examination.

If examination from the inner surface is not practical (due to inaccessibility, particular shape of welded joint, etc.), the scanning technique to be used is the one explained for wall thickness up to 85 mm (3,35 in.), and the scanning surfaces are to comply with the prescriptions given in paragraph 6.2.

In figs 4 and 5, the scanning paths to be followed using angle-beam probes and straight-beam probes on butt welds are illustrated.

For fillet welds, positions 5, 6 and 9 in fig. 4 and position 5, 6, 7, 8, 9, 10 in fig. 5 are not applicable.

9. REGISTRAZIONE

Sono indicazioni da registrare tutte quelle che riguardano discontinuità che producono eco riflessa con ampiezza superiore al 50% di quella corrispondente nella curva di riferimento. Per quanto riguarda le discontinuità registrate, si devono notare i seguenti aspetti:

- l'estensione della superficie misurata con il metodo della riduzione di 6 dB;
- la distanza che separa una discontinuità dall'altra anche quando esse sono su livelli diversi della saldatura, con l'intendimento che tutte le discontinuità allineate, con distanza fra di esse inferiore al doppio della larghezza della più lunga, devono essere considerate come una discontinuità singola.

9. RECORDING

Indications to be recorded are all those regarding discontinuities producing echo reflections with amplitude more than 50% of the corresponding one in the reference curve. As regards the recorded discontinuities, the following specs should be noted:

- *the extent of defective area, measured by the "6 dB drop" method.*
- *the distance separating one discontinuity from another, even when they are on different levels of the weld, with the understanding that any aligned discontinuities with a distance between them less than twice the length of the longest one are to be considered as a single discontinuity.*

10. CRITERI DI ACCETTAZIONE

Tutte le indicazioni che producono un segnale riflesso di ampiezza maggiore del 20% del livello di riferimento devono essere esaminate al fine di determinare la loro forma, posizione e natura, e devono essere valutate per la loro accettazione come precisato di seguito.

Discontinuità interpretate come cricche, mancanza di fusione o incompleta penetrazione non sono accettabili, indipendentemente dalla loro dimensione.

Indicazioni di scoria e porosità sono accettabili se l'eco è maggiore di quella del livello di riferimento e se:

- la dimensione massima è ≤ ¼" (6 mm), per saldature di spessore ≤ ¾" (19 mm);
- la dimensione massima è ≤ 1/3 t, quando lo spessore t è > ¾" (19 mm) e ≤ 2¼" (57 mm);
- la dimensione massima è ≤ ¾" (19 mm) per saldature di spessore > 2¼" (57 mm);

(dove t è lo spessore del giunto in esame).

Se sono uniti con la saldatura lembi di spessori differenti, t è il minore fra gli spessori in esame.

Tutte le discontinuità considerate inaccettabili devono essere asportate dalla saldatura e la saldatura deve essere riparata con appropriate procedure.

Le zone riparate della saldatura e le zone ad esse adiacenti devono essere riesaminate con ultrasuoni secondo la presente procedura.

10 ACCEPTANCE CRITERIA

Any indications producing a reflected signal whose magnitude is greater than 20% of the reference level shall be examined in order to determine their form, location and nature, and shall be evaluated for acceptance as specified below.

Discontinuities interpreted as crack, lack of fusion or incomplete penetration are unacceptable, regardless of their size.

Indications of slag, porosity are acceptable if the echo is higher than that of the reference level and if:

- *the maximum dimension is ≤ ¼" (6 mm), for welds with thickness ≤ ¾" (19 mm);*
- *the maximum dimension is ≤ 1/3 t, when the wall thickness t is > ¾" (19 mm) and ≤ 2¼" (57 mm);*
- *the maximum dimension is ≤ ¾" (19 mm) for welds with thickness > 2¼" (57 mm);*

where t is the thickness of the joint under examination.

If edges of different thicknesses are joined in the weld, t is the lesser of the thicknesses under examination.

All discontinuities considered unacceptable shall be removed from the weld, and the weld shall be repaired by the appropriate procedures.

The repaired areas of weld and their adjacent areas shall be re-examined by ultrasonic test as described in this procedure.

11. CERTIFICATO DI ESAME

Il rapporto di esame ultrasonoro dovrà contenere come minimo le seguenti informazioni:

- nome del fabbricante;
- numero di commessa, disegno, numero di fabbrica e tipologia del componente esaminato;
- cliente, ente ispettivo;
- identificazione e localizzazione della saldatura esaminata;
- estensione dell'esame e/o fase della procedura;
- condizioni operative, come:

- presenti condizioni della superficie esaminata
- mezzi di accoppiamento usati
- strumento, sonde, blocchi di taratura impiegati
- frequenza

- registrazione dei difetti significativi e delle indicazioni geometriche;
- risultato dell'esame;
- firma dell'operatore e/o del tecnico di Livello II incaricato;
- data dell'esame.

11 EXAMINATION CERTIFICATE

The ultrasonic examination report shall contain at least the following information:

- *manufacturer;*
- *job order, drawing, serial numbers and type of equipment examined;*
- *customer, inspection authority;*
- *identification and location of weld examined;*
- *extent of examination and/or step of procedure;*
- *operating conditions such as:*

- *present conditions of surfaces examined*
- *coupling means used*
- *instrument, probes, calibration blocks utilized*
- *frequency*

- *recording of significant defects and geometric indications;*

- *results of examination;*
- *signature of operator and/or level II technician in charge;*
- *date of examination.*

12. PERSONALE ①

Il personale che effettua l'esame ultrasonoro di saldatura deve essere qualificato almeno al Livello II secondo la norma EN 473.

I risultati dell'esame devono essere valutati secondo la suddetta procedura da personale qualificato al Livello II.

12 PERSONNEL ①

Personnel conducting ultrasonic examination of welds shall be qualified at least at Level II in accordance with EN 473.

The test result should be evaluated accordance with the above written procedure by personnel Level II.

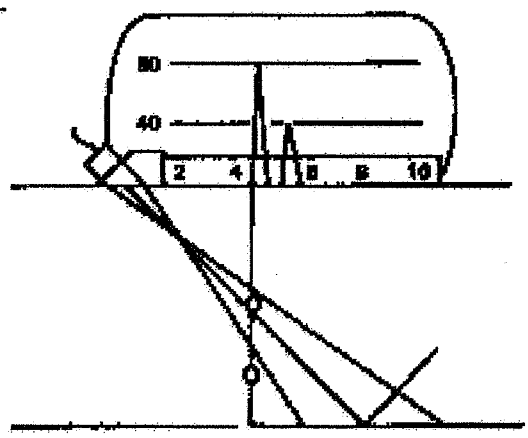
APPENDICE I

Linearità dell'altezza dello schermo

Posizionare una sonda angolata su un blocco di calibrazione come mostrato nella figura in modo che le altezze delle indicazioni dai fori a ½ e ¾T siano in rapporto di 2:1. Regolare la sensibilità in modo che l'indicazione più alta risulti all'80% dello schermo. Senza muovere la sonda, regolare la sensibilità in modo che l'indicazione più alta passi successivamente dal 100% al 20% dello schermo con salti del 10% e verificare l'altezza dell'indicazione più piccola. Il valore letto sullo schermo deve essere 50% dell'indicazione più ampia con un errore del 5% dell'ampiezza totale dello schermo. In alternativa può essere utilizzata una sonda a fascio dritto su un blocco campione che consenta di avere 2 segnali separati di diversa ampiezza.

Screen height linearity

Position an angle beam search unit on a calibration block, as shown in figure so that indications from both the ½ and ¾T holes give a 2:1 ratio of amplitudes between the two indications. Adjust the sensitivity so that the larger indication is set at 80% of full screen height. Without moving the search unit, adjust sensitivity to successively set the larger indication from 100% to 20% of full screen height, in 10% increments, and read the smaller indication at each setting. The reading shall be 50% of the larger amplitude, within 5% of full screen height. Alternatively, a straight beam search unit may be used on any calibration block that provides amplitudes differences, with sufficient signal separation.



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2	Typewriting mistake	
1	Revised where indicated ①	N. SOU0116554/4
0	Emissione - Issue	LINGUA-LANG. AI — PAGINA-SHEET 20 / 21
REV.	DESCRIZIONE - DESCRIPTION	

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SOSTITUITO DA - REPLACED BY

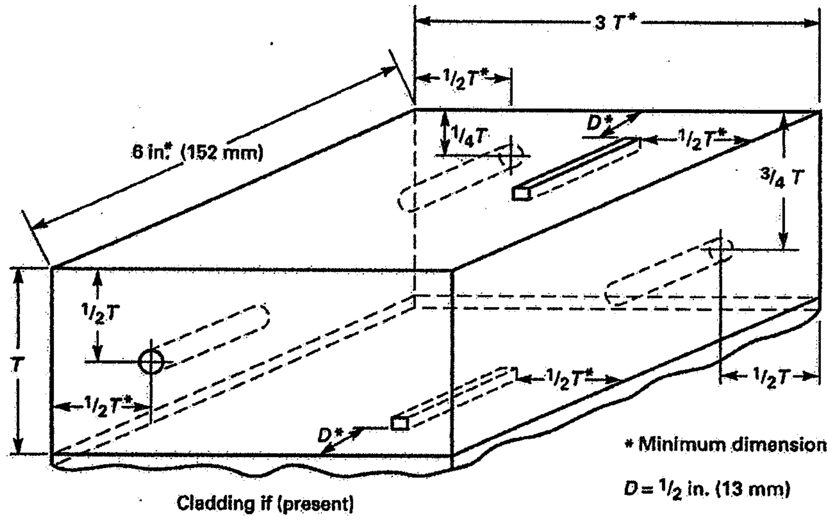
Linearità dell'amplificazione

Posizionare una sonda angolata su un blocco di calibrazione come mostrato nella figura in modo che l'indicazione dal foro a ½ T sia al centro dello schermo. Regolare la sensibilità come indicato nella seguente tabella. L'indicazione deve apparire all'interno dei limiti specificati. In alternativa può essere usato un altro riflettore su qualsiasi blocco di calibrazione con una sonda angolata o una sonda a fascio dritto.

Amplitude control linearity

Position an angle beam search unit on a basic calibration block, as shown in figure so that the indication from the ½ T side-drilled hole is peaked on the screen. Adjust the sensitivity as shown in the following table. The indication shall fall within the specified limits. Alternatively, any other convenient reflector from any calibration block may be used with angle or straight beam search units.

Ampiezza indicazione rispetto allo schermo *Indication set at % of full screen*	Variazione dB *dB control change*	Limiti dell'indicazione rispetto allo schermo *Indication limits % of full screen*
80%	- 6 dB	32 ÷ 48%
80%	- 12 dB	16 ÷ 24%
40%	+ 6 dB	64 ÷ 96%
20%	+ 12 dB	64 ÷ 96%



Weld Thickness (t) in. (mm)	Calibration Block Thickness (T) in. (mm)	Hole Diameter in. (mm)
Up to 1 (25)	¾ (19) or t	3/32 (2.4)
Over 1 (25) through 2 (51)	1½ (38) or t	⅛ (3.2)
Over 2 (51) through 4 (102)	3 (76) or t	3/16 (4.8)
Over 4 (102)	t ± 1 (25)	**

Notch Dimensions in. (mm)
Notch Depth = 2% T
Notch Width = ¼ (6.4) max.
Notch Length = 1 (25) min.

** For each increase in weld thickness of 2 in. (51 mm), or fraction thereof over 4 in. (102 mm), the hole diameter shall increase 1/16 in. (1.6 mm).

GENERAL NOTES:
(a) Holes shall be drilled and reamed 1.5 in. (38 mm) deep minimum, essentially parallel to the examination surface.
(b) For curved surfaces, two sets of calibration reflectors (holes, notches) oriented 90 deg from each other shall be used. Alternatively, two curved calibration blocks may be used.
(c) The tolerance for hole diameter shall be ± 1/32 in. (0.8 mm). The tolerance for hole location through the calibration block thickness (i.e., distance from the examination surface) shall be ± ⅛ in. (3.2 mm).
(d) All three holes may be located on the same face (side) of the calibration block provided care is exercised to locate the holes far enough apart to prevent one hole from masking the indication of another hole during calibration.
(e) Minimum notch depth shall be 1.6%T and maximum notch depth shall be 2.2%T plus the thickness of cladding, if present.

Figure 1 – Calibration blocks

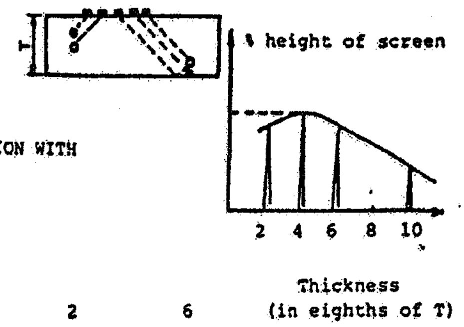


FIGURE 2 - DAC CURVE FOR EXAMINATION WITH TRANSVERSE-WAVE PROBES

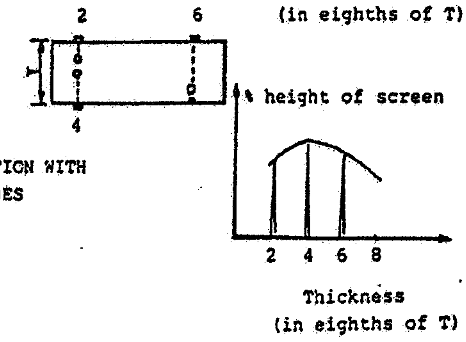


FIGURE 3 - DAC CURVE FOR EXAMINATION WITH LONGITUDINAL-WAVE PROBES

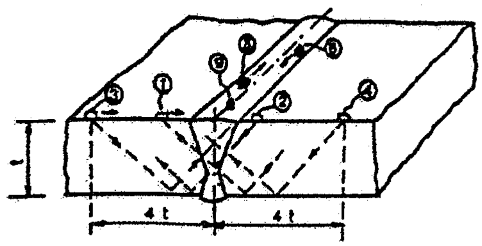


FIGURE 4 - SCANNING PATHS TO BE FOLLOWED FOR WELDS OF THICKNESS UP TO 85 MM.

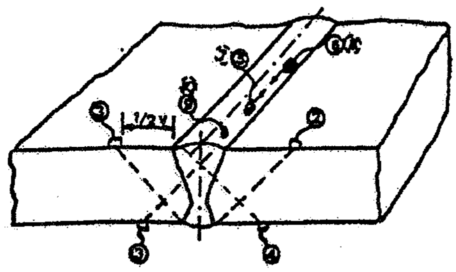


FIGURE 5 - SCANNING PATHS TO BE FOLLOWED FOR WELDS OF THICKNESS GREATER THAN 85 MM.

Nuovo Pignone MASSA	CLIENTE – CUSTOMER *CONOCO PHILLIPS*
	LOCALITA' - PLANT LOCATION *WILHELMSHAVEN, GERMANY*
COMMESSA - JOB **3100274÷3100279**	IMPIANTO - PLANT *WRG-DEEP CONVERSION PROJECT*

TITOLO - TITLE

ULTRASONIC EXAMINATION OF WELD DEPOSITED OVERLAY

Lloyd's Register EMEA
REVIEWED/~~WITNESSED~~
G.L. Frolla 4/1/07
Viareggio Office
Lloyd's Register

A PROCEED

AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

NAME:

02 OKT. 2006

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REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
2	Revised where indicated ②	Zappavigna	Chiappini F.	Zappavigna G.	11.09.06
1	Revised where indicated ①	Zappavigna	Chiappini	Zappavigna	29.05.06
0	Emissione - Issue	Zappavigna	Chiappini	Zappavigna	30.01.06

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Nuovo Pignone MASSA	ULTRASONIC EXAMINATION OF WELD DEPOSITED OVERLAY

CUSTOMER	CONOCO PHILLIPS
JOB	3100274, 3100275, 3100276, 3100277, 3100278, 3100279
ITEM	D-6211, D-6231, D-6212, D-6232, D-6214, D-6234
MATERIALS	**SHELL:** ASME SA 336 F22V **HEADS:** ASME SA 542 Gr.D Cl.4a **NOZZLES and PIPE NECKS:** ASME SA 182 F22V **SPOOLS:** ASME SA 182 F22V **WELD OVERLAY:** S.S. TP 347
DOCUMENTS	UOP Specification 3-17-3 NP Fabrication and Inspection Plan. SOU0110203/4 NP GENERAL DRAWINGS SUO 0269055 ÷SUO 0269060 GENERAL PROCEDURE (from page 5/16) – TECHNIQUE 2
PART TO BE EXAMINED	WELD DEPOSITED OVERLAY
EXTENT OF THE EXAMINATION ②	• 100% FROM EXTERNAL SURFACE (BASE MATERIAL) • SPOT FROM INSIDE (WELD OVERLAY SURFACE) ON SURFACE AND 100% AROUND EACH INTERNAL ATTACHMENTS (2") AND SUPPORT RINGS
TESTING MACHINES	KRAUTKRAMER - Type USN52 or PANAMETRICS – Type EPOCH III
TRANSDUCERS	KRAUTKRAMER – B2SN – Angle 0° - Freq. 2 MHz – Size Ø 25 mm (2") KRAUTKRAMER – B4SN – Angle 0° - Freq. 4 MHz – Size Ø 25 mm (2")
SUPERFACE CONDITION OF WELDED	AS WELDED
CONDITION OF SCANNING SURFACE	MACHINED for inspection from BASE MATERIAL AS WELDED for inspection from WELD OVERLAY SURFACE
COUPLANT	U47 (CGM)
METHOD OF SCANNING	100% FROM OUTSIDE (BASE MATERIAL SURFACE). SPOT FROM INSIDE (WELD OVERLAY SURFACE)

REV.	DESCRIZIONE - DESCRIPTION	
2	Revised where indicated ②	ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234
1	Revised where indicated ①	N. SOU0116555/4
0	Emissione - Issue	LINGUA-LANG. AI — PAGINA-SHEET 2 / 3

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SOSTITUITO DA - REPLACED BY

SCANNING OVERLAP	> 10%
METHOD FOR SIZING INDICATIONS	6 dB DROP
CALIBRATION OF THE SENSIBILITY	DIRECTLY ON COMPONENT TO BE CHECKED ON INDICATION-FREE AREA. FIRST BACK REFLECTION AT 75±5% OF SCREEN HEIGHT.
RECORDABLE INDICATION	DISCONTINUITIES CAUSING COMPLETE LOSS OF BACK REFLECTION AND INDICATIONS WITH AMPLITUDE EQUAL OR GREATER THAN 50% OF THE INITIAL REFLECTION AND ACCOMPANIED BY A 50% LOSS OF BACK REFLECTION
SUPPLEMENTARY INSPECTION	ANY INDICATION OF LACK OF BOND DETECTED FROM EXTERNAL SURFACE (BASE MATERIAL) SHALL BE INVESTIGATED FROM INTERNAL SURFACE (OVERLAIED MATERIAL).
PERSONNEL	PERSONNEL CONDUCTING EXAMINATION SHALL BE QUALIFIED AT LEAST AT LEVEL II ACCORDING TO EN 473
ACCEPTANCE CRITERIA	ASME V, SA 578 Level C
ATTACHMENT	EXAMPLE OF ULTRASONIC TEST REPORT

Nuovo Pignone
MASSA

ULTRASONIC EXAMINATION OF WELD DEPOSITED OVERLAY

Nuovo Pignone
MASSA

CERTIFICATO di ESAME con ULTRASUONI
ULTRASONIC TEST REPORT

Nr. : UTxxx-yy
Page Pag. : 1 / 1

Purchaser Cliente : ______ Order Ordine N° : ______

Shop Job Commessa : ______ Item Sigla : ______ Serial N° N° Fabbr. : ______ Dwg N° Disegno N° : ______

Inspecting Authority Ente di Collaudo : ______ Inspecting Plan Piano di Collaudo N° : ______ Stage Fase N° : ______

Specific Item Data Dati Specifici del Prodotto	Specific Procedure Specifica di Controllo	Tested Particular Particolare Controllato	Material Materiale	Extent Test Esten. Contr.
	Details of the Test Descrizione dell' esame			

Equipment / Strumentazione

Instruments Type Tipo di Apparecchi		Sonde Usate / Used Probes					
EPOCH III PANAMETRICS	☐	Type Tipo					
MG 15D GILARDONI	☐	Size Misura mm					
USM 25 DAC KRAUTKRAMER N°1754	☐	Angle Angolo					
USN52R KRAUTKRAMER	☐	Frequency Frequenza MHz					

Technical Test Conditions / Condizioni di Controllo

Thickness Spessori | Welding Procedure Procedimento Saldatura ☐ Automatic Automatico ☐ Manual Manuale | Coupling Accoppiamento | Calibration blocks Blocchi di Taratura

Calibration Sensitivity Sensibilità di Calibrazione ______ | Scanning Sensitivity Sensibilità di Scansione ______ | Reference Holes Fori di Riferimento ϕ mm ______ | Recording Level Livello di Registrazione ______

Transfer Correction Correzione di Trasferimento ☐ No No ☐ Yes Si dB ______

Surface Conditions Stato delle Superfici ☐ Lavorato di Macchina / Machined ☐ Come Saldato / As Welded ☐ Molato / Ground ☐

Scanning Surface Superficie di Scansione ☐ Lavorato di Macchina / Machined ☒ Molato / Ground

Test Carried Out Esame Effettuato ☐ Prima / Before ☐ Dopo / After

☐ Saldatura / Welding ☐ T.T. / P.W.H.T. ☐ T.T. Loc. / Loc. P.W.H.T. ☐ Prova Idraulica / Hydrotest

Test Results / Risultati d' Esame

☐ No indications to be recorded Nessuna indicazione da registrare ☐ Recorded Indications Indicazioni Registrate See page Vedi pag. ______

Result Conforming to the Specified Requirements RISULTATI CONFORMI AI REQUISITI DI SPECIFICA ☐ Yes Si ☐ No No ☐ ASME VIII Div.1 App.12 ☐ ASME VIII Div.2 Art.9-3 ☐ ASME VIII Div.3

Examiner Operatore ______ Level II Livello II | Q.C. Department Level II Controllo Qualità Livello II ______

Massa li ______ Inspectors Ispettori ______

REV.	DESCRIZIONE - DESCRIPTION
2	Revised where indicated ②
1	Revised where indicated ①
0	Emissione - Issue

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234

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SOSTITUITO DA - REPLACED BY

PROCEDURE GENERALE

SPECIFICA PER L'ESAME ULTRASONORO DI PLACCATURA MEDIANTE DEPOSITO SALDATO.

GENERAL PROCEDURE

SPECIFICATION OF STRAIGHT BEAM ULTRASONIC EXAMINATION OF WELD DEPOSITED CLADDING.

REV.	DESCRIZIONE - DESCRIPTION
2	Revised where indicated ②
1	Revised where indicated ①
0	Emissione - Issue

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234

N. SOU0116555/4

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   SCOPE
2. CONDIZIONI DI ESAME
   EXAMINATION CONDITIONS
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   EQUIPMENT
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   - 4.2 TARATURA
     CALIBRATION
   - 4.3. SCANSIONE
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5. TECNICA 2 (ASME V – Art.23 SA578)
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6. ASPORTAZIONE DEI DIFETTI
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7. PULIZIA DOPO ESAME
   CLEANING AFTER EXAMINATION
8. RAPPORTO DI ESAME
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9. QUALIFICA DEL PERSONALE
   PERSONNEL QUALIFICATION

1. SCOPO

Questa specifica descrive le modalità per l'esecuzione dell'esame ultrasonoro per rilevare mancanza di aderenza nell'interfaccia fra metallo di placcatura depositato con saldatura e materiale base.

Questa specifica fa riferimento alle prescrizioni della Sezione V del Codice ASME (Art. 5 par. T-543 e Art. 23 SA578), e può essere applicata quando l'esame del deposito di placcatura è richiesto dal Cliente o dal Codice.

1. SCOPE

This specification describes how perform the ultrasonic examination for lack of bond at the weld deposited cladding to base material interface.

This specifications is referred to requirements of ASME Code Section V (Art. 5 par. T-543 and Art. 23 SA578) and may be applied when the examination of weld deposited clad is required by the Customer or by the Code.

2. CONDIZIONI DI ESAME

La superficie da cui verrà effettuato l'esame deve essere pulita ed esente da sporco, scorie e da ogni irregolarità che possa interferire con l'accoppiamento fra la sonda e la superficie stessa.

La superficie placcata può essere allo stato come saldata, molata oppure lavorata di macchina.

L'esame può essere effettuato dal lato della placcatura o dal lato del materiale base.

Il mezzo di accoppiamento può essere pasta a base di glicerina.

2. EXAMINATION CONDITIONS

The surface from which the examination shall be carried out shall be clean and free from dirt, loose scale and from any irregularity that may interfere with the coupling between search unit and the surface.

The clad surface may be in the as welded condition, ground or machined.

The examination can be carried out from the clad side or from the base material side.

The coupling medium may be glycerine base paste.

3. APPARECCHIATURE

Sarà utilizzato un apparecchio ultrasonoro Krautkramer tipo USN 52 o un suo equivalente.

Si userà una sonda a fascio diritto con cristallo da 1" (25 mm) di diametro, ed una frequenza nominale di 2,25 MHz.

3. EQUIPMENT

A Krautkramer USN 52 ultrasonic-flaw detector or equivalent shall be used.

Compressional straight beam search unit crystal 1" (25 mm) in diameter will be used. A nominal frequency of 2,25 MHz shall be used.

4. TECNICA 1 (ASME V – Art.5 par. T-543)

4.1 BLOCCO DI TARATURA

Si userà un blocco di taratura placcato con lo stesso procedimento di saldatura del particolare in produzione da esaminare; il materiale base dovrà avere lo stesso "P number" del pezzo in produzione.

I riflettori per la taratura saranno fori a fondo piano di diametro 3/8" (9,5 mm) forati fino all'interfaccia fra placcatura oppure dal lato del rivestimento saldato (figura 1).

Quando l'esame viene effettuato dalla superficie del materiale base, lo spessore del materiale base del blocco di taratura non deve discostarsi più di 1" (25 mm) da quello del particolare da esaminare

Quando l'esame viene effettuato dalla superficie placcata, lo spessore del materiale base del blocco di taratura deve essere almeno doppio dello spessore della placcatura.

4. TECHNIQUE 1 (ASME V – Art.5 par. T-543)

4.1 CALIBRATION BLOCK

A calibration block clad by the same welding procedure as the production part shall be used, the base material shall have the same "P number" of the production part.

The calibration reflectors shall be flat bottom holes having 3/8" (9,5 mm) diameter drilled to the weld clad interface from base material or weld overlay side (figure 1).

If the examination is carried out from the base material surface the thickness of base material of the calibration block shall be within 1 in (25 mm) of the part to be examined.

If the examination is carried out from the clad surface the thickness of base material of the calibration block shall be at least twice the thickness of the cladding.

4.2. TARATURA

La taratura viene effettuata appoggiando la sonda sulla superficie del blocco di taratura opposta a quella da cui è stato effettuato il foro, e muovendo la sonda stessa per ottenere la massima risposta della prima indicazione risolvibile dal fondo del foro di taratura.

La regolazione del guadagno deve essere disposta in modo che tale risposta sia all'80±5% dell'altezza dello schermo.

Questo sarà il livello di riferimento primario.

4.2. CALIBRATION

Calibration shall be accomplished by placing the search unit on the calibration block on the side opposite from which the hole was drilled and manipulating the search unit for the maximum response of the first resolvable indication from the bottom of the calibration hole.

The gain control shall be set so that this response is 80 ±5% of full screen.

This is primary reference level.

4.3. SCANSIONE

L'esame deve essere effettuato sul 100% della superficie dallo stesso lato dal quale è stata fatta la taratura. La superficie placcata sarà controllata muovendo la sonda perpendicolarmente alla direzione delle passate di saldatura.

La sonda deve essere mossa manualmente con una velocità non superiore a 6 in/sec (150 mm/sec) e con una sovrapposizione di almeno il 10% del diametro della sonda stessa.

Durante la scansione il livello di riferimento primario deve essere aumentato mediante una regolazione del guadagno di 6 dB.

Tutte le indicazioni saranno valutate al livello di riferimento primario.

Le verifiche della taratura, effettuata come detto sopra, devono essere fatte:

- ogni volta che si cambia apparecchiatura o parti di essa, come cavi o trasduttore;
- ogni volta che cambia l'operatore;

- dopo ogni tre ore di esame;
- alla fine dell'esame.

4.3. SCANNING

The examination shall be carried out on 100% of surface from the side for which the calibration has been performed. The clad surface shall be scanned by moving the search unit perpendicular to the clad direction.

The search unit shall be moved manually with the rate not exceeding 6 in. per second (150 mm/sec) and with a minimum overlap of 10% of search unit diameter.

During scanning the primary reference level shall be magnified increasing the gain setting of 6 dB.

All indications shall be evaluated at the primary reference level.

Calibration checks on the above shall follow after:

- *changing equipment or parts e.g. cables or transducer;*
- *changing personnel;*
- *each three hour examination;*
- *end of examination.*

4.4. REGISTRAZIONE

Tutte le indicazioni provenienti dal piano di interfaccia tra la nastratura e il materiale base di ampiezza uguale o superiore al 50% dell'eco di riferimento saranno registrate.

4.4. RECORDING

All indications from the plane of the interface of the clad and backing steel with amplitude equal or greater than 50% reference level shall be recorded.

4.5. STANDARDS DI ACCETTAZIONE

Tutte le indicazioni provenienti dal piano di interfaccia tra la nastratura e il materiale base con ampiezza uguale o superiore all'eco di riferimento saranno considerate inaccettabili.

4.5. ACCEPTANCE STANDARDS

All indications from the plane of the interface of the clad and backing steel with amplitude equal or greater than reference level are unacceptable.

5. TECNICA 2 (ASME V – Art.23 SA578)

5.1 TARATURA

La taratura sarà eseguita direttamente sul pezzo sottoposto a controllo.

Il sistema sarà regolato in modo tale da ottenere un eco di fondo di 75±5% dello schermo quando il trasduttore è posizionato in corrispondenza di un'area del componente esente da difetti.

5. TECHNIQUE 2 (ASME V – Art.23 SA578)

5.1 CALIBRATION

Calibration shall be performed directly on the component to be checked.

The instrument shall be set so that the first back reflection is 75±5% of screen height when the transducer is placed on an indication-free area of component.

5.2. SCANSIONE

La superficie placcata verrà controllata al 100% muovendo la sonda perpendicolarmente alla direzione delle passate di saldatura.

La sonda deve essere mossa manualmente con una velocità non superiore a 6 in/sec (150 mm/sec) e con una sovrapposizione di almeno il 10% del diametro della sonda stessa.

La taratura deve essere verificata:

- ogni volta che si cambia apparecchiatura o parti di essa, come cavi o trasduttore;
- ogni volta che cambia l'operatore;
- dopo ogni tre ore di esame;
- alla fine dell'esame.

5.2. SCANNING

The clad surface shall be 100% scanned by moving the search unit perpendicular to the clad direction.

The search unit shall be removed manually with the rate not exceeding 6 in per second (150 mm/sec) and with a minimum overlap of 10% of search unit diameter.

Calibration checks on the above shall follow after:

- *changing equipment or parts e.g. cables or transducer;*
- *changing personnel;*
- *each three hour examination;*
- *end of examination.*

5.3 REGISTRAZIONE

Saranno registrate le indicazioni che

- causano una completa scomparsa dell'eco di fondo o
- hanno ampiezza maggiore o uguale al 50% dell'eco iniziale di fondo e sono accompagnate da un'attenuazione del 50% dell'eco di fondo.

5.3 RECORDING

Indications

- *causing complete loss of back reflection or*
- *with amplitudes equal to or greater than 50% of the initial reflection and accompanied by a 50% loss of back reflection*

shall be recorded.

5.4. STANDARDS DI ACCETTAZIONE

Ogni area dove una o più discontinuità producono una continua e totale perdita dell'eco di fondo accompagnata da un'indicazione continua sullo stesso piano che non può essere circoscritta in un cerchio di diametro 1 in. (25 mm) è inaccettabile (vedi SA578 Livello C).

5.4. ACCEPTANCE STANDARDS

Any area where one or more discontinuities produce a continuous total loss of back reflection accompanied by continuous indications on the same plane that cannot be encompassed within a 1 in. (25 mm) diameter circle is unacceptable. (see SA578 Level C).

6. ASPORTAZIONE DEI DIFETTI

Le indicazioni superiori agli standards di accettazione devono essere asportate con mezzi idonei e riparate.

Le zone riparate devono essere riesaminate usando la stessa procedura del primo esame.

6. REMOVAL OF DEFECTS

Indications in excess to acceptance standards shall be removed by suitable means and repaired.

The repaired areas shall be re-inspected using the same ultrasonic procedure as per first examination

7. PULIZIA DOPO ESAME

Dopo l'esame il mezzo di accoppiamento usato verrà asportato con acqua o solvente.

7. CLEANING AFTER EXAMINATION

After examination the coupling medium, used for the ultrasonic examination, shall be removed by water or solvent.

8. RAPPORTO DI ESAME

Il rapporto scritto dell'esame verrà compilato su apposito modulo completato con tutte le informazioni richieste per il controllo (commessa, specifica di controllo, marca e modello dell'apparecchiatura, tipo e frequenza del trasduttore, accoppiante, taratura, risultati, operatore, data, ecc.).

8. *EXAMINATION REPORT AND CERTIFICATION*

The written examination report shall be issued on an appropriate form completed with all required information (job, specific procedure, make and model of instrument, type and frequency of transducer, couplant, calibration, results, operator, date, etc.).

9. QUALIFICA DEL PERSONALE

Tutto il personale che effettua l'esame ultrasonoro deve essere qualificato secondo la norma EN 473.
L'esaminatore deve essere certificato come minimo al Livello II.

9. *PERSONNEL QUALIFICATION*

All personnel performing ultrasonic examination must be qualified in according with EN 473.
The examiner shall be certified Level II as a minimum.

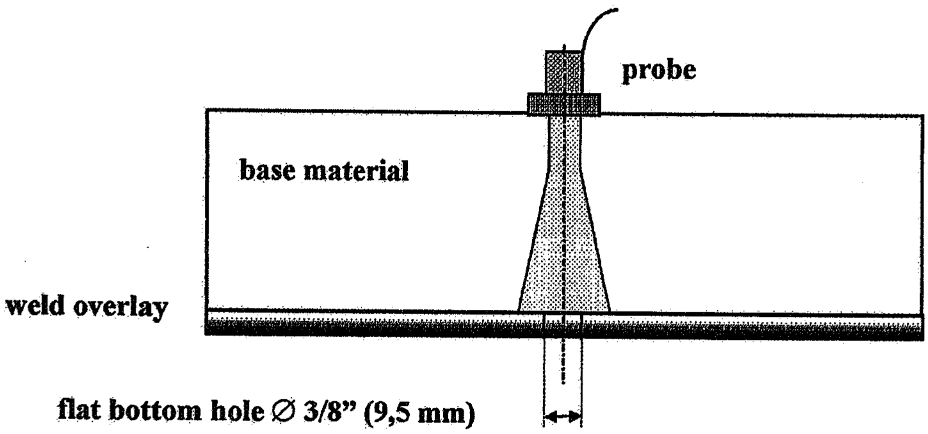

Figure 1 – Technique 1: calibration

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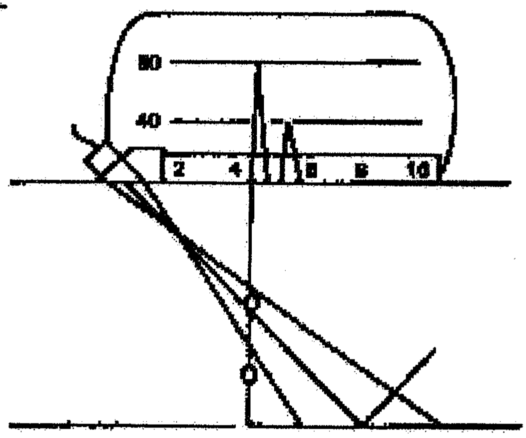
APPENDICE I

Linearità dell'altezza dello schermo

Posizionare una sonda angolata su un blocco di calibrazione come mostrato nella figura in modo che le altezze delle indicazioni dai fori a ½ e ¾T siano in rapporto di 2:1. Regolare la sensibilità in modo che l'indicazione più alta risulti all'80% dello schermo. Senza muovere la sonda, regolare la sensibilità in modo che l'indicazione più alta passi successivamente dal 100% al 20% dello schermo con salti del 10% e verificare l'altezza dell'indicazione più piccola. Il valore letto sullo schermo deve essere 50% dell'indicazione più ampia con un errore del 5% dell'ampiezza totale dello schermo. In alternativa può essere utilizzata una sonda a fascio dritto su un blocco campione che consenta di avere 2 segnali separati di diversa ampiezza.

Screen height linearity

Position an angle beam search unit on a calibration block, as shown in figure so that indications from both the ½ and ¾T holes give a 2:1 ratio of amplitudes between the two indications. Adjust the sensitivity so that the larger indication is set at 80% of full screen height. Without moving the search unit, adjust sensitivity to successively set the larger indication from 100% to 20% of full screen height, in 10% increments, and read the smaller indication at each setting. The reading shall be 50% of the larger amplitude, within 5% of full screen height. Alternatively, a straight beam search unit may be used on any calibration block that provides amplitudes differences, with sufficient signal separation.



Linearità dell'amplificazione

Posizionare una sonda angolata su un blocco di calibrazione come mostrato nella figura in modo che l'indicazione dal foro a ½ T sia al centro dello schermo. Regolare la sensibilità come indicato nella seguente tabella. L'indicazione deve apparire all'interno dei limiti specificati. In alternativa può essere usato un altro riflettore su qualsiasi blocco di calibrazione con una sonda angolata o una sonda a fascio dritto.

Amplitude control linearity

Position an angle beam search unit on a basic calibration block, as shown in figure so that the indication from the ½ T side-drilled hole is peaked on the screen. Adjust the sensitivity as shown in the following table. The indication shall fall within the specified limits. Alternatively, any other convenient reflector from any calibration block may be used with angle or straight beam search units.

Ampiezza indicazione rispetto allo schermo *Indication set at % of full screen*	Variazione dB *dB control change*	Limiti dell'indicazione rispetto allo schermo *Indication limits % of full screen*
80%	- 6 dB	32 ÷ 48%
80%	- 12 dB	16 ÷ 24%
40%	+ 6 dB	64 ÷ 96%
20%	+ 12 dB	64 ÷ 96%

Nuovo Pignone MASSA	CLIENTE – CUSTOMER *CONOCO PHILLIPS* ①
	LOCALITA' - PLANT LOCATION *WILHELMSHAVEN, GERMANY*
COMMESSA - JOB 3100274÷3100279	IMPIANTO - PLANT *WRG-DEEP COVERSION PROJECT* ①

TITOLO - TITLE

RADIOGRAPHIC EXAMINATION

A PROCEED

AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

NAME:

07 AUG. 2006

FLUOR B.V.

A PROCEED

FLUOR®

DATE: 10-07-06

WELDING-ENGINEER

AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

P05-0006 REV1

REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
1	Revised where indicated ①	Zappavigna	Chiappini	Zappavigna	19.05.06
0	Emissione - Issue	Zappavigna	Chiappini	Zappavigna	30.01.06

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①

N. SOU0116556/4

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CUSTOMER	CONOCO PHILLIPS ①
JOB	3100274, 3100275, 3100276, 3100277, 3100278, 3100279
ITEM	D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①
MATERIALS	**SHELL:** ASME SA 336 F22V **HEADS:** ASME SA 542 Gr.D Cl.4a **NOZZLES and PIPE NECKS:** ASME SA 182 F22V **SPOOLS:** ASME SA 182 F22V **WELD OVERLAY:** S.S. TP 347 **SKIRT:** ASME SA 387 Gr.22 Cl.2 / SA 516 Gr.70
DOCUMENTS ①	UOP Specification 3-17-3 NP Fabrication and Inspection Plan. SOU0110203/4 NP GENERAL DRAWINGS SUO 0269055 ÷SUO 0269060 GENERAL PROCEDURE (from page 6/37) ASME Section V Article 2 ASME Section VIII Div 2.
THICKNESS ①	**INLET A and OUTLET B**: 39,7 mm-**Øext**: 457.2 mm (D-6211, D-6231,D-6212,D-6232) **INLET A and OUTLET B**: 31,8 mm - **Øext**: 355,6 mm (items D-6214, D-6234) **CATALYST WITHDRAWAL D**: 18,2 mm- **Øext**: 219 mm (for all items) **SKIRT**: 45 mm (D-6211, D-6231,D-6212,D-6232), 40 mm (D-6214, D-6234)
PART TO BE EXAMINED ①	SPOOL WELDED JOINTS LONGITUDINAL and CIRCUMFERENTIAL WELDS of SKIRT
EXTENT OF THE EXAMINATION ①	100 % for SPOOL SPOT for SKIRT
SOURCE ①	γ **RAY** IRIDIUM 192 or COBALT 60 (only for DOUBLE WALL technique)
FOCAL SPOT	2 mm × 2 mm for Ir 192 or 3 mm × 3 mm for Co 60
FILM SELECTION	AGFA STRUCTURIX D4 or D5

FILM SIZE	150 × 400 mm
SCREENS SELECTION	**TYPE:** LEAD **THICKNESS:** FRONT and BACK: 0.25 mm
EXPOSURE TECHNIQUE ①	DIRECTIONAL – DOUBLE WALL - SINGLE IMAGE or PANORAMIC - SINGLE WALL – SINGLE IMAGE
FILMS FOR CHASSIS	N° 1 - SINGLE FILM VIEWING
MINIMUM SOURCE–OBJECT DISTANCE	FOR DIRECTIONAL EXPOSURE: 0 FOR PANORAMIC EXPOSURE: Øint/2
OBJECT (source side)-FILM DISTANCE	FOR DIRECTIONAL EXPOSURE: Øext FOR PANORAMIC EXPOSURE: pipe thickness
AREA TO BE RADIOG. FOR EACH FILM	< 300 mm
PENETRAMETER TYPE	ASMT SET B (WIRES).
SENSITIVITY	ACCORDING TO ASME V ART. 2 TABLE T-276
DENSITY	> 2 < 4
FILM PROCESSING	AUTOMATIC or MANUAL **DEVELOPER BRAND NAME:** G 135 (or equivalent) **FIXER BRAND NAME:** G 335 (or equivalent)
PERSONNEL	PERSONNEL CONDUCTING EXAMINATION SHALL BE QUALIFIED AT LEAST AT LEVEL II ACCORDING TO EN 473
ACCEPTANCE CRITERIA	ASME VIII Div. 2 App. 8, Art. I-5
ATTACHMENT	EXAMPLE OF RADIOGRAPHIC TEST REPORT

Nuovo Pignone
MASSA

RADIOGRAPHIC EXAMINATION

Nuovo Pignone MASSA	RIEPILOGO RADIOGRAFICO *RADIOGRAPHIC INSPECTION REPORT*	Nr.: RTxxx-yy Page Pag.: 1 / 2

Purchaser Cliente : ____ Order Ordine N° ____

Shop Job Commessa : ____ Item Sigla : ____ Serial N° N° Fabbr. : ____ Dwg N° Disegno N° : ____

Inspecting Authority Ente di Collaudo : ____ Inspecting Plan Piano di Collaudo N° : ____ Stage Fase N° : ____

SCHEMA POSIZIONI RX - X Rays POSITION SKETCH

RAGGI X - X RAYS	GAMMA RADIATION	Dimensione Macchia focale Effic. Size (mm)	Pellicole - Films	Tecnica Esposizione-Exposure Technical
LINATRON 2000 ☐	IRIDIO - IRIDIUM ☐		Tipo Type	Direzionale - Directional ☐
GILARDONI 350 KV ☐	COBALTO - COBALT ☐		Formato Size	Panoramica - Panoramic ☐
SEIFERT 400KV ☐	☐			Singola Parete - Single Wall ☐
				Doppia Parete - Double Wall ☐

Film per Cassetta Films for Chassis N°	Schermi - Screens	Materiali - Materials	Specifica di Controllo Specific Procedure
Visione Singola Del Film Single Viewing of Film ☐	Spessori - Thickness		
Visione Doppia del Film Multiple Viewing of Film ☐			

Componenti - Components ____

Spessori - Thickness (mm) ____

Attività Sorgente - Source Strength (Ci) ____

Minima distanza Fuoco-Oggetto - Minimum Source-Object Distance (mm) ____

Distanza Oggetto (lato sorgente)-Film alla minima distanza sorgente-oggetto
Distance Object (source side)-Film (mm) at the minimum source-object distance ____

Tensione - Voltage (KV) ____

Intensità - Current (mA) ____

Tempo di Esposizione - Exposure Time ____

Tipo di Penetrametro - IQI Type ____

Diametro Filo - Wire Diameter (mm) ____

Densità - Density ____

Lunghezza Utile Film - Effective Film Length (mm) ____

Altro - Other ____

REV.	DESCRIZIONE - DESCRIPTION	
		ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①
1	Revised where indicated ①	N. SOU0116556/4
0	Emissione - Issue	LINGUA-LANG. AI / PAGINA-SHEET 4 / 5

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

Nuovo Pignone
MASSA

RADIOGRAPHIC EXAMINATION

Nuovo Pignone
MASSA

RIEPILOGO RADIOGRAFICO
RADIOGRAPHIC INSPECTION REPORT

Nr.: RTxxx-yy
Page / Pag.: 2 / 2

Purchaser / Cliente : ____________ Order / Ordine N° ____________

Shop Job / Commessa : ________ Item / Sigla : ________ Serial N° / N° Fabbr. : ________ Dwg N° / Disegno N° : ________

Tipologia Discontinuità - Type of Discontinuity

Aa	Indicazioni isolate tondeggianti / *Rounded isolated indication(s)*	C	Mancata fusione / *Lack of fusion*
Ab	Indicazioni allineate tondeggianti / *Aligned rounded indication(s)*	D	Mancata penetrazione / *Incomplete penetration*
Ac	Gruppo di indicazioni tondeggianti / *Cluster of rounded indication(s)*	Ea	Cricche longitudinali / *Longitudinal crack indication(s)*
Ba	Inclusioni allungate tipo scoria / *Elongated inclusion such as slag*	Eb	Cricche trasversali / *Transverse crack indication(s)*
Bb	Gruppo di inclusioni allineate / *Group of inclusions in line*	F	Incisioni marginali / *Undercut indication(s)*

Simboli di Valutazione - Evaluation Symbol

G	Difetti di film / *Blemish indication(s)*
1	Senza indicazioni / *No indication(s)*
2	Indicazioni accettabili / *Acceptable indication(s)*
3	Indicazioni / Difetti film non accettabili / *Not acceptable indication(s) / Blemish(es)*

Criteri di accettazione in accordo: / Acceptance criteria according to:
- ☐ ASME VIII Div. 1 - UW 51-52 App. 4
- ☐ ASME VIII Div. 2 - App. 8 Art. 1-5
- ☐ ASME VIII Div. 3 - Par. KE 331 and App. 6
- ☐ ISPESL - Raccolta S Classe 1

Posizioni RX XR Location	Giudizio Evaluation	Posizioni RX XR Location	Giudizio Evaluation	Posizioni RX XR Location	Giudizio Evaluation	Posizioni RX XR Location	Giudizio Evaluation	Posizioni RX XR Location	Giudizio Evaluation

Operatore Livello II / Operator Level II	Controllo N.P. Livello II / Shop Control Level II	L'Ispettore / Ispector	L'Ispettore / Ispector
____________ Massa il: ________			

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①

REV.	DESCRIZIONE - DESCRIPTION
1	Revised where indicated ①
0	Emissione - Issue

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LINGUA-LANG.	PAGINA-SHEET
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SOSTITUISCE IL - REPLACES PARI NUMERO
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ESAME RADIOGRAFICO SU GIUNTI SALDATI

PROCEDURA GENERALE.

RADIOGRAPHIC EXAMINATION

GENERAL PROCEDURE

Lloyd's Register EMEA
REVIEWED/~~WITNESSED~~
G.L. Frolla 20/2/07
Viareggio Office
Lloyd's Register

REV.	DESCRIZIONE - DESCRIPTION
1	Revised where indicated ①
0	Emissione - Issue

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①

N. SOU0116556/4

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1. SCOPO E APPLICAZIONE

1.1 La presente procedura illustra i criteri ed i requisiti per l'esecuzione di radiografie con raggi X e gamma dei giunti saldati di testa in parti metalliche.

1. SCOPE AND APPLICATION

1.1 This procedure describes criteria and requirements for X-Ray and Gamma-Ray radiographic examination of welded butt joints in metallic parts.

1.2. La presente procedura è basata sulle norme:

- ASME Sez. V, ultima edizione.
- ASME Sez. VIII Div. 1 - 2 -3, ultima edizione.
- ASME Sez. I, ultima edizione.

1.2. This procedure is based on:

- *ASME V, latest edition and addenda*
- *ASME VIII Div. 1-2-3, latest edition and addenda.*
- *ASME I, latest edition and addenda.*

1.3. Per quanto non specificato nella presente procedura i requisiti delle norme ASME verranno considerati come i requisiti che integrano il presente procedimento.
La necessità dell'esame radiografico, quando richiesto dal progetto, sarà indicata nel disegno del componente da esaminare.

1.3. For what not specifically detailed here, the requirements of ASME Code shall be considered as requirements that integrate with the present procedure.
The need of radiographic examination, when required by the design, shall be indicated into the drawing of vessel or other item to be tested.

2. REQUISITI GENERALI

2.1. <u>Procedura Specifica</u>

L'esame radiografico dovrà essere effettuato in accordo ad una procedura che dovrà:

- fare riferimento alla presente procedura generale;
- essere specifica per il particolare lavoro;
- contenere almeno le seguenti informazioni:
  - a) tipo del materiale e spessore;
  - b) isotopo o massimo voltaggio della sorgente di Raggi X da usare;
  - c) minima distanza sorgente o pellicola;
  - d) massima dimensione della sorgente;
  - e) marca e designazione delle pellicole;
  - f) schermi.

La dimostrazione della densità e dell'immagine del penetrametro richieste dalla procedura specifica ottenute nelle radiografie in produzione, saranno considerate come evidenza soddisfacente per la conformità a tale specifica.

2. <u>GENERAL REQUIREMENTS</u>

2.1. <u>Specific Procedure</u>

The radiographic examination shall be performed in accordance with a procedure that shall:

- *make reference to this general procedure;*
- *be specific for the pertinent job;*
- *contain, as a minimum, the following information:*
  - *a) material and thickness range;*
  - *b) isotope used or maximum X-Ray voltage;*
  - *c) minimum source-to-film distance;*
  - *d) maximum source size;*
  - *e) film brand and designation*
  - *f) screen used.*

Demonstration of the density and penetrameter image requirements of the specific procedure on producion radiographs shall be considered satisfactory evidence of compliance with that procedure.

2.2. Preparazione delle superfici

Le superfici dei materiali in esame, oltre che risultare rispondenti alle prescrizioni di fornitura, dovranno essere esenti da ogni irregolarità che in qualche modo possa interferire con i risultati dell'esame.

Sono da rimuovere rugosità, incisioni, spruzzi e quanto altro può mascherare difetti, essere confuso con i medesimi o comunque pregiudicare la corretta valutazione delle indicazioni contenute nelle radiografie.

2.2. Surface Preparation

The surface of materials under examination shall satisfy the requirements of the applicable material specifications and shall be free from those irregularities that could interfere with examination results.

The weld surface irregularities shall be removed so that the resulting radiographic image due to any irregularities cannot mask or be confused with the image of any discontinuity.

3. SCELTA DELLA SORGENTE DI RADIAZIONE

3.1. Raggi X.

Per i normali esami radiografici dei diversi tipi di materiali, la tensione massima non dovrà superare i limiti indicati nei diagrammi di Fig. 1A, 1B, 1C.

3. SELECTION OF RADIATION ENERGY

3.1. X-Radiation

For normal radiographic examination of various types of material, the maximum voltage used shall not exceed the limits indicated in the diagrams in Fig. 1A, 1B, 1C.

3.2. Radiazioni Gamma

Per isotopi di Iridio 192 e Cobalto 60 lo spessore minimo per il quale possono essere usati è il seguente:

Materiale	Iridio 192	Cobalto 160
Acciaio	19,05 mm.	38,1 mm.
Rame o Nickel alto legato	16,51 mm	33,02 mm
Alluminio	63,5 mm.	---

3.2. Gamma Radiation

For Iridium 192 and Cobalt 60 sources the minimum thickness for which they may be used, is as follows:

Material	*Iridium 192*	*Cobalt 60*
Steel	*19,05 mm*	*38,1 mm*
Copper or high nickel	*16,51 mm*	*33,02 mm*
Aluminium	*63,5 mm.*	---

3.3. Il valore minimo di spessore consigliato può essere ridotto quando le tecniche radiografiche utilizzate dimostrano che è stata raggiunta la sensibilità radiografica richiesta.

3.3. The minimum recommended thickness limitation may be reduced when the radiographic technique used demonstrate that the required radiographic sensitivity has been obtained.

3.4. Quando è impossibile conformarsi ai paragrafi precedenti o quando deve essere usato un isotopo diverso, verrà preparata una procedura dettagliata e verranno eseguite delle prove per dimostrare la sensibilità con i penetrametri posti in corrispondenza dello spessore minimo.

3.4. Where it is impossible to comply with previous paragraphs or when a different isotope must be used, a detailed procedure shall be prepared and tests shall be performed to demonstrate the sensitivity with the penetrameter placed on the minimum thickness of the part.

4. SCELTA DELLE PELLICOLE

Il tipo di pellicola verrà scelto in modo da garantire la minima sensibilità richiesta, prendendo in considerazione il tipo di materiale e la sorgente di energia.

Una guida generale per la scelta della pellicola viene fornita alla fig. 4A, dove per tipo I si intendono pellicole a grana molto fine (Gevaert D4 o equivalenti) e per il Tipo II si intendono pellicole a grana fine (Gevaert D7 o equivalenti).

4. FILM SELECTION

The type of films shall be selected in order to guarantee a minimum required sensitivity taking into consideration of material type and source energy.

A general guide for the selection of film is given in Fig. 4A.

Type I are very Fine Grain Films (Gevaert D4 or equivalent); type II are Fine Grain Films (Gevaert D7 or equivalent).

5. SCHERMI

Per energia fino a 400 KV, verranno usati degli schermi di piombo con uno spessore minimo di 0,13 mm. su entrambi i lati.

Quando verranno usati isotopi radioattivi, lo spessore dello schermo sarà il seguente:

per Iridio 192 sp. 0.25 mm (davanti) (retro)

per Cobalto 60 sp. 0.25 mm (davanti) (retro)

Per energia da 1 MeV ad 8 MeV verranno usati schermi di piombo da 1 mm. di spessore su entrambi i lati della pellicola.

5. SCREENS

For energies up to 400 KV, lead screens shall be used, having a minimum thickness of 0.13 mm. both side. When radioactive isotopes are used, the screen thickness shall be as follows:

for iridum 192 thk. 0.25 mm. (front) (back)

for cobalt 60 thk. 0.25 mm. (front) (back)

For energy of 1 MeV up to 8 MeV, lead screens 1 mm thickness both side, shall be used.

6. LIMITI DELLA PENOMBRA GEOMETRICA

La penombra geometrica della radiografia verrà determinata secondo:

$$U_g = F \times d / D$$

dove:

- U_g = penombra geometrica
- F = dimensioni della sorgente (mm): è la massima dimensione della sorgente radiante (o macchia focale effettiva) proiettata sul piano perpendicolare alla distanza D della saldatura da radiografare.
- D = distanza (mm) dalla sorgente di radiazione alla saldatura o oggetto che viene radiografato.
- d = distanza (mm) dal lato sorgente della saldatura o dell'oggetto da radiografare alla pellicola.

La penombra geometrica massima tollerata non supererà i valori seguenti:

Spessore del materiale	**U_g massimo**
< 2" (50.8 mm)	0.020" (0.51 mm)
da 2" (50.8 mm) a 3" (76.2 mm)	0.030" (0.76 mm)
da 3" (76.2 mm) a 4" (101.6 mm)	0.040" (1.02 mm)
> 4" (101.6 mm)	0.070" (1.78 mm)

6. GEOMETRIC UNSHARPNESS LIMITATIONS

Geometric unsharpness of the radiograph shall be determined in accordance with:

$$Ug = F \times d / D$$

where:

- *Ug = Geometric unsharpness*
- *F = Source size (mm): the maximum projected dimension of the radiating source (or effective focal spot) in the plane perpendicular to the distance D from the weld being radiographed.*
- *D = Distance (mm) from source of radiation to weld or object being radiographed.*
- *d = Distance (mm) from source side of weld or object being radiographed to the film.*

The maximum permissible geometric unsharpness shall not exceed the following:

Material thickness	*U_g maximum*
under 2" (50.8 mm)	*0.020" (0.51 mm)*
over 2" (50.8 mm) through 3" (76.2 mm)	*0.030" (0.76 mm)*
over 3" (76.2 mm) through 4" (101.6 mm)	*0.040" (1.02 mm)*
greater than 4" (101.6 mm)	*0.070" (1.78 mm)*

7. VERIFICA DELLE DIMENSIONI DELLA SORGENTE

I documenti forniti dal costruttore delle apparecchiature, come manuali tecnici o dichiarazioni scritte che documentino la dimensione effettiva o massima della sorgente (o macchia focale), verranno considerati come verifica delle dimensioni della sorgente. Per le macchina a Raggi X da 320 KV e inferiori, le dimensioni della macchia focale possono essere determinate col metodo del foro di spillo

7. SOURCE SIZE VERIFICATION

Documents supplied by the Manufacturer of the equipment, such as technical manuals or written statements documenting the actual or maximum source size or focal spot, shall be considered as source size verification.

For X-Ray machines, 320 KV and less, the focal spot size may be determined by the pinhole method.

8. MARCATORI DI POSIZIONE

I marcatori di posizione, che devono apparire come immagini radiografiche nelle pellicole, devono essere posti sul pezzo e non sul contenitore delle pellicole o sulla cassetta.

Le loro posizioni dovranno essere segnate in modo permanente sulla superficie del pezzo in esame quando ciò è consentito, o in una mappa, in modo da permettere che la zona di interesse in una radiografia possa essere accuratamente rintracciabile per quanto riguarda la sua posizione sul pezzo, per il periodo di conservazione della radiografia richiesto.

I marcatori di posizione verranno posti sul pezzo dal lato sorgente nei seguenti casi:

a) componenti piatti o giunti longitudinali in componenti conici o cilindrici;

b) componenti sferici o curvi in cui lato convesso è verso la sorgente.

I marcatori di posizione possono essere posti sul lato pellicole quando i componenti sferici o cilindrici devono essere radiografati e la sorgente è verso la superficie della parete concava e quando la distanza sorgente pellicola è maggiore del raggio interno.

Per i componenti piatti, giunti longitudinali o componenti cilindrici, si possono usare i marcatori di posizione lato pellicola purché vengano rispettate le condizioni di cui alla Fig. 5A (e).

8. LOCATION MARKS

Location markers, which are to appear as radiographic image on the film, shall be placed on the part not on the exposure holder/cassette.

Their locations shall be permanently marked on the surface of the part being radiographed when permitted, or on a map, in a manner permitting the area of interest on a radiograph to be accurately traceable to its location on the part, for the required retention period of the radiograph.

Location markers shall be placed on the part at source side, in the following circumstances:

a) flat components or longitudinal seams in cylindrical or conical component;

b) curved or spherical components whose convex/side is towards the source.

The location markers shall be placed on film side when cylindrical or spherical components are to be radiographed and source is toward the concave wall surface and when source-to-material distance is greater than the inside radius.

For flat component or longitudinal seam on conical or cylindrical components, the film side location markers may be used provided that conditions as per Fig. 5A (e) are met.

9. RADIAZIONI DIFFUSE

Per verificare la presenza di radiazioni diffuse porre una lettera in piombo "B" (spessore di circa 1,6 mm e 12,5 mm di altezza) sul lato posteriore del contenitore della pellicola.

La radiografia verrà considerata inaccettabile se una leggera immagine della "B" appare su un fondo più scuro della radiografia.
Un'immagine scura della "B" su un fondo più chiaro è accettabile.

9. SCATTERED RADIATION

To check for the presence of backscattered radiation, place a lead letter "B" (approx. 1.6 mm thick and 12.5 mm in height) on the back side of the film container.
The radiograph shall be considered unacceptable if a light image of the "B" appears on a darker background of the radiograph.
A dark image of the "B" on a lighter background is acceptable.

10. SISTEMA DI IDENTIFICAZIONE ①

L'identificazione delle radiografie dovrà essere resa permanente e comprenderà almeno i seguenti dati:

a) Numero di commessa
b) Numero dell'item
c) Numero progressivo della radiografia (le radiografie di saldature riparate avranno lo stesso numero con un suffisso per la prima riparazione, un secondo suffisso per la seconda riparazionme e così via)
d) Identificazione del costruttore
e) Data di esposizione.

Queste ultime informazioni (d) (e) non devono necessariamente apparire nell'immagine radiografica permanente ma possono essere marcate sulla pellicola in modo definitivo, al di fuori dell'area di interesse.

10. IDENTIFICATION SYSTEM ①

The identification of radiograph shall be made in permanent way and must be constituted at minimum by all the following data:

a) Job number
b) Item number

c) Progressive number of radiograph (films of repair welds shall become the same radiograph number with a suffix for the first repair and a second suffix for the second repair)

d) Manufacturer identification

e) Date of exposure

These last information (d) (e) have not necessarily to appear in the permanent radiographic image, but they can be marked on the film in a permanent way, out of the area of interest.

11. DENSITÀ RADIOGRAFICA

La densità dell'immagine radiografica sarà:

a) non inferiore a 1.8 per visioni singole di pellicola per radiografie ai Raggi X.

b) non inferiore a 2 per visioni singole di pellicola per radiografie ai Raggi Gamma.

Per visione composita di esposizioni a più pellicole:

ogni pellicola delle serie composita avrà una densità minima di 1.3. La densità massima sarà di 4 sia per visioni singole che composite.

Se la densità della radiografia in qualsiasi punto dell'area di interesse varia di meno del 15% o di più del 30% della densità letta sul penetrametro a fori o sull'area adiacente al filo designato nel penetrametro a filo entro i limiti minimo e massima di densità precisati al punto 11.1, verrà allora usato un ulteriore penetrametro per ogni area o aree eccezionali e la radiografia verrà ripetuta.

La misurazione della densità radiografica verrà fatta utilizzando un densitometro secondo le istruzioni fornite dal suo fabbricante.

La taratura del densitometro verrà fatta confrontandolo con una pellicola tarata della scale dei grigi riconducibile a norme nazionali.

Il densitometro verrà tarato in conformità al paragrafo 5 di ASME SE 1079 ogni 3 mesi.

11. RADIOGRAPHIC DENSITY

The density of the radiographic image shall be:

a) not less than 1.8 for single film viewing for radiography using X-Ray source.

b) not less than 2 for single film viewing for radiography using Gamma Ray source.

For composite viewing of multiple film exposures:

Each film of the composite set shall have a minimum density of 1.3. The maximum density shall be 4.0 either single or composite viewing.

If the density of the radiograph through the area of interest varies by more than minus 15% or plus 30% from the density through the body of the hole penetrameter or adjacent to the designated wire of a wire penetrameter, within the minimum/maximum allowable density range specified in par. 11.1 then an additional penetrameter shall be used for each exceptional area or areas and the radiograph retaken.

The measurement of the radiographic density shall be made by using a densitometer according to the instruction supplied by its manufacturer.

The calibration of densitometer shall be done by comparison with a calibrated step wedge film traceable to a national standard.

The densitometer shall be calibrated in accordance with Par. 5 of ASME SE 1079 every three months.

12. <u>INDICATORI DELLA QUALITÀ DELL'IMMAGINE (I.Q.I.) (PENETRAMETRI)</u>

Normalmente verranno utilizzati penetrametri in conformità alle ASME Sez. V, Articolo 2 tabella T-276 o ASME Sez. VIII articolo KE-1 tabella KE-101.

Tipi differenti di penetrametri a fili possono essere usati quando si esaminano prodotti non costruiti in accordo al Codice ASME e quando ciò è concordato con il Cliente.

Per le saldature, lo spessore su cui è basata la scelta del penetrametro è lo spessore di parete singola nominale più il rinforzo ammesso dalla Sezione del Codice applicabile (Vedi tabella 10L).

Gli anelli e le piastrine di rinforzo non devono essere considerati parte dello spessore della saldatura o del rinforzo nella scelta del penetrametro.

Quando la radiografia verrà fatta senza togliere il rinforzo di saldatura o la piattina di rinforzo, una piastrina di materiale radiograficamente simile al metallo di saldatura verrà posizionata, se necessario, sotto il penetrametro, in modo che la densità radiografica nella zona di interesse non sia maggiore del -15% rispetto alla densità radiografica attraverso il penetrametro.

Lo spessore della piastrina verrà scelto in modo da considerare lo spessore di rinforzo della saldatura ammesso dal Sez. Codice più lo spessore della piattina di rinforzo se non è rimosso.

Le dimensioni della piastrina saranno maggiori di quelle del penetrametro in modo che almeno tre lati del contorno del penetrametro siano visibili sulla radiografia.

12 IMAGE QUALITY INDICATORS (I.Q.I.) (PENETRAMETERS)

Generally, the designated penetrameters conforming to ASME Code Sect. V, Article 2 table T-276 or ASME Code Sect. VIII Div. 3, Article KE-1 table KE-101 shall be used.

Different type of wire penetrameters may be used when examining of jobs not fabricated in accordance with the ASME Code and when so agreed with Customer.

For welds, the thickness on which the penetrameter is based, is the nominal single wall thickness plus the reinforcement permitted by the referencing Code Section (see table 10L).

Backing rings or strips are not to be considered as part of the weld or reinforcement thickness in penetrameter selection.

When the radiography will be performed without removing of weld reinforcement or backing strip, a shim of material radiographically similar to the weld metal shall be placed between the part and the hole penetrameter, if needed, so that the radiographic density throughout the area of interest is no more than minus 15% from (lighter than) the radiographic density through the penetrameter.

The shim thickness shall be selected in such way to consider the weld reinforcement thickness allowed by the Code Section plus backing strip thickness (if not removed).

The shim dimensions shall exceed the penetrameters dimensions such that at least three sides of the penetrameter image shall be visible in the radiograph.

13. SENSIBILITÀ DELL'ESAME

Le apparecchiature e la tecnica utilizzate per l'esecuzione dell'esame radiografico, garantiranno una sensibilità sufficiente per visualizzare l'immagine del penetrametro a fori e il foro specificato, o il filo designato del penetrametro a filo, che rappresentano indicazioni essenziali della qualità dell'immagine della radiografia.

Le radiografie dovranno inoltre mostrare i numeri e le lettere di identificazione del penetrametro.

Se l'immagine del penetrametro a fori richiesta e il foro specificato, o il filo designato, non si vedono in ciascuna pellicola nella tecnica e a pellicole multiple, ma si vedono nella visione composita, l'interpretazione sarà ammessa soltanto con la visione composita.

13 EXAMINATION SENSITIVITY

The equipment and the technique employed for performing the radiographic examination shall ensure a sufficient sensitivity to display the hole penetrameter image and the specified hole, or the designated wire of wire penetrameter which are essential indications of the image quality of the radiograph.

The radiographs shall also display the identifying numbers and letters.

If the required hole penetrameter image and specified hole, or designated wire, do not show on any film in a multiple film technique, but do show in composite film viewing, interpretation shall be permitted only by composite film viewing.

14. POSIZIONAMENTO E NUMERO DEI PENETRAMETRI

Verrà usato normalmente un penetrametro per ogni radiografia.

I penetrametri a fili verranno posti sulla saldatura dal lato della sorgente in modo che la lunghezza dei fili sia perpendicolare alla lunghezza della saldatura.

Normalmente un penetrametro del tipo a fori verrà posto vicino al metallo base dal lato sorgente.

Quando non è possibile posizionare il penetrametro dal lato della sorgente per ragioni di inaccessibilità, questo verrà posto a contatto con il pezzo lato pellicola, e la lettera "F" verrà posta su o vicino al penetrametro, al di fuori della zona di interesse.

In caso di esposizione panoramica, quando si usa più di un film e la sorgente viene posta sull'asse del recipiente o del componente cilindrico, almeno 3 penetrametri verranno posti con un intervallo di 120°.

Per recipienti sferici, quando la sorgente è ubicata nel centro dei recipienti e più di un film viene esposto simultaneamente, verranno usati almeno 3 penetrametri equamente distanziati su un cordone circonferenziale di 360°, più un ulteriore penetrametro per ogni altro cordone.

Allo scopo di mantenere la continuità delle registrazioni che interessano esposizioni successive, tutte le radiografie che mostrano i penetrametri che qualificano la tecnica usata dovranno essere conservate.

14 PLACEMENT AND NUMBER OF PENETRAMETERS

Normally one penetrameter for each radiograph shall be used.

Wire type penetrameter shall be placed on the weld so that the length of the wires is perpendicular to the length of the weld, on the source side.

Normally the hole type penetrameter shall be placed adjacent to the weld on the base metal, on the source side.

Where inaccessibility prevents placing the penetrameter on the source side, it shall be placed on the film side, in contact with the part being examined and a lead letter "F" shall be placed on/or adjacent to the penetrameter, out of the area of interest.

In case of panoramic exposure, when more than one film are used and the source is placed on the axis of the cylindrical vessel or component, at least 3 penetrameters shall be placed with 120° spacing.

For spherical vessel when the source is located at the center of the vessel and more than one film are simultanously exposed, at least 3 equally spaced penetrameters for 360 degr. circumferential seam, plus one additional penetrameter for each other seam shall be used.

In order to maintain the continuity of records involving subsequent exposures, all radiographs exhibiting penetrameters which qualify the technique, must be retained.

15. TECNICA RADIOGRAFICA

15.1 Tecnica a parete singola.

Normalmente le radiografie verranno eseguite utilizzando la tecnica a parete singola, ogni volta che questa è possibile, nella quale la radiazione attraversa una sola parete della saldatura.

15.1 Single-Wall Technique

Radiography shall be done normally using a single wall exposure technique, wherever practicable, in which the radiation passes through only one wall of the weld.

15.2 Tecnica a parete doppia

Quando la tecnica a parete singola non è applicabile, verrà adottata la tecnica a parete doppia, nella quale la radiazione passa attraverso due pareti.

In questo caso, quando i diametri nominali esterni delle saldature cilindriche sono superiori a 89 mm, verrà usata una ripresa a parete singola per l'accettazione, considerando soltanto la parete lato pellicola.

Verrà effettuato un numero di esposizione adeguato per dimostrare che è stata ottenuta la copertura richiesta.

Quando si richiede una copertura completa delle saldature circonferenziali si dovranno eseguire almeno tre pose a 120° l'una dall'atra.

Per tubazioni con diametro nominale esterno di 89 mm o inferiore, verrà usata anche la tecnica a doppia parete e in questo caso entrambe le pareti sono visionate per accettazione sulla stessa radiografia (visione a doppia parete).

Il fascio di radiazioni può essere deviato dal piano della saldatura con un angolo sufficiente a separare le immagini della porzione di saldatura dal lato della sorgente da quella dal lato pellicola in modo che non ci sia sovrapposizione delle zone da interpretare.

Quando viene richiesta una copertura completa vengono prese almeno 2 esposizioni a 90° per ogni giunto.

Per la visione a doppia parete sarà usato un penetrametro lato sorgente come indicato in fig. 7B.

Per esposizioni a doppia parete il tipo di penetrametro verrà scelto dalla tabella 6A tenendo conto dello spessore di una parete.

15.2 Double-Wall Technique.

When the single wall technique is not practical, a double wall technique shall be used, in which the radiation passes through two walls.

In this case, when the nominal outside diameter of cylindrical welds is more than 89 mm, a single wall viewing for acceptance shall be used, by considering only the film side wall.

An adequate number or exposures shall be made to demonstrate that the required coverage has been obtained.

When complete coverage is required for circumferential welds, a minimum of three exposure taken 120 deg. to each other shall be made.

For welds in piping 89 mm or less in nominal outside diameter, the double wall technique shall also be used and in this case both walls are viewed for acceptance on the same radiograph (double-wall viewing).

The radiation beam may be offset from the plane of the weld at an angle sufficient to separate the images of the source side and film side portions of the weld, so that there is no overlap of the areas to be interpreted.

When complete coverage is required a minimum to two exposures taken 90 deg. to each other shall be made for each joint.

For double wall viewing only, a source side penetrameter shall be used as indicated in fig. 7B.

For double wall exposures, the penetrameter type selected from table 6A considering the thickness of one wall, shall be used.

16. SVILUPPO PELLICOLE

Le radiografie sono sviluppate manualmente o automaticamente.

I bagni verranno mantenuti alla temperatura minima di 20°C. Il tempo di sviluppo sarà quello consigliato dal costruttore.

Per la fase di sviluppo verranno usati porta pellicole in acciaio inossidabile.

L'asciugatura verrà ottenuta in forni con circolazione di aria calda.

Le pellicole sviluppate dovranno essere esenti da difetti chimici, meccanici o altre macchie che possano mascherare l'immagine di eventuali discontinuità nella zona di interesse.

16 FILM PROCESSING

The radiographs are developed by manual or automatical processing.

The baths shall be maintained at the minimum temperature of 20°C. The developing time shall be recommended by the manufacturer.

For developing stage, stainless steel film holder shall be used.

Drying is obtained in ovens with hot air circulation.

The developed films shall be free from mechanical, chemical or other blemishes that can mask the image of any discontinuity in the area of interest.

17. VALUTAZIONE DELLA RADIOGRAFIA

La valutazione delle radiografie viene fatta da personale del Nuovo Pignone qualificato al Livello III, che verifica la loro qualità e che i risultati degli esami siano conformi alle norme applicabili. Lo stesso personale registrerà l'interpretazione di ogni radiografia e la disposizione sul componente esaminato su un modulo di interpretazione radiografica che accompagna le radiografie.

17 EVALUATION OF RADIOGRAPH

The radiographs evaluation shall be performed by Nuovo Pignone personnel qualified at Level III, that verifies their required quality and that results of the examination are complying with the applicable code. The same personnel shall record the interpretation of each radiograph and disposition of the material examined on a radiographic interpretation review form accompanying the radiographs.

18. CRITERI DI ACCETTAZIONE

I seguenti tipi di imperfezioni verranno considerati inaccettabili e dovranno essere riparate:

1) Qualsiasi tipo di cricca o zona di fusione o penetrazione incompleta.
2) Qualsiasi inclusione allungata, tipo scoria, la cui lunghezza superi:
   a) 1/4" (6 mm) per t fino a 3/4" (19 mm) ①
   b) 1/3 t per t da 3/4" (19 mm) a 2 1/4" (57 mm)
   c) 3/4" (19 mm) per t oltre 2 1/2" (57 mm)

   dove:

   t = Spessore di saldatura
3) Qualsiasi gruppo di inclusioni in linea la cui lunghezza superi t in una lunghezza di 12 t, escluso quando la distanza fra le imperfezioni successive superi 6 L, dove L è la lunghezza dell'imperfezione più lunga del gruppo.
4) Indicazioni arrotondate superiori a quelle specificate dalle norme di accettazione, illustrate nell'Appendice 4 dell'ASME VIII, Div.1, nella Appendice 8 dell'ASME VIII, Div.2, nella Appendice 6 dell'ASME VIII, Div.3 e nell'Appendice A-250 dell'ASME I.

18 ACCEPTANCE CRITERIA

The following types of imperfections shall be judged unacceptable and shall be repaired.

1) Any type of crack, or zone of incomplete fusion or penetration.

2) Any elongated inclusion, such as slag, which has lenght greater than:

a) 1/4" (6 mm) for t up to 3/4 in (19 mm) ①

b) 1/3 t for t from 3/4"(19 mm) to 2 1/4"(57 mm)

c) 3/4" (19 mm) for t over 2 1/4" (57 mm)

where:

t = the thickness of the weld.

3) Any group of inclusions in line that has an aggregate length greater than t in a length of 12 t, except when the distance between the successive imperfection exceeds 6L, where L is the length of the longest imperfection in the group.

4) Rounded indications in excess of that specified by the acceptance standards given in Appendix 4 of ASME Code Sect. VIII Div.1, in Appendix 8 of ASME Code Sect. VIII Div.2, in Appendix 6 of ASME Code Sect. VIII Div.3 and in Appendix A-250 of ASME Code Sect.I.

19. PERSONALE ①

Il personale impiegato nell'esame in conformità alla presente procedura, sarà quello qualificato secondo EN 473.

La valutazione del controllo radiografico sarà eseguita da un operatore certificato al II livello.

19. PERSONNEL ①

The personnel employed in the examination in accordance with this procedure shall be that qualified according to EN 473.

Results of RT testing should be interpreted by a level II.

20. REGISTRAZIONE DI ESAME

Ogni esame radiografico verrà provvisto di una registrazione del procedimento specifico utilizzato dal Nuovo Pignone, comprendente almeno le seguenti informazioni:

a) Commessa di identificazione o numero del componente.

b) Tipo di materiali e gamma di spessori.
c) Isotopo usato o massima tensione di Raggi X usata.
d) Distanza minima sorgente pellicola.
e) Dimensioni reali della macchia focale
f) Marca e designazione delle pellicole
g) Tipo di schermi
h) Numero di esposizioni
i) Numero di pellicole per cassetta
l) Esposizione a parete singola o doppia
m) Visione a parete singola o doppia.

20 EXAMINATION RECORD

Each radiographic examination shall be provided with a record of the specific procedure utilized by Nuovo Pignone, including as a minimum the following informations:

a) Identification job or ITEM number
b) Material type and thickness range
c) Isotope used or maximum X-Ray voltage used
d) Minimum source to film distance
e) Effective focal spot sizes
f) Film brand and designation
g) Screen type
h) Number of exposures
i) Number of film per cassette
l) Single or double wall exposure
m) Single or double wall viewing

TAVOLA 10L

Massimi spessori per i rinforzi di saldatura su ciascuna faccia:

< 3/32" (2.38 mm)	1/32" (0.79 mm)
3/32" (2.38 mm) ÷ 3/16" (4.76 mm)	1/16" (1.59 mm)
3/16" (4.76 mm) ÷ 1" (25.4 mm)	3/32" (2.38 mm)
1" (25.4 mm) ÷ 2" (50.8 mm)	1/8" (3.18 mm)
2" (50.8 mm) ÷ 3" (76.2 mm)	5/32" (3.97 mm)
3" (76.2 mm) ÷ 4" (101.6 mm)	7/32" (5.56 mm)
4" (101.6 mm) ÷ 5" (127 mm)	1/4" (6.35 mm)
> 5" (127 mm)	5/16" (7.94 mm)

TABLE 10L

Maximum thickness for the weld reinforcement on each face:

Less than 3/32" (2.38 mm)	*1/32" (0.79 mm)*
3/32" (2.38 mm) ÷ 3/16" (4.76 mm)	*1/16" (1.59 mm)*
3/16" (4.76 mm) ÷ 1" (25.4 mm)	*3/32" (2.38 mm)*
1" (25.4 mm) ÷ 2" (50.8 mm)	*1/8" (3.18 mm)*
2" (50.8 mm) ÷ 3" (76.2 mm)	*5/32" (3.97 mm)*
3" (76.2 mm) ÷ 4" (101.6 mm)	*7/32" (5.56 mm)*
4" (101.6 mm) ÷ 5" (127 mm)	*1/4" (6.35 mm)*
Over 5" (127 mm)	*5/16" (7.94 mm)*

ARTICLE 2 — RADIOGRAPHIC EXAMINATION

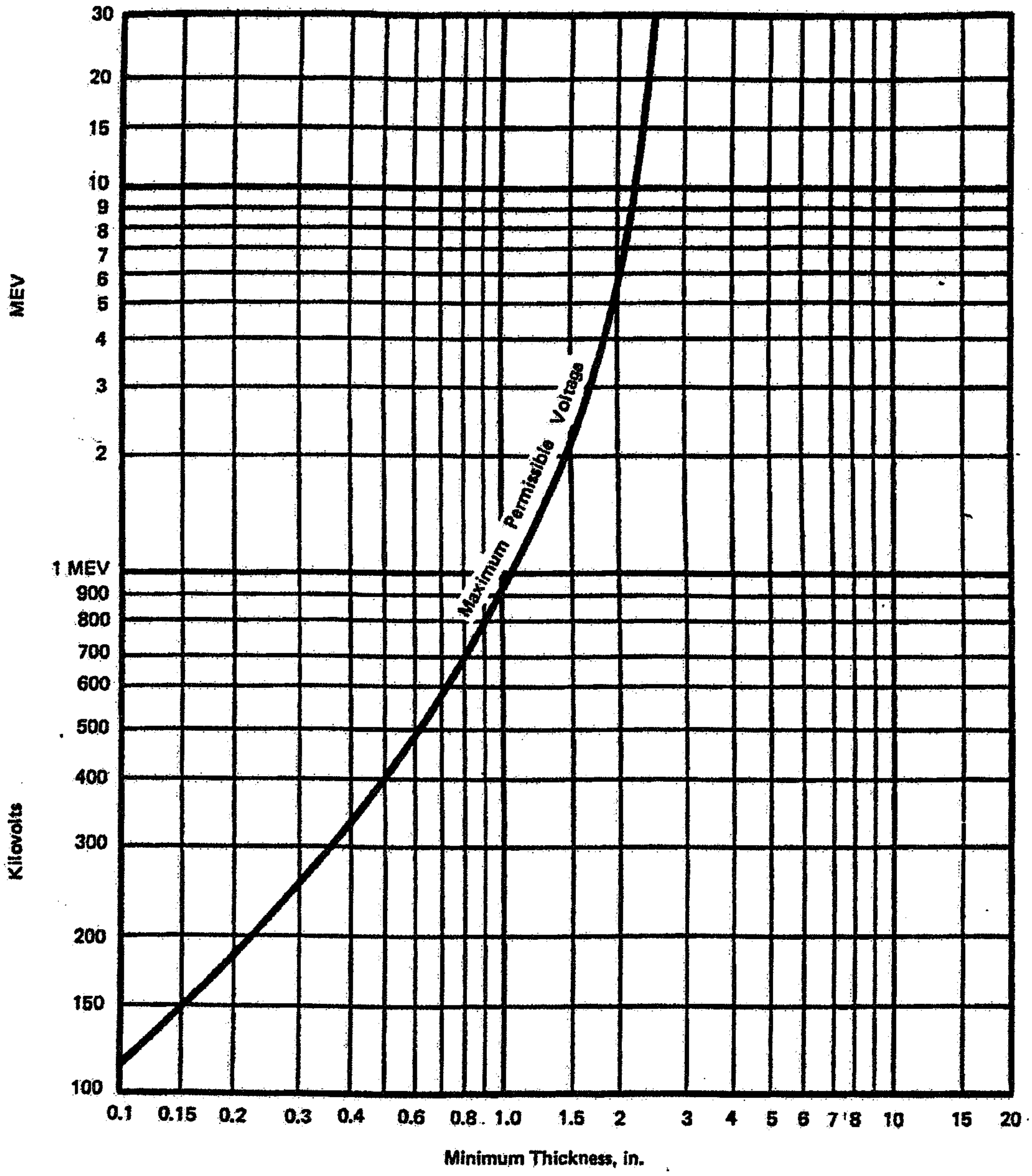

FIG. 1A MAXIMUM VOLTAGE FOR STEEL

REV.	DESCRIZIONE - DESCRIPTION	
		ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①
1	Revised where indicated ①	N. SOU0116556/4
0	Emissione - Issue	LINGUA-LANG. AI — PAGINA-SHEET 29 / 30

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

Nuovo Pignone
MASSA

RADIOGRAPHIC EXAMINATION

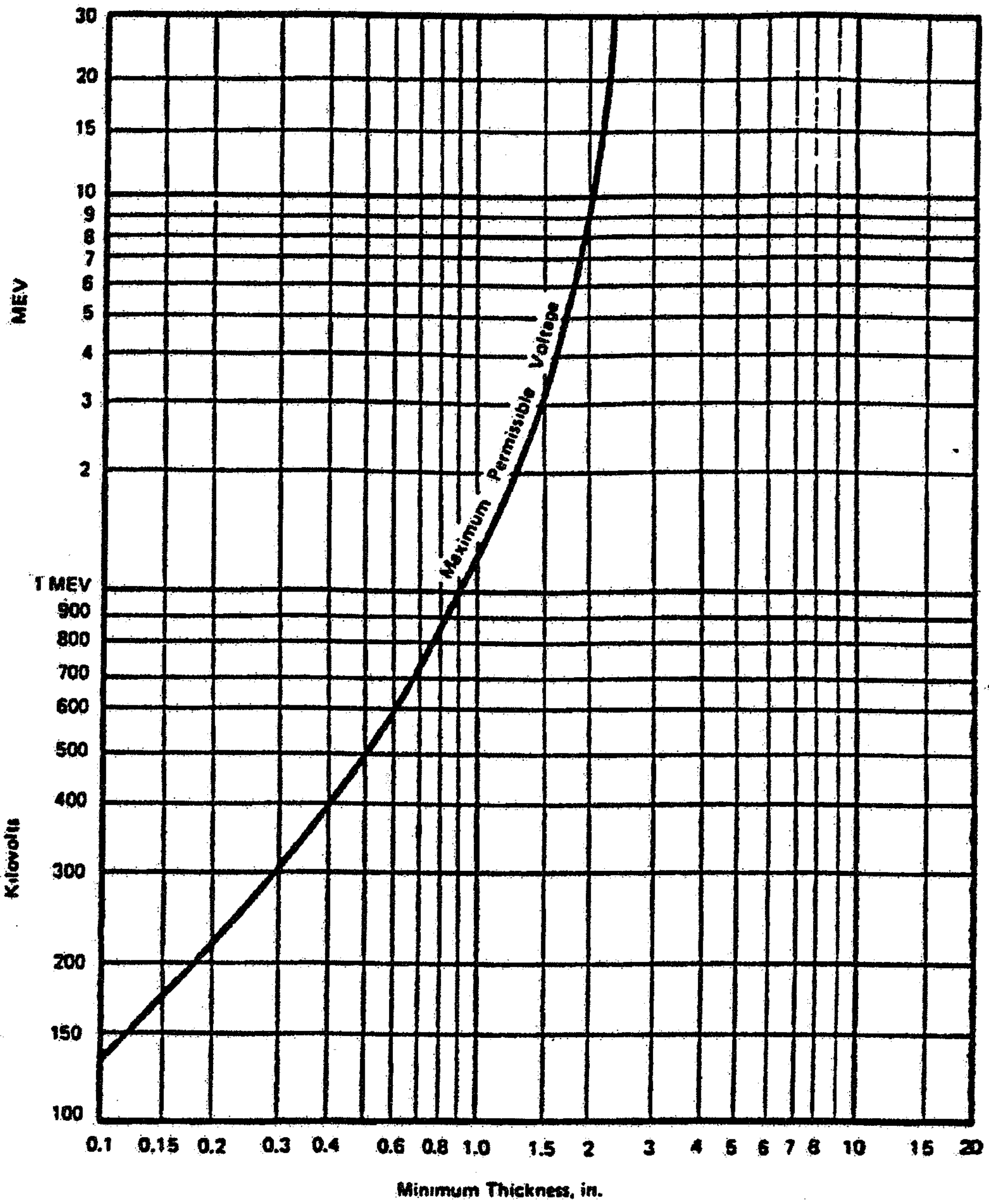

FIG. 1B MAXIMUM VOLTAGE FOR ALLOYS OF COPPER AND/OR HIGH NICKEL

REV.	DESCRIZIONE - DESCRIPTION
1	Revised where indicated ①
0	Emissione - Issue

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①

N. SOU0116556/4

LINGUA-LANG.	PAGINA-SHEET
AI	30 / 31

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

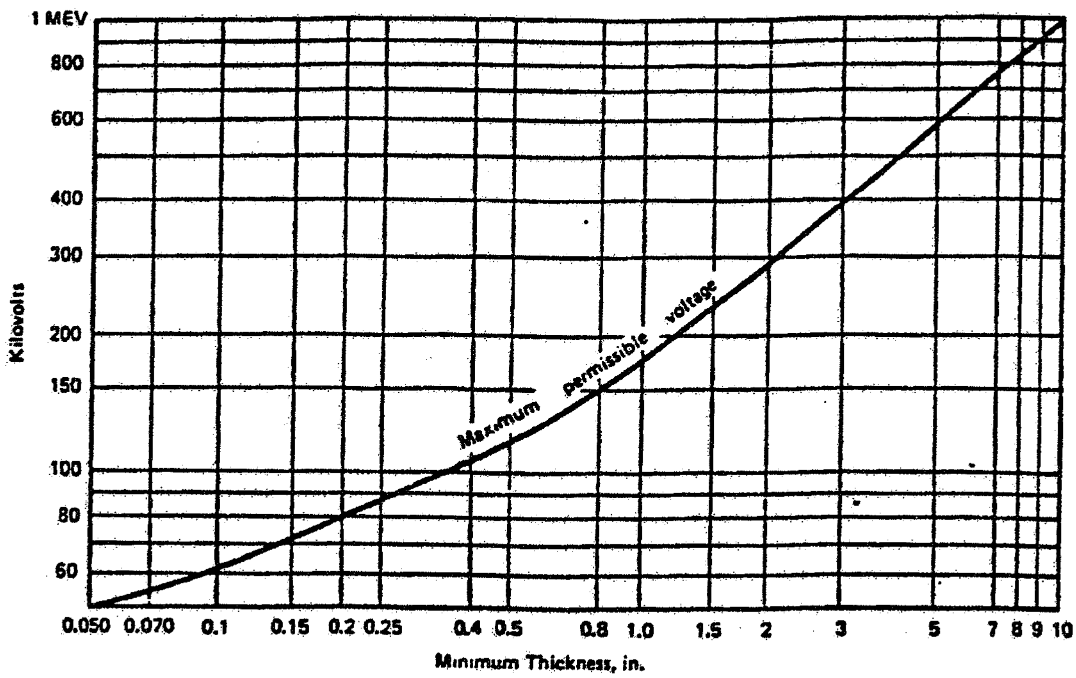

FIG. 1C MAXIMUM VOLTAGE PERMITTED FOR ALUMINUM AND ALUMINUM ALLOYS

Figure 4A

Source	Lead screens		Composite Illustration				Film	Notes
			A	B	C	D		
			Steel thickness					
	Front	Back	25 mm	50 mm	100 mm	150 mm		
150 KV	0,12 mm	0,12 mm	X				Type II	6 mm lead mask
250 KV	0,12 mm	0,12 mm		X			Type II	6 mm lead mask
1000 KV	0,76 mm	0,25 mm	X	X	X	X	Type I	
	0,12 mm	0,12 mm	X	X	X		Type II	
2000 KV	0,76 mm	0,25 mm	X	X	X	X	Type I	
	0,12 mm	0,12 mm	X	X	X	X	Type II	
10 Mev	1,0 mm	0,25 mm	X	X	X	X	Type II	
15 Mev	1,0 mm	0,25 mm	X	X	X	X	Type I	
Iridium 192	0,12 mm	0,25 mm	X				Type II	
	0,25 mm	0,25 mm		X	X		Type II	
Cobalt 60	0,12 mm	0,25 mm	X				Type II	
	0,25 mm	0,25 mm		X	X		Type II	

①

Note:

These are the minimum requirements according to ASME Code.

For definition of used film, see specific procedure.

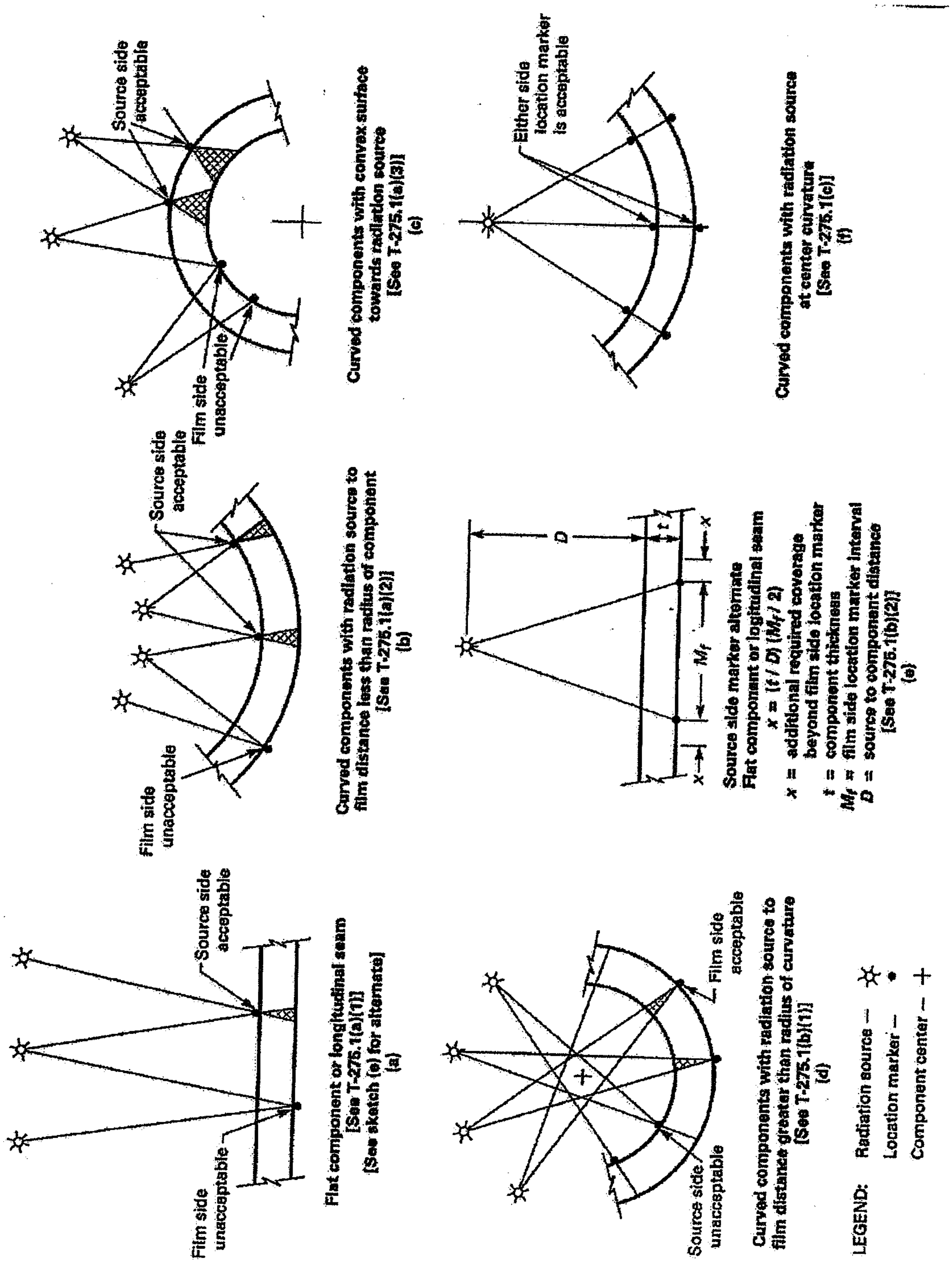

Figure 5A: Marker location

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TABLE 6A

IQI SELECTION

Nominal Single-Wall Material Thickness Range		IQI			
		Source Side		Film Side	
in.	mm	Hole-Type Designation	Wire-Type Essential Wire	Hole-Type Designation	Wire-Type Essential Wire
Up to 0.25, incl.	Up to 6.4, incl.	12	5	10	4
Over 0.25 through 0.375	Over 6.4 through 9.5	15	6	12	5
Over 0.375 through 0.50	Over 9.5 through 12.7	17	7	15	6
Over 0.50 through 0.75	Over 12.7 through 19.0	20	8	17	7
Over 0.75 through 1.00	Over 19.0 through 25.4	25	9	20	8
Over 1.00 through 1.50	Over 25.4 through 38.1	30	10	25	9
Over 1.50 through 2.00	Over 38.1 through 50.8	35	11	30	10
Over 2.00 through 2.50	Over 50.8 through 63.5	40	12	35	11
Over 2.50 through 4.00	Over 63.5 through 101.6	50	13	40	12
Over 4.00 through 6.00	Over 101.6 through 152.4	60	14	50	13
Over 6.00 through 8.00	Over 152.4 through 203.2	80	16	60	14
Over 8.00 through 10.00	Over 203.2 through 254.0	100	17	80	16
Over 10.00 through 12.00	Over 254.0 through 304.8	120	18	100	17
Over 12.00 through 16.00	Over 304.8 through 406.4	160	20	120	18
Over 16.00 through 20.00	Over 406.4 through 508.0	200	21	160	20

TABLE 6B – 6C

HOLE-TYPE IQI DESIGNATION, THICKNESS, AND HOLE DIAMETERS

IQI Designation	IQI Thickness, in. (mm)	1*T* Hole Diameter, in. (mm)	2*T* Hole Diameter, in. (mm)	4*T* Hole Diameter, in. (mm)
5	0.005 (0.13)	0.010 (0.25)	0.020 (0.51)	0.040 (1.02)
7	0.0075 (0.19)	0.010 (0.25)	0.020 (0.51)	0.040 (1.02)
10	0.010 (0.25)	0.010 (0.25)	0.020 (0.51)	0.040 (1.02)
12	0.0125 (0.32)	0.0125 (0.32)	0.025 (0.64)	0.050 (1.27)
15	0.015 (0.38)	0.015 (0.38)	0.030 (0.76)	0.060 (1.52)
17	0.0175 (0.44)	0.0175 (0.44)	0.035 (0.89)	0.070 (1.78)
20	0.020 (0.51)	0.020 (0.51)	0.040 (1.02)	0.080 (2.03)
25	0.025 (0.64)	0.025 (0.64)	0.050 (1.27)	0.100 (2.54)
30	0.030 (0.76)	0.030 (0.76)	0.060 (1.52)	0.120 (3.05)
35	0.035 (0.89)	0.035 (0.89)	0.070 (1.78)	0.140 (3.56)
40	0.040 (1.02)	0.040 (1.02)	0.080 (2.03)	0.160 (4.06)
45	0.045 (1.14)	0.045 (1.14)	0.090 (2.29)	0.180 (4.57)
50	0.050 (1.27)	0.050 (1.27)	0.100 (2.54)	0.200 (5.08)
60	0.060 (1.52)	0.060 (1.52)	0.120 (3.05)	0.240 (6.10)
70	0.070 (1.78)	0.070 (1.78)	0.140 (3.56)	0.280 (7.11)
80	0.080 (2.03)	0.080 (2.03)	0.160 (4.06)	0.320 (8.13)
100	0.100 (2.54)	0.100 (2.54)	0.200 (5.08)	0.400 (10.16)
120	0.120 (3.05)	0.120 (3.05)	0.240 (6.10)	0.480 (12.19)
140	0.140 (3.56)	0.140 (3.56)	0.280 (7.11)	0.560 (14.22)
160	0.160 (4.06)	0.160 (4.06)	0.320 (8.13)	0.640 (16.26)
200	0.200 (5.08)	0.200 (5.08)	0.400 (10.16)	...
240	0.240 (6.10)	0.240 (6.10)	0.480 (12.19)	...
280	0.280 (7.11)	0.280 (7.11)	0.560 (14.22)	...

WIRE IQI DESIGNATION, WIRE DIAMETER, AND WIRE IDENTITY

Set A			Set B		
Wire Diameter, in.	(mm)	Wire Identity	Wire Diameter, in.	(mm)	Wire Identity
0.0032	(0.08)	1	0.010	(0.25)	6
0.004	(0.10)	2	0.013	(0.33)	7
0.005	(0.13)	3	0.016	(0.41)	8
0.0063	(0.16)	4	0.020	(0.51)	9
0.008	(0.20)	5	0.025	(0.64)	10
0.010	(0.25)	6	0.032	(0.81)	11

Set C			Set D		
Wire Diameter, in.	(mm)	Wire Identity	Wire Diameter, in.	(mm)	Wire Identity
0.032	(0.81)	11	0.100	(2.54)	16
0.040	(1.02)	12	0.126	(3.20)	17
0.050	(1.27)	13	0.160	(4.06)	18
0.063	(1.60)	14	0.200	(5.08)	19
0.080	(2.03)	15	0.250	(6.35)	20
0.100	(2.54)	16	0.320	(8.13)	21

FIG. A-210-1 SINGLE-WALL RADIOGRAPHIC TECHNIQUES

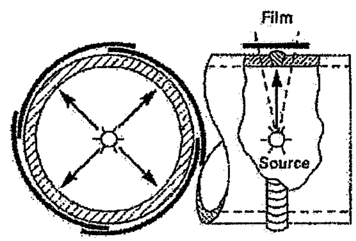
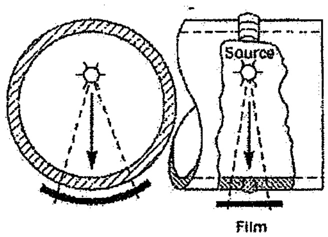
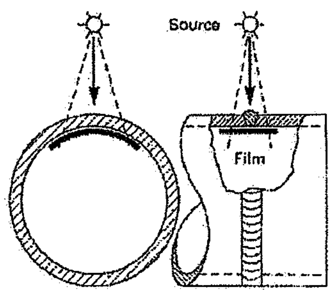
O.D.	Exposure Technique	Radiograph Viewing	Source-Weld-Film Arrangement		IQI		Location Marker Placement
			End View	Side View	Selection	Placement	
Any	Single-Wall T-271.1	Single-Wall	 Exposure Arrangement — A		T-276 and Table T-276	Source Side T-277.1(a) Film Side T-277.1(b)	Either Side T-275.3 T-275.1(c)
Any	Single-Wall T-271.1	Single-Wall	 Exposure Arrangement — B		T-276 and Table T-276	Source Side T-277.1(a) Film Side T-277.1(b)	Film Side T-275.1 (b)(1)
Any	Single-Wall T-271.1	Single-Wall	 Exposure Arrangement — C		T-276 and Table T-276	Source Side T-277.1(a) Film Side T-277.1(b)	Source Side T-275.1 (a)(3)

FIG. A-210-2 DOUBLE-WALL RADIOGRAPHIC TECHNIQUES

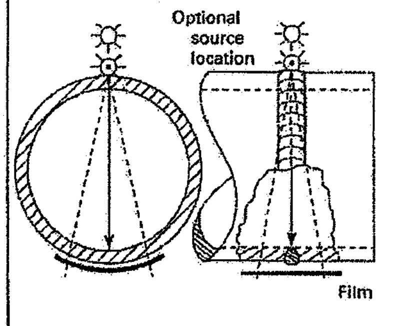
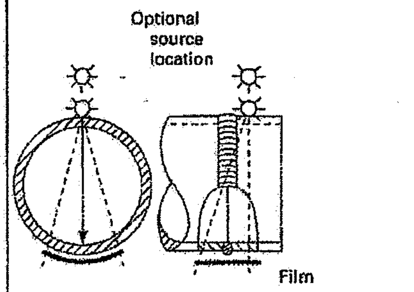
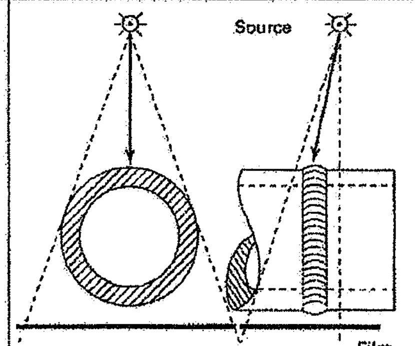
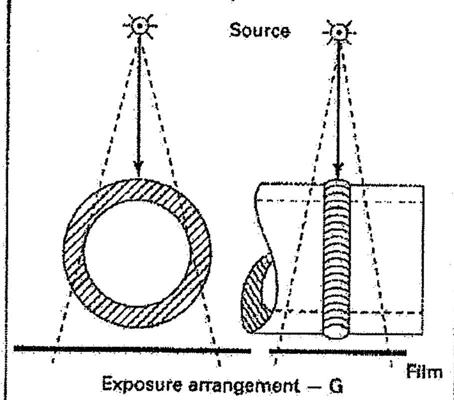
O.D.	Exposure Technique	Radiograph Viewing	Source-Weld-Film Arrangement: End View	Source-Weld-Film Arrangement: Side View	IQI Selection	IQI Placement	Location Marker Placement
Any	Double-Wall: T-271.2(a) at Least 3 Exposures 120 deg. to Each Other for Complete Coverage	Single-Wall	 Exposure arrangement — D		T-276 and Table T-276	Source Side T-277.1(a) Film Side T-277.1(b)	Film Side T-275.1 (b)(1)
Any	Double-Wall: T-271.2(a) at least 3 Exposures 120 deg. to Each Other for Complete Coverage	Single-Wall	 Exposure arrangement — E		T-276 and Table T-276	Source Side T-277.1(a) Film Side T-277.1(b)	Film Side T-275.1 (b)(1)
3½ in. (88 mm) or Less	Double-Wall T-271.2(b)(1) at Least 2 Exposures at 90 deg. to Each Other for Complete Coverage	Double-Wall (Ellipse): Read Offset Source Side and Film Side Images	 Exposure arrangement — F		T-276 and Table T-276	Source Side T-277.1(a)	Either Side T-275.2

FIG. A-210-2 DOUBLE-WALL RADIOGRAPHIC TECHNIQUES (CONT'D)

O.D.	Exposure Technique	Radiograph Viewing	Source-Weld-Film Arrangement		IQI		Location Marker Placement
			End View	Side View	Selection	Placement	
$3\frac{1}{2}$ in. (88 mm) or Less	Double-Wall: T-271.2(b)(2) at Least 3 Exposures at 60 deg. or 120 deg. to Each Other for Complete Coverage	Double-Wall. Read Super-imposed Source Side and Film Side Images	 Exposure arrangement — G		T-276 and Table T-276	Source Side T-277.1(a)	Either Side T-275.2

Nuovo Pignone MASSA	CLIENTE – CUSTOMER *CONOCO PHILLIPS* ①
	LOCALITA' - PLANT LOCATION *WILHELMSHAVEN, GERMANY*
COMMESSA - JOB 3100274÷3100279	IMPIANTO - PLANT *WRG-DEEP CONVERSION PROJECT* ①

TITOLO - TITLE

A PROCEED
AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER
NAME:
07 AUG. 2006
FLUOR B.V.

ULTRASONIC INSPECTION WITH TIME OF FLIGHT DIFFRACTION TECHNIQUE (T.O.F.D.T.)

PROCEDURA PER IL CONTROLLO ULTRASONORO CON TECNICA T.O.F.D.

A PROCEED
FLUOR®
DATE: 10-7-06
WELDING-ENGINEER
AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

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G.L. Frolla 20/2/06
Viareggio Office
Lloyd's Register

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ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①

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1. SCOPE

This procedure has been developed for the execution of automatized ultrasonic inspection on: circumferential butt joints belt to belt, belt to upper head and skirt to vessel attachment according to scan-plan (see tables 1 and 2).

Jobs concerned are following:

1. SCOPO

Questa procedura è stata sviluppata per l'esecuzione del controllo automatico dei giunti di testa circonferenziali virola a virola, virola a fondo superiore e l'attacco della gonna in accordo allo "scan-plan" (vedi tabella 1 e 2).

Le commesse interessate dal controllo in oggetto sono le seguenti:

Job *Commessa*	Item ① *Sigla*	Drawing *Disegno*	Thickness (mm) *Spessore*	Material *Materiale*
3100274 3100275	D-6211 D-6231	SUO 0269055/1 SUO 0269056/1	shell: 270 + 4,2 mm head: 139 + 4,2 mm	ASME SA 336 F22V ASME SA 542 Gr.D Cl.4a
3100276 3100277	D-6212 D-6232	SUO 0269057/1 SUO 0269058/1	shell: 260 + 4,2 mm head: 134 + 4,2 mm	ASME SA 336 F22V ASME SA 542 Gr.D Cl.4a
3100278 3100279	D-6214 D-6234	SUO 0269059/1 SUO 0269060/1	shell: 241 + 4,2 mm head: 125 + 4,2 mm	ASME SA 336 F22V ASME SA 542 Gr.D Cl.4a

2. METHOD OF EXAMINATION

Technique "Time of Flight Diffraction" with automatized system capable to record at 100% the joint under examination, on floppy disk to allow subsequent evaluation.

2. METODO DI ESAME

Tecnica "Time of Flight Diffraction (TOFD)" con sistema automatico in grado di registrare al 100% l'esame della saldatura su base magnetica per la successiva analisi dei dati.

3. REFERENCE DOCUMENTS

ASME sect. V article 4 (edition 2004)

ASME sect. VIII div. 2 (edition 2004)

ASME Code Case 2235-7 ①

3. DOCUMENTI DI RIFERIMENTO

ASME sez. V articolo 4 (edizione 2004)

ASME sez. VIII div.2 (edizione 2004)

ASME Code Case 2235-7 ①

4. SURFACE CONDITIONS

The surface of the part to be examined shall be free of weld spatter, rust or other extraneous particles which can interfere with correct contact of the transducer.

Examination will be performed on weld flush grounded externally.

4. CONDIZIONI SUPERFICIALI

La superficie del pezzo da esaminare dovrà essere esente da gocce di saldatura, ruggine od altro materiale estraneo che possa interferire con un buon contatto delle sonde.

L'esame sarà eseguito su saldature rasate esternamente a liscio.

5. COUPLANT

A couplant shall be used which guarantees excellent wettability, transmission of ultrasonic energy, viscosity and easy removal.

The same couplant used for calibration shall be used for ultrasonic inspection and any post-calibration.

In this job a continuos water jet shall be used.

5 ACCOPPIAMENTO

Dovrà essere usato un accoppiante tale da garantire ottime bagnabilità, trasmissione di onde ultrasonore, viscosità e facilità di rimozione.

L'accoppiante impiegato per la calibrazione dovrà essere uguale a quello impiegato per il controllo e per l'eventuale post-calibrazione

In questa commessa sarà utilizzato un getto di acqua continuo.

6. REFERENCE SYSTEM

To clearly identify the position of the indications, the starting point for inspection of each joint, the "zero point" on one axis of the item, shall be punched with low stress stamp.

Every joint shall have a progressive identification number.

A sketch shall be provided showing the joint identification, the location of the "zero point", and the direction of rotation during inspection for each joint.

6. SISTEMA DI RIFERIMENTO

Allo scopo di localizzare in modo univoco la posizione delle indicazioni è richiesta la punzonatura del punto di inizio del controllo di ogni giunto "punto 0" in corrispondenza di un asse dell'apparecchio con punzoni low stress.

Ogni giunto dovrà avere un numero progressivo di identificazione.

Dovrà essere redatto uno sketch nel quale saranno riportate, per ogni giunto, l'identificazione del giunto, la localizzazione del "punto 0" ed il senso di rotazione durante il controllo.

7. APPARATUS

7.1. Computer configuration

An ultrasonic computerized system shall be used for the TOFD technique.

The main features of the system are:

- transducer;
- fast portable computer Dolch 486/100 Hard Driver, VGA color TFT active matrix display containing P/R and A/D board

- TOFD technique software;
- dedicate scanner;
- power driver for mechanized scanner;

printer for copier documentation

7.2. Ultrasonic probes

Probes used for inspection shall comply with the following requirements:

- Number of probes: 2 (Transmitter / Receiver) for each scanning;
- Compressional wave;
- Type: SIGMA SWSMB-1/1-2;
- Refraction angle: 45° and 60° (see tables 1 and 2)
- Frequency: 2 MHz or 3,5 MHz;
- Crystal: barium titanate

7.3. Scanner

The weld shall be inspected using a scanner which holds the probes, transmitter and receiver in a symmetric position across the weld section.

The scanner shall be moved manually, while the record of position is automatic.

The scanner features shall provide probe center spacing regulation, appropriate pressure on probes to ensure correct contact, and encoder system to identify probe position in real time

7.4. System Configuration

The system shall be configured with one transducer, as trasmitter, and a second transducer as receiver. Use of preamplifier (typical fixed amplification in the range of 40 ÷ 60 dB) shall be foreseen. If used, such preamplifier should be placed on the receiver line, near the receiver.

7. APPARECCHIATURE

7.1. Configurazione del computer

Per la tecnica TOFD dovrà essere usato un sistema ad ultrasuoni computerizzato.

Le principali caratteristiche del sistema sono:

- *sonda;*

- *computer veloce portatile Dolch 486/100 disco rigido, scheda video VGA color TFT a matrice attiva e scheda P/R e A/D.*
- *software per tecnica TOFD;*
- *scanner dedicato;*
- *driver per scanner automatico;*
- *stampante per copie di documentazione.*

7.2. Sonde ultrasonore

Le sonde usate per il controllo dovranno essere conformi ai seguenti requisiti:

- *Numero di sonde: 2 (Trasmettitore/ Ricevitore) per ogni scansione;*
- *Onde di compressione;*
- *Tipo: SIGMA SWSMB-1/1-2*
- *A angolo di rifrazione: 45° e 60° (vedi tabelle 1 e 2);*
- *Frequenza: 2 MHz o 3,5 MHz (banda larga);*
- *Cristallo: titanato di bario*

7.3.Scanner

La saldatura sarà controllata usando uno scanner che contiene le sonde, con trasmettitore e ricevitore in posizione simmetrica rispetto alla sezione del giunto saldato.

Lo scanner viene manovrato manualmente, mentre la registrazione della posizione è automatica.

Le caratteristiche dello scanner dovranno includere la regolazione dell'interasse delle sonde, della pressione sulle sonde stesse per garantire un adeguato contatto, ed un sistema ad encoder per identificare la posizione della sonda in tempo reale.

7.4. Configurazione del sistema

La configurazione del sistema dovrà comprendere un primo trasduttore con funzioni di trasmettitore, ed un secondo trasduttore con funzioni di ricevitore. Dovrà essere previsto l'impiego di un preamplificatore (amplificazione tipica fissa tra 40 e 60 dB) che sarà disposto sulla linea del ricevitore in prossimità di quest'ultimo

8. CALIBRATION

8.1 Calibration blocks ①

The calibration for the time-of-flight diffraction measurements shall be performed using special blocks. The blocks shall include a set of cylindrical reflectors located at varius depths according to ASME V Art.4, Fig.T-434.2.1 having a diameter of 3 mm and one planar surface flaw, oriented parallel to the fusion line and no larger than the flaw in table 2 Code Case 2235-7.

The minimun requirements of the reference heat treated blocks are the following:

1) It should be made of a similar material the object under inspection with regard to sound velocity, grain attenuation and surface condition.
2) The width and the length of the scanning surface shall be adequate for probe movement over the reference reflectors.

Figure 1A shows the calibration blocks used.

8.2. Time base calibration

The PCS should be set appropriately for either the full depth of the component or for the depth and full range of a zone to be inspected (DZ).

Timebase calibration should always be performed with the trasducers set at appropriate PCS for the application (component), not for the calibration blocks. After setting for the component all set-up variables (trasducers, wedges, PCS), should be maintained constant.

Couple the transducers to a calibration reference standard that is flat, reasonably close in thickness to the component to be inspected, and of accurately known thickness.

Time base calibration requires precise measurement of pulse transit times for the lateral and back wall signals. Both shall be measured with system delay (∅-Offset) set to 0.

These times can be used to calculate ∅-Offset and precise PCS (earlier mechanical measure- ments do not account for beam emergence point inaccuracies, etc.).

The equation for making these calculations is:

$\varnothing\text{-Offset} = (Tbw^2 - Tlat^2 - 4t^2/V^2) / 2\,(Tbw - Tlat)$

$PCS = (Tlat - \varnothing\text{-Offset})\,V$

where:

V = Velocity

t = material thickness

Tlat = Pulse transit time to lateral wave

Tbw = Pulse transit time to back wall

∅-Offset = time used in electronics, cables and wedges (often called system delay)

PCS = exact probe center spacing:

Enter the resulting ∅-Offset and PCS values at the appropiate points in the TOFD acquisition and analysis programs.

8.3. Time base verification

Perform a scan of the calibration reference block thickness using the time/thickness algorithm applied to the image from the lateral wave to the backwall reflection. Adjust PCS in the analysis program, as necessary, such that 0 depth falls at the lateral waves.

To be an acceptable calibration, the ultrasonically measured block thickness must be within ± 5% of the actual block thickness

8.4. Reference sensitivity setting

Calibration of reference sensitivity shall be made for each PCS as defined in the Scan-Plan for the joint under examination (see tables 1 and 2).

8.5 Scanning Sensitivity

For scanning purposes, at least 6 dB shall be added to the reference gain. At the scanning gain the lateral wave response should not exceed ±50% FSH.

8 TARATURA

8.1. Blocchi di calibratura ①

La taratura per il controllo con la tecnica TOFD sarà eseguita su appositi blocchi. I blocchi devono avere una serie di riflettori cilindrici disposti a varie profondità secondo ASME V Art.4, Fig. T-434.2.1 aventi diametro di 3 mm ed un difetto planare superficiale orientato parallelamente alla linea di fusione ed avente dimensioni inferiori a quelle indicate nella tabella 2 del Code-Case 2235-7.

I requisiti minimi dei blocchi di riferimento non saldati sono i seguenti:

1) Il blocco dovrà essere di un materiale avente velocità di propagazione del suono, dimensione del grano, attenuazione e stato della superficie uguali a quello dell'oggetto in esame.

2) La larghezza e la lunghezza della superficie di scansione dovranno essere adeguate al movimento della sonda rispetto ai riflettori.

La figura 1A mostra i blocchi di taratura da usare.

8.2. Taratura dell'asse dei tempi

Il PCS (interasse tra le sonde) dovrà essere adeguato allo spessore totale del componente o alla profondità di scansione di interesse (DZ).

La taratura della base dei tempi dovrà essere sempre eseguita con i trasduttori distanziati di un PCS appropriato per l'applicazione (componente), e non per i blocchi di riferimento. Tutte le funzioni selezionate per il componente (trasduttori, zoccoli, PCS) dovranno essere mantenute costanti.

I trasduttori dovranno essere accoppiati ad un blocco di riferimento piano avente spessore noto e ragionevolmente simile a quello del componente da esaminare.

La taratura della base dei tempi richiede una precisa misurazione dei tempi di volo degli impulsi per i segnali dalla superficie (laterali) e dal fondo, entrambi questi valori dovranno essere misurati con il ritardo (∅-Offset) regolato a 0.

Questi tempi possono essere usati per calcolare con precisione valori di ∅-Offset di PCS (misurazioni meccaniche anteriori non tenevano in considerazione le imprecisioni del punto di emersione del fascio, ecc.).

L'equazione usata per eseguire tali calcoli è la seguente:

$$\varnothing\text{-Offset} = (Tbw^2 - Tlat^2 - 4t^2/V^2) / 2\,(Tbw - Tlat)$$

$$PCS = (Tlat - \varnothing\text{-Offset})\,V$$

dove:

V = velocità

t = spessore del materiale

Tlat = tempo di volo dalla superficie

Tbw = tempo di volo dal fondo

∅-Offset = tempo per percorrere cavi e zoccoli (spesso definito come ritardo)

PCS = Spazio esatto dalla sonda centrale

Impostare i risultanti valori di ∅-Offset e PCS nel programma di calcolo predisposto.

8.3. Verifica dell'asse dei tempi

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Eseguire una scansione sul blocco di calibrazione usando l'algoritmo tempo/spessore dell'immagine dall'onda superficiale (laterale) al fondo. Aggiustare PCS nel programma in modo che la profondità 0 sia in corrispondenza dell'onda superficiale.

La calibrazione è da considerare come accettabile se la misura ultrasonora dello spessore non differisce di ± 5% dello spessore effettivo del blocco

8.4. Taratura della sensibilità di riferimento

La calibrazione delle sensibilità di riferimento sarà eseguita per ogni PCS come definito nello Scan-Plan per il giunto in esame (vedi tabelle 1 e 2).

8.5 Sensibilità di scansione

Durante la scansione, almeno 6 dB saranno aggiunti all'amplificazione di riferimento. Con l'amplificazione di riferimento, la risposta della lateral wave non deve superare ± 50% dello schermo

9. SCANNING

9.1. Scan plan

A documented examination strategy shall be provided showing the main features of the TOFD technique applied to the specific components to be examined, (see figures 1B and 1C).

The following items shall be defined:

- thickness of weld;
- thickness, number and features of calibration blocks;
- transducer to be used;
- depth zone (DZ);
- probe center spacing (PCS);
- beam centerline (BC).

The initial straight beam material examination for reflectors that could interfere with the angle beam examination, shall be performed manually according to SOU 0116554/4.

9.2. Scanning direction

Scanning should be performed parallel to the weld axis, with the transducers positioned equally on both sides of the weld (D-SCAN) and with the trasducers along the nominal weld centerline (B//-SCAN)

Scans should be performed on 1 m step lengths.

Each step is identified by progressive number (1-2, 2-3, 3-4,...).

Scanning perpendicular to the weld axis shall be carried out only for sizing relevant indications (B⊥-SCAN).

9.3. Scanning coverage

Ultrasonic inspection shall cover 100 % of the weld joint, the H.A.Z. and a ¼ in. (6 mm) band on each side of the joint with a minimum overlap of 20%.

9.4. Scanning speed

The maximum speed of examination shall be dictated by the capability of the computer to acquire and process waveform.

The scanning speed shall be less than 75 mm/sec.

9. SCANSIONE

9.1. Programma di scansione

Dovrà essere fornita una adeguata strategia di esame indicante le principali caratteristiche della tecnica TOFD applicata ai componenti in esame (vedere figure 1B e 1C).

Dovranno essere definiti i seguenti parametri:

- *spessore del giunto saldato;*
- *spessore, numero e caratteristiche dei blocchi di taratura;*
- *trasduttore da usare;*
- *porzione di spessore sotto controllo (DZ);*
- *interasse tra le sonde (PCS);*
- *asse del fascio (BC).*

Il controllo iniziale con fascio dritto del materiale base per la ricerca di riflettori che possono interferire con l'esame a fascio angolato sarà eseguito manualmente in accordo a SOU 0116554/4.

9.2. Direzione di scansione

La scansione deve essere eseguita parallelamente all'asse del giunto saldato, sia con i trasduttori posizionati simmetricamente sui lati opposti di questo (D-SCAN) sia con entrambi i trasduttori sull'asse della saldatura (B//-SCAN).

La scansione deve essere eseguita su tratti di 1 m di lunghezza di saldatura.

Ogni step è da individuare con numeri progressivi (1-2, 2-3, 3-4,...).

La scansione perpendicolare all'asse del giunto saldato dovrà essere eseguita soltanto per il dimensionamento dell'indicazione (B⊥-SCAN).

9.3. Copertura

L'esame ultrasonoro dovrà interessare il 100% del giunto saldato, la Z.T.A. più il volume compreso in una distanza di ¼ in. (6 mm) da ogni lato del giunto con una sovrapposizione minima del 20%.

9.4. Velocità di scansione

La velocità massima di controllo dipenderà dalla capacità del computer di acquisire ed elaborare i segnali.

La velocità di scansione dovrà essere minore di 75 mm/s

10. DATA ACQUISITION

10.1. Acquisition gate

Data shall be recorded in unprocessed form.

A complete data set with no gating, filtering or thresholding shall be included in the data record.

10.2. Acquisition rate and signal averaging

The acquisition rate shall be a minimum of one A-scan, for 2 mm. All data shall be acquired using 16 averages to reduce the random level on the RF A-scan.

10.3. Data analysis

TOFD images shall be overviewed in order to determine whether they contain any significant flaws or whether the indications can be classified "geometric".

All indications deemed to be "geometric" need not be characterized or sized, but shall be documented.

Indications to be selected for the evaluation are those emerging from the background image for its shope, dimensions and intensity.

10. ACQUISIZIONE DEI DATI

10.1. Logica di acquisizione

I dati saranno registrati in forma non elaborata.

Dovrà essere inclusa nella registrazione una serie completa di dati rilevati senza filtraggi o limite di soglia.

10.2. Frequenza di acquisizione e media del segnale

La frequenza di acquisizione dovrà essere almeno di una scansione A ogni 2 mm. Tutti i dati saranno acquisiti impiegando una media su 16 valori per ridurre il livello random della RF A-scan.

10.3. Analisi dei dati

Le immagini TOFD dovranno essere analizzate per verificare se contengono difetti significativi o indicazioni classificabili come "geometriche".

Le indicazioni ritenute "geometriche" non devono essere caratterizzate o misurate, ma dovranno essere documentate.

Le indicazioni da selezionare per la valutazione sono quelle che risaltano dal sottofondo dell'immagine per la loro forma, dimensione ed intensità.

11. EVALUATION OF TOFD INDICATIONS

11.1. Recording

Significant indications listed in the TOFD report are:

1. for TOFD D-scan, all isolated flaw-like indications which appear to be greater than 5 mm and clusters of indications which appear to be associated with each other (i.e. not randomly dispersed throughout the image) shall be deemed reportable.
2. for TOFD B//-scan (trasverse flaws) all pairs of indications which could potentially result from the tips of trasverse planar flaws (including disturbances to the lateral wave response and/or backwall echo) shall be deemed reportable.

All significant indications shall be investigated to characterize the type of flaw (crack, lack of fusion, slag, etc) using manual pulse-echo technique (ref. procedure SOU 0116554/4).

11. VALUTAZIONE DELLE INDICAZIONI

11.1. Registrazione

Le indicazioni significative riportate nel rapporto TOFD saranno:

1. *per il TOFD D-scan saranno ritenute registrabili tutte le indicazioni isolate che presentano dimensioni maggiori di 5 mm e i gruppi di indicazioni che appaiono associate l'una a l'altra (cioè non casualmente disperse nell'immagine).*
2. *Per il TOFD B//-scan (difetti trasversali) saranno ritenute registrabili tutte le indicazioni che potrebbero risultare dalle estremità di un difetto planare trasversale (inclusi i disturbi della lateral wave o dell'eco di fondo).*

Tutte le indicazioni significative saranno analizzate per caratterizzare il tipo di difetto (cricca, mancata fusione, scoria, ecc.) con la tecnica pulse-echo manuale (procedura SOU 0116554/4).

11.2. Acceptance criteria ①

Recorded imperfection shall be investigated to the extent that the operator can determine the shape, identity and location of all such imperfections and evaluate them in terms of the acceptance standards given in (a), (b) and (c) below.

(a) Indication characterized as crack, lack of fusion, or incomplete penetration are unacceptable regardless of length.

(b) Other imperfections are unacceptable if the indications have dimension which exceed what indicated in table 2 Code Case 2235-7 (see page 18 of this procedure).

(c) Discontinuous flaw shall be considered a singular planar flaw if the distance between adjacent flaws is equal to or less than “S” as shown in Fig.2.

Discontinuous flaws that are oriented primarily in parallel planes shall be considered a singular planar flaw if the distance between tha adjacent planes is equal to or less ½ in. (refer to Fig.3)

Discontinuous flaws that are complanar and nonaligned in the through-wall thickness direction of the component shall be considered a singular planar flaw if the distance between adjacent flaws is equal to or less than “S” as shown in Fig.4.

Discontinuous flaws that are complanar in the through-wall direction within two parallel planes ½ apart (i.e., normal to the pressure-retaining surface of the component) are unacceptable if the additive flaw depth dimension of the flaws exceeds those shown in Fig.5

11.2. Criteri di accettazione ①

Le imperfezioni registrate saranno studiate in modo da determinarne la forma, la natura e la posizione e valutarne l'accettabilità secondo i criteri stabiliti in (a) e (b).

(a) Le indicazioni considerate come cricca, mancata fusione o incompleta penetrazione sono inaccettabili indipendentemente dalla lunghezza.

(b) Le altre indicazioni sono inaccettabili se hanno dimensioni superiori a quelle indicate nella tabella 2 del Code Case 2235-7 (vedi pag. 18 di questa procedura).

c) Difetti discontinui saranno considerati un unico difetto planare se la distanza fra difetti adiacenti è minore o uguale a “S” indicato in Fig.2.

Difetti discontinui orientati principalmente secondo piani paralleli saranno considerati un unico difetto planare se la distanza fra piani adiacenti è minore o uguale a ½ in. (vedi Fig.3)

Difetti discontinui complanari e non allineati nella direzione dello spessore saranno considerati un unico difetto planare se la distanza fra difetti adiacenti è minore o uguale a “S” indicato in Fig.4.

Difetti discontinui complanari nella direzione dello spessore entro due piani paralleli distanti ½ in (cioè normali alla superficie del componente) sono inaccettabili se l'altezza complessiva supera quella indicata in Fig.5.

Flaw acceptance criteria for 1" (25,4 mm) to 12" (304,8 mm) thick weld
(table 2 Code Case 2235-7) ①

	1 in. < t < 2 ½ in.		4 in. < t < 12 in.	
Aspect Ratio a/l	**Surface flaw a/t**	**Subsurface flaw a/t**	**Surface flaw a/t**	**Subsurface flaw a/t**
0,00	0,031	0,034	0,019	0,020
0,05	0,033	0,038	0,020	0,022
0,10	0,036	0,043	0,022	0,025
0,15	0,041	0,049	0,025	0,029
0,20	0,047	0,057	0,028	0,033
0,25	0,055	0,066	0,033	0,038
0,30	0,064	0,078	0,038	0,044
0,35	0,074	0,090	0,044	0,051
0,40	0,083	0,105	0,050	0,058
0,45	0,085	0,123	0,051	0,067
0,50	0,087	0,143	0,052	0,076

t=thickness of the weld excluding any allowable reinforcement

a,l=see figure 1D

12. REPORT OF EXAMINATION

Each joint shall be certified with TOFD report and manual pulse-echo report (see attachment)

12. CERTIFICATO DI ESAME

Per ogni giunto dovrà essere emesso un certificato TOFD ed un certificato pulse-echo manuale (vedi allegato).

13. PERSONNEL

Personnel who carry out TOFD examination shall be qualified and certified at least as level II in accordance with EN 473.

In addition, personnel shall have received training on TOFD technique and experience on high thickness welds examination with TOFD of at least one year.

The final interpretation and evaluation shall be performed by another qualified level III individual.

13. PERSONALE

Il personale incaricato di eseguire gli esami TOFD dovrà essere qualificato e certificato almeno al II livello secondo la norma EN 473.

Inoltre il personale dovrà aver partecipato a un corso di istruzione sulla tecnica TOFD e dimostrare esperienza sull'esame con tecnica TOFD dei giunti saldati di alto spessore di almeno un anno.

L'interpretazione e la valutazione finale saranno eseguite da un altro operatore qualificato al III livello.

Nuovo Pignone MASSA	**ULTRASONIC INPECTION WITH T.O.F.D. TECHNIQUE**

Nuovo Pignone MASSA	CERTIFICATO di ESAME con ULTRASUONI *ULTRASONIC TEST REPORT*	Nr. : Toxxx-yy Page Pag. : 1/2

Purchaser Cliente : ____ Order Ordine N° : ____

Shop Job Commessa : ____ Item Sigla : ____ Serial N° N° Fabbr. : ____ Dwg N° Disegno N° : ____

Inspecting Authority Ente di Collaudo : ____ Inspecting Plan Piano di Collaudo N° : ____ Stage Fase N° : ____

Specific Item Data Dati Specifici del Prodotto	Specific Procedure Specifica di Controllo	Tested Particular Particolare Controllato	Materials Materiali	Extent Test Esten. Contr.
	Details of the Test Descrizione dell' esame			

Equipment Strumentazione

COMPUTERIZED ULTRASONIC SYSTEM / SISTEMA ULTRASONORO COMPUTERIZZATO

UT HARDWARE	Computerized system test - pro system - Infometrics / I&T
UT SOFTWARE	B-C Scan-TOFD (Time Of Flight Diffraction)
SCANNER	NP 01

Technical Test Conditions

Condizioni di Controllo

Data Setting / Dati di Settaggio

DZ	PSC [mm]	*Probes* / Sonde			
		Type	Size	Angle	Frequency
1					
2					
1T					

Number Position Steps	*Thickness*	*Step Length*	*Start Position*	*Acquisition Step*

Calibratio blocks Blocchi di taratura	Holes	*Reference specifications* Specifiche di riferimento

Surface conditions Stato superfici	*Coupling* Accoppiamento	*Scanning surface* Superfice di scansione

Test carried out Esame effettuato ☐ *Before* Prima ☐ *After* Dopo ☐ *Heat treatment* Trattamento termico ☐ *Hydraulic test* Prova idraulica

Result conforming to the specified requirements Risultati conformi ai requisiti di specifica ☐ *Yes* Si ☐ *Not* No — ASME Code Case 2235 - 6

REV.	DESCRIZIONE - DESCRIPTION	
		ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①
1	Revised where indicated ①	N. SOU0116557/4
0	Emissione - Issue	LINGUA-LANG. AI — PAGINA-SHEET 20 / 21

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Nuovo Pignone
MASSA

ULTRASONIC INPECTION WITH T.O.F.D. TECHNIQUE

Nuovo Pignone
MASSA

CERTIFICATO di ESAME con ULTRASUONI
ULTRASONIC TEST REPORT

Nr.: Toxxx-yy
Page / Pag.: 2/2

Shop Job / Commessa: ________ Item / Sigla: ________ Serial N° / N° Fabbr.: ________ Dwg N° / Disegno N°: ________

Type of discontinuity - Tipologia di Discontinuita'				Evaluation Symbols- Simboli di Valutazione	
Aa	Indicazioni isolate tondeggianti. *Rounded isolated indication(s).*	C	Mancata fusione. *Lack of fusion.*	1	Senza indicazioni. *No indication(s).*
Ab	Indicazioni allineate tondeggianti. *Rounded aligned indication(s).*	D	Mancata penetrazione. *Incomplete penetration.*	2	Indicazioni trascurabili. *Not relevant indication(s).*
Ac	Gruppo di indicazioni tondeggianti. *Cluster of rounded indication(s).*	Ea	Cricche longitudinali. *Longitudinal crack.*	3	Indicazioni accettabili. *Acceptable indication(s).*
B	Incisioni allungate tipo scoria. *Elongated inclusion, such as slag.*	Eb	Cricche trasversali. *Transversal crack.*	4	Indicazioni non accettabili. *Not acceptable indication(s).*

TOFD Technique According to procedure N° ________

Circumferential Welded Joint: Shell Course Mark ... to Shell Course Mark ...

Step Dz1	Evaluation	Step Dz2	Evaluation	Step Dz1T	Evaluation						

TOFD Technique | PULSE ECHO Technique *According to Spec. N°*

Weld Item	Step	Dz	Distance from start point [mm]	Length indication [mm]	Depth indication [mm]	Height indication [mm]	Type used probe	Size [mm]	Angle	Frequency [MHz]	DAC h %	Type indication

Examiner / Operatore ________ Level II / Livello II

Q.C. Department Level III / Controllo Qualità Livello III ________

Massa il ________ Inspectors / Ispettori ________

REV.	DESCRIZIONE - DESCRIPTION	
		ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①
1	Revised where indicated ①	N. SOU0116557/4
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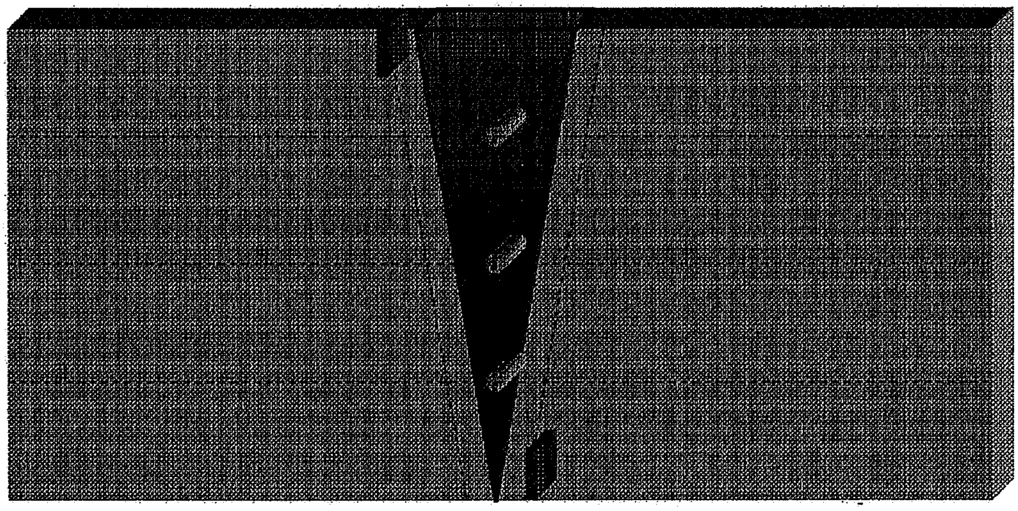


SDH Ø 3 mm and 50 mm length at ¼ t, ½ t, and ¾ t.
Notches 10 mm depth and 20 mm length at ¼ in. from bevel

Figure 1A - Calibration blocks

t = thickness = 255 mm ± 10% (shell welds)

t = thickness = 132 mm ± 10% (heads welds)

Table 1 - D SCAN PLAN (ITEM D-6211 and D-6231) ①

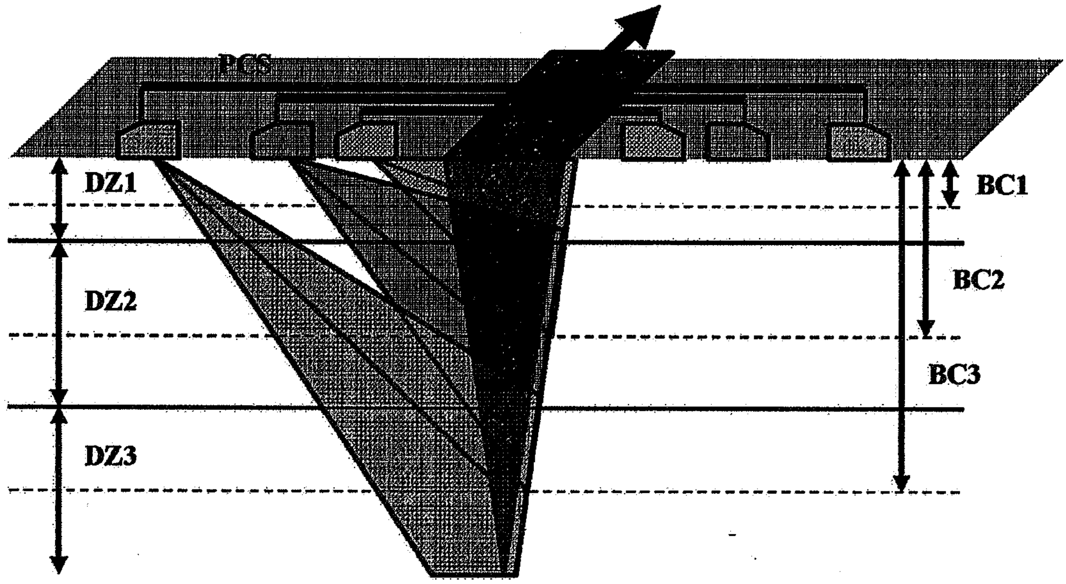
Component	Thick. Block (mm)	Thick. Weld (mm)	Probe angle	Ø (mm)	Freq. (MHz)	DZ1 (mm)	DZ2 (mm)	DZ3 (mm)	PCS (mm)	BC (mm)
shell	255±10%	270	60°	12.5	3,5	50			87	25
	255±10%	270	45°	25	2		110		220	110
	255±10%	270	45°	25	2			110	400	200
heads	132±10%	139	60°	12.5	3,5	50			87	25
	132±10%	139	45°	25	2		89		200	100
skirt	45±10%	45	60°	12.5	3,5	45			87	25

Table 1 - D SCAN PLAN (ITEM D-6212 and D-6232) ①

Component	Thick. Block (mm)	Thick. Weld (mm)	Probe angle	Ø (mm)	Freq. (MHz)	DZ1 (mm)	DZ2 (mm)	DZ3 (mm)	PCS (mm)	BC (mm)
shell	255±10%	260	60°	12.5	3,5	50			87	25
	255±10%	260	45°	25	2		110		220	110
	255±10%	260	45°	25	2			100	400	200
heads	132±10%	134	60°	12.5	3,5	50			87	25
	132±10%	134	45°	25	2		84		200	100
skirt	45±10%	45	60°	12.5	3,5	45			87	25

Table 1 - D SCAN PLAN (ITEM D-6214 and D-6234) ①

Component	Thick. Block (mm)	Thick. Weld (mm)	Probe angle	Ø (mm)	Freq. (MHz)	DZ1 (mm)	DZ2 (mm)	DZ3 (mm)	PCS (mm)	BC (mm)
shell	255±10%	241	60°	12.5	3,5	50			87	25
	255±10%	241	45°	25	2		100		220	110
	255±10%	241	45°	25	2			91	400	200
heads	132±10%	125	60°	12.5	3,5	50			87	25
	132±10%	125	45°	25	2		75		200	100
skirt	45±10%	40	60°	12.5	3,5	40			87	25



overlap: > 25 mm (1")

Figure 1B

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Table 2 – B// SCAN PLAN (ITEM D-6211 and D-6231) ①

Item	Thick. Block (mm)	Thick. Weld (mm)	Probe angle	Ø (mm)	Freq. (MHz)	DZ1 (mm)	DZ2	PCS (mm)	BC (mm)
shell	255±10%	270	45°	25	2	270		280	140
heads	127±10%	139	45°	25	2	139		150	75

Table 2 – B// SCAN PLAN (ITEM D-6212 and D-6232) ①

Item	Thick. Block (mm)	Thick. Weld (mm)	Probe angle	Ø (mm)	Freq. (MHz)	DZ1 (mm)	DZ2	PCS (mm)	BC (mm)
shell	255±10%	260	45°	25	2	260		280	140
heads	127±10%	134	45°	25	2	134		150	75

Table 2 – B// SCAN PLAN (ITEM D-6214 and D-6234) ①

Item	Thick. Block (mm)	Thick. Weld (mm)	Probe angle	Ø (mm)	Freq. (MHz)	DZ1 (mm)	DZ2	PCS (mm)	BC (mm)
shell	255±10%	241	45°	25	2	241		260	130
heads	127±10%	125	45°	25	2	125		140	70

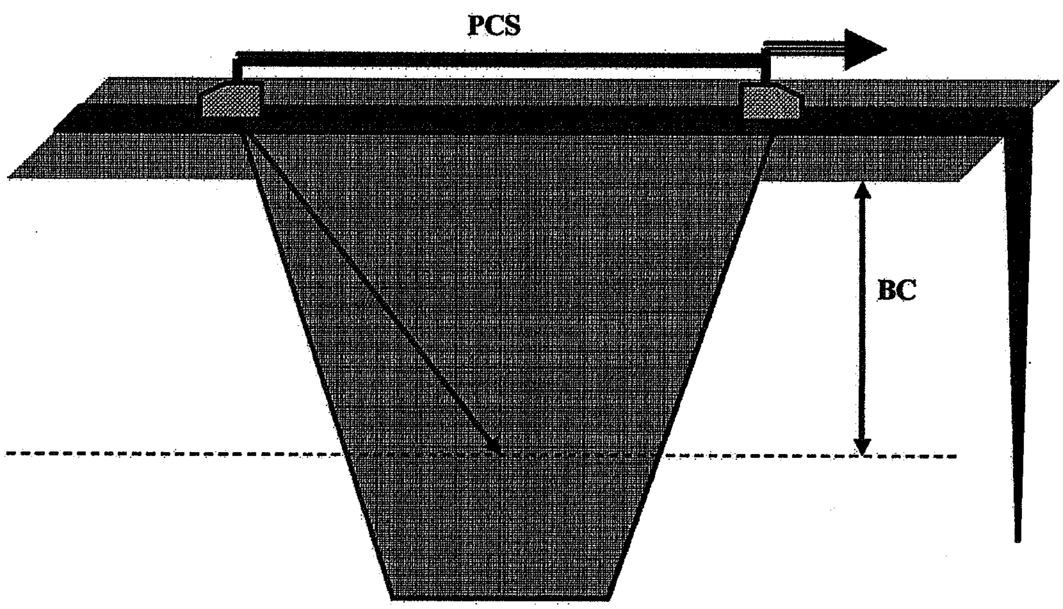

Figure 1C

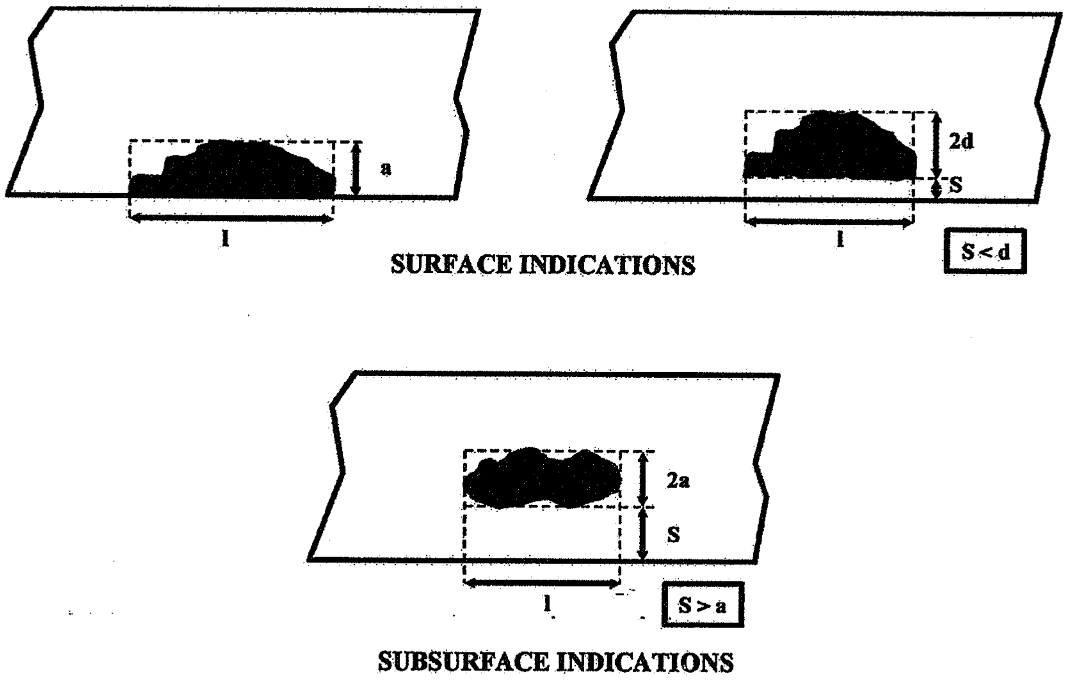

Figure 1D – Single indications (ASME Code Case 2235-7) ①

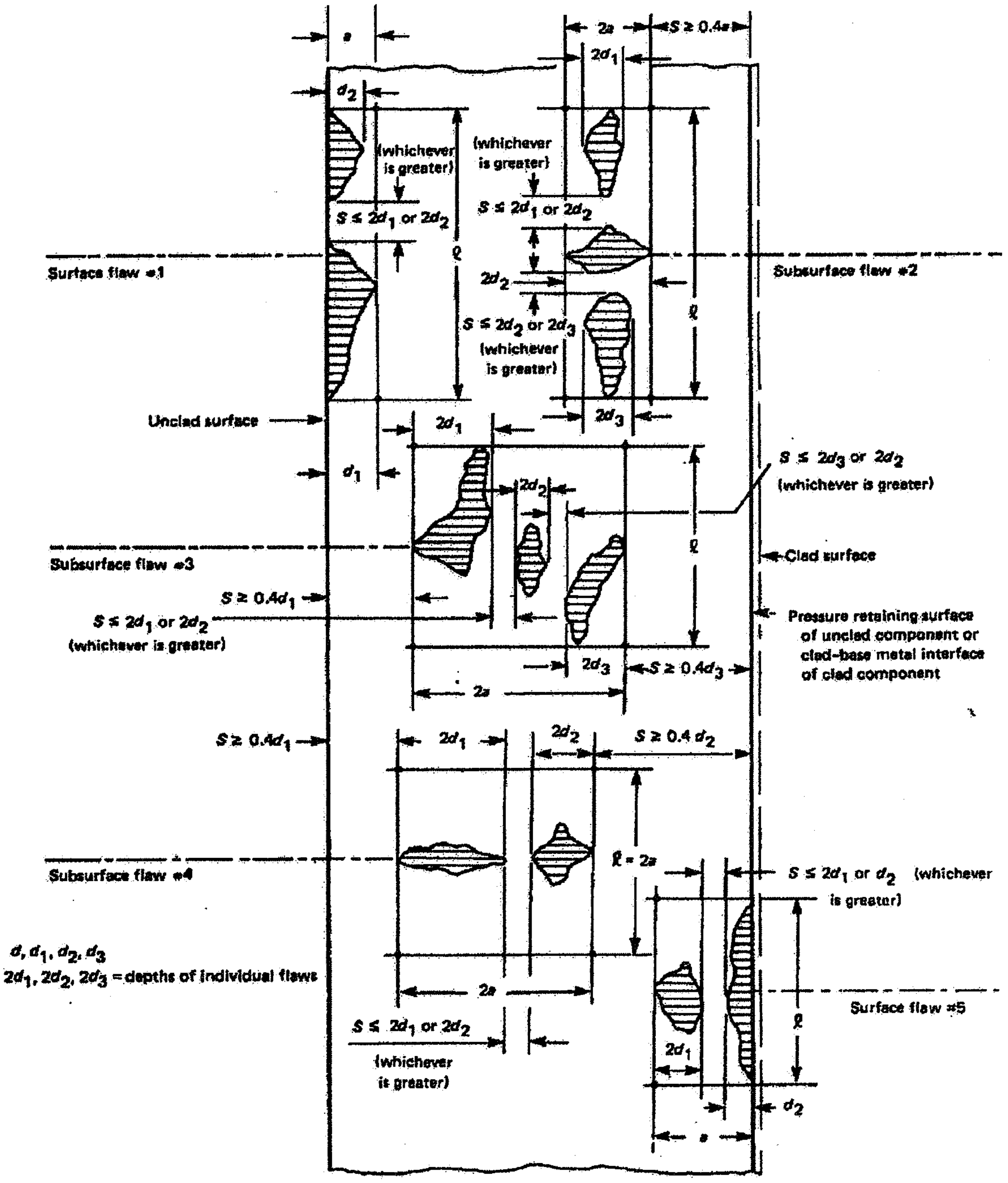

FIG. 2 MULTIPLE PLANAR FLAWS ORIENTED IN PLANE NORMAL TO PRESSURE RETAINING SURFACE

REV.	DESCRIZIONE - DESCRIPTION	
		ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①
1	Revised where indicated ①	N. SOU0116557/4
0	Emissione - Issue	LINGUA-LANG. AI — PAGINA-SHEET 27 / 28

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Nuovo Pignone MASSA	ULTRASONIC INPECTION WITH T.O.F.D. TECHNIQUE

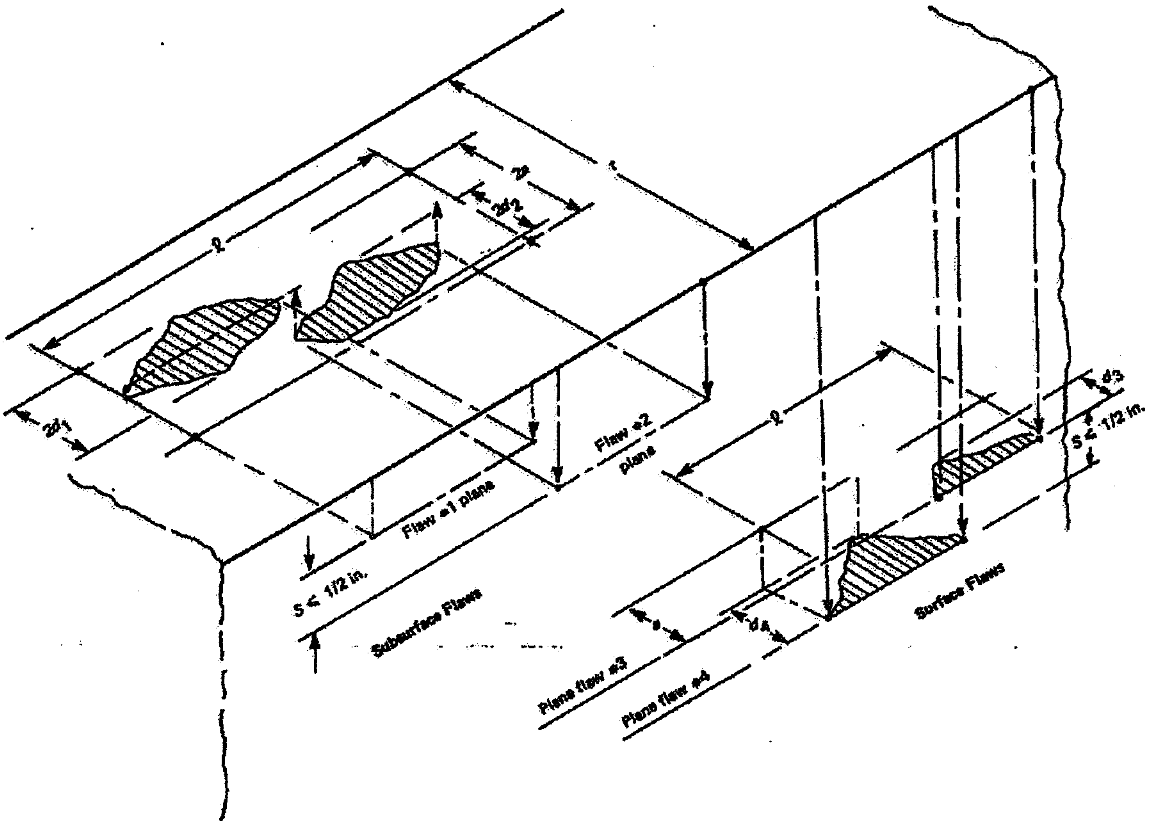

FIG. 3

		ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①	
1	Revised where indicated ①	N. SOU0116557/4	
0	Emissione - Issue	LINGUA-LANG.	PAGINA-SHEET
REV.	DESCRIZIONE - DESCRIPTION	AI	28 / 29

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SOSTITUITO DA - REPLACED BY

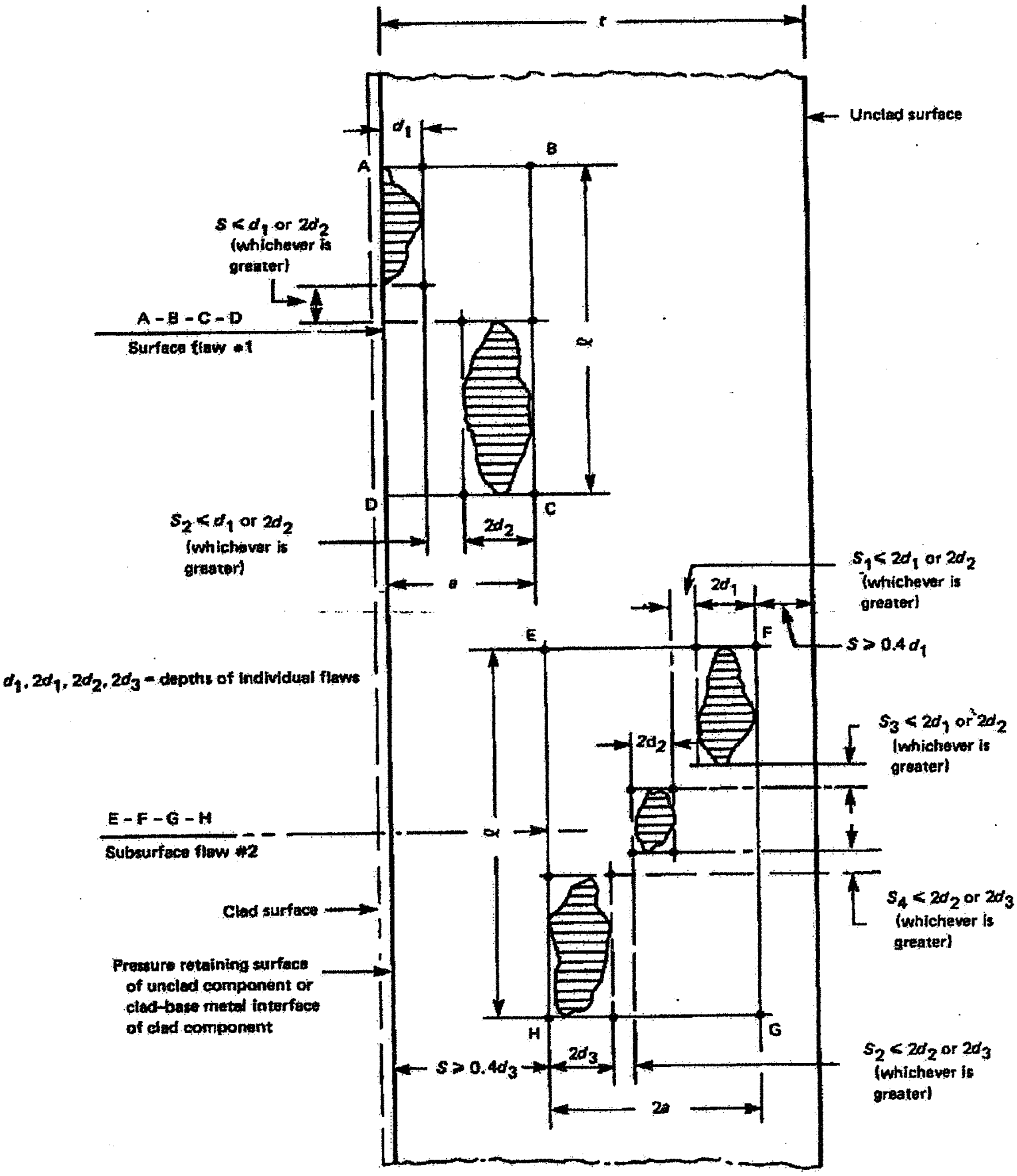
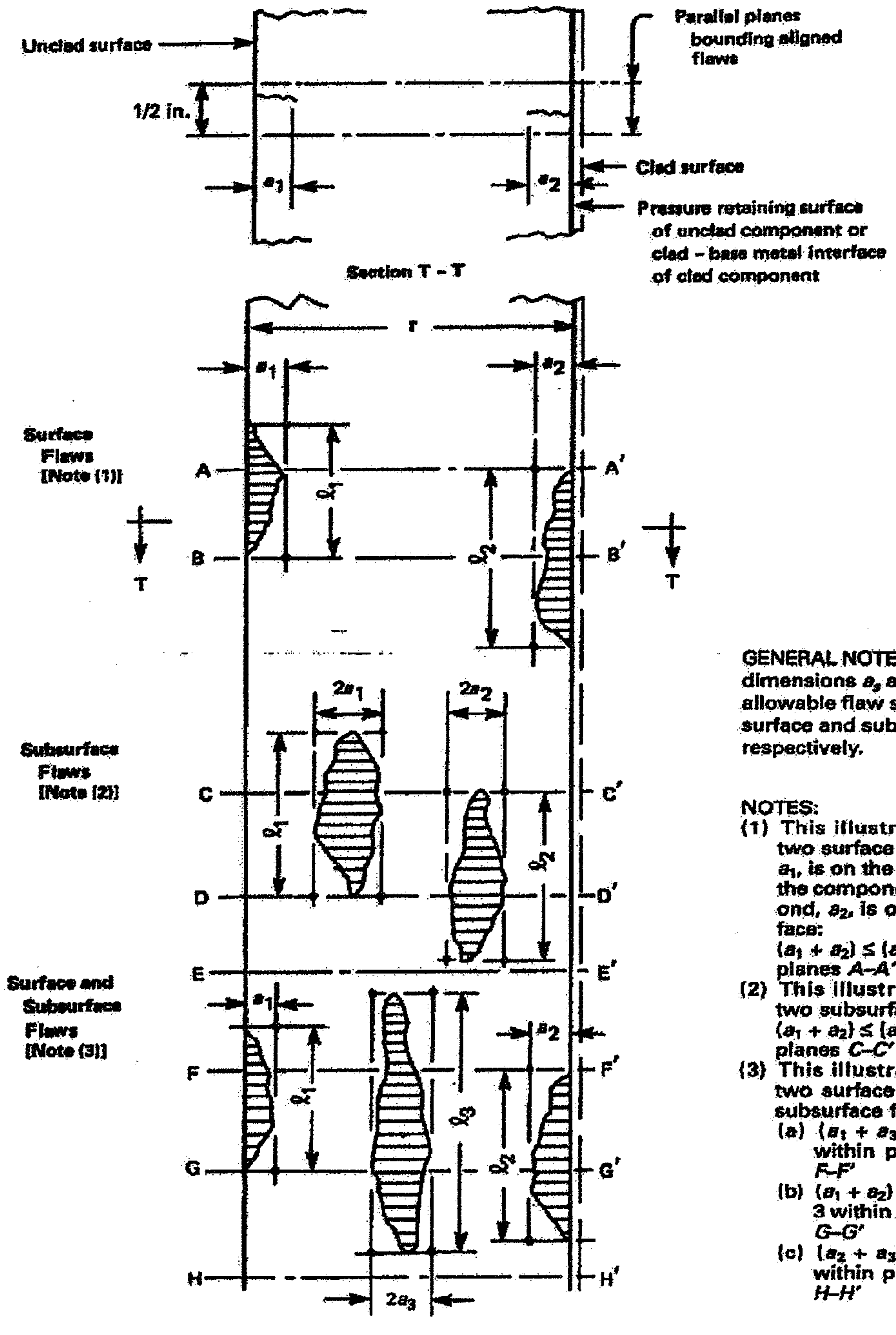


FIG. 4 NONALIGNED COPLANAR FLAWS IN PLANE NORMAL TO PRESSURE RETAINING SURFACE (ILLUSTRATIVE FLAW CONFIGURATIONS)



GENERAL NOTE: The flaw depth dimensions a_s and a_e are the allowable flaw standards for surface and subsurface flaws, respectively.

NOTES:

(1) This illustration indicates two surface flaws. The first, a_1, is on the outer surface of the component, and the second, a_2, is on the inner surface: $(a_1 + a_2) \le (a_s + a'_s)/2$ within planes *A–A'* and *B–B'*

(2) This illustration indicates two subsurface flaws: $(a_1 + a_2) \le (a_e + a'_e)/2$ within planes *C–C'* and *D–D'*

(3) This illustration indicates two surface flaws and one subsurface flaw:
  (a) $(a_1 + a_3) \le (a_s + a'_e)/2$ within planes *E–E'* and *F–F'*
  (b) $(a_1 + a_2) \le (a_s + a_e + a'_s)/3$ within planes *F–F'* and *G–G'*
  (c) $(a_2 + a_3) \le (a'_s + a_e)/2$ within planes *G–G'* and *H–H'*

FIG. 5 MULTIPLE ALIGNED PLANAR FLAWS

Nuovo Pignone MASSA	CLIENTE – CUSTOMER CONOCO PHILLIPS ①
	LOCALITA' - PLANT LOCATION WILHELMSHAVEN, GERMANY
COMMESSA - JOB 3100274÷3100279	IMPIANTO - PLANT WRG-DEEP CONVERSION PROJECT ①

TITOLO - TITLE

A PROCEED
AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER
NAME:
07 AUG. 2006
FLUOR B.V.

SPECIFICA PER L'ESAME ULTRASONORO CON TECNICA B-C SCAN DELLE SALDATURE.

B-C SCAN TECHNIQUE FOR ULTRASONIC EXAMINATION OF WELDS

Lloyd's Register EMEA
REVIEWED/~~WITNESSED~~
G.L. Frolla 10/7/07
Viareggio Office
Lloyd's Register

A PROCEED
FLUOR.
DATE: 10-7-06
WELDING-ENGINEER
AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

P05-0013 REV1

1	Revised where indicated ①	Zappavigna	Chiappini	Zappavigna	29.05.06
0	Emissione - Issue	Zappavigna	Chiappini	Zappavigna	30.01.06
REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①

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Electronically approved draw. GE NuovoPignone Internal DT-'N'

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1. SCOPO

Questa procedura è stata sviluppata per l'esecuzione del controllo ultrasonoro semimeccanizzato sulle saldature connessione-mantello, connessione-fondo e fondo inferiore-mantello.

Le commesse a cui verrà applicato sono le seguenti:

1. SCOPE

This procedure has been developed for execution of semi-mechanized ultrasonic inspection on nozzle-shell, nozzle-head and bottom head to shell joints.

Jobs concerned are the following:

Job *Commessa*	Item ① *Sigla*	Drawing *Disegno*	Thickness (mm) *Spessore*	Material *Materiale*
3100274	D-6211	SUO 0269055/1	shell: 270 + 4,2 mm	ASME SA 336 F22V
3100275	D-6231	SUO 0269056/1	head: 139 + 4,2 mm	ASME SA 542 Gr.D Cl.4a
3100276	D-6212	SUO 0269057/1	shell: 260 + 4,2 mm	ASME SA 336 F22V
3100277	D-6232	SUO 0269058/1	head: 134 + 4,2 mm	ASME SA 542 Gr.D Cl.4a
3100278	D-6214	SUO 0269059/1	shell: 241 + 4,2 mm	ASME SA 336 F22V
3100279	D-6234	SUO 0269060/1	head: 125 + 4,2 mm	ASME SA 542 Gr.D Cl.4a

2. METODO D'ESAME ①

Sarà utilizzata una tecnica semimeccanizzata impiegando un sistema computerizzato per l'acquisizione dei dati con rappresentazione B-C SCAN.

Considerando che l'estensione della ZTA è misurata e documentata in fase di qualifica del processo di saldatura e che la posizione dei trasduttori è controllata utlizzando vernice indelebile, il controllo ultrasonoro comprenderà il volume di saldatura, la ZTA più ¼ in. (6 mm) da entrambe le parti della saldatura su tutta la lunghezza da esaminare.

Il volume della saldatura controllata, con le relative indicazioni, sarà visibile sul monitor del computer in tempo reale in rappresentazione B-C SCAN.

Le immagini sono registrate sull'hard-disk e sono disponibili per la valutazione.

Il controllo completo sarà registrato su CD.

2. METHOD EXAMINATION ①

Semi-mechanized technique employing computerized system for data acquisition B-C SCAN presentation shall be used.

Considering that the extend of weld HAZ is measured and documented during the weld qualification process and that ultrasonic trasducer positioning and scanning device is controlled using a reference paint mark, the ultrasonic examination shall include the volume of the weld, the HAZ plus ¼ in (6 mm) of each side of the weld for the full length to be examined.

The full section of the examined weld, with its indications, shall be displayed in real time on the monitor of the computer in B-C SCAN presentation.

The images are recorded on hard-disk and made available for evaluation.

The full inspection will be recorded on CD.

3. DOCUMENTI DI RIFERIMENTO

- Codice ASME Sezione V, Art. 4 (edizione 2004)
- Codice ASME Sezione VIII Divisione II (edizione 2004)
- Codice ASME - Code Case 2235-7 ①

3. REFERENCE DOCUMENT

- *ASME Code Section V, Art.4 (edition 2004)*
- *ASME Code Section VIII Division II (edition 2004)*
- *ASME Code - Code Case 2235-7* ①

4. CONDIZIONI SUPERFICIALI

La superficie del pezzo da esaminare dovrà essere esente da gocce di saldatura, ruggine o altro materiale estraneo che possa interferire con un buon contatto del trasduttore.

Le superfici delle saldature saranno rasate prima del controllo.

4. SURFACE CONDITION

The surface of the object to be examined shall be free of weld spatter, rust or other extraneous particles which can interfere with a correct contact of the transducer.
The surface of all welded joints will be flush grounded before ultrasonic examination.

5. ACCOPPIANTE

Dovrà essere utilizzato un accoppiante tale da garantire un'ottima trasmissione dell'energia ultrasonora, resistenza alla corrosione, viscosità e facilità di rimozione.
In questa commessa sarà impiegato il tipo U47 della CGM applicato con un pennello.

5. COUPLANT

Appropriate couplant shall be used to guarantee excellent transmission of ultrasonic energy, corrosion resistence, viscosity and easy removal.
In this job couplant type U47 brand CGM, brought by brush, shall be used.

6. RINTRACCIABILITÀ

Allo scopo di localizzare in modo univoco la posizione delle indicazioni è richiesta la punzonatura del punto di inizio del controllo di ogni giunto "punto 0" in corrispondenza di un asse dell'apparecchio con punzoni *low stress.*
Ogni giunto dovrà avere un numero progressivo di identificazione.
Dovrà essere redatto uno sketch nel quale saranno riportate, per ogni giunto, l'identificazione del giunto, la localizzazione del "punto 0" e il senso di rotazione durante il controllo.

6. TRACEABILITY

To clearly identify the position of the indications, the starting point of the inspection of each joint, the "zero point" on one axis of the item shall be punched with low stress stamp.
Every joint shall have a progressive identification number.
A sketch shall be provided showing the joint identification, the location of "zero point" and the direction of rotation during inspection for each joint.

7. APPARECCHIATURA

7.1. Computer

- Computer portatile Field Works - Pentium 133 MHz, RAM 32 Mb, Hard Drive 1.2G, active matrix TFT SVGA True color 600.
- Software I2-SONIC - Controllo di giunti testa-testa, con scansione da un lato: monitoraggi e visione in tempo reale della correttezza del controllo; visione in tempo reale dei difetti in saldatura e nella zona termicamente alterata secondo due rappresentazioni: *top view* (vista dall'alto) e *side view* (vista in sezione). L'ampiezza dei segnali sarà visualizzata sulle due rappresentazioni secondo una scala di colori riferita alla curva DAC costruita sul relativo blocco campione.
- Set di sensori acustici per il monitoraggio della posizione (*x*, *y*, *z*).
- Stampante portatile a colori.

7.2. Sonde per ultrasuoni

Le sonde utilizzate per la tecnica semimeccanizzata con rappresentazione C-SCAN avranno le seguenti caratteristiche:

- Tipo: onde trasversali
- Angolo: 45° e 60°
- Frequenza: 2 MHz
- Cristallo: titanato di bario
- Dimensione cristallo: 20 X 22 mm

7.3. Scanner

La posizione *x-y* del trasduttore verrà fornita al sistema in tempo reale tramite una triangolazione tra i due emettitori posti su un supporto magnetico fisso con l'emettitore posizionato sul portasonde (vedi figura 1). Il portasonde sarà movimentato manualmente.

7. EQUIPMENT

7.1. Computer

- *Fast portable Computer Field Works - Pentium 133 MHz, RAM 32 Mb, Hard Drive 1.2G, active matrix TFT SVGA True color 600,*
- *Software I2-SONIC - Inspection of planar butt joints, scanning from one side: real time monitoring and imaging of testing technology performance with real time feedback, imaging*

of defects in the weld and heat affected zone with two representation: top view and side view. Indications will be shown on two maps with different colors depending on DAC percentage.

- *Set of acoustic sensor for mechanics free monitoring location (x, y, z)*
- *Portable color printer.*

7.2. Ultrasonic probes

Probes used for semi-mechanized technique with C-SCAN presentation shall be of the following type:

Type: shear waves

Refraction angle: 45° and 60°

Frequency: 2 MHz

Crystal: barium titanate

Crystal dimension: 20 X 22 mm

7.3. Scanner

The computer will give in real time the position (x-y) of transducer considering the triangle between two airborne ultrasonic receivers on magnetic support and one airborne ultrasound emitter on probe-holder (see figure 1). The probe-holder shall be moved manually.

8. SCANSIONE

8.1.Direzione ①

La scansione avverrà parallelamente all'asse della saldatura e contemporaneamente la sonda sarà mossa in senso perpendicolare alla saldatura in modo tale da controllare la sezione completa della saldatura. (vedi figura 1) con entrambe le sonde (45° e 60°).

8.2 Velocità di scansione

La velocità massima d'esame è determinata dalla capacità del computer di acquisire e analizzare il segnale. La velocità massima risulterà dalla completa acquisizione di tutti i segnali a un valore fissato di lunghezza ricoperta senza perdita di dati.

La velocità di scansione dovrà essere minore di 75mm/secondo.

8.3 Passo di acquisizione

Il passo di acquisizione sarà di una immagine A-scan ogni 4 mm.

8. SCANNING

8.1. Direction ①

Scanning shall be made moving scanner parallel to the weld axis meanwhile the probe is moved perpendicularly to the weld in order to inspect the full section (see figure 1) with both probes (45° and 60°)

8.2 Scanning speed

The maximum speed of examination shall be dictated by the capability of the computer to acquire and process waveforms. The maximum speed that should be used will result in comprehensive acquisition of all waveforms at the selected number for scan length without data drop-out.

The scanning speed shall be less than 75 mm/second.

8.3 Acquisition rate

The acquisition rate shall be one image A-scan for each 4 mm.

9. TARATURA

La taratura della base dei tempi verrà eseguita utilizzando il blocco campione n°1 dell'I.I.W.

La linearità verticale e quella orizzontale saranno verificate in accordo alle prescrizioni delle Appendici I e II articolo 4 ASME V.

9. CALIBRATION

Time base calibration shall be made on test block n°1 of I.I.W.

Screen height linearity and amplidude control linearity shall be verified according to Appendix I and II article 4 ASME V.

10. TARATURA SENSIBILITÀ ①

La taratura della sensibilità per la rappresentazione C-SCAN sui blocchi sarà in accordo a ASME V Art.4, Figura T-434.2.1 con fori da 3 mm di diametro e un difetto planare superficiale, orientato parallelamente alla linea di fusione e con dimensioni inferiori a quelle dei difetti riportati in tabella 2 del Code Case 2235-7.

I requisiti minimi del blocco di taratura non saldato sono i seguenti:

1 Dovrà essere composto dello stesso materiale del componente da controllare in riferimento alla velocità del suono, al grano e alle condizioni superficiali.

2 Lo spessore sarà uguale (± 10 %) a quello del componente da controllare.

3 La larghezza e la lunghezza della superficie di scansione sarà idonea per consentire il movimento della sonda sui riflettori di riferimento.

La curva DAC sarà disegnata seguendo i fori di riferimento. La sensibilità di esame verrà fissata all'80% dell'altezza dello schermo utilizzando il foro passante che produce la risposta più ampia. Durante il controllo il guadagno sarà incrementato di 14 dB.

10. <u>SENSITIVITY CALIBRATION</u> ①

The calibration of sensitivity for C-SCAN on blocks according to ASME V Art. 4, Fig. T-434.2.1 with side drilled holes of 3 mm in diameter and one surface planar flaw, oriented parallel to the fusion line and no larger than the flaws in table 2 Code Case 2235-7.

The minimum requirements of the reference heat treated block are the following:

1 Should be made of similar material as the component under inspection with regard to sound, velocity, grain noise and surface condition.

2 The wall thickness shall be equal (± 10 %) than the nominal wall thickness of tha component under inspection.

3 The width and the length scanning surface shall be adeguate to allow probe movement over the reference reflectors.

DAC curve shall be traced on reference holes. The examination sensitivity shall be established at 80% of full screen height using the side drilled hole producing the largest response.

The scanning gain shall be 14 dB higher than the reference (D.A.C.) gain.

11. <u>ACQUISIZIONE DEI DATI</u>

I dati saranno registrati in forma non elaborata. Il set completo di dati senza amplificazioni, filtro o soglie sarà incluso nel data record.

11. <u>ACQUISITION DATA</u>

Data shall be recorded in unprocessed form. A complete data set with no gating, filtering or thresholding shall be included in the data record.

12. REGISTRAZIONE DELLE INDICAZIONI

12.1 Criteri di registrazione

Le indicazioni con ampiezza superiore al 20% del livello di riferimento saranno automaticamente registrate in rappresentazione B-C-SCAN con diversi colori a seconda dell'ampiezza. L'ampiezza massima, la dislocazione e l'estensione di queste indicazioni saranno registrate. Tutte le indicazioni rilevanti saranno valutate applicando i criteri di accettabilità indicati nel capitolo 13 di questa procedura.

12.2 Valutazione delle indicazioni

Le indicazioni registrate durante il controllo saranno analizzate con la tecnica pulse-echo manuale in accordo alla procedura SOU 0116554/4.

12. RECORD OF INDICATIONS

12.1 Recording criteria

Reflectors that produce a response greater than 20% of reference level shall be automatically recorded in B-C SCAN presentation with different color depending on amplitude indications. The maximum amplitude, location and extent of these reflectors shall be recorded. All relevant indications will be assessed using the acceptance criteria outlined in chapter 13 of this procedure.

12.2 Evaluation of indications

Indications recorded along examination shall be investigated with manual pulse-echo technique according to procedure SOU 0116554/4.

13. CRITERI DI ACCETTAZIONE ①

Le imperfezioni registrate saranno studiate in modo da determinarne la forma, la natura e la posizione e valutarne l'accettabilità secondo i criteri stabiliti in (a), (b) e (c).

(a) Le indicazioni considerate come cricca, mancata fusione o incompleta penetrazione sono inaccettabili indipendentemente dalla lunghezza.

(b) Le altre indicazioni sono inaccettabili se hanno dimensioni superiori a quelle indicate nel Code Case 2235-7 tabella 2.

(c) Difetti discontinui saranno considerati un unico difetto planare se la distanza fra difetti adiacenti è minore o uguale a "S" indicato in Fig.2.

Difetti discontinui orientati principalmente secondo piani paralleli saranno considerati un unico difetto planare se la distanza fra piani adiacenti è minore o uguale a ½ in. (vedi Fig.3)

Difetti discontinui complanari e non allineati nella direzione dello spessore saranno considerati un unico difetto planare se la distanza fra difetti adiacenti è minore o uguale a "S" indicato in Fig.4.

Difetti discontinui complanari nella direzione dello spessore entro due piani paralleli distanti ½ in (cioè normali alla superficie del componente) sono inaccettabili se l'altezza complessiva supera quella indicata in Fig.5

13. ACCEPTANCE CRITERIA ①

Recorded imperfection shall be investigated to the extent that the operator can determine the shape, identity and location of all such imperfections and evaluate them in terms of the acceptance standards given in (a, (b) and (c) below.

(a) Indication characterized as crack, lack of fusion, or incomplete penetration are unacceptable regardless of length.

(b) Other imperfections are unacceptable if the indications have dimension which exceed what indicated in Code Case 2235-7 table 2.

(c) Discontinuous flaw shall be considered a singular planar flaw if the distance between adjacent flaws is equal to or less than "S" as shown in Fig.2.

Discontinuous flaws that are oriented primarily in parallel planes shall be considered a singular planar flaw if the distance between the adjacent planes is equal to or less ½ in. (refer to Fig.3)

Discontinuous flaws that are complanar and nonaligned in the through-wall thickness direction of the component shall be considered a singular planar flaw if the distance between adjacent flaws is equal to or less than "S" as shown in Fig.4.

Discontinuous flaws that are complanar in the through-wall direction within two parallel planes ½ apart (i.e., normal to the pressure-retaining surface of the component) are unacceptable if the additive flaw depth dimension of the flaws exceeds those shown in Fig.5

Flaw acceptance criteria for 1" (25,4 mm) to 12" (304,8 mm) thick weld (table 2 Code Case 2235-7) ①

	1 in. < t < 2 ½ in.		4 in. < t < 12 in.	
Aspect Ratio a/l	**Surface flaw a/t**	**Subsurface flaw a/t**	**Surface flaw a/t**	**Subsurface flaw a/t**
0,00	0,031	0,034	0,019	0,020
0,05	0,033	0,038	0,020	0,022
0,10	0,036	0,043	0,022	0,025
0,15	0,041	0,049	0,025	0,029
0,20	0,047	0,057	0,028	0,033
0,25	0,055	0,066	0,033	0,038
0,30	0,064	0,078	0,038	0,044
0,35	0,074	0,090	0,044	0,051
0,40	0,083	0,105	0,050	0,058
0,45	0,085	0,123	0,051	0,067
0,50	0,087	0,143	0,052	0,076

t=thickness of the weld excluding any allowable reinforcement

a,l=see figure 1B

14. RAPPORTO DI ESAME

I risultati del controllo saranno riportati in un modulo idoneo per il B-C SCAN.

Sui rapporti d'esame saranno riportate le indicazioni significative, la valutazione con le informazioni richieste (vedi allegato).

Ogni saldatura avrà un "punto 0" al quale tutte le indicazioni devono essere riferite.

Il rapporto d'esame contiene tutte le caratteristiche del controllo, come il tipo di sistema computerizzato impiegato, le sonde, la frequenza, ecc.

14. FINAL REPORT

The result of examination shall be performed for each weld on proper B-C SCAN format report.

These reports shall contain the significative indications, the evaluation with information requested (see attachment).

Each weld shall have a "zero point" to which all the indications have to be referred.

The report contains the main features of the examination, like type of computerized system, probes, frequency, etc.

15. QUALIFICA DEL PERSONALE

Il personale che esegue i controlli B-C SCAN sarà qualificato e certificato in accordo a EN 473 al II o III livello.

Inoltre il personale avrà ricevuto un idoneo addestramento sulla tecnica B-C SCAN e avrà accumulato un'esperienza di almeno un anno nel campo dei controlli di saldature di alto spessore.

L'interpretazione e la valutazione finale saranno eseguite da un altro operatore qualificato al III livello.

15. PERSONNEL REQUIREMENTS

Personnel who carry out B-C SCAN examinations shall be qualified and certified according EN 473 at the II and III level.

In addition personnel shall have received training on B-C SCAN technique and experience on high tickness weld examination for at least one year.

The final interpretation and evaluation shall be performed by another qualified level III individual.

Nuovo Pignone
MASSA

CERTIFICATO di ESAME con ULTRASUONI
B-C Scan Ultrasonic Examination Test Report

Nr. : CSxxx-yy
Page
Pag. : 1 / 2

Purchaser
Cliente : ______ Order Ordine N° : ______

Shop Job Commessa : ______ Item Sigla : ______ Serial N° N° Fabbr. : ______ Dwg N° Disegno N° : ______

Inspecting Authority Ente di Collaudo : ______ Inspecting Plan Piano di Collaudo N° : ______ Stage Fase N° : ______

Specific Item Data Dati Specifici del Prodotto	Specific Procedure Specifica di Controllo	Tested Particular Particolare Controllato	Material/ Materiale	Extent Test Esten. Contr.
	Details of the Test Descrizione dell' esame			

Equipment / Strumentazione

COMPUTERIZED ULTRASONIC SYSTEM / SISTEMA ULTRASONORO COMPUTERIZZATO

UT HARDWARE KONTRON IP Lite Computer

UT SOFTWARE I2_SONIC_Ultrasonic Testing Defect Recording System

USED PROBES	Type	Size	Angle	frequency
	WB 45-2	20x22	45°	2MHz
	WB 60-2	20x22	60°	2MHz

Technical Test Conditions / Condizioni di Controllo

Number Position Steps	Part Length (step)	Start Position	Acquisition Step

Thickness Spessori [mm]	Welding Procedure Procedimento Saldatura	Coupling Accoppiamento	Calibration blocks Blocchi di Taratura
	☐ Automatic Automatico ☐ Manual Manuale		

Calibration Sensitivity Sensibilità di Calibrazione	Scanning Sensitivity Sensibilità di Scansione dB	Reference Holes Fori di Riferimento ϕ mm	Recording Level Livello di Registrazione
80 % F.S.H. (D.A.C.)	+ 14	3	> 20 % D.A.C.

Transfer Correction Correzione di Trasferimento ☐ No No ☐ Yes Si dB ______

Surface Conditions Stato delle Superfici ☐ Come Saldato / As Welded ☐ Molato / Ground

Scanning Surface Superficie di Scansione ☐ Lavorato di Macchina / Machined ☐ Molato / Ground

Test Carried Out Esame Effettuato ☐ Prima / Before ☐ Dopo / After ☐ T.T. / P.W.H.T. ☐ T.T. Loc. / Loc. P.W.H.T. ☐ Prova Idraulica / Hydrotest

Test Result / Risultati dell'esame

☐ No indications to be recorded Nessuna indicazione da registrare ☐ Recorded Indications Indicazioni Registrate See page Vedi pag. ______

Result Conforming to the Specified Requirements
RISULTATI CONFORMI AI REQUISITI DI SPECIFICA ☐ Yes Si ☐ No No

☐ ASME VIII Div.1 App.12
☐ ASME VIII Div.2 Art.9-3
☐ Code Case 2235-6

Examiner Operatore ______ Level II Livello II Q.C. Department Level III Controllo Qualità Livello III ______

Massa li ______ Inspectors Ispettori ______

REV.	DESCRIZIONE - DESCRIPTION	
		ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①
1	Revised where indicated ①	N. SOU0116558/4
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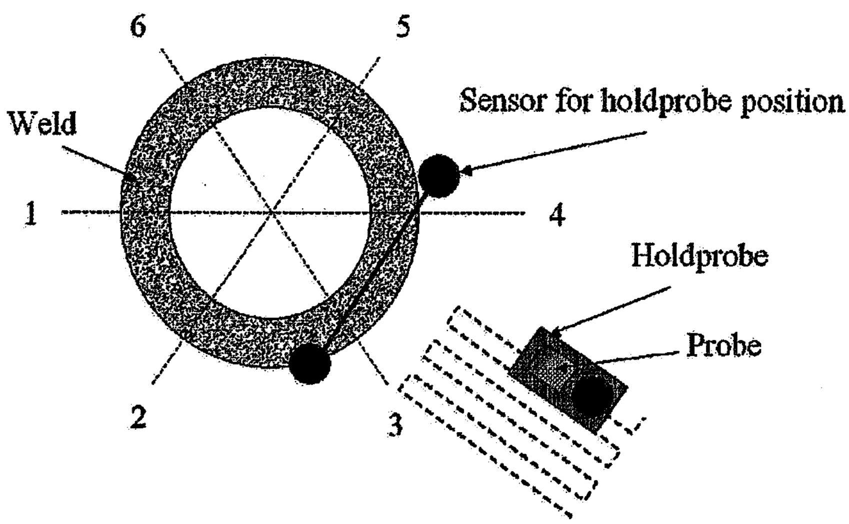
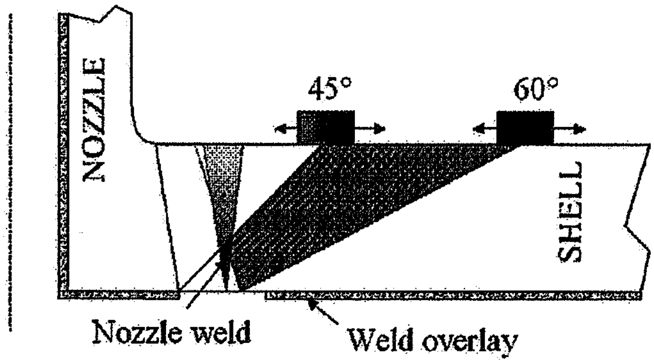
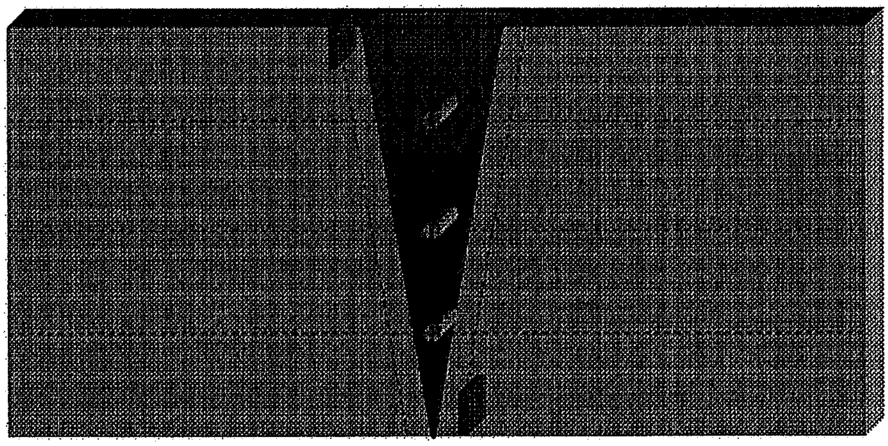


SCANNING PATTERN FOR EXAMINATION OF POS.3-4 OF A NOZZLES WELD



PATTERN FOR EXAMINATION OF NOZZLE WELD

Figure 1 – Scanning pattern.
The complete volume shall be checked twice: with 45° and with 60° probe ①



SDH Ø 3 mm and 50 mm length at ¼ t, ½ t, and ¾ t.
Notches 10 mm depth and 20 mm length at ¼ in. from bevel

Figure 1A - Calibration blocks

t = thickness = 255 ± 10% mm (for shell welds)

t = thickness = 132 ± 10% mm (for head welds)

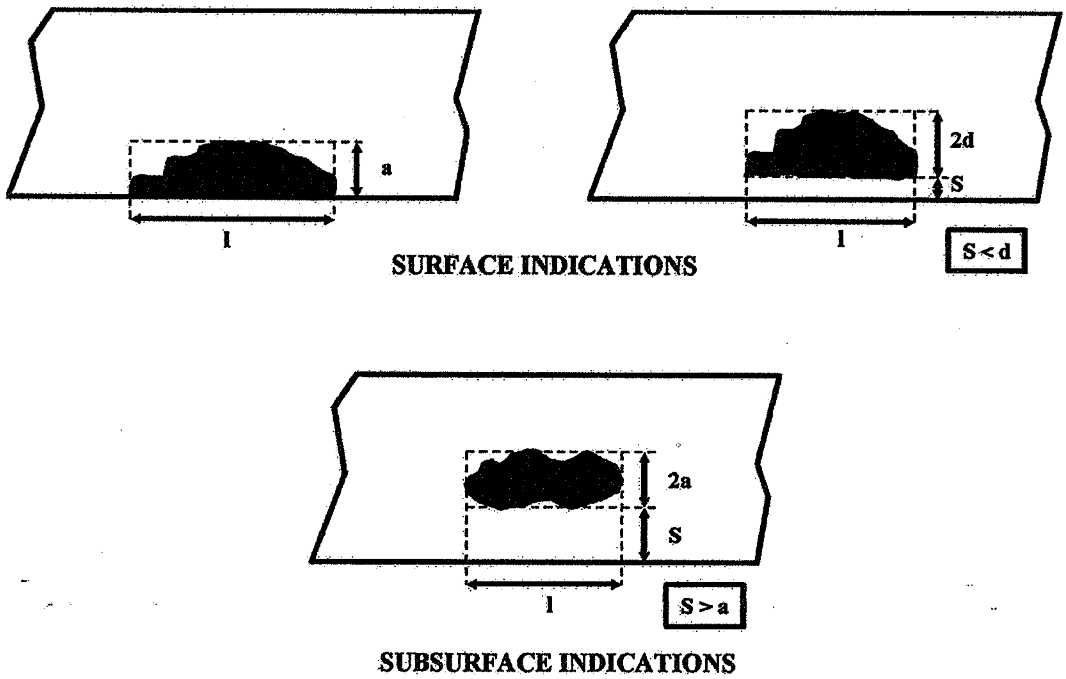


Figure 1B - Single indications (Code Case 2235-7) ①

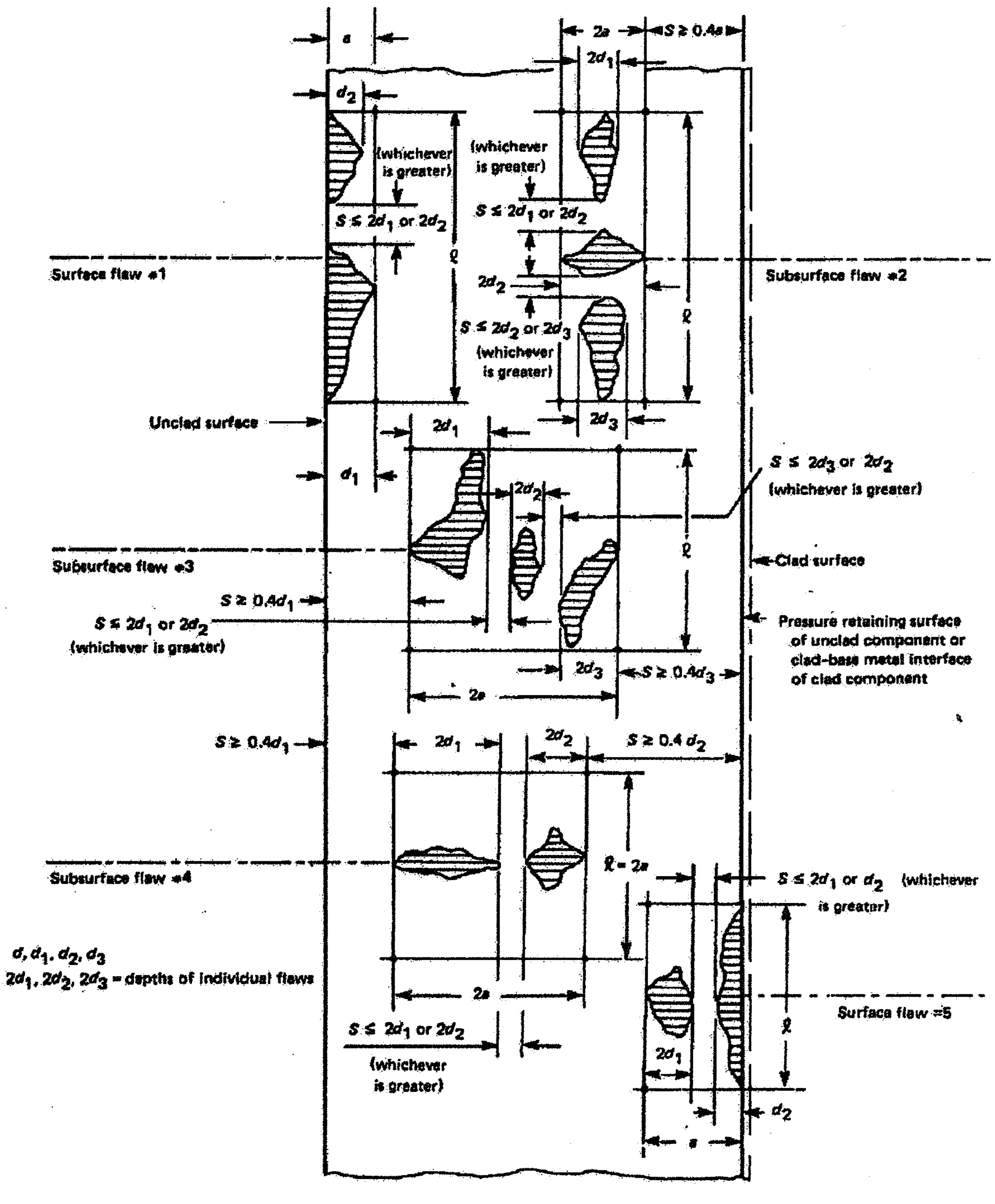


FIG. 2 MULTIPLE PLANAR FLAWS ORIENTED IN PLANE NORMAL TO PRESSURE RETAINING SURFACE

Nuovo Pignone MASSA	B-C SCAN TECHNIQUE FOR ULTRASONIC EXAMINATION OF WELDS

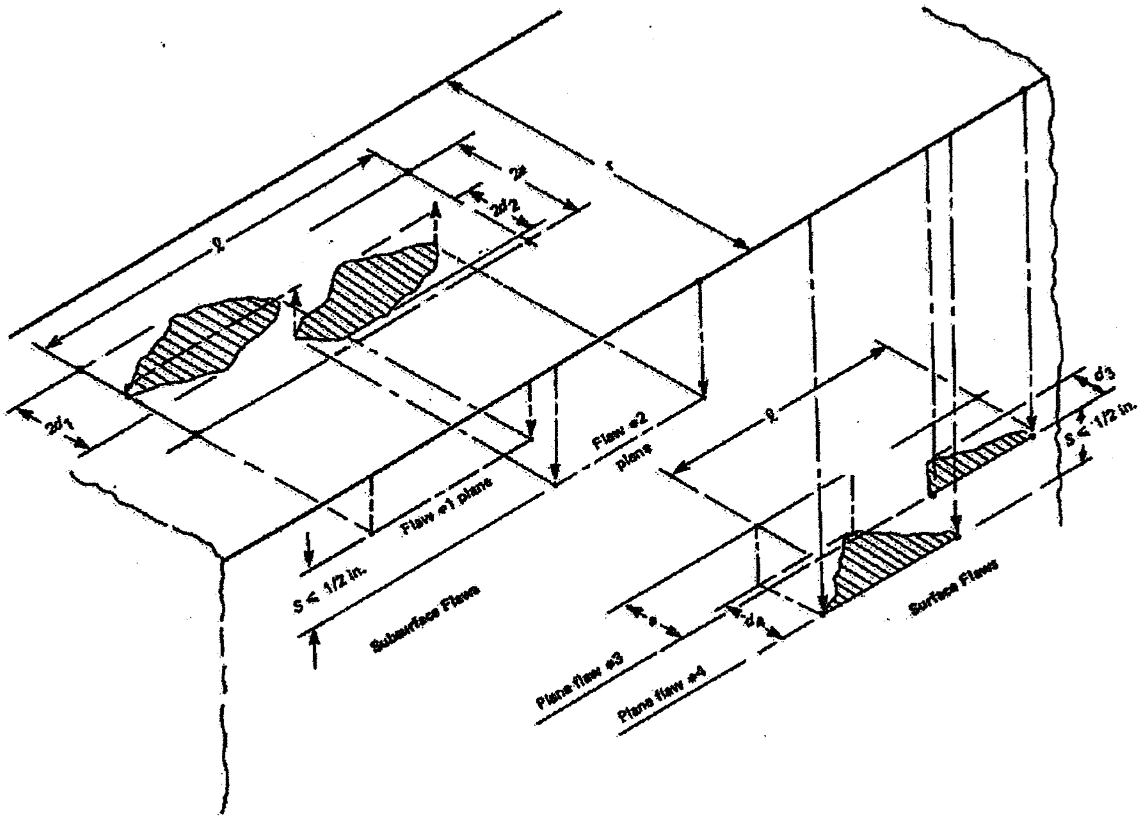


FIG. 3

		ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①	
		N. SOU0116558/4	
1	Revised where indicated ①	LINGUA-LANG.	PAGINA-SHEET
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REV.	DESCRIZIONE - DESCRIPTION		

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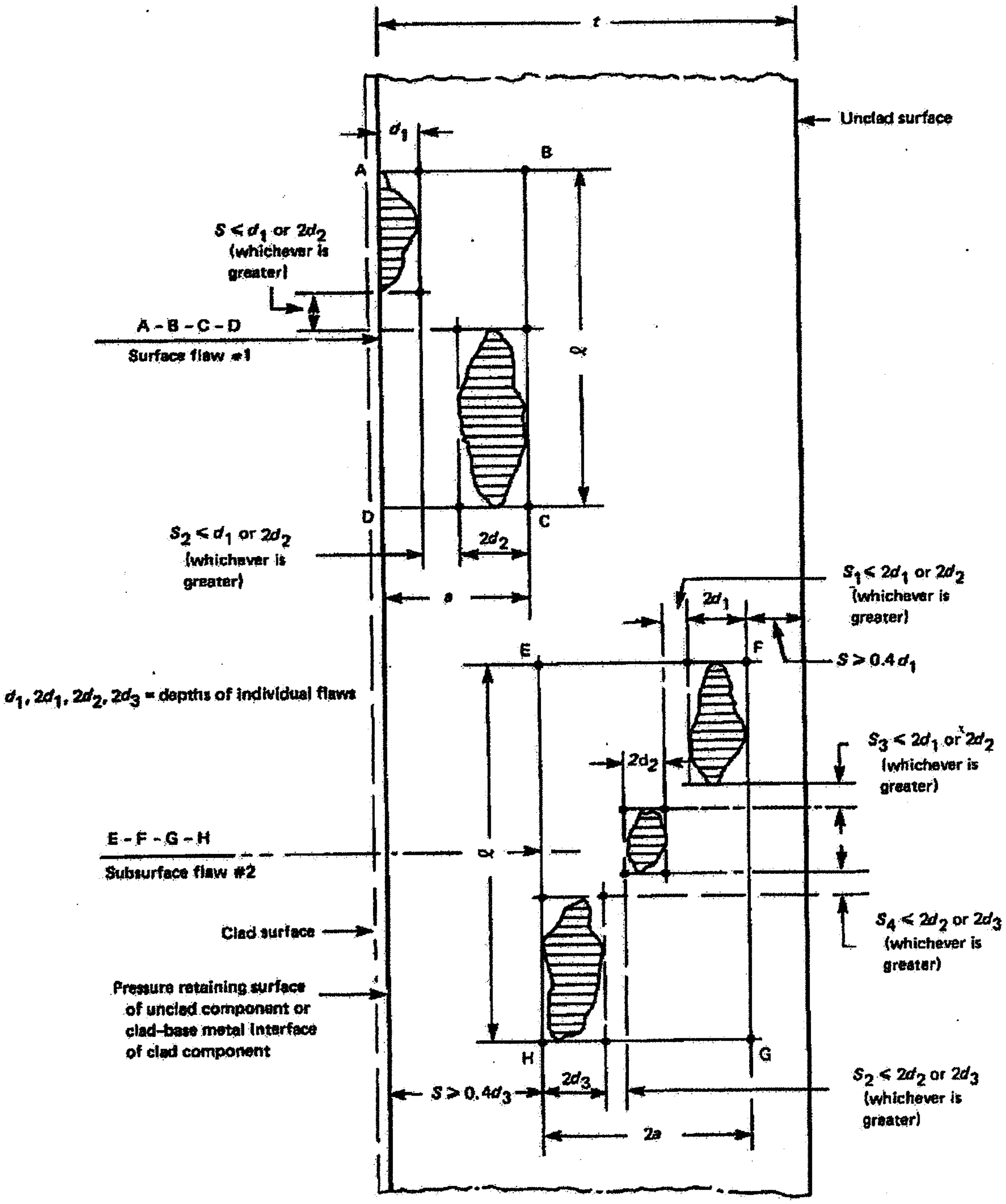
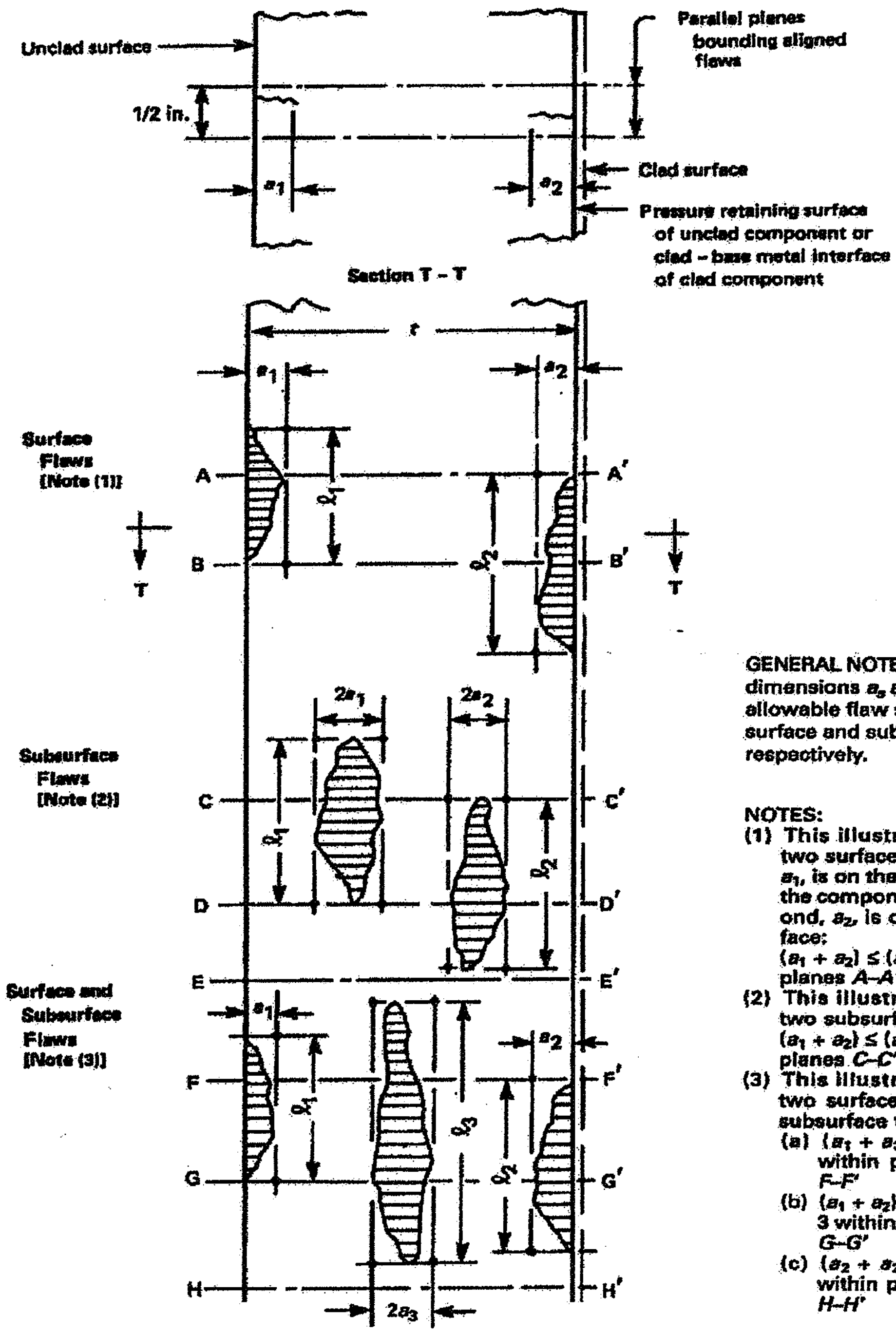


FIG. 4 NONALIGNED COPLANAR FLAWS IN PLANE NORMAL TO PRESSURE RETAINING SURFACE (ILLUSTRATIVE FLAW CONFIGURATIONS)



GENERAL NOTE: The flaw depth dimensions a_s and a_e are the allowable flaw standards for surface and subsurface flaws, respectively.

NOTES:

(1) This illustration indicates two surface flaws. The first, a_1, is on the outer surface of the component, and the second, a_2, is on the inner surface:
$(a_1 + a_2) \leq (a_s + a'_s)/2$ within planes A–A' and B–B'

(2) This illustration indicates two subsurface flaws:
$(a_1 + a_2) \leq (a_e + a'_e)/2$ within planes C–C' and D–D'

(3) This illustration indicates two surface flaws and one subsurface flaw:
- (a) $(a_1 + a_3) \leq (a_s + a'_e)/2$ within planes E–E' and F–F'
- (b) $(a_1 + a_2) \leq (a_s + a_e + a'_s)/3$ within planes F–F' and G–G'
- (c) $(a_2 + a_3) \leq (a'_s + a_e)/2$ within planes G–G' and H–H'

FIG. 5 MULTIPLE ALIGNED PLANAR FLAWS

Nuovo Pignone MASSA	CLIENTE – CUSTOMER ***CONOCO PHILLIPS*** ①
	LOCALITA' - PLANT LOCATION ***WILHELMSHAVEN, GERMANY***
COMMESSA - JOB **3100274÷3100279**	IMPIANTO - PLANT ***WRG-DEEP CONVERSION PROJECT*** ①

TITOLO - TITLE

FERRITE CHECK SPECIFICATION

A PROCEED

AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

NAME:

07 AUG. 2006

FLUOR B.V.

Lloyd's Register EMEA

REVIEWED/ ~~WITNESSED~~

G.L. Frolla 20/2/07

Viareggio Office

Lloyd's Register

4545166-P05-0012 REV 01

1	Revised where indicated ①	Zappavigna	Chiappini	Zappavigna	29.05.06
0	Emissione - Issue	Zappavigna	Chiappini	Zappavigna	30.01.06
REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①

N. SOU0116559/4

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1. SCOPE

This document specifies the extent and the method of execution of Ferrite Content Check, before final PWHT.

2. REFERENCE DOCUMENTS

Reference documents are:

- UOP Specification 3-17-3 and comments
- Operating Instructions Manual of FERITSCOPE MP30
- NP Fabrication and Inspection Plan. SOU0110203/4
- NP GENERAL DRAWING SUO 0269055 ÷0269060

3. TEST EQUIPMENT

The FERITSCOPE MP30 (FISCHER) shall be used.

4. CALIBRATION

The instrument shall be daily calibrated with Feritscope MP30 sonde.
When the equipment is switched on the calibration is performed on 3 different standards, according to the operator manual:

N. 2087 (1,85 FN = 2,09 Fe%)
N. 2088 (8,9 FN =10,3 Fe%)
N. 2089 (34,7 FN = 30,9 Fe%)

The ferrite content of standards has been determined by comparative measurements against secondary master standards owned by HELMUT FISCHER GmbH & Co. The standards are guaranteed to be accurate within the greater of 5% of stated value or +/- 0,4FN.

5. SURFACE PREPARATION

Brushing the measurement area, which shall be clean, dry and grease free.

6. TESTING ①

The ferrite content of the weld overlay shall be measured with Feritscope MP30 prior to PWHT; a minimum of six ferrite readings for each location shall be taken on the surface to be tested.
Reading shall be taken randomly on the following location for each welding process used as minimum (location shall be chosen with the inspector):

- each head: 10 locations
- each shell ring: 10 locations
- each nozzle: 2 locations (1 location at one end and the other on flange face of self reinforced nozzles)
- each piping: 2 locations (1 location at both ends)
- each weld restoration: 2 locations
- each build-up: 3 locations

The measurements carried out with the Feritscope, shall be compared with the values obtained with the Chemical Analysis

7. ACCEPTANCE CRITERIA ①

The average value of delta ferrite for each component shall be between 3FN to 8FN (inclusive).

8. REPORT

All acceptance ferrite check test results shall be recorded on a report (see attachment 1), and included in the Final Data Book.

Attachment 1

Nuovo Pignone
MASSA

CERTIFICATO di CONTROLLO FERRITE
FERRITE CHECK REPORT

Nr.: FE***-01
Page / Pag.: 1 / 1

Purchaser / Cliente : ____________________ Order / Ordine N° : ____________________

Shop Job / Commessa : __________ Item / Sigla : __________ Serial N° / N° Fabbr. : __________ Dwg N° / Disegno N° : __________

Inspecting Authority / Ente di Collaudo : __________ Inspecting Plan / Piano di Collaudo N° : __________ Stage / Fase N° : __________

Description of the Test
Descrizione dell' esame :

LOCATION	AVERAGE FN VALUE
UPPER HEAD	
BELT A	
BELT B	
BELT C	
LOWER HEAD	
RESTORING UPPER HEAD TO BELT A	
RESTORING BELT A TO BELT B	
RESTORING NOZZLE ... TO BELT ...	

Examiner / Operatore __________ Q.C. Department / Uff. Controllo Qualità __________

Massa li __________ Inspectors / Ispettori __________

Nuovo Pignone MASSA	CLIENTE – CUSTOMER **CONOCO PHILLIPS**
	LOCALITA' - PLANT LOCATION **WILHELMSHAVEN, GERMANY**
COMMESSA - JOB **3100274÷3100279**	IMPIANTO - PLANT **WRG-DEEP CONVERSION PROJECT**

TITOLO - TITLE

POSITIVE MATERIAL IDENTIFICATION

Lloyd's Register EMEA
REVIEWED/
G.L. Frolla 24/9/07
Viareggio Office
Lloyd's Register

"A"
Proceed
FDS 17/09/07

REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
5	Revised where indicated ⑤	Zappavigna	Chiappini F.	Zappavigna G.	22.08.07
4	New attachment 2	Zappavigna	Chiappini	Zappavigna	13.03.07
3	Attachment 2	Zappavigna	Chiappini	Zappavigna	24.11.06
2	Typewriting mistake	Zappavigna	Chiappini	Zappavigna	11.09.06
1	Revised where indicated ①	Zappavigna	Chiappini	Zappavigna	29.05.06
0	Emissione - Issue	Zappavigna	Chiappini	Zappavigna	30.01.06

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234

N. SOU0116560/4

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Nuovo Pignone MASSA	POSITIVE MATERIAL IDENTIFICATION

CUSTOMER	CONOCO PHILLIPS
JOB	3100274, 3100275, 3100276, 3100277, 3100278, 3100279
ITEM	D-6211, D-6231, D-6212, D-6232, D-6214, D-6234
MATERIALS	**SHELL:** ASME SA 336 F22V **HEADS:** ASME SA 542 Gr.D Cl.4a **NOZZLES and PIPE NECKS:** ASME SA 182 F22V **SPOOLS:** ASME SA 182 F22V **WELD OVERLAY:** S.S. TP 347 **SKIRT:** ASME SA 387 Gr.22 Cl.2 / SA 516 Gr.70
DOCUMENTS	NP Fabrication and Inspection Plan. SOU0110203/4 NP GENERAL DRAWINGS SUO 0269055 ÷ SUO 0269060 CONOCO PHILLIPS Required standard – Positive Material identification
EQUIPMENT	TEXAS NUCLEAR – METALLURGIST-XR mod. 9277 or NITON METAL ALLOY ANALYZER (Xlt 898)
ACCURACY	20% for content between 0,2% and 1% 10% for content between 1% and 10% 5% for content between 10% and 20%
PART TO BE EXAMINED ⑤	BASE MATERIAL and PRESSURE WELDED JOINTS ALLOY WELD METAL FOR EACH CONSUMABLE HEAT INTERNAL ATTACHMENT AND ATTACHMENTS WELDS BOLTING MATERIAL (SPOT CHECK) WELD OVERLAY SURFACE (*)
COMPONENT TESTED	Chromium – Molybdenum – Vanadium (for 2 ¼ Cr, 1 Mo, ¼ V material) Chromium – Nickel – Niobium or Titanium (for stainless steel material)
EXTENT OF EXAMINATION	One measurement each belt and head, nozzle, pipe and all under pressure joints One measurement each consumable heat
CALIBRATION	Prior to use, the equipment shall be verified on the test block according to TEXAS NUCLEAR handbook or NITON METAL ALLOY ANALYZER handbook
TIME OF TEST	After assembly and prior to Heat Treatment
ACCEPTANCE STANDARS	ASME Sect. IIA
MARKING	All verified materials with acceptable analysis shall be marked with the letter "AV" using a marker (no punching). Marker shall be free of metallic oxides and chlorides
ATTACHMENT	EXAMPLE OF PMI TEST REPORT

⑤ ***Note (*): IN ADDITION WELD OVERLAY SHALL BE CHECKED WITH WET ANALYSIS ON CHIPS AT 1/8" DEPTH ACCORDING TO PMI MAP (ATTACHMENT 2)***

REV.	DESCRIZIONE - DESCRIPTION	
5	Revised where indicated ⑤	ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234
4	New attachment 2	
3	Attachment 2	N. SOU0116560/4
2	Typewriting mistake	LINGUA-LANG. A / PAGINA-SHEET 2 / 3

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

Nuovo Pignone MASSA	**POSITIVE MATERIAL IDENTIFICATION**

ATTACHMENT 1: EXAMPLE OF PMI REPORT

Nuovo Pignone MASSA	CERTIFICATO di P.M.I. *POSITIVE MATERIAL IDENTIFICATION REPORT*	Nr.: PMIxxx-01 Page / Pag.: 1 /

Purchaser / Cliente:						Order / Ordine N°	
Shop Job / Commessa:		Item / Sigla:		Serial N° / N° Fabbr.:		Dwg N° / Disegno N°:	
Inspecting Authority / Ente di Collaudo:			Inspecting Plan / Piano di Collaudo N°:			Stage / Fase N°:	

Specific Item Data / Dati Specifici del Prodotto	Specific Procedure / Specifica di Controllo	Tested Particular / Particolare Controllato	Equipment / Strumento	Extent Test / Esten. Contr.
	Details of the Test / Descrizione dell' esame			

COMPONENT	Cr 2,00÷2,50	Mo 0,90÷1,10	V 0,25÷0,35			MATERIAL
Belt A						
Belt B						
Belt C						
Belt D						
Belt E						
Belt F						
Belt G						
Belt H						
Belt I						
Belt L						
Belt M						
Belt N						
Belt O						

Technical Test Conditions / Condizioni di Controllo

Surface Conditions / Stato delle Superfici: ☐ Lavorato di Macchina / Machined ☐ Molato / Ground ☐ Come Saldato / As Welded

Test Carried Out / Esame Effettuato: ☐ Prima / Before ☐ Dopo / After

☐ Saldatura / Welding ☐ T.T. / P.W.H.T. ☐ T.T. Loc. / Loc. P.W.H.T. ☐ Prova Idraulica / Hydrotest

Test Results / Risultati d' Esame

☐ No value outside range / Nessun valore esterno al range ☐ Values outside range / Valori esterni al range — See page / Vedi pag.

Result Conforming to the Specified Requirements / RISULTATI CONFORMI AI REQUISITI DI SPECIFICA: ☐ Yes / Si ☐ No / No — ☐ ASME II ☐ ASME IX ☐

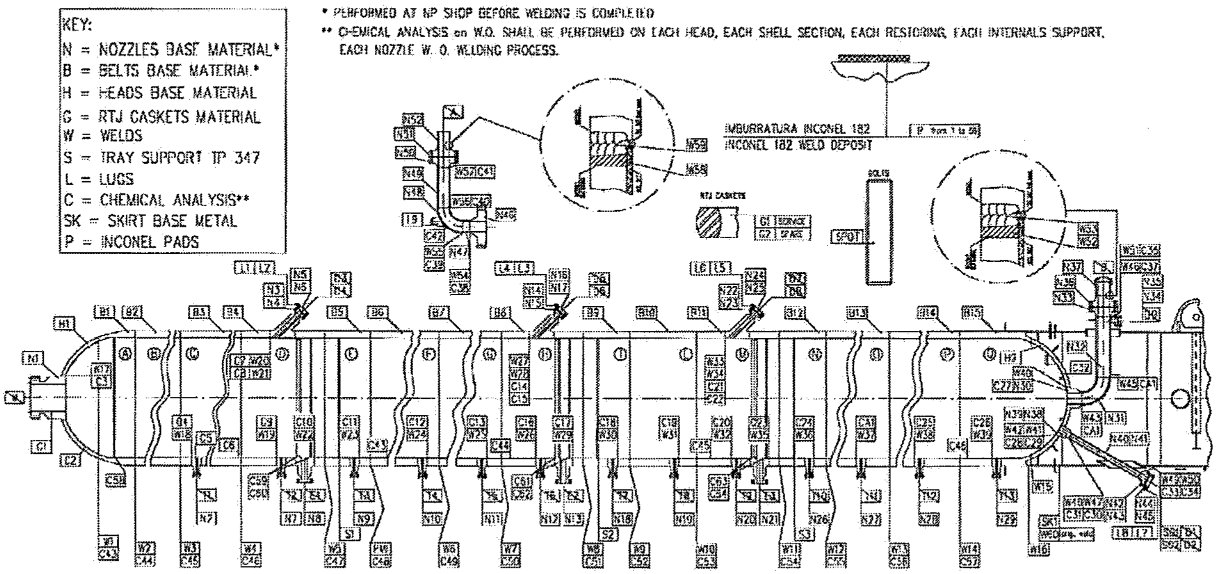
Examiner / Operatore		Quality Control Department / Controllo Qualità	
Massa il		Inspectors / Ispettori	

REV.	DESCRIZIONE - DESCRIPTION		
5	Revised where indicated ⑤	ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234	
4	New attachment 2		
3	Attachment 2	N. SOU0116560/4	
2	Typewriting mistake	LINGUA-LANG. A	PAGINA-SHEET 3 / 4

SOSTITUISCE IL - REPLACES PARI NUMERO
SOSTITUITO DA - REPLACED BY

Nuovo Pignone MASSA	**POSITIVE MATERIAL IDENTIFICATION**

ATTACHMENT 2: PMI MAP



5	Revised where indicated ⑤	ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234
4	New attachment 2	
3	Attachment 2	**N. SOU0116560/4**
2	Typewriting mistake	LINGUA-LANG. A — PAGINA-SHEET 4 / 4
REV.	DESCRIZIONE - DESCRIPTION	

SOSTITUISCE IL - REPLACES — PARI NUMERO
SOSTITUITO DA - REPLACED BY

Nuovo Pignone

MASSA

CLIENTE – CUSTOMER
CONOCO PHILLIPS ①

LOCALITA' - PLANT LOCATION
WILHELMSHAVEN, GERMANY

COMMESSA - JOB
3100274÷3100279

IMPIANTO - PLANT
WRG-DEEP CONVERSION PROJECT ①

TITOLO - TITLE

HARDNESS MEASUREMENT PROCEDURE FOR PRODUCTION WELDS

A PROCEED

AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

NAME:

07 AUG. 2006

FLUOR B.V.

Lloyd's Register EMEA
REVIEWED/~~WITNESSED~~
G.L. Frolla 2/2/07
Viareggio Office
Lloyd's Register

4545166-P05-0017 REV 01

REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE
1	Revised where indicated ①	Zappavigna	Chiappini	Zappavigna	29.05.06
0	Emissione - Issue	Zappavigna	Chiappini	Zappavigna	30.01.06

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234 ①

N. SOU0116561/4

LINGUA-LANG.	PAGINA-SHEET
A	1 / 2

SOSTITUISCE IL - REPLACES
SOSTITUITO DA - REPLACED BY

1. SCOPE ①

This procedure describes the method to perform the hardness testing on the post weld heat treated production welds on REACTORS items D-6211, D-6231, D-6212, D-6232, D-6214, D-6234. The material is

- SHELL: ASME SA 336 F22V
- HEADS: ASME SA 542 Gr.D Cl.4a
- NOZZLES and PIPE NECKS: ASME SA 182 F22V
- SKIRT: ASME SA 387 Gr.22 Cl.2 / ASME SA 516 Gr.70

2. REFERENCE DOCUMENTS ①

- UOP Specification 3-17-3 and comments
- NP Fabrication and Inspection Plan. SOU0110203/4
- NP GENERAL DRAWING SUO 0269055 ÷ SUO 0269060
- API 934

3. PERSONNEL

Only operators who have followed the necessary training and are familiar with the equipment and the calibration procedure shall perform the measurements

4. EQUIPMENT

A portable hardness tester (GNEHM type percussion) shall be used.

5. CALIBRATION

Prior to the testing, the read-out shall be verified by using the calibration block EFO471421 (253,6 HBW2.5/187.5). Calibration shall be done in accordance with the users manual

6. TIME OF TESTING

Hardness testing shall be performed after post weld heat treatment of the pressure vessel equipment

7. EXTEND OF TESTING ①

The hardness shall be determined on the weld itself, on the 2 heat affected zones (HAZ) and on both base materials (see appendix 1).

One set of hardness measurements shall be carried out every 3 meters of pressure weld seam.

The average values of 3 readings for each location shall be reported (see appendix 2)

Readings shall be taken on outside surface (readings on inside surface is not possible due to overlay deposit).

8. SURFACE PREPARATION

Before starting the examination, the surface under examination shall be ground and polished. To find the heat affected zone an additional etching of the surface is required

9. SURFACE TEMPERATURE

The temperature of the surface under examination shall be between 10 and 30 °C

10. MAXIMUM ALLOWABLE HARDNESS ①

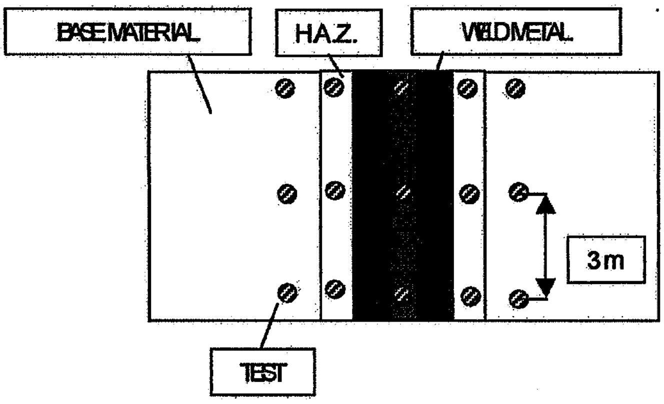
The maximum allowable hardness of base material, heat affected zone and weld metal shall be 235 HB. The weld shall be rejected and a NCR written if the average of the three readings exceeds the maximum.

11. REPORTING

The test result, with the location of the measurement point shall be included in a certificate signed by Nuovo Pignone Q.C. Department and by the Inspector charged by the Client (see Appendix 2). The report shall contain the following information as a minimum:

- Client
- Client P.O. number
- Item number
- Procedure number
- Hardness equipment and probe
- Drawing number
- Location/weld number
- Material specification
- Status of pressure vessel (after or before PWHT)
- Number of measures
- Hardness values
- Date of examination
- Name of operator/inspector

Appendix 1: Sketch of measurement



Appendix 2: Example of test report

Nuovo Pignone
MASSA

CERTIFICATO di CONTROLLO DUREZZE
HARDNESS TEST REPORT

Nr.: HB***-01
Page / Pag.: 1 / 1

Purchaser / Cliente: ____________ Order / Ordine N°: ____________

Shop Job / Commessa: ________ Item / Sigla: ________ Serial N° / N° Fabbr.: ________ Dwg N° / Disegno N°: ________

Inspecting Authority / Ente di Collaudo: ________ Inspecting Plan / Piano di Collaudo N°: ________ Stage / Fase N°: ________

Precedure / Procedura: ________ Equipment and probe / Apparecchiatura: ________

Material / Materiale: ________ Surface Condition / Condizioni superficiali: ________

Time of test / Momento di esecuzione del test: AFTER P.W.H.T.

DESCRIPTION	B.M. 1	HAZ 1	W.M.	HAZ 2	B.M. 2
UPPER HEAD TO BELT A (about at 0°)					
BELT A TO BELT B (about at 0°)					
BELT B TO BELT C (about at 0°)					
BELT C TO BELT D (about at 0°)					

Note:
B.M. = Base Material; H.A.Z.= Heat Affected Zone; W.M.= Weld Metal.
Unit of Measure = HV10

Examiner / Operatore: ________ Q.C. Department / Uff. Controllo Qualità: ________

Massa il ________ Inspectors / Ispettori: ________

Nuovo Pignone MASSA	CLIENTE – CUSTOMER **CONOCO PHILLIPS**
	LOCALITA' - PLANT LOCATION **WILHELMSHAVEN, GERMANY**
COMMESSA - JOB **3100274÷3100279**	IMPIANTO - PLANT **WRG-DEEP CONVERSION PROJECT**

TITOLO - TITLE

COPPER SULPHATE INSPECTION

A PROCEED

AUTHORIZATION TO PROCEED DOES NOT RELIEVE CONTRACTOR/VENDOR OF ITS RESPONSIBILITY OR LIABILITY UNDER THE CONTRACT/PURCHASE ORDER

NAME: 07 AUG. 2006

FLUOR B.V.

4545166-P05-0104 REV 00

0	Emissione - Issue	Zappavigna	Chiappini F.	Zappavigna G.	04.07.06
REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE

ITEM D-6211, D-6231, D-6212, D-6232, D-6214, D-6234

N. SOU0116575/4

LINGUA-LANG.	PAGINA-SHEET
A	1 / 2

SOSTITUISCE IL - REPLACES

SOSTITUITO DA - REPLACED BY

1. SCOPE

This procedure describes the method to determine the complete removal of stainless steel weld overlay from the stripped edges of integrally weld overlaid low alloy steel (2 ¼ Cr – 1 Mo – ¼ V) prior to welding on REACTORS items D-6211, D-6231, D-6212, D-6232, D-6214, D-6234. The material is

- SHELL: ASME SA 336 F22V
- HEADS: ASME SA 542 Gr.D Cl.4a
- NOZZLES and PIPE NECKS: ASME SA 182 F22V
- WELD OVERLAY: S.S. Tp. 347

2. REFERENCE DOCUMENTS

- NP Fabrication and Inspection Plan. SOU0110203/4
- NP GENERAL DRAWINGS SUO 0269055 ÷ SUO 0269060

3. EQUIPMENT

The equipment consists of:

- 10% w/v aqueous solution of Copper Sulphate Penthahydrate,
- a suitable plastic material container,
- a paint brush applicator.

4. SURFACE PREPARATION

Examination shall be performed on the stripped edges of weld overlaid forging or plate. The edges to be inspected shall be prepared be grinding and shall be free of any major surfaces irregularities. The edges to be examined shall be free of oil, grease, rust, scale, paint or other material that are likely to impair the test technique or the interpretation of results.

5. TEST PROCEDURE

The Copper Sulphate solution shall be applied to the prepared edges by brushing with a paint brush. The Copper Sulphate solution shall be in contact with the test area for a minimum period of 2 minutes. The temperature of the edges to be examined shall not be less than 10 °C or greater than 50 °C

6. REMOVAL OF EXCESS REAGENT

At the conclusion of the dwell time, the excess of Copper Sulphate solution shall be removed by flushing with a minimum amount of clean water. The edges need not be dried after removal of the excess reagent but, if drying is desired, it shall be accomplished using hot air not by hand wiping with paper towel or clothes

7. RESULTS

Copper will have plated out on all areas of low alloy steel where the weld overlay material has been removed. Any areas not revealing a bright Copper plating shall be re-stripped and re-examined.

Nuovo Pignone MASSA	CLIENTE – CUSTOMER **CONOCOPHILLIPS**
	LOCALITA' - PLANT LOCATION **WILHELMSHAVEN (GERMANY)**
COMMESSA - JOB **3100276**	IMPIANTO - PLANT **WRG-DEEP CONVERTION PROJECT**

TITOLO - TITLE

TITLE

Procedure for nozzles weld overlay removal and restoring

NOZZLES "B" and "E2"

TOTAL PAGES: 3

0	ISSUE	Lazzerini	Ricci S.	Ronchieri A.	13-04-07
REV.	DESCRIZIONE - DESCRIPTION	PREP'D	CONT-CHK'D	APP-APPR'D	DATA-DATE

ITEMS D-6212

N. SOU0120367/4

LINGUA-LANG.	PAGINA-SHEET
A	1 / 2

SOSTITUISCE IL - REPLACES

SOSTITUITO DA - REPLACED BY

0. SCOPE

This procedure is applicable for nozzles "B" and "E2", where ferrite reading on TP-347 W.O. are not conform to the applicable specifications requirements.

This procedure describes actions to be undertaken in order to solve this issue.

1. PROCEDURE

1a NOZZLE "B" (ON BOTTOM HEAD)

- WELD OVERLAY REMOVAL by machining.
- COPPER SULFATE CHECK ACCORDING TO SOU0116575 + THICKNESS ULTRASONIC TEST (Residual Thk. shall be greater than the minimum reported in the following table).

NOZZLE	NOMINAL THK (mm)	MINIMUM THK (mm)
OUTLET NOZZLE "B"	52.4	51,2

- MT WHERE ACCESSIBLE or PT ACCORDING TO SOU0116553/4 or SOU0116552/4 of 100% of the machined surface.
- W.O. DEPOSIT ACCORDING TO THE APPLICABLE WPS (WPS 1-0274-05).
- NDT CHECK ACCORDING TO THE APPLICABLE FABRICATION INSPECTION PLAN (stage 2).
- FERRITE CHECH SHALL BE PERFORMED AFTER FIRST LAYER ALSO (for information).

1b NOZZLE "E2" (ON SHELL)

- LOCAL WELD OVERLAY REMOVAL by machining. <u>ONLY THE LAST LAYER 3.3mm SHALL BE REMOVED.</u>
- PT ACCORDING TO SOU0116552 of 100% of the machined surface.
- W.O. DEPOSIT ACCORDING TO THE APPLICABLE WPS (WPS 1-0274-06). <u>JUST LAYER N° 3</u>. THIS LAYER SHALL BE APPLIED LONGITUDINALLY WITH THE WELDING PLAN IN HORIZONTAL POSITION. (APPLY W.O. ON HALF NOZZLE THAN TURN THE VESSEL SECTION 180° AND APPLY W.O. ON THE SECOND HALF NOZZLE).
- NDT CHECK ACCORDING TO THE APPLICABLE FABRICATION INSPECTION PLAN (stage 2).

- FERRITE CHECK
- INTERNAL SURFACE MACHINING ACCORDING TO DWG SUO0269057/1
- FERRITE CHECK AFTER MACHINING (FOR INFORMATION ONLY)
- PMI CHECK ON WELD OVERLAY SURFACE.