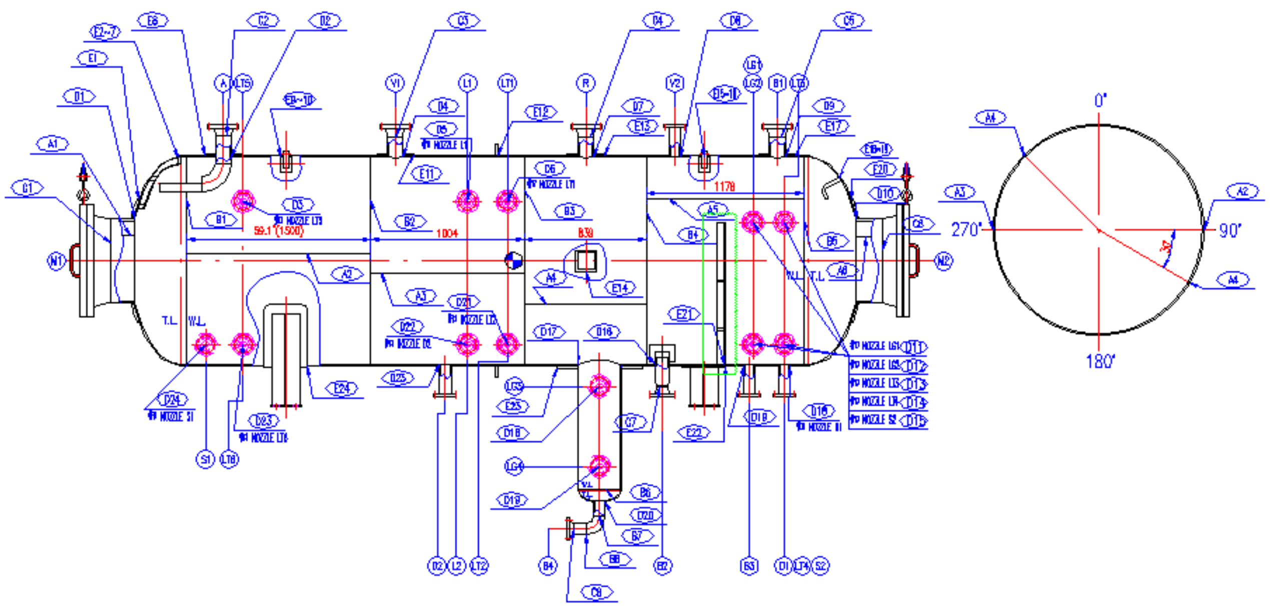
| 焊 缝 识 别 卡<br>**Joint Identification Card** | 文件编号/版本号<br>Doc. No./Rev. | W2-22-40/Rev.0 |
|---|---|---|
| | 页 数<br>Page | 第 1 页 共 4 页<br>Page 1 of 4 |

| 工作令号<br>Job No. | 22-006R | 产品名称<br>Prod. Name | 氨汽提塔回流罐<br>Ammonia Stripper Reflux Drum | 图号/修改号<br>Drawing No./Rev. No. | A2202-R-0 /Rev.0 |
|---|---|---|---|---|---|

产品焊缝编号及分布位置示意图 Welds Location Sketch




| 焊缝编号<br>Weld No. | 接头数量<br>Joint Quantity |
|---|---|
| A1～6 | 6 |
| B1～8 | 8 |
| C1～8 | 8 |
| D1～24 | 24 |
| E1～24 | 24 |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

| 编制<br>Pre .By | 日期<br>Date | 审核<br>Rev .By | 日期<br>Date | 批准<br>App. By | 日期<br>Date |
|---|---|---|---|---|---|

样 表: 7-6 修改：0
Exhibit Rev.

| 焊 缝 识 别 卡<br>Joint Identification Card | 文件编号/版本号<br>Doc. No./Rev. | W2-22-40/Rev.0 |
|---|---|---|
| | 页 数<br>Page | 第 2 页 共 4 页<br>Page 2 of 4 |

| 工作令号<br>Job No. | 22-006R | 产品名称<br>Prod. Name | 氨汽提塔回流罐<br>Ammonia Stripper Reflux Drum | 图号/修改号<br>Drawing No./Rev. No. | A2202-R-0 /Rev.0 |
|---|---|---|---|---|---|

| 焊缝编号<br>Joint No. | 母材材料标准/牌号<br>Mat'L Spec.Type or Grade | 焊接工艺编号/更改号<br>WPS No./Rev. No. | 接头类型<br>Joint type | 接头厚度<br>Joint thickness (mm) | 焊后热处理要求<br>PWHT requirements | 冲击要求<br>Impact requirements | 焊接方法<br>Welding Process | 焊工需具的资格代号<br>WELDER'S QUAL.TYPE REQ | 备注<br>Remarks |
|---|---|---|---|---|---|---|---|---|---|
| A1～6,<br>B1～5 | SA-240(UNS S32750) | WPS-22-专 08-012Rev.2 | 筒体纵环缝及与封头环缝<br>Circ. and Long. weld of shell and circ. weld of shell to head.<br>人孔接管纵缝<br>Long. welds of manway nozzle. | 8～10 | 无<br>No | 有-40℃<br>Yes | GTAW | GTAW F | |
| C1、C6 | SA-182-F53(UNS S32750<br>SA-240(UNS S32750) | WPS-22-专 08-011 Rev.2 | 人孔接管与法兰环缝<br>Circ. welds of manway nozzle and flange | 8 | 无<br>No | 有-40℃<br>Yes | SMAW | SMAW F | |
| B7～8<br>C7～8、 | SA-182-F53(UNS S32750)<br>SA-815(UNS S32760) | WPS-22-专 08-012 Rev.2 | δ＜10mm 接管与弯头、法兰环缝<br>Circ. welds of nozzle to elbow and flange δ＜10mm | 6～7.5 | 无<br>No | 无<br>No | GTAW | GTAW H | |
| B6<br>C3～5 | SA-182-F53(UNS S32750)<br>SA-815(UNS S32760) | WPS-22-专 08-011 Rev.2<br>WPS-22-专 08-012 Rev.2 | δ≥10mm 接管与法兰环缝<br>Circ. weld of nozzle to flange δ≥10mm | 10～16 | 无<br>No | 有-40℃<br>Yes | GTAW<br>SMAW | GTAW H<br>SMAW H | 打底 Root Pass: GTAW 6mm<br>其余 Other:SMAW |
| D1～24<br>E1、E8<br>E11、E13、<br>E17、E20<br>E23 | SA-182-F53(UNS S32750<br>SA-240(UNS S32750) | WPS-22-专 08-012Rev.2<br>WPS-22-专 08-012 Rev.2 | 接管与筒体、封头及管帽角焊缝<br>Fillet welds of nozzle to shell, head and pipe cap. | 6～16/<br>8～16 | 无<br>No | 部分有<br>-40℃<br>Part Yes | GTAW | GTAW H | |

| 编制<br>Pre .By | 日期<br>Date | 审核<br>Rev .By | 日期<br>Date | 批准<br>App. By | 日期<br>Date |
|---|---|---|---|---|---|

| 焊 缝 识 别 卡<br>**Joint Identification Card** | 文件编号/版本号<br>Doc. No./Rev. | W2-22-40/Rev.0 |
|---|---|---|
| | 页 数<br>Page | 第 3 页 共 4 页<br>Page 3 of 4 |

| 工作令号<br>Job No. | 22-006R | 产品名称<br>Prod. Name | 氨汽提塔回流罐<br>Ammonia Stripper Reflux Drum | 图号/修改号<br>Drawing No./Rev. No. | A2202-R-0 /Rev.0 |
|---|---|---|---|---|---|

| 焊缝编号<br>Joint No. | 母材材料标准/牌号<br>Mat'L Spec.Type or Grade | 焊接工艺编号/更改号<br>WPS No./Rev. No. | 接头类型<br>Joint type | 接头厚度<br>Joint thickness (mm) | 焊后热处理要求<br>PWHT requirements | 冲击要求<br>Impact requirements | 焊接方法<br>Welding Process | 焊工需具的资格代号<br>WELDER'S QUAL.TYPE REQ | 备注<br>Remarks |
|---|---|---|---|---|---|---|---|---|---|
| E2～7<br>E9～10<br>E12、E14-16<br>E18-19<br>E21-22、E24 | SA-240(UNS S32750) | WPS-22-专 08-012 Rev.2 | 非受压件与受压件角焊缝<br>Fillet welds of non-pressure parts to pressure parts | / | 无<br>No | 有-40℃<br>Yes | GTAW | GTAW H | |
| | | WPS-22-专 08-011 Rev.2 | 点焊<br>Tack welding | / | 无<br>No | 有-40℃<br>Yes | SMAW | SMAW H | |
| | | WPS-22-专 08-011 Rev.2 | 临时焊缝<br>Temporary welds | / | 无<br>No | 有-40℃<br>Yes | SMAW | SMAW H | 临时附件材料: SA-240(UNS S32750)The material fo temporary welding shall be SA-240(UNS S32750) |

补充要求:
Supplementary requirements:

1.层间温度不高于100°C。
1. The interpass temperature shall not be higher than 100°C.

2.氩弧焊时，背面应充氩保护。
2. During argon arc welding, the back shall be filled with argon for protection.

3.碳钢、低合金钢和有色金属材料上使用的砂轮不得用于不锈钢设备，清洁不锈钢时，只能使用不锈钢刷子和工具
3. Grinding wheels used on carbon steel, low alloy steel and non-ferrous metal materials shall not be used for stainless steel equipment. When cleaning stainless steel, only stainless steel brushes and tools can be used.

| 编制<br>Pre. By | 日期<br>Date | 审核<br>Rev. By | 日期<br>Date | 批准<br>App. By | 日期 |
|---|---|---|---|---|---|

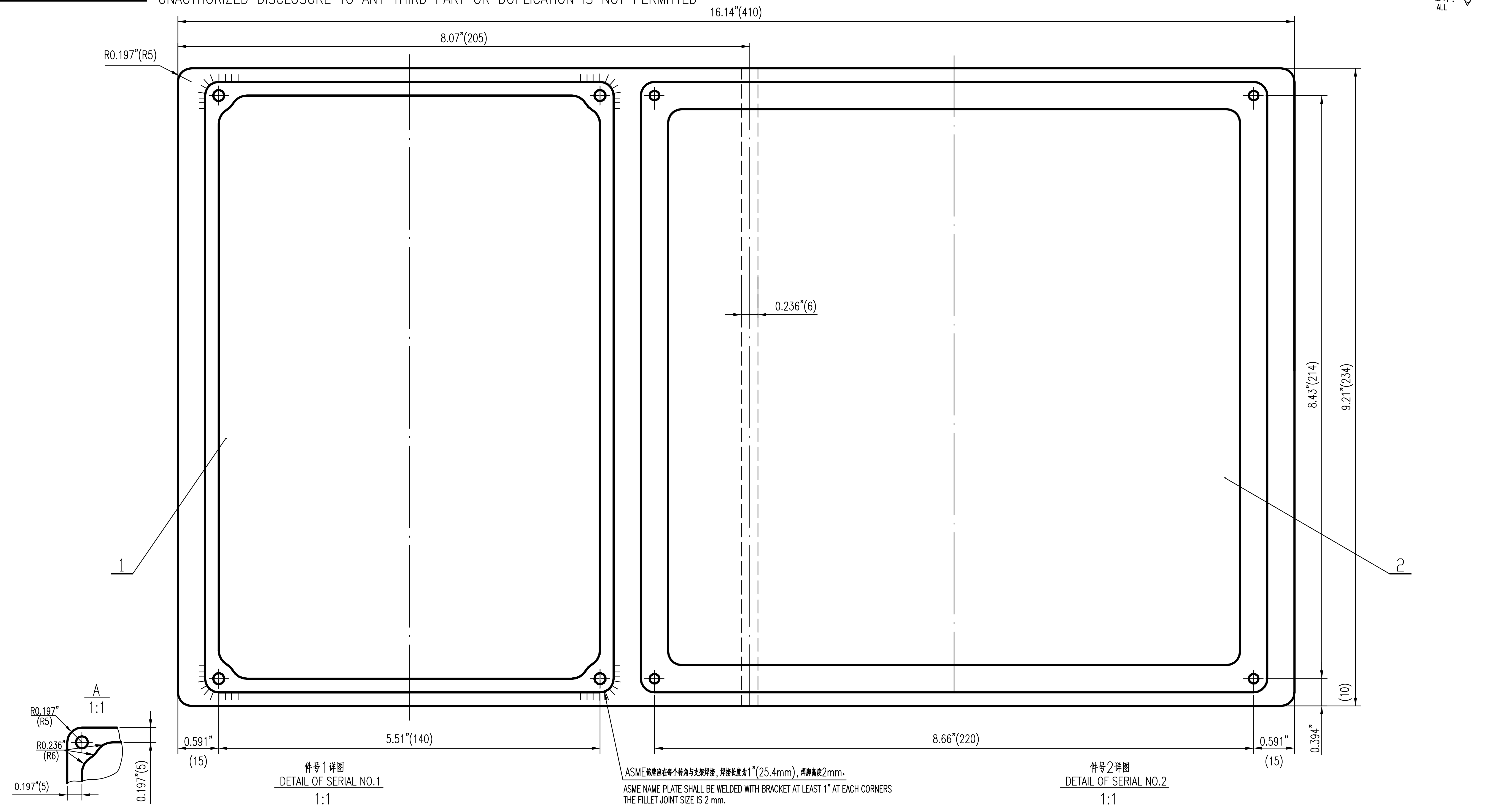
<table>
<tr><td colspan="5" rowspan="2">焊 缝 识 别 卡<br>Joint Identification Card</td><td>文件编号/版本号<br>Doc. No./Rev.</td><td>W2-22-40/Rev.0</td></tr>
<tr><td>页 数<br>Page</td><td></td></tr>
<tr><td>工作令号<br>Job No.</td><td>22-006R</td><td>产品名称<br>Prod. Name</td><td>氨汽提塔回流罐<br>Ammonia Stripper Reflux Drum</td><td colspan="2">图号/修改号<br>Drawing No./Rev. No.</td><td>A2202-R-0 /Rev.0</td></tr>
<tr><td colspan="7">补充要求:<br>Supplementary requirements:</td></tr>
<tr><td colspan="7">4.厚度小于32mm时，每层焊道厚度须小于9.5mm。<br>4. For thickness less than 32 mm, each weld pass thickness shall be less than 9.5 mm.</td></tr>
<tr><td colspan="7">5.焊条摆动幅度须小于 3 倍焊芯直径或 13 mm（1/2 in），以较小者为准。<br>5. Weaving of the electrode shall be limited to a maximum of 3 times core wire diameter or 13 mm (1/2 in), whichever is smaller.</td></tr>
<tr><td colspan="7">6.背面清根不允许使用碳弧气刨。<br>6. Carbon arc air gouging is not permitted in back gouging.</td></tr>
</table>

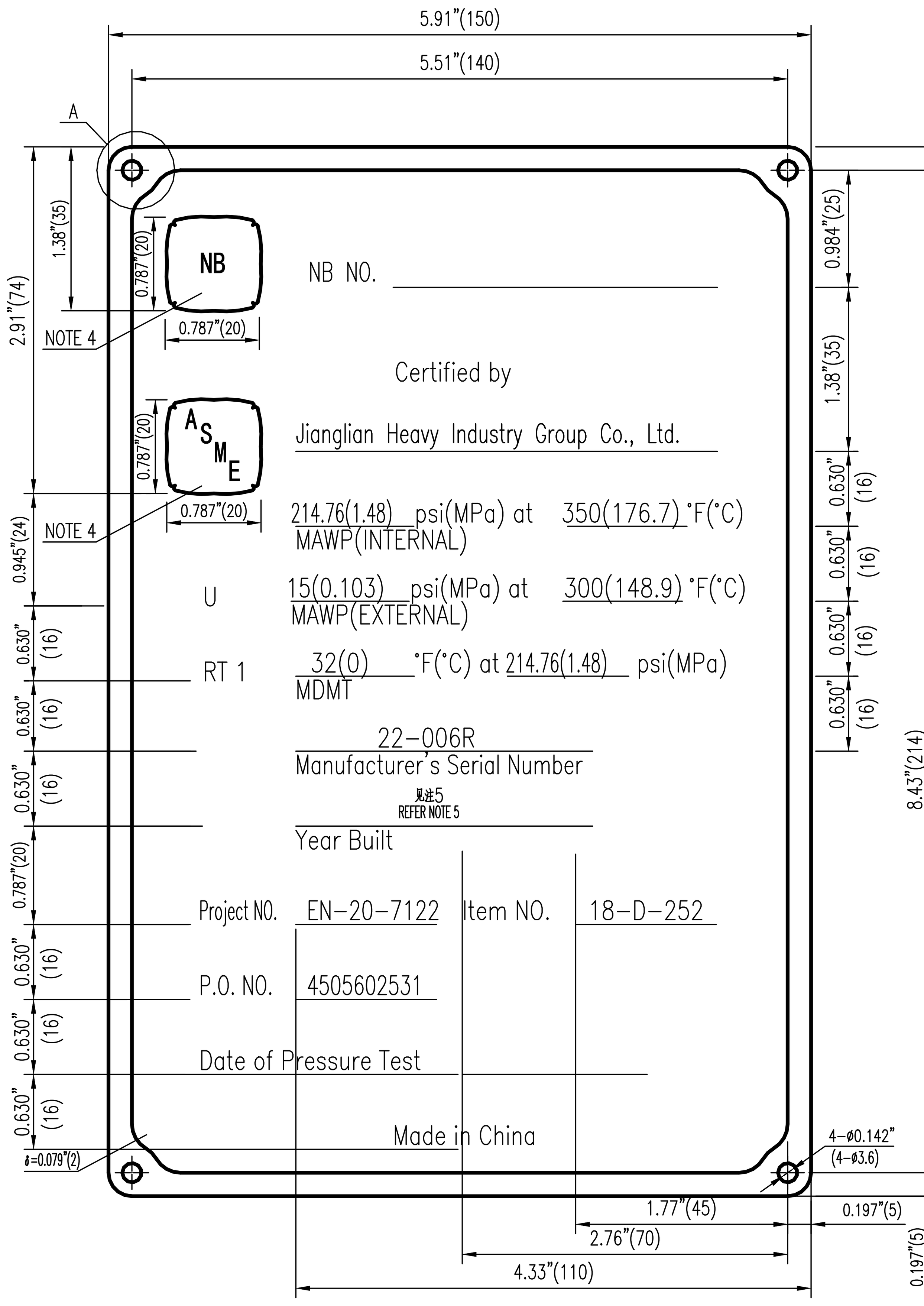
| 编制<br>Pre. By | 日期<br>Date | 审核<br>Rev. By | 日期<br>Date | 批准<br>App. By | 日期<br>Date |
|---|---|---|---|---|---|

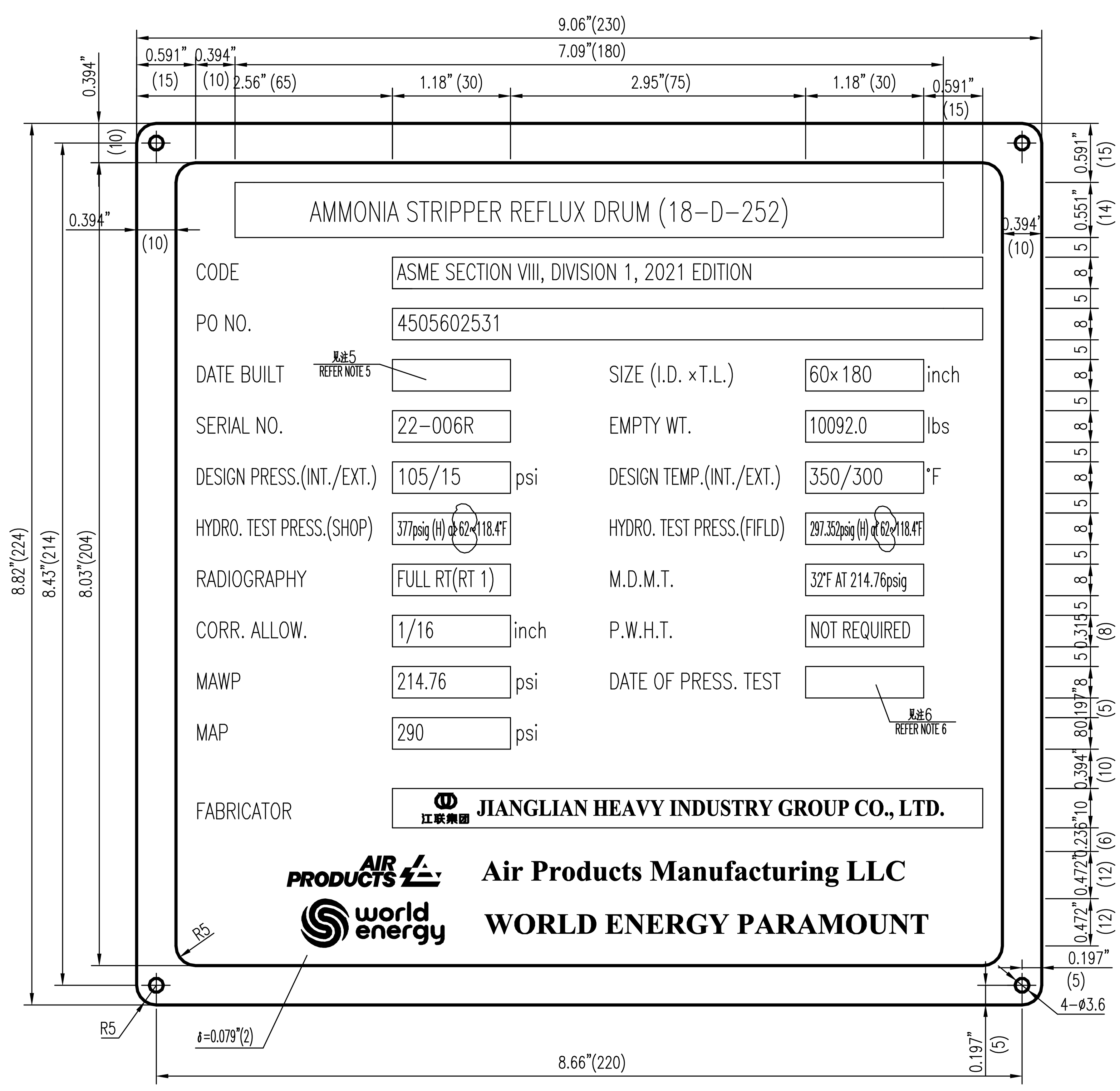
DWG. NO. A2202-R-MP

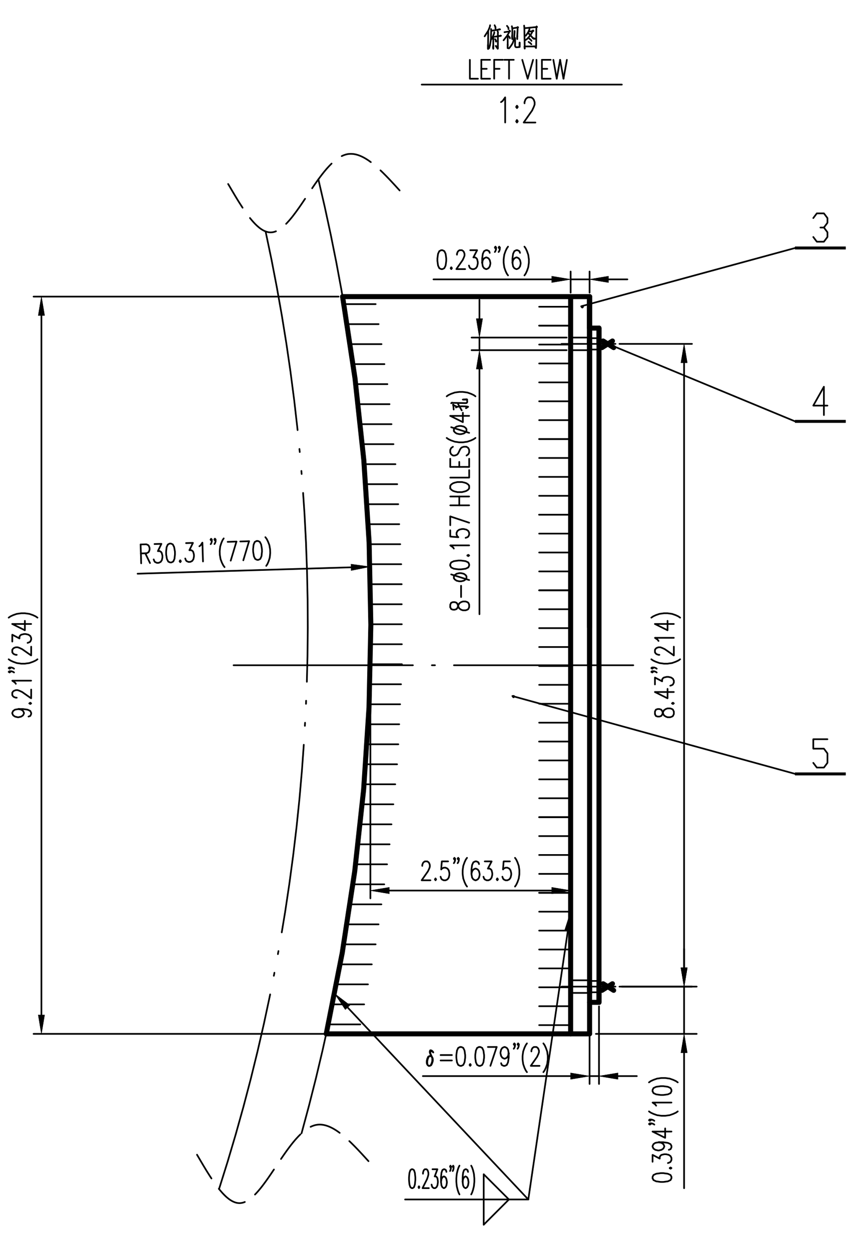
THE DRAWINGS AND DOCUMENTS ARE THE PROPERTY OF JIANGLIAN HEAVY INDUSTRY GROUP CO., LTD.
UNAUTHORIZED DISCLOSURE TO ANY THIRD PART OR DUPLICATION IS NOT PERMITTED

全部: ALL




注：1. 铭牌中所有字符(字母及数字)均要求采用ARIAL字体，字体高度不小于4mm。
2. 铭牌中所有字符(字母及数字)，下划线和边框均需凸起0.3mm，需经蚀刻并表面抛光。
3. 其余低凹部位烘烤0.1mm厚的黑色瓷漆。
4. 在"ASME"处打ASME认证标记。在"NB"处打NB认证标记。
5. 建造年份应与提供"规范钢印"的日期相对应，并应进行物理硬冲压。
6. 水压试验后，应以DD-MM-YYYY格式印上实际日期(雕刻或硬冲压)，且必须清晰可辨。

NOTES:
1. ALL CHARACTERS IN THE NAMEPLATE SHALL BE ARIAL FONT AND BE NOT LESS THAN 4mm HIGH.
2. ALL CHARACTERS, UNDERLINES AND FRAME IN THE NAMEPLATE SHALL BE RAISED 0.3mm HIGH BY ETCHING AND THEIR SURFACES SHALL BE POLISHED BY BUFFING.
3. THE OTHER LOWER BACKGROUND PARTS SHALL BE PAINTED WITH 0.1mm THICKNESS BLACK ENAMEL.
4. THE "ASME" IS THE PLACE WHERE MARKING ASME CERTIFICATION MARK. THE "NB" IS THE PLACE WHERE MARKING NB CERTIFICATION MARK.
5. YEAR OF BUILT SHALL BE CORRESPOND TO THE DATE OF APPLYING "CODE STAMP" AND SHALL BE HARD PUNCHED PHYSICALLY.
6. ACTUAL DATE SHALL BE PUNCHED (ENGRAVING OR HARD STAMPING) AFTER HYDROTEST IN DD-MM-YYYY FORMAT AND MUST BE CLEARLY LEGIBLE.

| 件号 SERIAL NO. | 图号及标准号 DWG. NO. OR STD. | 名称 DESCRIPTION | 数量 QTY. | 材料 MATERIAL | 单 SINGLE 重量 | 总 TOTAL (kg) | 备注 REMARK |
|---|---|---|---|---|---|---|---|
| 5 | | 支撑板 $\delta=6$ SUPPORT PLATE | 1 | SA-240(UNS S32750) | | 2.3 | |
| 4 | GB/T827-1986 | 铆钉 3x10 RIVET | 8 | S.S.316L | | | |
| 3 | | 铭牌座 $\delta=6$ NAMEPLATE BRACKET | 1 | SA-240(UNS S32750) | | 4.6 | |
| 2 | 按本图 ACCORDING TO THIS DRAWING | 用户铭牌 OWNER NAMEPLATE | 1 | S.S.316L | | 0.8 | |
| 1 | 按本图 ACCORDING TO THIS DRAWING | ASME铭牌 ASME NAMEPLATE | 1 | S.S.316L | | 1.2 | |

| 版本号 REV. NO. | 日期 DATE | 说明 DESCRIPTION | 设计 DESIGNED | 审核 REVIEWED | 批准 APPROVED | 授权检验师 AI |
|---|---|---|---|---|---|---|
| 4 | 2023.8.21 | 供审查 FOR APPROVAL | 曹瑟 Cao Se | 戴雪峰 Dai Xuefeng | | |
| 3 | 2023.7.12 | 供审查 FOR APPROVAL | 曹瑟 Cao Se | 戴雪峰 Dai Xuefeng | | |
| 2 | 2023.3.1 | 供审查 FOR APPROVAL | 曹瑟 Cao Se | 戴雪峰 Dai Xuefeng | | |

**Air Products Manufacturing LLC**

**JIANGLIAN HEAVY INDUSTRY GROUP CO., LTD.**

铭牌
NAMEPLATE

组合件
ASSEMBLY PARTS

| | |
|---|---|
| DWG. NO. | A2202-R-MP |
| JOB NO. | 22-006R |
| SERIAL NO. | |
| WEIGHT (kg) | 8.9 |
| SCALE | |
| SHT. NO. 1 | TOTAL 1 |

| | |
|---|---|
| PROJECT NAME | WORLD ENERGY RENEWABLES PROJECT, CA.USA |
| PROJECT NUMBER OF FLUOR | A8KM |
| PROJECT NUMBER OF AP | EN-20-7122 |
| CLIENT DOCUMENT NUMBER | |
| PO NO. | 4505602531 |
| TAG NO. | 18-D-252 |
| VDR CODE | BE04 |

借(通)用件登记
图形输出
底图校对
旧底图总号
底图总号
签 字
日 期

Bill of Materials

PO Number： 4505602531

Project Number:EN-20-7122

Project Name:Energy Renewables Project, Paramount, CaliforniaParamount, California

Tag Number: 18-D-252

By: Cao Se

Rev.0

BOM is Vendors Responsibility. Vendor to ensure that the all the materials, as per the requirements are included in the BOM.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 26 | ASME B16.5-2017 | 法兰 NPS 2-CL300 LWN/RF<br>FLANGE | 2 | SA-182-F53(UNS S32750) | 9.0 | 18.0 | |
| 25 | ASME B16.5-2017 | 法兰 NPS 2-CL300 LWN/RF<br>FLANGE | 3 | SA-182-F53(UNS S32750) | 8.0 | 24.0 | |
| 24 | ASME B16.5-2017 | 法兰 NPS 2-CL300 LWN/RF<br>FLANGE | 1 | SA-182-F53(UNS S32750) | | 9.0 | |
| 23 | A2202-R-9 | 吊耳<br>LIFTING LUG | 4 | 组合件<br>ASSEMBLY PARTS | 10 | 40 | |
| 22 | A2202-R-8 | 补强圈 12"<br>REINFORCING PAD | 1 | SA-240(UNS S32750) | | 15 | |
| 21 | | 接管 NPS 12,δ=10 L=906<br>BOOT SHELL | 1 | SA-240(UNS S32750) | | 89 | |
| 20 | ASME B16.9-2018 | 管帽 NPS 12-16(Min.12.7)<br>PIPE CAP | 1 | SA-815(UNS S32760) | | 15.5 | |
| 19 | ASME B16.5-2017 | 法兰 NPS 2-CL300 LWN/RF<br>FLANGE | 1 | SA-182-F53(UNS S32750) | | 7.0 | 法兰高度Y=209mm<br>FLANGE HEIGHT |
| 18 | ASME B16.5-2017 | 法兰 NPS 3-CL300 WN/RF<br>FLANGE | 1 | SA-182-F53(UNS S32750) | | 8.2 | B=57 |
| 17 | | 接管 NPS 3,δ=16 L=196<br>PIPE | 1 | SA-182-F53(UNS S32750) | | 4.4 | |
| 16 | A2202-R-7 | 防涡流挡板<br>RAISED VORTEX BRAKER | 1 | 组合件<br>ASSEMBLY PARTS | | 2.0 | |
| 15 | A2202-R-6 | 鞍座<br>SADDLE | 2 | 组合件<br>ASSEMBLY PARTS | 130 | 260 | |
| 14 | ASME B16.5-2017 | 法兰 NPS 2-CL300 LWN/RF<br>FLANGE | 3 | SA-182-F53(UNS S32750) | 8.0 | 24.0 | 法兰高度Y=230mm<br>FLANGE HEIGHT |
| 13 | A2202-R-5 | 溢流堰<br>OVERFLOW WEIR | 1 | SA-240(UNS S32750) | | 150 | |
| 12 | A2202-R-MP | 铭牌<br>NAMEPLATE | 1 | 组合件<br>ASSEMBLY PARTS | | 3.0 | |
| 11 | | 接管 NPS 4,δ=16 L=145<br>PIPE | 1 | SA-182-F53(UNS S32750) | 3.3 | 6.6 | |
| 10 | | 外压加强圈 Ø1545/Ø1748 δ=8<br>STIFFENING RING | 1 | SA-240(UNS S32750) | | 33.4 | |
| 9 | | 筒体 I.D. 1524x8 L=4521<br>CYLINDRICAL SHELL | 1 | SA-240(UNS S32750) | | 1380 | |
| 8 | ASME B16.5-2017 | 法兰 NPS 4-CL300 WN/RF<br>FLANGE | 3 | SA-182-F53(UNS S32750) | 12 | 36 | B=82 |
| 7 | | 接管 NPS 4,δ=16 L=196<br>PIPE | 1 | SA-182-F53(UNS S32750) | | 4.4 | |
| 6 | ASME B16.9-2018 | 无缝90°长半径弯头 NPS 4-16<br>SEAMLESS 90° LONG RADIUS ELBOW | 1 | SA-815(UNS S32760) | | 6.0 | |
| 5 | | 半管 NPS 4,δ=16<br>HALF PIPE | 1 | SA-182-F53(UNS S32750) | | 7.0 | |
| 4 | A2202-R-4 | 内部耐磨板<br>INTERNAL WEAR PLATE | 1 | HASTELLOY C-276 | | 40 | |
| 3 | A2202-R-3 | 支撑板<br>STAND-OFF CLIPS | 6 | SA-240(UNS S32750) | 1.0 | 6.0 | |
| 2 | A2202-R-2 | 2:1椭圆形封头 I.D. 1524x10(8.0)<br>2:1 ELLIPSOIDAL HEAD | 2 | SA-240(UNS S32750) | 206 | 412 | h=25mm |
| 1 | A2202-R-1 | 人孔<br>MANWAY | 2 | 组合件<br>ASSEMBLY PARTS | 500 | 1000 | |
| 件号<br>SERIAL NO. | 图号及标准号<br>DWG. NO. OR STD. | 名称<br>DESCRIPTION | 数量<br>QTY. | 材料<br>MATERIAL | 单<br>SINGLE<br>重量<br>WEIGHT | 总<br>TOTAL<br>(kg) | 备注<br>REMARK |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| 1 | 2022.6.10 | 供审查<br>FOR APPROVAL | 曹瑟<br>Cao Se | 魏志刚<br>Wei Zhigang | | |
| 0 | 2022.2.23 | 供审查<br>FOR APPROVAL | 曹瑟<br>Cao Se | 魏志刚<br>Wei Zhigang | | |
| 版本号<br>REV. NO. | 日期<br>DATE | 说明<br>DESCRIPTION | 设计<br>DESIGNED | 审核<br>REVIEWED | 批准<br>APPROVED | 授权检验师认可<br>ACCEPTED BY AI |

# CRS-18-D-252 Calculations（REV.0）

<table>
<tr><td>AP 意见<br>AP comments</td><td>江联回复<br>Jianglian response</td></tr>
<tr><td>Distance from Saddle to Vessel tangent a1 or a 29.00 in<br><br>Saddle Width b1 or b 8.00 in<br>Saddle Bearing Angle delta or theta 120.00 degrees<br><br>Wear Plate Width b2 or b1 13.00 in<br>Wear Plate Bearing Angle delta2 or theta1 130.00 degrees<br>Wear Plate Thickness e2 or tr 0.3150 in<br>Wear Plate Allowable Stress fw or Sr 30650.00 psi<br><br>Inside Depth of Head Hi or h2 15.06 in<br><br>150 deg as per SPEC-ENG-DOC001, and saddle shall be full base support.</td><td>因 18-D-252 为卧式设备，本身带有的与筒体焊接的鞍座就是其运输鞍座，鞍座包角为 120 度。<br>18-D-252 is a horizontal equipment with saddles that welded on the shell. This saddle is regarded as the transportation saddle for 18-D-252. So, we think the saddle bearing angle in the calculations shall be kept as 120 Degree.</td></tr>
<tr><td></td><td></td></tr>
</table>

# TRANSPORT CALCULATION SHEET FOR

# AMMONIA STRIPPER REFLUX DRUM

(JOB NO.: 22-006R)

(DRAWING NO.: A2202-R-YS-0)

(DOCUMENT NO.: D1-22-02-YS/Rev.1)

| | |
|---|---|
| Project Name | WORLD ENERGY RENEWABLES PROJECT, CA. USA |
| PROJECT NUMBER OF FLUOR | A8KM |
| PROJECT NUMBER OF AP | EN-20-7122 |
| OPEN TEXT DOCUMENT NUMBER | |
| PO No. | 4505602531 |
| Tag No. | 18-D-252 |
| VDR CODE | BI01 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| 1 | 2023.10.11 | FOR APPROVAL | Cao Se | Dai Xuefeng | |
| 0 | 2023.8.19 | FOR APPROVAL | Cao Se | Dai Xuefeng | |
| REV. | DATE | DESCRIPTION | DESIGNED | REVIEWED | APPROVED |

江联重工
Jlianco

**JIANGLIAN HEAVY INDUSTRY GROUP CO., LTD.**

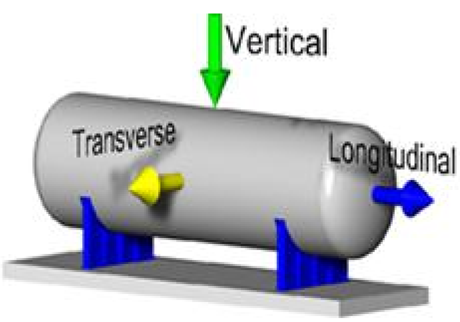
PV Elite 25 SP1   Licensee: SL Licensed User
FileName : 18-D-252 - y-------------------------------------
Saddle Calcs: Road Transport:         Step:   18   4:44pm  Oct 10,2023

**ASME VIII Division 2 Horizontal Vessel Analysis, Left Saddle:**

Horizontal Vessel Stress Calculations : Road Transport

**Input and Calculated Values:**

```
 Vessel Mean Radius                              Rm       30.16  in
 Shell Thickness used in this Case                t       0.315  in
 Stiffened Vessel Length per 4.15.6               L      159.81  in
 Distance from Saddle to Vessel tangent   a1 or a       28.00  in

 Saddle Width                                b1 or b       8.00  in
 Saddle Bearing Angle                 delta or theta     120.00  degrees

 Wear Plate Width                            b2 or b1      13.00  in
 Wear Plate Bearing Angle           delta2 or theta1     130.00  degrees
 Wear Plate Thickness                        e2 or tr     0.3150  in
 Wear Plate Allowable Stress                 fw or Sr   30650.00  psi

 Inside or Mean Depth of Head                Hi or hm      15.20  in

 Shell Allowable Stress used in Calculation             30650.00  psi
 Head Allowable Stress used in Calculation              30650.00  psi
 Circumferential Efficiency in Plane of Saddle              1.00
 Circumferential Efficiency at Mid-Span                     1.00

 Distance from Saddle Base to Centerline          B       78.62  in
 Coefficient of Friction                         mu        0.40
```




```
                                   Saddle Force Q for this Transportation Case         14552.27   lbf
 Shipping Longitudinal Acceleration              gx         1.50  g
 Shipping Transverse Acceleration                gz         1.50  g
 Shipping Vertical Acceleration                  gy         2.00  g
 Vertical Acceleration Acting with Transverse   gw         2.00  g
 Internal Pressure during Transport                         0.03  psig
 Transportation Wind Load Scalar Factor        wlsf         1.00
 Transportation Wind Velocity                    wv         88.0  mile/hr


 Horizontal Vessel Analysis Results:      Actual |     Allowable |
                                             psi |           psi |
```

```
---------------------------------------------------------------
Long. Stress at Top    of Midspan       -149.39 |    -72000.00 |
Long. Stress at Top    of Midspan        149.39 |     30650.00 |
Long. Stress at Bottom of Midspan        152.65 |     30650.00 |
Long. Stress at Top    of Saddles        854.10 |     30650.00 |
Long. Stress at Bottom of Saddles       -470.87 |    -72000.00 |
Long. Stress at Bottom of Saddles        470.87 |     30650.00 |
---------------------------------------------------------------
Tangential Shear in Shell               1033.84 |     24520.00 |
Circ. Stress at Horn of Saddle          4368.11 |     45975.00 |
Circ. Compressive Stress in Shell        137.11 |     30650.00 |
---------------------------------------------------------------
```

**Intermediate Results: Saddle Reaction Q due to Road Transport Load:**

Transverse Force due to Wind during Transport [Ft_w]:

```
  = Transverse Area * 0.00256 * wv^2 * wlsf
  = 107.64 * 0.00256 * 88^2 * 1
  = 2133.9 lbf
```

Longitudinal Force due to Wind during Transport [Fl_w]:

```
  = pi * D^2/4 * 0.00256 * wv^2 * wlsf * Wind Dia. Mult
  = pi * 5.3025^2/4 * 0.00256 * 88^2 * 1 * 1.2
  = 525.3 lbf
```

Transverse Force due to Lateral Acceleration [Ft]:

```
  = gz * saddle Load * gw + Ft_w
  = 1.5 * 4038.1 * 2 + 2133.9
  = 14248.3 lbf
```

Longitudinal Force due to Axial Acceleration [Fl]:

```
  = gx * saddle Load * gw + Fl_w
  = 1.5 * 4038.1 * 2 + 525.34
  = 12639.7 lbf
```

Saddle Reaction Force due to Lateral Acceleration [Fwt]:

```
  = Ft/Num of Saddles * B / E
  = 14248/2 * 78.62/53
  = 10514.1 lbf
```

Saddle Reaction Force due to Transport Load  [Fwl]:

```
  = Fl * B / Ls
  = 12640 * 78.62/120
  = 8239.0 lbf
```

Saddle Reaction Force due to Vertical Transportation Acceleration  [Fsl]:

```
  = Saddle Load * gy
  = 4038.1 * 2
  = 8076.248 lbf
```

Load Combination Results due to Transport Loading [Q]:

```
  = Saddle Load + max( Fwl, Fwt, Fsl )
  = 4038.1 + max( 8239, 10514, 8076.2 )
  = 14552.3 lbf
```

**Summary of Loads at the Base of this Saddle:**

```
Vertical Load (including saddle weight)            15295.17  lbf
Transverse Shear Load                              10514.15  lbf
Longitudinal Shear Load                            12639.71  lbf
```

**Formulas and Substitutions for Horizontal Vessel Analysis:**

Note: Wear Plate is Welded to the Shell, k = 0.1

Saddle Dimension [E]:
```
  = Baseplate Length
  = 53.000 in
```

**The Computed K values from Table 4.15.1:**

```
 K1  = 0.1066     K2  = 1.1707     K3  = 0.8799     K4  = 0.4011
 K5  = 0.7603     K6  = 0.0529     K7  = 0.0472     K8  = 0.3405
 K9  = 0.2711     K10 = 0.0581     K1* = 0.1923     K6p = 0.0449
 K7p = 0.0401
```

*The suffix 'p' denotes the values for a wear plate if it exists.*

Note: Dimension a is greater than or equal to Rm/2.

Moment per Equation 4.15.1 [M1]:
```
  = -Q*a [1 - (1- a/L + (Rm²-hm²)/(2a*L))/(1+(4hm²)/3L)]
  = -14552*28[1-(1-28/159.81+(30.158²-15.199²)/
    (2*28*159.81))/(1+(4*15.199)/(3*159.81))]
  = -81796.8 in-lb
```

Moment per Equation 4.15.2 [M2]:
```
  = Q*L/4(1+2(Rm²-hi²)/(L²))/(1+(4hi)/( 3L))-4a/L
  = 14552*159.81/4(1+2(30.158²-15.199²)/(159.81²))/(1+(4*15.199)/
    (3*159.81))-4*28/159.81
  = 135921.9 in-lb
```

Longitudinal Stress at Top of Shell (4.15.4) [sigma1]:
```
  = P * Rm/(2t) - M2/(pi*Rm²t)
  = 0.034 * 30.158/(2*0.315 ) - 135922/(pi*30.158²*0.315 )
  = -149.39 psi
```

Longitudinal Stress at Bottom of Shell (4.15.5) [sigma2]:
```
  = P * Rm/(2t) + M2/(pi * Rm² * t)
  = 0.034 * 30.158/(2 * 0.315 ) + 135922/(pi * 30.158² * 0.315 )
  = 152.65 psi
```

Longitudinal Stress at Top of Shell at Support (4.15.8) [sigma*3]:
```
  = P * Rm/(2t) - M1/(K1*pi*Rm²t)
  = 0.034*30.158/(2*0.315)--81797/(0.1066*pi*30.158²*0.315)
  = 854.10 psi
```

Longitudinal Stress at Bottom of Shell at Support (4.15.9) [sigma*4]:
```
  = P * Rm/(2t) + M1/(K1* * pi * Rm² * t)
  = 0.034*30.158/(2*0.315)+-81797/(0.1923*pi*30.158²*0.315)
  = -470.87 psi
```

Maximum Shear Force in the Saddle (4.15.3) [T]:
```
  = Q(L-2a)/(L+(4*hm/3))
  = 14552 ( 159.81 - 2 * 28 )/(159.81 + ( 4 * 15.199/3))
  = 8389.1 lbf
```

Shear Stress in the shell no rings, not stiffened (4.15.12) [tau2]:
```
  = K2 * T / ( Rm * t )
  = 1.1707 * 8389.1/( 30.158 * 0.315 )
  = 1033.84 psi
```

Decay Length (4.15.20) [x1,x2]:
```
  = 0.78 * sqrt( Rm * t )
  = 0.78 * sqrt( 30.158 * 0.315 )
  = 2.404 in
```

Effective reinforcing plate width (4.15.24) [B1]:
```
  = min( b + 1.56 * sqrt( Rm * t ), 2a  )
  = min( 8 + 1.56 * sqrt( 30.158 * 0.315 ), 2 * 28 )
  = 12.81 in
```

Wear Plate/Shell Stress ratio (4.15.26) [eta]:
```
  = 1.0000 Materials are the same, transport case
```

Circumferential Stress at Saddle Base with Wear Plate (4.15.25) [sigma6,r]:
```
  = -K5 * Q * k / ( B1( t + eta * tr ) )
  = -0.7603 * 14552 * 0.1/( 12.808 ( 0.315 + 1 * 0.315 ) )
  = -137.11 psi
```

Circ. Comp. Stress at Horn of Saddle, L<8Rm (4.15.29) [sigma7,r✱]:
```
  = -Q/(4(t+eta*tr)b1) - 12*K7*Q*Rm/(L(t+eta*tr)²)
  = -14552/(4(0.315 + 1 * 0.315 )12.808 ) -
     12*0.04718*14552*30.158/(159.81(0.315+1*0.315)²)
  = -4368.11 psi
```

**Results for Vessel Ribs, Web and Base:**

| | | | |
|---|---|---|---|
| Baseplate Length | Bplen | 53.0000 | in |
| Baseplate Thickness | Bpthk | 0.3940 | in |
| Baseplate Width | Bpwid | 9.0000 | in |
| Number of Ribs ( inc. outside ribs ) | Nribs | 4 | |
| Rib Thickness | Ribtk | 0.3940 | in |
| Web Thickness | Webtk | 0.3940 | in |
| Web Location | Webloc | Center | |
| Saddle Yield Stress | Sy | 62700.0 | psi |
| Height of Web at Center | Hw,c | 42.0 | in |
| Friction Coefficient | mu | 0.400 | |

**Moment of Inertia of Saddle - Transverse Direction (90 degrees to long axis)**

Inertia of Shell [ShellInertia]:
```
  = (( 1.56 * sqrt( R * t ) + WearPlateWidth )t³ )/12
  = (( 1.56 * sqrt( 30 * 0.315 ) + 13 )0.315³ )/12
  = 0.046 in**4
```

Resolved Inertia for the Shell [I,shell]:
```
  = ShellInertia + AShell( C1 - Y )²
  = 0.04635 + 5.6056 ( 19.585 - 0.1575 )²
  = 2115.827 in**4
```

| | B in | D in | Y in | A in^2 | AY in³ | I + AD² in**4 |
|---|---|---|---|---|---|---|
| Shell | 17.7956 | 0.3150 | 0.1575 | 5.6056 | 0.8829 | 2115.8267 |
| Wearplate | 13.0000 | 0.3150 | 0.4725 | 4.0950 | 1.9349 | 1495.9364 |
| Web | 0.3940 | 47.1960 | 24.2280 | 18.5952 | 450.5250 | 3852.4893 |
| BasePlate | 9.0000 | 0.3940 | 48.0230 | 3.5460 | 170.2895 | 2867.7014 |
| Totals | ... | ... | ... | 31.8418 | 623.6323 | 10331.9541 |

Distance to Centroid [C1]:
```
  = AY / A
  = 623.63/31.842
  = 19.585 in
```

Angle [beta]:
```
  = 180 - Saddle Angle/2
  = 180 - 120/2
  = 120.0
```

Saddle Splitting Coefficient [K1]:

```
  = ( 1 + cos(beta) - 0.5*sin(beta)²  )/(pi - beta + sin(beta)cos(beta) )
  = ( 1 + cos(120 ) - 0.5*sin(120 )²  )/(pi - 2.0944 + sin(120 )cos(120 ) )
  = 0.2035
```

Saddle Splitting Force [Fh]:

```
  = K1 * Q
  = 0.2035 * 14552
  = 2961.7024 lbf

 Tension Stress, St = ( Fh/As )       =        112.8860  psi
 Allowed Stress, Sa = 0.6 * Yield Str =      37620.0000  psi
```

Saddle Splitting Dimension [d]:

```
  = B - R * sin(theta/2)/(theta/2 in radians)
  = 78.62 - 30 * sin(120/2)/1.0472
  = 53.410 in

 Bending Moment, M  = Fh * d          =     158185.1250  in-lb

 Bending Stress, Sb = ( M * C1 / I  ) =        299.8567  psi
 Allowed Stress, Sa = 2/3 * Yield Str =      41800.0000  psi
```

**Minimum Thickness of Baseplate per Moss:**

```
  = sqrt( 3( Q + Saddle_Wt )BasePlateWidth / ( 4 * BasePlateLength * AllStress ))
  = sqrt( 3(14552 + 742.9 )9/( 4 * 53 * 41800 ))
  = 0.216 in
```

**Calculation of Axial Load, Intermediate Values and Compressive Stress:**

Web Length Dimension [ Web Length ]:

```
  = 2 * cos( 90 - Saddle Angle/2 )( Inside Radius + Shell Thk + Wear Plate Thk )
  = 2 * cos( 90 - 120/2 )( 30 + 0.315 + 0.315 )
  = 53.053 in
```

Distance between Ribs [e]:

```
  = Web Length / ( Nribs - 1 )
  = 53.053/( 4 - 1 )
  = 17.684 in
```

Baseplate Pressure Area [Ap]:

```
  = e * Bpwid / 2
  = 17.684 * 9/2
  = 79.579 in^2
```

Bearing Pressure [Bp]:

```
  = Q / ( BasePlateLength * BasePlateWidth )
  = 14552/( 53 * 9 )
  = 30.508 lbf/in^2
```

Axial Load [P]:

```
  = Ap * Bp
  = 79.579 * 30.508
  = 2427.791 lbf
```

Area of the Rib and Web [Ar]:

```
  = Rib Area + Web Area
  = 2.9968 + 3.4838
  = 6.481 in^2
```

Compressive Stress [Sc]:

```
  = P/Ar
  = 2427.8/6.4806
  = 374.627 psi
```

**Check of Outside Ribs:**

Inertia of Saddle, Outer Ribs - Longitudinal Direction

| | B | D | Y | A | AY | Io |
|---|---|---|---|---|---|---|
| Rib+Web | 0.3940 | 8.0000 | ... | 3.1520 | ... | 16.8107 |

Rib dimension [D]:
```
  = Saddle Width - Web Thickness
  = 8 - 0.394
  = 7.606 in
```

Distance to Centroid from Datum [ytot]:
```
  = AY / A
  = 0/6.4806
  = 0.000 in
```

Distance to Centroid [C1]:
```
  = Saddle Width / 2
  = 8/2
  = 4.000 in
```

Radius of Gyration [r]:
```
  = sqrt( Total Inertia / Total Area )
  = sqrt( 16.811/6.4806 )
  = 1.611 in
```

Length of Outer Rib, step 1, [Lw]:
```
  = 2 * sin( saddle bearing angle / 2 )( radius + shlthk + wpdthk )
  = 2 * sin( 120/2 )( 30 + 0.315 + 0.315 )
  = 53.053 in
```

Length of Outer Rib, step 2, [Bd]:
```
  = Baseplate length - clearance
  = 53 - 2
  = 51.000 in
```

Length of Outer Rib, step 3, [Dd]:
```
  = ( Lw - Bd )/2
  = ( 53.053 - 51 )/2
  = 1.026 in
```

Length of Outer Rib [L]:
```
  = sqrt( Rl² + Dd² )
  = sqrt( 62.519² + 1.0264² )
  = 62.519 in
```

Intermediate Term [Cc]:
```
  = sqrt( 2 * pi² * Elastic Modulus / Yield Stress )
  = sqrt( 2 * pi² * 29000000/62700 )
  = 95.550
```

Slenderness ratio [KL/r]:
```
  = KL/r
  = 1 * 62.519/1.6106
  = 38.818
```

Bending Moment [Rm]:
```
  = Fl /( 2 * Bplen ) * e * L / 2
  = 12640/( 2 * 53 ) * 17.684 * 62.519/2
  = 65917.773 in-lb
```

Compressive Allowable, KL/r < Cc ( 38.818 < 95.55 ) per AISC E2-1 [Sca]:

```
= ( 1-(Klr)^2/(2*Cc^2))Fy/(5/3+3*(Klr)/(8*Cc)-(Klr^3)/(8*Cc^3)
= ( 1-( 38.818 )^2/(2 * 95.55^2 ))62700/
  ( 5/3+3*(38.818 )/(8* 95.55 )-( 38.818^3)/(8*95.55^3)
= 31771 psi
```

**AISC Unity Check of Outside Ribs ( must be <= 1 )**

```
= Sc/Sca + ( Rm * C1 / I )/Sba
= 374.63/31771 + ( 65918 * 4/16.811 )/41800
= 0.387
```

**Check of Inside Ribs:**

Inertia of Saddle, Inner Ribs - Axial Direction

| | B | D | Y | A | AY | Io |
|---|---|---|---|---|---|---|
| Rib | 0.3940 | 7.6060 | 0.0000 | 2.9968 | 0.0000 | 16.8087 |
| Web | 17.6842 | 0.3940 | 0.0000 | 6.9676 | 0.0000 | 0.0901 |
| Totals | ... | ... | ... | 9.9644 | ... | 16.8988 |

Distance to Centroid from Datum [ytot]:

```
= AY / A
= 0/9.9644
= 0.000 in
```

Distance to Centroid [C1]:

```
= Saddle Width / 2
= 8/2
= 4.000 in
```

Length of Inner Rib [L]:

```
= Saddle Height - sqrt( (Ro + Wpdthk)^2 - (Pitch/2)^2 ) - Bpthk
= 78.62 - sqrt( (30.63 + 0.315 )^2 - (17.684/2)^2 ) - 0.394
= 48.500 in
```

Radius of Gyration [r]:

```
= sqrt( Total Inertia / Total Area )
= sqrt( 16.899/9.9644 )
= 1.302 in
```

Slenderness ratio [KL/r]:

```
= KL/r
= 1 * 48.5/1.3023
= 37.242
```

Unit Force [Force,u]:

```
= Fl / ( 2 * Baseplate Length )
= 12640/( 2 * 53 )
= 119.243 lbf/in
```

Moment at base of inner Rib [Mbase,c]:

```
= Unit Force * e * L
= 119.24 * 17.684 * 48.5
= 102272.602 in-lb
```

Bending Stress due to Transverse Force and Weight Load [SigmaB,base,c]:

```
= Bending Moment / Section Modulus
= 102273/4.2247
= 24208.262 psi
```

Compressive Allowable, KL/r < Cc ( 37.242 < 95.55 ) per AISC E2-1 [Sca]:

```
= ( 1-(Klr)^2/(2*Cc^2))Fy/(5/3+3*(Klr)/(8*Cc)-(Klr^3)/(8*Cc^3)
```

$= ( 1-( 37.242 )^2/(2 * 95.55^2 ))62700/$
$( 5/3+3*(37.242 )/(8* 95.55 )-( 37.242^3 )/(8*95.55^3) )$
= 32091 psi

**AISC Unity Check of Inside Ribs ( must be <= 1 )**

```
= Sc/Sca + ( Mbase,c * C1/I )/Sba
= 487.3/32091 + ( 102273 * 4/16.899 )/41800
= 0.594
```

**ASME VIII Division 2 Horizontal Vessel Analysis, Right Saddle:**

**Input and Calculated Values:**

```
Vessel Mean Radius                             Rm       30.16  in
Shell Thickness used in this Case               t       0.315  in
Stiffened Vessel Length per 4.15.6              L      159.81  in
Distance from Saddle to Vessel tangent   a1 or a       29.00  in

Saddle Width                             b1 or b        8.00  in
Saddle Bearing Angle               delta or theta     120.00  degrees

Wear Plate Width                         b2 or b1      13.00  in
Wear Plate Bearing Angle         delta2 or theta1     130.00  degrees
Wear Plate Thickness                     e2 or tr      0.3150  in
Wear Plate Allowable Stress              fw or Sr    30650.00  psi

Inside or Mean Depth of Head             Hi or hm        3.49  in

Shell Allowable Stress used in Calculation          30650.00  psi
Head Allowable Stress used in Calculation           29200.00  psi
Circumferential Efficiency in Plane of Saddle           1.00
Circumferential Efficiency at Mid-Span                  1.00

Distance from Saddle Base to Centerline        B      78.62  in
Coefficient of Friction                       mu       0.40

Saddle Force Q for this Transportation Case         18658.14  lbf
Shipping Longitudinal Acceleration            gx       1.50  g
Shipping Transverse Acceleration              gz       1.50  g
Shipping Vertical Acceleration                gy       2.00  g
Vertical Acceleration Acting with Transverse  gw       2.00  g
Internal Pressure during Transport                     0.03  psig
Transportation Wind Load Scalar Factor      wlsf       1.00
Transportation Wind Velocity                  wv       88.0  mile/hr

Horizontal Vessel Analysis Results:      Actual |    Allowable |
                                            psi |          psi |
----------------------------------------------------------------
Long. Stress at Top    of Midspan       -258.53 |    -72000.00 |
Long. Stress at Top    of Midspan        258.53 |     30650.00 |
Long. Stress at Bottom of Midspan        261.79 |     30650.00 |
Long. Stress at Top    of Saddles        625.17 |     30650.00 |
Long. Stress at Bottom of Saddles       -343.98 |    -72000.00 |
Long. Stress at Bottom of Saddles        343.98 |     30650.00 |
----------------------------------------------------------------
Tangential Shear in Shell               1423.38 |     24520.00 |
Circ. Stress at Horn of Saddle          5880.40 |     45975.00 |
Circ. Compressive Stress in Shell        175.79 |     30650.00 |
----------------------------------------------------------------
```

**Intermediate Results: Saddle Reaction Q due to Road Transport Load:**

Transverse Force due to Wind during Transport [Ft_w]:

```
  = Transverse Area * 0.00256 * wv^2 * wlsf
  = 107.64 * 0.00256 * 88^2 * 1
  = 2133.9 lbf
```

Longitudinal Force due to Wind during Transport [Fl_w]:

```
  = pi * D^2/4 * 0.00256 * wv^2 * wlsf * Wind Dia. Mult
  = pi * 5.3025^2/4 * 0.00256 * 88^2 * 1 * 1.2
  = 525.3 lbf
```

Transverse Force due to Lateral Acceleration [Ft]:

```
  = gz * saddle Load * gw + Ft_w
  = 1.5 * 5315.7 * 2 + 2133.9
  = 18081.0 lbf
```

Longitudinal Force due to Axial Acceleration [Fl]:

```
  = gx * saddle Load * gw + Fl_w
  = 1.5 * 5315.7 * 2 + 525.34
  = 16472.5 lbf
```

Saddle Reaction Force due to Lateral Acceleration [Fwt]:

```
  = Ft/Num of Saddles * B / E
  = 18081/2 * 78.62/53
  = 13342.4 lbf
```

Saddle Reaction Force due to Transport Load  [Fwl]:

```
  = Fl * B / Ls
  = 16472 * 78.62/120
  = 10737.3 lbf
```

Saddle Reaction Force due to Vertical Transportation Acceleration  [Fsl]:

```
  = Saddle Load * gy
  = 5315.7 * 2
  = 10631.418 lbf
```

Load Combination Results due to Transport Loading [Q]:

```
  = Saddle Load + max( Fwl, Fwt, Fsl )
  = 5315.7 + max( 10737, 13342, 10631 )
  = 18658.1 lbf
```

**Summary of Loads at the Base of this Saddle:**

| | | |
|---|---|---|
| Vertical Load (including saddle weight) | 19401.04 | lbf |
| Transverse Shear Load | 13342.43 | lbf |
| Longitudinal Shear Load | 16472.46 | lbf |

**Formulas and Substitutions for Horizontal Vessel Analysis:**

Note: Wear Plate is Welded to the Shell, k = 0.1

Saddle Dimension [E]:

```
  = Baseplate Length
  = 53.000 in
```

**The Computed K values from Table 4.15.1:**

| | | | |
|---|---|---|---|
| K1 = 0.1066 | K2 = 1.1707 | K3 = 0.8799 | K4 = 0.4011 |
| K5 = 0.7603 | K6 = 0.0529 | K7 = 0.0498 | K8 = 0.3405 |
| K9 = 0.2711 | K10 = 0.0581 | K1* = 0.1923 | K6p = 0.0449 |
| K7p = 0.0423 | | | |

*The suffix 'p' denotes the values for a wear plate if it exists.*

Note: Dimension a is greater than or equal to Rm/2.

Moment per Equation 4.15.1 [M1]:

```
  = -Q*a [1 - (1- a/L + (Rm^2 -hm^2 )/(2a*L))/(1+(4hm^2 )/3L)]
  = -18658*29[1-(1-29/159.81+(30.158^2 -3.492^2 )/
    (2*29*159.81))/(1+(4*3.492)/(3*159.81))]
  = -59830.2 in-lb
```

Moment per Equation 4.15.2 [M2]:

```
  = Q*L/4(1+2(Rm^2 -hi^2 )/(L^2 ))/(1+(4hi)/( 3L))-4a/L
  = 18658*159.81/4(1+2(30.158^2 -3.492^2 )/(159.81^2 ))/(1+(4*3.492)/
    (3*159.81))-4*29/159.81
  = 234146.6 in-lb
```

Longitudinal Stress at Top of Shell (4.15.4) [sigma1]:

```
  = P * Rm/(2t) - M2/(pi*Rm^2 t)
  = 0.034 * 30.158/(2*0.315 ) - 234147/(pi*30.158^2 *0.315 )
  = -258.53 psi
```

Longitudinal Stress at Bottom of Shell (4.15.5) [sigma2]:

```
  = P * Rm/(2t) + M2/(pi * Rm^2  * t)
  = 0.034 * 30.158/(2 * 0.315 ) + 234147/(pi * 30.158^2  * 0.315 )
  = 261.79 psi
```

Longitudinal Stress at Top of Shell at Support (4.15.8) [sigma*3]:

```
  = P * Rm/(2t) - M1/(K1*pi*Rm^2 t)
  = 0.034*30.158/(2*0.315)--59830/(0.1066*pi*30.158^2 *0.315)
  = 625.17 psi
```

Longitudinal Stress at Bottom of Shell at Support (4.15.9) [sigma*4]:

```
  = P * Rm/(2t) + M1/(K1* * pi * Rm^2  * t)
  = 0.034*30.158/(2*0.315)+-59830/(0.1923*pi*30.158^2 *0.315)
  = -343.98 psi
```

Maximum Shear Force in the Saddle (4.15.3) [T]:

```
  = Q(L-2a)/(L+(4*hm/3))
  = 18658 ( 159.81 - 2 * 29 )/(159.81 + ( 4 * 3.492/3))
  = 11550.0 lbf
```

Shear Stress in the shell no rings,  not stiffened (4.15.12) [tau2]:

```
  = K2 * T / ( Rm * t )
  = 1.1707 * 11550/( 30.158 * 0.315 )
  = 1423.38 psi
```

Decay Length (4.15.20) [x1,x2]:

```
  = 0.78 * sqrt( Rm * t )
  = 0.78 * sqrt( 30.158 * 0.315 )
  = 2.404 in
```

Effective reinforcing plate width  (4.15.24) [B1]:

```
  = min( b + 1.56 * sqrt( Rm * t ), 2a  )
  = min( 8 + 1.56 * sqrt( 30.158 * 0.315 ), 2 * 29 )
  = 12.81 in
```

Wear Plate/Shell Stress ratio  (4.15.26) [eta]:

```
  = 1.0000 Materials are the same, transport case
```

Circumferential Stress at Saddle Base with Wear Plate (4.15.25) [sigma6,r]:

```
  = -K5 * Q * k / ( B1( t + eta * tr ) )
  = -0.7603 * 18658 * 0.1/( 12.808 ( 0.315 + 1 * 0.315 ) )
  = -175.79 psi
```

Circ. Comp. Stress at Horn of Saddle, L<8Rm  (4.15.29) [sigma7,r*]:

```
  = -Q/(4(t+eta*tr)b1) - 12*K7*Q*Rm/(L(t+eta*tr)^2 )
  = -18658/(4(0.315 + 1 * 0.315 )12.808 ) -
```

```
    12*0.04981*18658*30.158/(159.81(0.315+1*0.315)² )
  = -5880.40 psi
```

**Results for Vessel Ribs, Web and Base:**

| | | | |
|---|---|---|---|
| Baseplate Length | Bplen | 53.0000 | in |
| Baseplate Thickness | Bpthk | 0.3940 | in |
| Baseplate Width | Bpwid | 9.0000 | in |
| Number of Ribs ( inc. outside ribs ) | Nribs | 4 | |
| Rib Thickness | Ribtk | 0.3940 | in |
| Web Thickness | Webtk | 0.3940 | in |
| Web Location | Webloc | Center | |
| Saddle Yield Stress | Sy | 62700.0 | psi |
| Height of Web at Center | Hw,c | 42.0 | in |
| Friction Coefficient | mu | 0.400 | |

**Moment of Inertia of Saddle - Transverse Direction (90 degrees to long axis)**

Inertia of Shell [ShellInertia]:

```
  = (( 1.56 * sqrt( R * t ) + WearPlateWidth )t³ )/12
  = (( 1.56 * sqrt( 30 * 0.315 ) + 13 )0.315³ )/12
  = 0.046 in**4
```

Resolved Inertia for the Shell [I,shell]:

```
  = ShellInertia + AShell( C1 - Y )²
  = 0.04635 + 5.6056 ( 19.585 - 0.1575 )²
  = 2115.827 in**4
```

| | B in | D in | Y in | A in^2 | AY in³ | I + AD² in**4 |
|---|---|---|---|---|---|---|
| Shell | 17.7956 | 0.3150 | 0.1575 | 5.6056 | 0.8829 | 2115.8267 |
| Wearplate | 13.0000 | 0.3150 | 0.4725 | 4.0950 | 1.9349 | 1495.9364 |
| Web | 0.3940 | 47.1960 | 24.2280 | 18.5952 | 450.5250 | 3852.4893 |
| BasePlate | 9.0000 | 0.3940 | 48.0230 | 3.5460 | 170.2895 | 2867.7014 |
| Totals | ... | ... | ... | 31.8418 | 623.6323 | 10331.9541 |

Distance to Centroid [C1]:

```
  = AY / A
  = 623.63/31.842
  = 19.585 in
```

Angle [beta]:

```
  = 180 - Saddle Angle/2
  = 180 - 120/2
  = 120.0
```

Saddle Splitting Coefficient [K1]:

```
  = ( 1 + cos(beta) - 0.5*sin(beta)²  )/(pi - beta + sin(beta)cos(beta) )
  = ( 1 + cos(120 ) - 0.5*sin(120 )²  )/(pi - 2.0944 + sin(120 )cos(120 ) )
  = 0.2035
```

Saddle Splitting Force [Fh]:

```
  = K1 * Q
  = 0.2035 * 18658
  = 3797.3357 lbf

 Tension Stress, St = ( Fh/As )       =       144.7364  psi
 Allowed Stress, Sa = 0.6 * Yield Str =     37620.0000  psi
```

Saddle Splitting Dimension [d]:

```
  = B - R * sin(theta/2)/(theta/2 in radians)
  = 78.62 - 30 * sin(120/2)/1.0472
```

```
  = 53.410 in

 Bending Moment, M  = Fh * d          =     202816.4688  in-lb

 Bending Stress, Sb = ( M * C1 / I  ) =        384.4602  psi
 Allowed Stress, Sa = 2/3 * Yield Str =      41800.0000  psi
```

**Minimum Thickness of Baseplate per Moss:**

```
  = sqrt( 3( Q + Saddle_Wt )BasePlateWidth / ( 4 * BasePlateLength * AllStress ))
  = sqrt( 3(18658 + 742.9 )9/( 4 * 53 * 41800 ))
  = 0.243 in
```

**Calculation of Axial Load, Intermediate Values and Compressive Stress:**

Web Length Dimension [ Web Length ]:

```
  = 2 * cos( 90 - Saddle Angle/2 )( Inside Radius + Shell Thk + Wear Plate Thk )
  = 2 * cos( 90 - 120/2 )( 30 + 0.315 + 0.315 )
  = 53.053 in
```

Distance between Ribs [e]:

```
  = Web Length / ( Nribs - 1 )
  = 53.053/( 4 - 1 )
  = 17.684 in
```

Baseplate Pressure Area [Ap]:

```
  = e * Bpwid / 2
  = 17.684 * 9/2
  = 79.579 in^2
```

Bearing Pressure [Bp]:

```
  = Q / ( BasePlateLength * BasePlateWidth )
  = 18658/( 53 * 9 )
  = 39.116 lbf/in^2
```

Axial Load [P]:

```
  = Ap * Bp
  = 79.579 * 39.116
  = 3112.782 lbf
```

Area of the Rib and Web [Ar]:

```
  = Rib Area + Web Area
  = 2.9968 + 3.4838
  = 6.481 in^2
```

Compressive Stress [Sc]:

```
  = P/Ar
  = 3112.8/6.4806
  = 480.326 psi
```

**Check of Outside Ribs:**

Inertia of Saddle, Outer Ribs - Longitudinal Direction

| | B | D | Y | A | AY | Io |
|---|---|---|---|---|---|---|
| Rib+Web | 0.3940 | 8.0000 | ... | 3.1520 | ... | 16.8107 |

Rib dimension [D]:

```
  = Saddle Width - Web Thickness
  = 8 - 0.394
  = 7.606 in
```

Distance to Centroid from Datum [ytot]:

```
= AY / A
= 0/6.4806
= 0.000 in
```

Distance to Centroid [C1]:

```
= Saddle Width / 2
= 8/2
= 4.000 in
```

Radius of Gyration [r]:

```
= sqrt( Total Inertia / Total Area )
= sqrt( 16.811/6.4806 )
= 1.611 in
```

Length of Outer Rib, step 1, [Lw]:

```
= 2 * sin( saddle bearing angle / 2 )( radius + shlthk + wpdthk )
= 2 * sin( 120/2 )( 30 + 0.315 + 0.315 )
= 53.053 in
```

Length of Outer Rib, step 2, [Bd]:

```
= Baseplate length - clearance
= 53 - 2
= 51.000 in
```

Length of Outer Rib, step 3, [Dd]:

```
= ( Lw - Bd )/2
= ( 53.053 - 51 )/2
= 1.026 in
```

Length of Outer Rib [L]:

```
= sqrt( Rl² + Dd² )
= sqrt( 62.519² + 1.0264² )
= 62.519 in
```

Intermediate Term [Cc]:

```
= sqrt( 2 * pi² * Elastic Modulus / Yield Stress )
= sqrt( 2 * pi² * 29000000/62700 )
= 95.550
```

Slenderness ratio [KL/r]:

```
= KL/r
= 1 * 62.519/1.6106
= 38.818
```

Bending Moment [Rm]:

```
= Fl /( 2 * Bplen ) * e * L / 2
= 16472/( 2 * 53 ) * 17.684 * 62.519/2
= 85906.102 in-lb
```

Compressive Allowable, KL/r < Cc ( 38.818 < 95.55 ) per AISC E2-1 [Sca]:

```
= ( 1-(Klr)²/(2*Cc²))Fy/(5/3+3*(Klr)/(8*Cc)-(Klr³)/(8*Cc³)
= ( 1-( 38.818 )²/(2 * 95.55²  ))62700/
  ( 5/3+3*(38.818 )/(8* 95.55 )-( 38.818³)/(8*95.55³)
= 31771 psi
```

**AISC Unity Check of Outside Ribs ( must be <= 1 )**

```
= Sc/Sca + ( Rm * C1 / I )/Sba
= 480.33/31771 + ( 85906 * 4/16.811 )/41800
= 0.504
```

**Check of Inside Ribs:**

Inertia of Saddle, Inner Ribs - Axial Direction

| | B | D | Y | A | AY | Io |
|---|---|---|---|---|---|---|
| Rib | 0.3940 | 7.6060 | 0.0000 | 2.9968 | 0.0000 | 16.8087 |
| Web | 17.6842 | 0.3940 | 0.0000 | 6.9676 | 0.0000 | 0.0901 |
| Totals | ... | ... | ... | 9.9644 | ... | 16.8988 |

Distance to Centroid from Datum [ytot]:

```
= AY / A
= 0/9.9644
= 0.000 in
```

Distance to Centroid [C1]:

```
= Saddle Width / 2
= 8/2
= 4.000 in
```

Length of Inner Rib [L]:

```
= Saddle Height - sqrt( (Ro + Wpdthk)^2 - (Pitch/2)^2 ) - Bpthk
= 78.62 - sqrt( (30.63 + 0.315 )^2 - (17.684/2)^2 ) - 0.394
= 48.500 in
```

Radius of Gyration [r]:

```
= sqrt( Total Inertia / Total Area )
= sqrt( 16.899/9.9644 )
= 1.302 in
```

Slenderness ratio [KL/r]:

```
= KL/r
= 1 * 48.5/1.3023
= 37.242
```

Unit Force [Force,u]:

```
= Fl / ( 2 * Baseplate Length )
= 16472/( 2 * 53 )
= 155.401 lbf/in
```

Moment at base of inner Rib [Mbase,c]:

```
= Unit Force * e * L
= 155.4 * 17.684 * 48.5
= 133284.859 in-lb
```

Bending Stress due to Transverse Force and Weight Load [SigmaB,base,c]:

```
= Bending Moment / Section Modulus
= 133285/4.2247
= 31548.963 psi
```

Compressive Allowable, KL/r < Cc ( 37.242 < 95.55 ) per AISC E2-1 [Sca]:

$$= ( 1-(Klr)^2/(2*Cc^2))Fy/(5/3+3*(Klr)/(8*Cc)-(Klr^3)/(8*Cc^3))$$
$$= ( 1-( 37.242 )^2/(2 * 95.55^2 ))62700/$$
$$( 5/3+3*(37.242 )/(8* 95.55 )-( 37.242^3)/(8*95.55^3))$$
$$= 32091 \text{ psi}$$

**AISC Unity Check of Inside Ribs ( must be <= 1 )**

```
= Sc/Sca + ( Mbase,c * C1/I )/Sba
= 624.78/32091 + ( 133285 * 4/16.899 )/41800
= 0.774
```

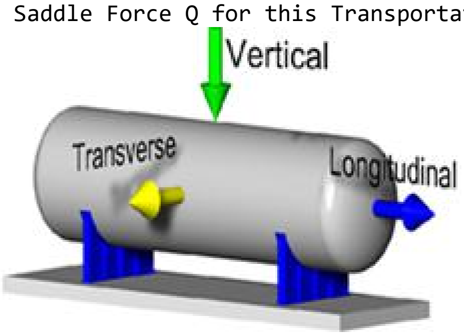
*Review notes about nozzle loadings and supports in the Warnings report.*

**ASME VIII Division 2 Horizontal Vessel Analysis, Left Saddle:**

Horizontal Vessel Stress Calculations : Ocean Transport

**Input and Calculated Values:**

```
Vessel Mean Radius                              Rm       30.16  in
Shell Thickness used in this Case                t       0.315  in
Stiffened Vessel Length per 4.15.6               L      159.81  in
Distance from Saddle to Vessel tangent   a1 or a        28.00  in

Saddle Width                              b1 or b        8.00  in
Saddle Bearing Angle              delta or theta       120.00  degrees

Wear Plate Width                         b2 or b1       13.00  in
Wear Plate Bearing Angle        delta2 or theta1      130.00  degrees
Wear Plate Thickness                     e2 or tr      0.3150  in
Wear Plate Allowable Stress              fw or Sr    30650.00  psi

Inside or Mean Depth of Head             Hi or hm       15.20  in

Shell Allowable Stress used in Calculation          30650.00  psi
Head Allowable Stress used in Calculation           30650.00  psi
Circumferential Efficiency in Plane of Saddle           1.00
Circumferential Efficiency at Mid-Span                  1.00

Distance from Saddle Base to Centerline        B       78.62  in
Coefficient of Friction                       mu        0.40

Saddle Force Q for this Transportation Case         14552.27  lbf
```




```
Shipping Longitudinal Acceleration              gx        1.50  g
Shipping Transverse Acceleration                gz        1.50  g
Shipping Vertical Acceleration                  gy        2.00  g
Vertical Acceleration Acting with Transverse    gw        2.00  g
Internal Pressure during Transport                        0.03  psig
Transportation Wind Load Scalar Factor        wlsf        1.00
Transportation Wind Velocity                    wv        88.0  mile/hr


Horizontal Vessel Analysis Results:      Actual |    Allowable |
                                            psi |          psi |
----------------------------------------------------------------
Long. Stress at Top    of Midspan       -149.39 |    -72000.00 |
Long. Stress at Top    of Midspan        149.39 |     30650.00 |
Long. Stress at Bottom of Midspan        152.65 |     30650.00 |
Long. Stress at Top    of Saddles        854.10 |     30650.00 |
Long. Stress at Bottom of Saddles       -470.87 |    -72000.00 |
Long. Stress at Bottom of Saddles        470.87 |     30650.00 |
----------------------------------------------------------------
Tangential Shear in Shell               1033.84 |     24520.00 |
Circ. Stress at Horn of Saddle          4368.11 |     45975.00 |
```

```
Circ. Compressive Stress in Shell        137.11 |     30650.00 |
----------------------------------------------------------------
```

**Intermediate Results: Saddle Reaction Q due to Ocean Transport Load:**

Transverse Force due to Wind during Transport [Ft_w]:
```
  = Transverse Area * 0.00256 * wv^2 * wlsf
  = 107.64 * 0.00256 * 88^2 * 1
  = 2133.9 lbf
```

Longitudinal Force due to Wind during Transport [Fl_w]:
```
  = pi * D^2/4 * 0.00256 * wv^2 * wlsf * Wind Dia. Mult
  = pi * 5.3025^2/4 * 0.00256 * 88^2 * 1 * 1.2
  = 525.3 lbf
```

Transverse Force due to Lateral Acceleration [Ft]:
```
  = gz * saddle Load * gw + Ft_w
  = 1.5 * 4038.1 * 2 + 2133.9
  = 14248.3 lbf
```

Longitudinal Force due to Axial Acceleration [Fl]:
```
  = gx * saddle Load * gw + Fl_w
  = 1.5 * 4038.1 * 2 + 525.34
  = 12639.7 lbf
```

Saddle Reaction Force due to Lateral Acceleration [Fwt]:
```
  = Ft/Num of Saddles * B / E
  = 14248/2 * 78.62/53
  = 10514.1 lbf
```

Saddle Reaction Force due to Transport Load  [Fwl]:
```
  = Fl * B / Ls
  = 12640 * 78.62/120
  = 8239.0 lbf
```

Saddle Reaction Force due to Vertical Transportation Acceleration  [Fsl]:
```
  = Saddle Load * gy
  = 4038.1 * 2
  = 8076.248 lbf
```

Load Combination Results due to Transport Loading [Q]:
```
  = Saddle Load + max( Fwl, Fwt, Fsl )
  = 4038.1 + max( 8239, 10514, 8076.2 )
  = 14552.3 lbf
```

**Summary of Loads at the Base of this Saddle:**
```
Vertical Load (including saddle weight)          15295.17  lbf
Transverse Shear Load                            10514.15  lbf
Longitudinal Shear Load                          12639.71  lbf
```

**<u>Formulas and Substitutions for Horizontal Vessel Analysis:</u>**

Note: Wear Plate is Welded to the Shell, k = 0.1

Saddle Dimension [E]:
```
  = Baseplate Length
  = 53.000 in
```

**The Computed K values from Table 4.15.1:**
```
K1  = 0.1066      K2  = 1.1707     K3  = 0.8799      K4  = 0.4011
K5  = 0.7603      K6  = 0.0529     K7  = 0.0472      K8  = 0.3405
K9  = 0.2711      K10 = 0.0581     K1* = 0.1923      K6p = 0.0449
K7p = 0.0401
```

*The suffix 'p' denotes the values for a wear plate if it exists.*

Note: Dimension a is greater than or equal to Rm/2.

Moment per Equation 4.15.1 [M1]:
= -Q*a [1 - (1- a/L + (Rm$^2$ -hm$^2$ )/(2a*L))/(1+(4hm$^2$ )/3L)]
= -14552*28[1-(1-28/159.81+(30.158$^2$ -15.199$^2$ )/
(2*28*159.81))/(1+(4*15.199)/(3*159.81))]
= -81796.8 in-lb

Moment per Equation 4.15.2 [M2]:
= Q*L/4(1+2(Rm$^2$ -hi$^2$ )/(L$^2$ ))/(1+(4hi)/( 3L))-4a/L
= 14552*159.81/4(1+2(30.158$^2$ -15.199$^2$ )/(159.81$^2$ ))/(1+(4*15.199)/
(3*159.81))-4*28/159.81
= 135921.9 in-lb

Longitudinal Stress at Top of Shell (4.15.4) [sigma1]:
= P * Rm/(2t) - M2/(pi*Rm$^2$ t)
= 0.034 * 30.158/(2*0.315 ) - 135922/(pi*30.158$^2$ *0.315 )
= -149.39 psi

Longitudinal Stress at Bottom of Shell (4.15.5) [sigma2]:
= P * Rm/(2t) + M2/(pi * Rm$^2$ * t)
= 0.034 * 30.158/(2 * 0.315 ) + 135922/(pi * 30.158$^2$ * 0.315 )
= 152.65 psi

Longitudinal Stress at Top of Shell at Support (4.15.8) [sigma*3]:
= P * Rm/(2t) - M1/(K1*pi*Rm$^2$ t)
= 0.034*30.158/(2*0.315)--81797/(0.1066*pi*30.158$^2$ *0.315)
= 854.10 psi

Longitudinal Stress at Bottom of Shell at Support (4.15.9) [sigma*4]:
= P * Rm/(2t) + M1/(K1* * pi * Rm$^2$ * t)
= 0.034*30.158/(2*0.315)+-81797/(0.1923*pi*30.158$^2$ *0.315)
= -470.87 psi

Maximum Shear Force in the Saddle (4.15.3) [T]:
= Q(L-2a)/(L+(4*hm/3))
= 14552 ( 159.81 - 2 * 28 )/(159.81 + ( 4 * 15.199/3))
= 8389.1 lbf

Shear Stress in the shell no rings, not stiffened (4.15.12) [tau2]:
= K2 * T / ( Rm * t )
= 1.1707 * 8389.1/( 30.158 * 0.315 )
= 1033.84 psi

Decay Length (4.15.20) [x1,x2]:
= 0.78 * sqrt( Rm * t )
= 0.78 * sqrt( 30.158 * 0.315 )
= 2.404 in

Effective reinforcing plate width (4.15.24) [B1]:
= min( b + 1.56 * sqrt( Rm * t ), 2a )
= min( 8 + 1.56 * sqrt( 30.158 * 0.315 ), 2 * 28 )
= 12.81 in

Wear Plate/Shell Stress ratio (4.15.26) [eta]:
= 1.0000 Materials are the same, transport case

Circumferential Stress at Saddle Base with Wear Plate (4.15.25) [sigma6,r]:
= -K5 * Q * k / ( B1( t + eta * tr ) )

= -0.7603 * 14552 * 0.1/( 12.808 ( 0.315 + 1 * 0.315 ) )
= -137.11 psi

Circ. Comp. Stress at Horn of Saddle, L<8Rm (4.15.29) [sigma7,r✱]:
= -Q/(4(t+eta*tr)b1) - 12*K7*Q*Rm/(L(t+eta*tr)$^2$)
= -14552/(4(0.315 + 1 * 0.315 )12.808 ) -
12*0.04718*14552*30.158/(159.81(0.315+1*0.315)$^2$)
= -4368.11 psi

**Results for Vessel Ribs, Web and Base:**

| | | | |
|---|---|---|---|
| Baseplate Length | Bplen | 53.0000 | in |
| Baseplate Thickness | Bpthk | 0.3940 | in |
| Baseplate Width | Bpwid | 9.0000 | in |
| Number of Ribs ( inc. outside ribs ) | Nribs | 4 | |
| Rib Thickness | Ribtk | 0.3940 | in |
| Web Thickness | Webtk | 0.3940 | in |
| Web Location | Webloc | Center | |
| Saddle Yield Stress | Sy | 62700.0 | psi |
| Height of Web at Center | Hw,c | 42.0 | in |
| Friction Coefficient | mu | 0.400 | |

**Moment of Inertia of Saddle - Transverse Direction (90 degrees to long axis)**

Inertia of Shell [ShellInertia]:
= (( 1.56 * sqrt( R * t ) + WearPlateWidth )t$^3$ )/12
= (( 1.56 * sqrt( 30 * 0.315 ) + 13 )0.315$^3$ )/12
= 0.046 in**4

Resolved Inertia for the Shell [I,shell]:
= ShellInertia + AShell( C1 - Y )$^2$
= 0.04635 + 5.6056 ( 19.585 - 0.1575 )$^2$
= 2115.827 in**4

| | B in | D in | Y in | A in^2 | AY in$^3$ | I + AD$^2$ in**4 |
|---|---|---|---|---|---|---|
| Shell | 17.7956 | 0.3150 | 0.1575 | 5.6056 | 0.8829 | 2115.8267 |
| Wearplate | 13.0000 | 0.3150 | 0.4725 | 4.0950 | 1.9349 | 1495.9364 |
| Web | 0.3940 | 47.1960 | 24.2280 | 18.5952 | 450.5250 | 3852.4893 |
| BasePlate | 9.0000 | 0.3940 | 48.0230 | 3.5460 | 170.2895 | 2867.7014 |
| Totals | ... | ... | ... | 31.8418 | 623.6323 | 10331.9541 |

Distance to Centroid [C1]:
= AY / A
= 623.63/31.842
= 19.585 in

Angle [beta]:
= 180 - Saddle Angle/2
= 180 - 120/2
= 120.0

Saddle Splitting Coefficient [K1]:
= ( 1 + cos(beta) - 0.5*sin(beta)$^2$ )/(pi - beta + sin(beta)cos(beta) )
= ( 1 + cos(120 ) - 0.5*sin(120 )$^2$ )/(pi - 2.0944 + sin(120 )cos(120 ) )
= 0.2035

Saddle Splitting Force [Fh]:
= K1 * Q
= 0.2035 * 14552
= 2961.7024 lbf

Tension Stress, St = ( Fh/As ) = 112.8860 psi

```
 Allowed Stress, Sa = 0.6 * Yield Str =      37620.0000  psi
```

Saddle Splitting Dimension [d]:

```
  = B - R * sin(theta/2)/(theta/2 in radians)
  = 78.62 - 30 * sin(120/2)/1.0472
  = 53.410 in
```

```
 Bending Moment, M  = Fh * d          =     158185.1250  in-lb

 Bending Stress, Sb = ( M * C1 / I  ) =        299.8567  psi
 Allowed Stress, Sa = 2/3 * Yield Str =      41800.0000  psi
```

**Minimum Thickness of Baseplate per Moss:**

```
  = sqrt( 3( Q + Saddle_Wt )BasePlateWidth / ( 4 * BasePlateLength * AllStress ))
  = sqrt( 3(14552 + 742.9 )9/( 4 * 53 * 41800 ))
  = 0.216 in
```

**Calculation of Axial Load, Intermediate Values and Compressive Stress:**

Web Length Dimension [ Web Length ]:

```
  = 2 * cos( 90 - Saddle Angle/2 )( Inside Radius + Shell Thk + Wear Plate Thk )
  = 2 * cos( 90 - 120/2 )( 30 + 0.315 + 0.315 )
  = 53.053 in
```

Distance between Ribs [e]:

```
  = Web Length / ( Nribs - 1 )
  = 53.053/( 4 - 1 )
  = 17.684 in
```

Baseplate Pressure Area [Ap]:

```
  = e * Bpwid / 2
  = 17.684 * 9/2
  = 79.579 in^2
```

Bearing Pressure [Bp]:

```
  = Q / ( BasePlateLength * BasePlateWidth )
  = 14552/( 53 * 9 )
  = 30.508 lbf/in^2
```

Axial Load [P]:

```
  = Ap * Bp
  = 79.579 * 30.508
  = 2427.791 lbf
```

Area of the Rib and Web [Ar]:

```
  = Rib Area + Web Area
  = 2.9968 + 3.4838
  = 6.481 in^2
```

Compressive Stress [Sc]:

```
  = P/Ar
  = 2427.8/6.4806
  = 374.627 psi
```

**Check of Outside Ribs:**

Inertia of Saddle, Outer Ribs - Longitudinal Direction

| | B | D | Y | A | AY | Io |
|---|---|---|---|---|---|---|
| Rib+Web | 0.3940 | 8.0000 | ... | 3.1520 | ... | 16.8107 |

Rib dimension [D]:

```
= Saddle Width - Web Thickness
= 8 - 0.394
= 7.606 in
```

Distance to Centroid from Datum [ytot]:

```
= AY / A
= 0/6.4806
= 0.000 in
```

Distance to Centroid [C1]:

```
= Saddle Width / 2
= 8/2
= 4.000 in
```

Radius of Gyration [r]:

```
= sqrt( Total Inertia / Total Area )
= sqrt( 16.811/6.4806 )
= 1.611 in
```

Length of Outer Rib, step 1, [Lw]:

```
= 2 * sin( saddle bearing angle / 2 )( radius + shlthk + wpdthk )
= 2 * sin( 120/2 )( 30 + 0.315 + 0.315 )
= 53.053 in
```

Length of Outer Rib, step 2, [Bd]:

```
= Baseplate length - clearance
= 53 - 2
= 51.000 in
```

Length of Outer Rib, step 3, [Dd]:

```
= ( Lw - Bd )/2
= ( 53.053 - 51 )/2
= 1.026 in
```

Length of Outer Rib [L]:

```
= sqrt( Rl^2 + Dd^2 )
= sqrt( 62.519^2 + 1.0264^2 )
= 62.519 in
```

Intermediate Term [Cc]:

```
= sqrt( 2 * pi^2 * Elastic Modulus / Yield Stress )
= sqrt( 2 * pi^2 * 29000000/62700 )
= 95.550
```

Slenderness ratio [KL/r]:

```
= KL/r
= 1 * 62.519/1.6106
= 38.818
```

Bending Moment [Rm]:

```
= Fl /( 2 * Bplen ) * e * L / 2
= 12640/( 2 * 53 ) * 17.684 * 62.519/2
= 65917.773 in-lb
```

Compressive Allowable, KL/r < Cc ( 38.818 < 95.55 ) per AISC E2-1 [Sca]:

```
= ( 1-(Klr)^2/(2*Cc^2))Fy/(5/3+3*(Klr)/(8*Cc)-(Klr^3)/(8*Cc^3)
= ( 1-( 38.818 )^2/(2 * 95.55^2 ))62700/
  ( 5/3+3*(38.818 )/(8* 95.55 )-( 38.818^3)/(8*95.55^3)
= 31771 psi
```

**AISC Unity Check of Outside Ribs ( must be <= 1 )**

```
= Sc/Sca + ( Rm * C1 / I )/Sba
= 374.63/31771 + ( 65918 * 4/16.811 )/41800
```

```
  = 0.387
```

**Check of Inside Ribs:**

Inertia of Saddle, Inner Ribs - Axial Direction

| | B | D | Y | A | AY | Io |
|---|---|---|---|---|---|---|
| Rib | 0.3940 | 7.6060 | 0.0000 | 2.9968 | 0.0000 | 16.8087 |
| Web | 17.6842 | 0.3940 | 0.0000 | 6.9676 | 0.0000 | 0.0901 |
| Totals | ... | ... | ... | 9.9644 | ... | 16.8988 |

Distance to Centroid from Datum [ytot]:

```
  = AY / A
  = 0/9.9644
  = 0.000 in
```

Distance to Centroid [C1]:

```
  = Saddle Width / 2
  = 8/2
  = 4.000 in
```

Length of Inner Rib [L]:

```
  = Saddle Height - sqrt( (Ro + Wpdthk)^2 - (Pitch/2)^2 ) - Bpthk
  = 78.62 - sqrt( (30.63 + 0.315 )^2 - (17.684/2)^2 ) - 0.394
  = 48.500 in
```

Radius of Gyration [r]:

```
  = sqrt( Total Inertia / Total Area )
  = sqrt( 16.899/9.9644 )
  = 1.302 in
```

Slenderness ratio [KL/r]:

```
  = KL/r
  = 1 * 48.5/1.3023
  = 37.242
```

Unit Force [Force,u]:

```
  = Fl / ( 2 * Baseplate Length )
  = 12640/( 2 * 53 )
  = 119.243 lbf/in
```

Moment at base of inner Rib [Mbase,c]:

```
  = Unit Force * e * L
  = 119.24 * 17.684 * 48.5
  = 102272.602 in-lb
```

Bending Stress due to Transverse Force and Weight Load [SigmaB,base,c]:

```
  = Bending Moment / Section Modulus
  = 102273/4.2247
  = 24208.262 psi
```

Compressive Allowable, KL/r < Cc ( 37.242 < 95.55 ) per AISC E2-1 [Sca]:

$$= ( 1-(Klr)^2/(2*Cc^2))Fy/(5/3+3*(Klr)/(8*Cc)-(Klr^3)/(8*Cc^3)$$
$$= ( 1-( 37.242 )^2/(2 * 95.55^2 ))62700/$$
$$( 5/3+3*(37.242 )/(8* 95.55 )-( 37.242^3)/(8*95.55^3)$$

```
  = 32091 psi
```

**AISC Unity Check of Inside Ribs ( must be <= 1 )**

```
  = Sc/Sca + ( Mbase,c * C1/I )/Sba
  = 487.3/32091 + ( 102273 * 4/16.899 )/41800
  = 0.594
```

**ASME VIII Division 2 Horizontal Vessel Analysis, Right Saddle:**

**Input and Calculated Values:**

```
Vessel Mean Radius                            Rm       30.16  in
Shell Thickness used in this Case              t       0.315  in
Stiffened Vessel Length per 4.15.6             L      159.81  in
Distance from Saddle to Vessel tangent   a1 or a       29.00  in

Saddle Width                             b1 or b        8.00  in
Saddle Bearing Angle              delta or theta      120.00  degrees

Wear Plate Width                         b2 or b1      13.00  in
Wear Plate Bearing Angle        delta2 or theta1      130.00  degrees
Wear Plate Thickness                     e2 or tr     0.3150  in
Wear Plate Allowable Stress              fw or Sr   30650.00  psi

Inside or Mean Depth of Head             Hi or hm       3.49  in

Shell Allowable Stress used in Calculation          30650.00  psi
Head Allowable Stress used in Calculation           29200.00  psi
Circumferential Efficiency in Plane of Saddle           1.00
Circumferential Efficiency at Mid-Span                  1.00

Distance from Saddle Base to Centerline        B       78.62  in
Coefficient of Friction                       mu        0.40

Saddle Force Q for this Transportation Case         18658.14  lbf
Shipping Longitudinal Acceleration            gx        1.50  g
Shipping Transverse Acceleration              gz        1.50  g
Shipping Vertical Acceleration                gy        2.00  g
Vertical Acceleration Acting with Transverse  gw        2.00  g
Internal Pressure during Transport                      0.03  psig
Transportation Wind Load Scalar Factor      wlsf        1.00
Transportation Wind Velocity                  wv        88.0  mile/hr

Horizontal Vessel Analysis Results:      Actual |    Allowable |
                                            psi |          psi |
----------------------------------------------------------------
Long. Stress at Top    of Midspan       -258.53 |    -72000.00 |
Long. Stress at Top    of Midspan        258.53 |     30650.00 |
Long. Stress at Bottom of Midspan        261.79 |     30650.00 |
Long. Stress at Top    of Saddles        625.17 |     30650.00 |
Long. Stress at Bottom of Saddles       -343.98 |    -72000.00 |
Long. Stress at Bottom of Saddles        343.98 |     30650.00 |
----------------------------------------------------------------
Tangential Shear in Shell               1423.38 |     24520.00 |
Circ. Stress at Horn of Saddle          5880.40 |     45975.00 |
Circ. Compressive Stress in Shell        175.79 |     30650.00 |
----------------------------------------------------------------
```

**Intermediate Results: Saddle Reaction Q due to Ocean Transport Load:**

Transverse Force due to Wind during Transport [Ft_w]:

```
  = Transverse Area * 0.00256 * wv^2 * wlsf
  = 107.64 * 0.00256 * 88^2 * 1
  = 2133.9 lbf
```

Longitudinal Force due to Wind during Transport [Fl_w]:

```
  = pi * D^2/4 * 0.00256 * wv^2 * wlsf * Wind Dia. Mult
  = pi * 5.3025^2/4 * 0.00256 * 88^2 * 1 * 1.2
  = 525.3 lbf
```

Transverse Force due to Lateral Acceleration [Ft]:

```
 = gz * saddle Load * gw + Ft_w
 = 1.5 * 5315.7 * 2 + 2133.9
 = 18081.0 lbf
```

Longitudinal Force due to Axial Acceleration [Fl]:

```
 = gx * saddle Load * gw + Fl_w
 = 1.5 * 5315.7 * 2 + 525.34
 = 16472.5 lbf
```

Saddle Reaction Force due to Lateral Acceleration [Fwt]:

```
 = Ft/Num of Saddles * B / E
 = 18081/2 * 78.62/53
 = 13342.4 lbf
```

Saddle Reaction Force due to Transport Load [Fwl]:

```
 = Fl * B / Ls
 = 16472 * 78.62/120
 = 10737.3 lbf
```

Saddle Reaction Force due to Vertical Transportation Acceleration [Fsl]:

```
 = Saddle Load * gy
 = 5315.7 * 2
 = 10631.418 lbf
```

Load Combination Results due to Transport Loading [Q]:

```
 = Saddle Load + max( Fwl, Fwt, Fsl )
 = 5315.7 + max( 10737, 13342, 10631 )
 = 18658.1 lbf
```

**Summary of Loads at the Base of this Saddle:**

| | | |
|---|---|---|
| Vertical Load (including saddle weight) | 19401.04 | lbf |
| Transverse Shear Load | 13342.43 | lbf |
| Longitudinal Shear Load | 16472.46 | lbf |

**<u>Formulas and Substitutions for Horizontal Vessel Analysis:</u>**

Note: Wear Plate is Welded to the Shell, k = 0.1

Saddle Dimension [E]:

```
 = Baseplate Length
 = 53.000 in
```

**The Computed K values from Table 4.15.1:**

| | | | |
|---|---|---|---|
| K1 = 0.1066 | K2 = 1.1707 | K3 = 0.8799 | K4 = 0.4011 |
| K5 = 0.7603 | K6 = 0.0529 | K7 = 0.0498 | K8 = 0.3405 |
| K9 = 0.2711 | K10 = 0.0581 | K1* = 0.1923 | K6p = 0.0449 |
| K7p = 0.0423 | | | |

*The suffix 'p' denotes the values for a wear plate if it exists.*

Note: Dimension a is greater than or equal to Rm/2.

Moment per Equation 4.15.1 [M1]:

```
 = -Q*a [1 - (1- a/L + (Rm^2-hm^2)/(2a*L))/(1+(4hm^2)/3L)]
 = -18658*29[1-(1-29/159.81+(30.158^2-3.492^2)/
   (2*29*159.81))/(1+(4*3.492)/(3*159.81))]
 = -59830.2 in-lb
```

Moment per Equation 4.15.2 [M2]:

```
 = Q*L/4(1+2(Rm^2-hi^2)/(L^2))/(1+(4hi)/( 3L))-4a/L
 = 18658*159.81/4(1+2(30.158^2-3.492^2)/(159.81^2))/(1+(4*3.492)/
   (3*159.81))-4*29/159.81
 = 234146.6 in-lb
```

Longitudinal Stress at Top of Shell (4.15.4) [sigma1]:
```
  = P * Rm/(2t) - M2/(pi*Rm² t)
  = 0.034 * 30.158/(2*0.315 ) - 234147/(pi*30.158² *0.315 )
  = -258.53 psi
```

Longitudinal Stress at Bottom of Shell (4.15.5) [sigma2]:
```
  = P * Rm/(2t) + M2/(pi * Rm²  * t)
  = 0.034 * 30.158/(2 * 0.315 ) + 234147/(pi * 30.158²  * 0.315 )
  = 261.79 psi
```

Longitudinal Stress at Top of Shell at Support (4.15.8) [sigma*3]:
```
  = P * Rm/(2t) - M1/(K1*pi*Rm² t)
  = 0.034*30.158/(2*0.315)--59830/(0.1066*pi*30.158² *0.315)
  = 625.17 psi
```

Longitudinal Stress at Bottom of Shell at Support (4.15.9) [sigma*4]:
```
  = P * Rm/(2t) + M1/(K1* * pi * Rm²  * t)
  = 0.034*30.158/(2*0.315)+-59830/(0.1923*pi*30.158² *0.315)
  = -343.98 psi
```

Maximum Shear Force in the Saddle (4.15.3) [T]:
```
  = Q(L-2a)/(L+(4*hm/3))
  = 18658 ( 159.81 - 2 * 29 )/(159.81 + ( 4 * 3.492/3))
  = 11550.0 lbf
```

Shear Stress in the shell no rings,  not stiffened (4.15.12) [tau2]:
```
  = K2 * T / ( Rm * t )
  = 1.1707 * 11550/( 30.158 * 0.315 )
  = 1423.38 psi
```

Decay Length (4.15.20) [x1,x2]:
```
  = 0.78 * sqrt( Rm * t )
  = 0.78 * sqrt( 30.158 * 0.315 )
  = 2.404 in
```

Effective reinforcing plate width  (4.15.24) [B1]:
```
  = min( b + 1.56 * sqrt( Rm * t ), 2a  )
  = min( 8 + 1.56 * sqrt( 30.158 * 0.315 ), 2 * 29 )
  = 12.81 in
```

Wear Plate/Shell Stress ratio  (4.15.26) [eta]:
```
  = 1.0000 Materials are the same, transport case
```

Circumferential Stress at Saddle Base with Wear Plate (4.15.25) [sigma6,r]:
```
  = -K5 * Q * k / ( B1( t + eta * tr ) )
  = -0.7603 * 18658 * 0.1/( 12.808 ( 0.315 + 1 * 0.315 ) )
  = -175.79 psi
```

Circ. Comp. Stress at Horn of Saddle, L<8Rm  (4.15.29) [sigma7,r*]:
```
  = -Q/(4(t+eta*tr)b1) - 12*K7*Q*Rm/(L(t+eta*tr)² )
  = -18658/(4(0.315 + 1 * 0.315 )12.808 ) -
     12*0.04981*18658*30.158/(159.81(0.315+1*0.315)² )
  = -5880.40 psi
```

**Results for Vessel Ribs, Web and Base:**

| | | | |
|---|---|---|---|
| Baseplate Length | Bplen | 53.0000 | in |
| Baseplate Thickness | Bpthk | 0.3940 | in |
| Baseplate Width | Bpwid | 9.0000 | in |
| Number of Ribs ( inc. outside ribs ) | Nribs | 4 | |
| Rib Thickness | Ribtk | 0.3940 | in |

| | | | |
|---|---|---|---|
| Web Thickness | Webtk | 0.3940 | in |
| Web Location | Webloc | Center | |
| Saddle Yield Stress | Sy | 62700.0 | psi |
| Height of Web at Center | Hw,c | 42.0 | in |
| Friction Coefficient | mu | 0.400 | |

**Moment of Inertia of Saddle - Transverse Direction (90 degrees to long axis)**

Inertia of Shell [ShellInertia]:
= (( 1.56 * sqrt( R * t ) + WearPlateWidth )$t^3$ )/12
= (( 1.56 * sqrt( 30 * 0.315 ) + 13 )$0.315^3$ )/12
= 0.046 in**4

Resolved Inertia for the Shell [I,shell]:
= ShellInertia + AShell( C1 - Y $)^2$
= 0.04635 + 5.6056 ( 19.585 - 0.1575 $)^2$
= 2115.827 in**4

| | B in | D in | Y in | A in^2 | AY $in^3$ | I + $AD^2$ in**4 |
|---|---|---|---|---|---|---|
| Shell | 17.7956 | 0.3150 | 0.1575 | 5.6056 | 0.8829 | 2115.8267 |
| Wearplate | 13.0000 | 0.3150 | 0.4725 | 4.0950 | 1.9349 | 1495.9364 |
| Web | 0.3940 | 47.1960 | 24.2280 | 18.5952 | 450.5250 | 3852.4893 |
| BasePlate | 9.0000 | 0.3940 | 48.0230 | 3.5460 | 170.2895 | 2867.7014 |
| Totals | ... | ... | ... | 31.8418 | 623.6323 | 10331.9541 |

Distance to Centroid [C1]:
= AY / A
= 623.63/31.842
= 19.585 in

Angle [beta]:
= 180 - Saddle Angle/2
= 180 - 120/2
= 120.0

Saddle Splitting Coefficient [K1]:
= ( 1 + cos(beta) - 0.5*sin(beta$)^2$ )/(pi - beta + sin(beta)cos(beta) )
= ( 1 + cos(120 ) - 0.5*sin(120 $)^2$ )/(pi - 2.0944 + sin(120 )cos(120 ) )
= 0.2035

Saddle Splitting Force [Fh]:
= K1 * Q
= 0.2035 * 18658
= 3797.3357 lbf

| | | | |
|---|---|---|---|
| Tension Stress, St = ( Fh/As ) | = | 144.7364 | psi |
| Allowed Stress, Sa = 0.6 * Yield Str | = | 37620.0000 | psi |

Saddle Splitting Dimension [d]:
= B - R * sin(theta/2)/(theta/2 in radians)
= 78.62 - 30 * sin(120/2)/1.0472
= 53.410 in

| | | | |
|---|---|---|---|
| Bending Moment, M = Fh * d | = | 202816.4688 | in-lb |

| | | | |
|---|---|---|---|
| Bending Stress, Sb = ( M * C1 / I ) | = | 384.4602 | psi |
| Allowed Stress, Sa = 2/3 * Yield Str | = | 41800.0000 | psi |

**Minimum Thickness of Baseplate per Moss:**
= sqrt( 3( Q + Saddle_Wt )BasePlateWidth / ( 4 * BasePlateLength * AllStress ))
= sqrt( 3(18658 + 742.9 )9/( 4 * 53 * 41800 ))

```
  = 0.243 in
```

**Calculation of Axial Load, Intermediate Values and Compressive Stress:**

Web Length Dimension [ Web Length ]:

```
  = 2 * cos( 90 - Saddle Angle/2 )( Inside Radius + Shell Thk + Wear Plate Thk )
  = 2 * cos( 90 - 120/2 )( 30 + 0.315 + 0.315 )
  = 53.053 in
```

Distance between Ribs [e]:

```
  = Web Length / ( Nribs - 1 )
  = 53.053/( 4 - 1 )
  = 17.684 in
```

Baseplate Pressure Area [Ap]:

```
  = e * Bpwid / 2
  = 17.684 * 9/2
  = 79.579 in^2
```

Bearing Pressure [Bp]:

```
  = Q / ( BasePlateLength * BasePlateWidth )
  = 18658/( 53 * 9 )
  = 39.116 lbf/in^2
```

Axial Load [P]:

```
  = Ap * Bp
  = 79.579 * 39.116
  = 3112.782 lbf
```

Area of the Rib and Web [Ar]:

```
  = Rib Area + Web Area
  = 2.9968 + 3.4838
  = 6.481 in^2
```

Compressive Stress [Sc]:

```
  = P/Ar
  = 3112.8/6.4806
  = 480.326 psi
```

**Check of Outside Ribs:**

Inertia of Saddle, Outer Ribs - Longitudinal Direction

| | B | D | Y | A | AY | Io |
|---|---|---|---|---|---|---|
| Rib+Web | 0.3940 | 8.0000 | ... | 3.1520 | ... | 16.8107 |

Rib dimension [D]:

```
  = Saddle Width - Web Thickness
  = 8 - 0.394
  = 7.606 in
```

Distance to Centroid from Datum [ytot]:

```
  = AY / A
  = 0/6.4806
  = 0.000 in
```

Distance to Centroid [C1]:

```
  = Saddle Width / 2
  = 8/2
  = 4.000 in
```

Radius of Gyration [r]:

= sqrt( Total Inertia / Total Area )
= sqrt( 16.811/6.4806 )
= 1.611 in

Length of Outer Rib, step 1, [Lw]:
= 2 * sin( saddle bearing angle / 2 )( radius + shlthk + wpdthk )
= 2 * sin( 120/2 )( 30 + 0.315 + 0.315 )
= 53.053 in

Length of Outer Rib, step 2, [Bd]:
= Baseplate length - clearance
= 53 - 2
= 51.000 in

Length of Outer Rib, step 3, [Dd]:
= ( Lw - Bd )/2
= ( 53.053 - 51 )/2
= 1.026 in

Length of Outer Rib [L]:
= sqrt( $Rl^2$ + $Dd^2$ )
= sqrt( $62.519^2$ + $1.0264^2$ )
= 62.519 in

Intermediate Term [Cc]:
= sqrt( 2 * $pi^2$ * Elastic Modulus / Yield Stress )
= sqrt( 2 * $pi^2$ * 29000000/62700 )
= 95.550

Slenderness ratio [KL/r]:
= KL/r
= 1 * 62.519/1.6106
= 38.818

Bending Moment [Rm]:
= Fl /( 2 * Bplen ) * e * L / 2
= 16472/( 2 * 53 ) * 17.684 * 62.519/2
= 85906.102 in-lb

Compressive Allowable, KL/r < Cc ( 38.818 < 95.55 ) per AISC E2-1 [Sca]:
= ( 1-$(Klr)^2$/(2*$Cc^2$))Fy/(5/3+3*(Klr)/(8*Cc)-($Klr^3$)/(8*$Cc^3$)
= ( 1-( 38.818 $)^2$/(2 * $95.55^2$ ))62700/
( 5/3+3*(38.818 )/(8* 95.55 )-( $38.818^3$)/(8*$95.55^3$)
= 31771 psi

**AISC Unity Check of Outside Ribs ( must be <= 1 )**
= Sc/Sca + ( Rm * C1 / I )/Sba
= 480.33/31771 + ( 85906 * 4/16.811 )/41800
= 0.504

**Check of Inside Ribs:**

Inertia of Saddle, Inner Ribs - Axial Direction

| | B | D | Y | A | AY | Io |
|---|---|---|---|---|---|---|
| Rib | 0.3940 | 7.6060 | 0.0000 | 2.9968 | 0.0000 | 16.8087 |
| Web | 17.6842 | 0.3940 | 0.0000 | 6.9676 | 0.0000 | 0.0901 |
| Totals | ... | ... | ... | 9.9644 | ... | 16.8988 |

Distance to Centroid from Datum [ytot]:
= AY / A
= 0/9.9644
= 0.000 in

Distance to Centroid [C1]:
```
  = Saddle Width / 2
  = 8/2
  = 4.000 in
```

Length of Inner Rib [L]:
```
  = Saddle Height - sqrt( (Ro + Wpdthk)^2 - (Pitch/2)^2 ) - Bpthk
  = 78.62 - sqrt( (30.63 + 0.315 )^2 - (17.684/2)^2 ) - 0.394
  = 48.500 in
```

Radius of Gyration [r]:
```
  = sqrt( Total Inertia / Total Area )
  = sqrt( 16.899/9.9644 )
  = 1.302 in
```

Slenderness ratio [KL/r]:
```
  = KL/r
  = 1 * 48.5/1.3023
  = 37.242
```

Unit Force [Force,u]:
```
  = Fl / ( 2 * Baseplate Length )
  = 16472/( 2 * 53 )
  = 155.401 lbf/in
```

Moment at base of inner Rib [Mbase,c]:
```
  = Unit Force * e * L
  = 155.4 * 17.684 * 48.5
  = 133284.859 in-lb
```

Bending Stress due to Transverse Force and Weight Load [SigmaB,base,c]:
```
  = Bending Moment / Section Modulus
  = 133285/4.2247
  = 31548.963 psi
```

Compressive Allowable, KL/r < Cc ( 37.242 < 95.55 ) per AISC E2-1 [Sca]:

$= ( 1-(Klr)^2/(2*Cc^2))Fy/(5/3+3*(Klr)/(8*Cc)-(Klr^3)/(8*Cc^3))$

$= ( 1-( 37.242 )^2/(2 * 95.55^2 ))62700/$

$( 5/3+3*(37.242 )/(8* 95.55 )-( 37.242^3)/(8*95.55^3))$

$= 32091$ psi

**AISC Unity Check of Inside Ribs ( must be <= 1 )**
```
  = Sc/Sca + ( Mbase,c * C1/I )/Sba
  = 624.78/32091 + ( 133285 * 4/16.899 )/41800
  = 0.774
```

*Review notes about nozzle loadings and supports in the Warnings report.*

# 设备运输绑扎计算

## Equipment Transportation and Binding Calculation

设备位号：18-D-252

Equipment Tag Number:18-D-252

运输总重:$m=m_f+m_s=4231+400=4631$ kg

运输载荷：纵向加速度 $g_x=1.5g$，横向加速度 $g_z=1.5g$，垂直加速度 $g_y=2.0g$

在鞍座上有 8 根横向绑扎绳，共有 8 根横向绑扎绳。考虑对称性，计算按 4 根绑扎绳。

吊耳上有 8 根纵向滑动绑扎绳，共 8 根纵向滑动绑扎绳，考虑对称性，计算按 4 根纵向绑扎绳。

1. 横向滑动计算：

$F_Z=mgg_z+F_{Z-W}=4631*9.81*1.5+9492.1=77637.3$ N

$F_Z\leq\mu mg+F_{Z-L}*4$

→ $77637.3\leq0.3*4631*9.81+F_{Z-L}*4$

→ $F_{Z-L}\geq16002$ N

考虑绑扎绳的斜拉角，每根绑扎绳的力应为：

$F_{Z-L}\geq16002/\sin70°/\cos20°=18122$ N

2. 横向倾斜计算：

a,设备中心到鞍座底板的距离 1997 mm;

b,鞍座底板长度的一半 1346/2=673 mm;

c，绑扎绳的力臂 1084 mm。

$F_Z*a\leq mgb+F_{Z-L}*4*c$

→ $77637.3*1997\leq4631*9.81*673+F_{Z-L}*4*1084$

→ $F_{Z-L}\geq28706$ N

考虑绑扎绳的倾斜角，每根绑扎绳的力应为：

$F_{Z-L}\geq28706/\sin70°/\cos20°=32509$ N =7308 lbf

3. 纵向滑动计算

$F_x=mgg_x=4631*9.81*1.5=68145.2$ N

$F_x\leq\mu mg+F_{x-L}*4$

→ $68145.2\leq0.3*4631*9.81+F_{x-L}*4$

→ $F_{x-L}\geq13629$ N

考虑绑扎绳的倾斜角，每根绑扎绳的力应为：

$F_{x-L}\geq13629/\sin45°/\sin45°=27258$ N =6128 lbf

Total Weight of Transportation: $m=m_f+m_s=4231+400=4631$ kg

Transport Load: Longitudinal Acceleration $g_x=1.5g$, Lateral Acceleration $g_z=1.5g$, Vertical Acceleration $g_y=2.0g$

There are 8 lateral binding ropes on the saddle,totaling 8 lateral binding ropes. Considering symmetry, the calculation is based on 4 binding ropes.

There are 8 longitudinal sliding binding ropes on the lifting ears, totaling 8 longitudinal sliding binding ropes. Considering symmetry, the calculation is based on 4 longitudinal binding ropes.

4. Lateral Sliding Calculation:

$F_Z=mgg_z+F_{Z-W}=4631*9.81*1.5+9492.1=77637.3$ N

$F_Z\leq\mu mg+F_{Z-L}*4$

→ $77637.3\leq0.3*4631*9.81+F_{Z-L}*4$

→ $F_{Z-L}\geq16002$ N

Considering the diagonal angle of the binding rope, the force of each binding rope should be:

$F_{Z-L}\geq16002/\sin70°/\cos20°=18122$ N

5. Lateral tilt Calculation:

a, The distance from the center of the equipment to the base plate of the saddle is 1997 mm;

b, Half of the length of the saddle base plate is 1346/2=673 mm;

c，The force arm of the binding rope is 1084 mm。

$F_Z*a\leq mgb+F_{Z-L}*4*c$

→ $77637.3*1997\leq4631*9.81*673+F_{Z-L}*4*1084$

→ $F_{Z-L}\geq28706$ N

Considering the inclination angle of the binding rope, the force of each binding rope should be:

$F_{Z-L}\geq28706/\sin70°/\cos20°=32509$ N =7308 lbf

6. Longitudinal sliding Calculation:

$F_x=mgg_x=4631*9.81*1.5=68145.2$ N

$F_x\leq\mu mg+F_{x-L}*4$

→ $68145.2\leq0.3*4631*9.81+F_{x-L}*4$

→ $F_{x-L}\geq13629$ N

Considering the inclination angle of the binding rope, the force of each binding rope should be:

$F_{x-L}\geq13629/\sin45°/\sin45°=27258$ N =6128 lbf

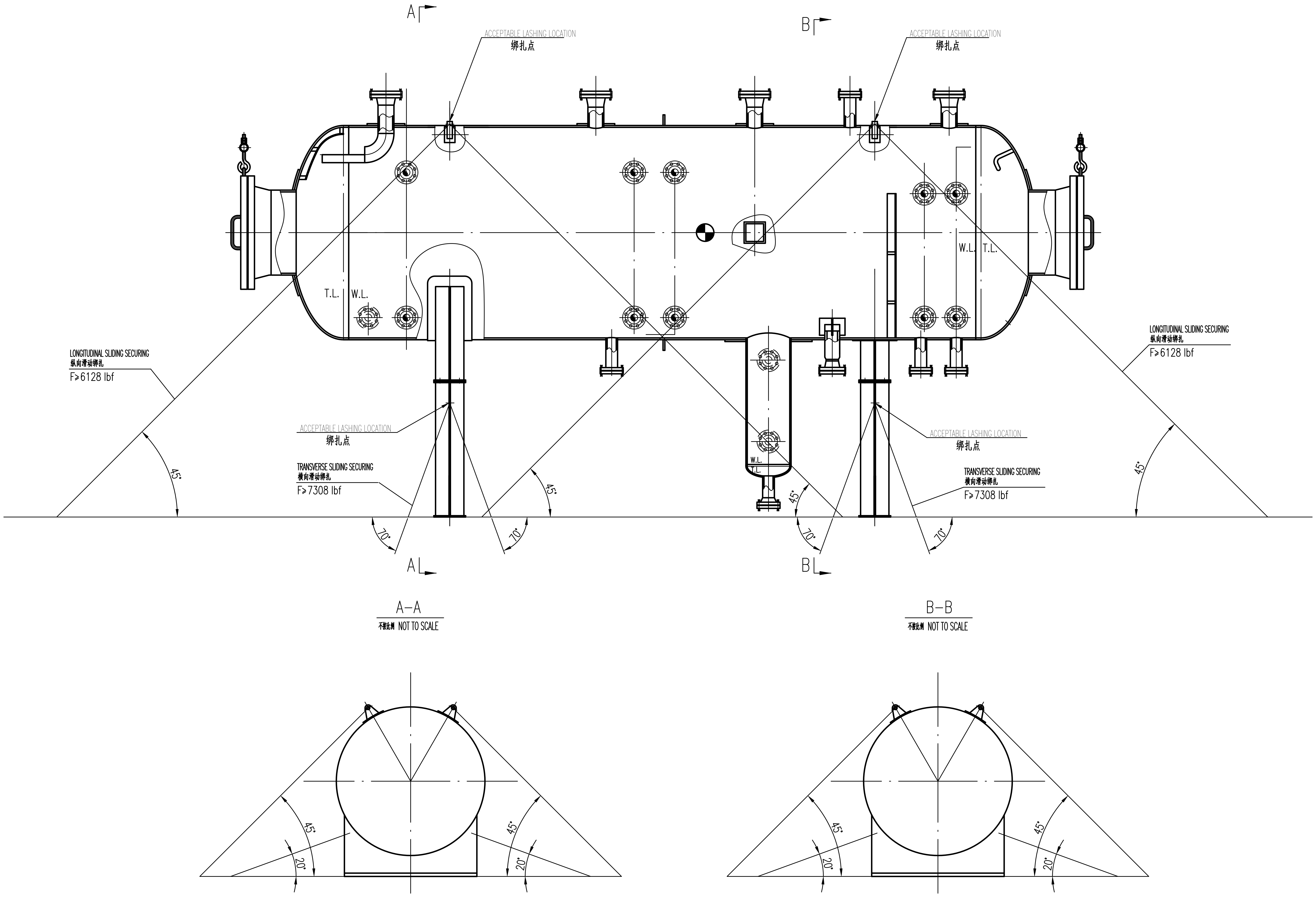



图1 设备运输绑扎示意图

Figure 1 Schematic Diagram of Equipment Transportation and Binding