REPORT

PRESSURE INSPECTION SUMMARY REPORT

API 510 Inspection of Pressure Vessel

R3 REACTOR

Client	:	Chemical Specialties (S) Pte Ltd
Location	:	31 Ayer Merbau Road, Jurong Island
Project	:	API Inspection
Project No	:	LEADS-23-03
Report No	:	LEADS-23-03-API-08 R1
Date of Inspection	:	04-05 May 2023

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Originated by	P Rajesh (API 510 Certificate: 61416)	Signature: 
Approved by	Sudhan P (General Manager)	Signature:  

PRESSURE VESSEL INSPECTION SUMMARY REPORT

1.0 Introduction

1.1 Works Brief

Leads was engaged as a third-party inspection company to carry out the inspection based on API 510 which encompasses below.

An American Petroleum Institute (API) 510 pressure vessel external inspection for Reactor R3 at CSL facility, Jurong Island, Singapore in May 2023 has been carried out. The vessel was in service, scaffolding has been provided to perform external for visual inspection & UTG inspection. This inspection complied with the API 510 standard. This vessel inspection included external visual inspection of the shell, nozzles, head, foundation and internal inspection. NDT data gathered will be part of the final report.

This report is generated on data gathered from three locations: applicable codes, regulations, and laws; the observed field conditions existent during the API inspection; and material provided in written form by the facility, end-user, or client (e.g., as-builts, previous inspection reports, written transcriptions of conversations with the facility.)

This inspection report is based solely on empirically observable conditions observed during the inspection process and correspondence with the facility or end-user. Information not empirically observable or presented to us in the course of this inspection, but which may be relevant to the inspection's findings, have not been evaluated or included in this inspection. The API inspector bears no responsibility for findings which could only be ascertained by information not made available to the API inspector.

1.2 General Arrangement & Reference

This inspection report is prepared with a photo and name of each item and / or a location for reference. In addition, the report is also complemented with all the necessary equipment and personnel certification to ensure that the job was performed in line with the requirements. Please note the content of the final report and report reference numbers are number numerical in each NDT method, however they are grouped in this summary by NDT method so they may not be sequential in their grouping.

1.2.1 Reference Documents

- API 510 – Pressure Vessel Inspection Code
- Leads NDT Technical Procedures
- General Arrangement Drawing: (CSL-HX-MHI-R3-001 Rev 0)

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1.3 Vessel Suitability for Service Statement

This report contains all the details and evaluation results used to arrive at this vessel suitability for service determination. Based on the findings and the detailed report below, we have determined that:

- The vessel can continue to operate. However, recommendations are provided for further follow up.

1.3.1 General Condition

Reactor R3 is Vertical vessel. The vessel is approx. 8121.6 mm tall with a 3962.4 mm outer diameter. Year manufactured in 1970 & in operation from 2018 (according to client information).

1.3.2 Structural Integrity

We define vessel structural integrity as the capability of the vessel to remain freestanding, with or without product, under the conditions of its design basis. Structural attributes include the vessel foundation, shell, head and their attachments. Ultrasonic thickness inspections of the shell & head were performed.

Based on our inspection of the accessible components and engineering evaluation, vessel is considered to have suitable structural integrity.

1.3.3 Coating Integrity

We define coating integrity as the interior wetted coating's ability to provide an impervious, completely continuous film barrier that prevents harmful environmental and service conditions corrosive agents to penetrate to the base metal, which could over time compromise hydraulic integrity.

Although corrosion and coating failures may not indicate structural failures; they present conditions which, in time, can lead to structural integrity failures.

No access to the shell plate due to insulation and water jackets. Based on our inspection of the accessible components and engineering evaluation, vessel is considered to have suitable coating integrity.

1.3.4 Hydraulic Integrity

Not Applicable as Hydrotest was not part of the scope this time.

1.4 Next Inspection Schedules

External Inspection:

API 510 recommends Unless justified by an RBI assessment, each aboveground vessel shall be given a visual external inspection at an interval that does not exceed the lesser of five years or the required internal/on-stream inspection. It is preferred to perform this inspection while the vessel is in operation.

Internal, On-stream, and Thickness Measurement Inspections:

Unless justified by a RBI assessment, the period between internal or on-stream inspections and thickness measurement inspections shall not exceed one-half the remaining life of the vessel or 10 years, whichever is less. Whenever the remaining life is less than four years, the inspection interval may be the full remaining life up to a maximum of two years.

Based on the thickness measurements, we recommend the below:

- **API internal inspection (out-of-service)**
    - no later than previous inspection recommendation (shall not exceed 10 years from last internal inspection)
- **UTG inspection** shall be conducted
    - Shell & bottom dish head: no later than May 2028 (5 years from May-2023 inspection)
    - Top dish head: no later than May 2033 (10 years from May-2023 inspection)
- **API external inspection (in-service)** be conducted
    - no later than May 2028 (5 years from May-2023 inspection) for a visual inspection

or sooner if a change in condition has occurred.

1.5 Inspector's Certification

I acknowledge that I am familiar with API Standard 510's provisions; the inspection and evaluation performed on Vessel at CSL facility and certify that the inspection was performed per the API Standard 510 provisions, good engineering practices, and with usual and customary care.

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2.0 Vessel Summary

2.1 Project Scope

An API 510 vessel inspection has been performed on the vessel. This vessel inspection included external visual inspection of the vessel shell, nozzles, head, foundation (where accessible) & UTG. Following the API 510 inspection's completion, report with findings is provided detailing all vessel conditions and repair recommendations.

2.2 Vessel Repair Definitions

Mandatory Repairs – repairs that need to be completed before the vessel can be returned to service. Mandatory Repairs consists of any failure / deficiency that hasbreached the hydraulic and/or structural integrity of the vessel, and/or presents an imminent danger to personnel and/or adjacent structures.

Non-Mandatory Recommended Repairs Preceding Return-To-Service – repairs that do not meet the requirements of being a Mandatory Repair, but will help maintainor improve vessel operability / serviceability, or else are required to meet current codes.Repairs noted under this category are recommended for performance prior to the vessel being returned to service.

Future Non-Mandatory Recommended Repairs – repairs that do not meet the requirements of being a Mandatory Repair, but will help maintain or improve vessel operability / serviceability, or else are required to meet current codes. Unlike the Non-Mandatory Recommended Repairs Preceding Return-To-Service, Future Non-Mandatory Recommended Repairs are not being recommended for performance prior to the vessel being returned to service.

Recurring Maintenance Recommendations - actions that should be taken on arecurring basis

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2.3 Vessel Repair Recommendations

The API 510 inspection has resulted in the following repair conditions:

Mandatory Repairs Preceding Return To Service	
I.1	None
Non-Mandatory Recommended Repairs Preceding Return-To-Service	
II.1	None
Future Non-Mandatory Recommended Repairs	
III.1	None
Recurring Maintenance Recommendations	
IV.1	Let the fire and safety systems be checked on an annular base by a safety engineer.
IV.2	Perform proper housekeeping on a regular base.
IV.3	Perform visual and UT inspections as per Inspection Interval Recommendation.

2.4 Vessel Design Data

DESIGN DATA		
DESIGN CODE ASME CODE SECTION VIII DIV. 1: 2017		
EQUIPMENT ITEM NO.	R-3	
EQUIPMENT TYPE	REACTOR	
POSITION	VERTICAL	
	VESSEL	JACKET
SHELL MATERIAL	SA 516-70	SA 516-70
ELLIP. HEAD 2:1 MATERIAL	SA 516-70	-
INTERNAL LINING MATERIAL	SS304L	-
MEDIUM	PROPYLENE GLYCOL	-
DESIGN PRESSURE	130.53 psi [9 bar]/ F.V.	NOT IN USE
DESIGN TEMPERATURE	554°F (290°C)	NOT IN USE
OPERATING PRESSURE	58 psi [4 bar] max.	NOT IN USE
OPERATING TEMPERATURE	320°F (160°C) max.	NOT IN USE
CORROSION ALLOWANCE	4.7625 mm	-
REQUIRED MDMT	-4 °F [-20 °C]	-
CALCULATED MDMT	-20.2 °F [-29 °C]	-
MAWP	184.0 psi [12,68 bar]	-
HYDROTEST PRESSURE	169.7 psi [11,7 bar]	-
HYDROTEST POSITION	VERTICAL	-
FLOW RATE	-	-
OPERATING S.G.	1.3	-
DESIGN S.G.	1.3 max	-
VISCOSITY	-	-
PRODUCT DENSITY	1.3	-
YEAR MANUFACTURED	1970	
INSULATION	50 mm	
WIND DESIGN CODE	ASCE-93	
WIND SPEED	22 m/s	
EARTHQUAKE DESIGN CODE	NO SEISMIC	
EMPTY WEIGHT	53,744 KG	
OPERATING WEIGHT	160,940 KG	
FULL WEIGHT	144,881 KG	
GROSS CAPACITY	92 m^3	
NET CAPACITY	83 m^3	

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3.0 Inspection Checklists and Summary

The following inspection summaries list all noted deficiencies and the governing criteria with which they fail to comply fully.

3.1 Vessel External (Online) Inspection

Ladders, Stairways, Platform, Walkways (API 572 Sec 9.3.2) :		
1	Ladder attachments to concrete base (corrosion, broken):	NA
2	Bolts and fasteners on stairways and ladder stringers (tightness and corrosion):	NA
3	Welds on stairways and ladder stringers (corrosion, broken):	NA
4	Welds on spiral stairway to shell supports (corrosion, broken):	NA
5	Stairways and ladders (corrosion, broken):	NA
6	Stairways and ladders (coating or paint failure):	NA
7	Attachment welds of handrails to stairways (corrosion, broken):	NA
8	Tubular / solid bar stairway handrails (corrosion, pitting, paint failure):	NA
9	The condition of flooring on platforms and walkways	NA
10	Crevice corrosion around the heads of bolts and nuts at bracket connections	NA
11	Loose or broken parts found any	NA
Foundation and Supports (API 572 sec 9.3.3)		
12	Plumpness of column supporting spherical tank	NA
13	Settlement Survey	NA
14	Condition of connected pipe lines due to settlement	NA
15	Misalignment of the foundation with the surrounding paving or ground due to settlement	NA
16	Check for deterioration such as spalling, cracking, and settling on the foundation	NA
Anchor Bolts (API 572 sec 9.3.4)		
17	Check for deterioration of the anchor bolt below the base plate	NA
18	Distortion of anchor bolts due to foundation settlement if any	NA
19	Tightness of nuts	NA
Concrete Support (API 572 sec 9.3.5)		
20	Sealing condition between concrete support and vessel shell	NA

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Steel Support (API 572 sec 9.3.6)		
21	Check for corrosion, distortion, and cracking	2
22	Remaining thickness of (Skirts, Columns and bracing)	U/A
23	Check for buckling, Excessive Deflection (measurement by straightedge or plumb line)	2
24	NDE (MT /PT) result of attachment weld supporting tank	NA
25	Insulation condition of supporting skirts	NA
26	Piping attachment to Spherical tank (Check for evidence of distortion due to pipe movement)	NA
27	Fireproofing Condition (Bulge , Rust stain, Crack)	2
Guy Wires (API 572 sec 9.3.8)		
28	Check for corrosion and broken strands	NA
Nozzles (API 572 sec 9.3.9)		
29	Check for distortion due to settlement	2
30	Nozzles painting / coating condition	2
31	Nozzles corrosion pitting condition	2
32	Check for flange leak (discoloration to the vessel, insulation, fireproofing, or paint, or damage)	2
33	Thickness survey reading	2
Grounding Connections (API 572 sec 9.3.10)		
34	Tightness, positive bonding to the vessels, and corrosion, Continuity of wires	2
35	Recommended Resistance achieved (5 to 25 Ohms)	NA
Auxiliary Equipment (API 572 sec 9.3.11)		
36	Evidence of Vibration if any	2
37	Drain lines and other connected piping	2
38	Gauges for liquid level, pressure, and temperature and other instruments	2
39	Safety and relief valves	NA
40	External water sprays and other fire-fighting equipment	NE
41	Instrument or utility stations	NA
42	Structural steel for platforms, supports, and lifting lugs	NA
Protective Coatings and Insulation (API 572 sec 9.3.12)		
43	Check for Rust spots, blisters, and film lifting	U/A
44	Condition of Insulation	2

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External Metal Surfaces (API 572 sec 9.3.13)		
45	Picking, scraping, and limited hammering	U/A
46	General external painting / coating condition	U/A
47	General external corrosion pitting condition	U/A
48	Thickness survey reading	2
49	NDE (MT / PT) results of support attachment location	NA
50	Condition of weld joints wherever accessible (lower and upper equator plate, lower and upper temperate, top and bottom center crown weld joints)	U/A
Roof / /Shell Appurtenances		
51	Manway covers secured in place, condition:	2
52	Roof nozzles condition:	2
53	Roof Platform condition:	NA

Legend:

1	Good Condition	3	Repair or alteration recommended	U/A	Un-assessable
2	Satisfactory Condition	4	Repair or alteration required	NE	None Evident
xx	Not to Code			N/A	Not applicable

Comments:

- In general, satisfactory condition. Hence, it's an insulated vessel, inspection was conducted for CUI and from UTG ports.

3.1.1 Remaining Life Calculations:

SHELL:
When P does not exceed 0.385SE, the following formula shall apply:

$$t = \frac{PR}{SE - 0.6P} * 25.4$$

- t_{min} is the minimum required thickness in mm,

Material	- SA 516 Grade 70N
P (internal design pressure, lbf/in.^{2})	– 130.53
R (inside radius, in.)	– 78
S (Max. allowable stress, lbf/in.^{2})	– 19400 (for temp 500 ^{o}F to 600^{o}F, Ref ASME Sec II – part D – Table 1A)
E (Joint Efficiency)	– 0.70 (no RT information available)

t=19.15mm

Corrosion allowance from drawings = 4.76mm

Actual lowest thickness – 47.09mm (1.854 in)

Maximum Allowable working pressure (MAWP) for the noted thickness:

$$P = \frac{SEt}{R+0.6t}$$

P = 318.24 psi

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ELLIPTICAL DISH HEAD:

$$t = \frac{PD}{2SE - 0.2P} * 25.4$$

- t_{min} is the minimum required thickness in mm,

Material - SA 516 Grade 70N

P (internal design pressure, lbf/in.^{2}) – 130.53

D (inside diameter, in.) – 78

S (Max. allowable stress, lbf/in.^{2}) – 19400 (for temp 500 ^{o}F to 600^{o}F, Ref ASME Sec II – part D – Table 1A)

E (Joint Efficiency) – 0.70 (no RT information available)

t=19.06mm

Corrosion allowance from drawings = 4.76mm

Remaining Life = t_{actual}-$t_{required}$ / corrosion rate

Plate No.	Original Thickness (mm)	Actual lowest Thickness (mm)	Wall loss (mm)	Years of Service	Long Term Corrosion Rate (mm/year)	Min. required thickness, incl. CA (mm)	Remaining Life (Years)	Next recommended UTG
Shell	44.45	No Access (due to water jacket)	NA	53	NA	23.91	Note 1	5 Years (Note 3)
Top Dish Head	44.45	47.09	NA	53	NA	23.82	Note 2	10 years
Bottom Dish Head	44.45	No Access (due to water jacket)	NA	53	NA	23.82	Note 1	5 Years (Note 3)

- UTG report number: LEADS-23-CSL-UTG-15
- Note 1: Perform internal inspection to find out shell thickness as external is blocked the water jacket.
- Note 2: Remaining life cannot be calculated as the actual thickness is higher than the design thickness.
- Note 3: Based on the previous report, and the corrosion rate from the top dish head, next recommended UTG is determined as 5 years

3.2 Vessel Offline Inspection

Internal Nozzles		
1	Check for distortion due to settlement	NA
2	Check for flange leak (discoloration to the vessel, insulation, fireproofing, or paint, or damage)	NA
3	Thickness survey reading	NA
Internal Linings / Coatings / Cladding		
4	Check for Rust spots, blisters, and film lifting	NA
5	Check for cracks, openings	NA
6	Others	NA
Internal Metal Surfaces		
7	Picking, scraping, and limited hammering	NA
8	NDE (MT / PT) results of support attachment location	NA
9	Condition of weld joints wherever accessible (lower and upper equator plate, lower and upper temperate, top and bottom center crown weld joints)	NA
Internal Evidence of Corrosion		
10	Evidence of Atmospheric corrosion, caustic embrittlement, hydrogen blistering, and soil corrosion	NA
Internal Appurtenances		
11	Manway covers secured in place, condition:	NA
12	Attachment welds condition	NA
13	Baffle / Weir / Impingement Plates / Mixer /Agitator / Heating coil / Thermowells / Tray / Distributor (where applicable) condition:	NA

4.0 NDT Inspection Reports

4.1 Visual Inspection Photographs

4.2 UTG Report

4.1 Visual Inspection Photographs

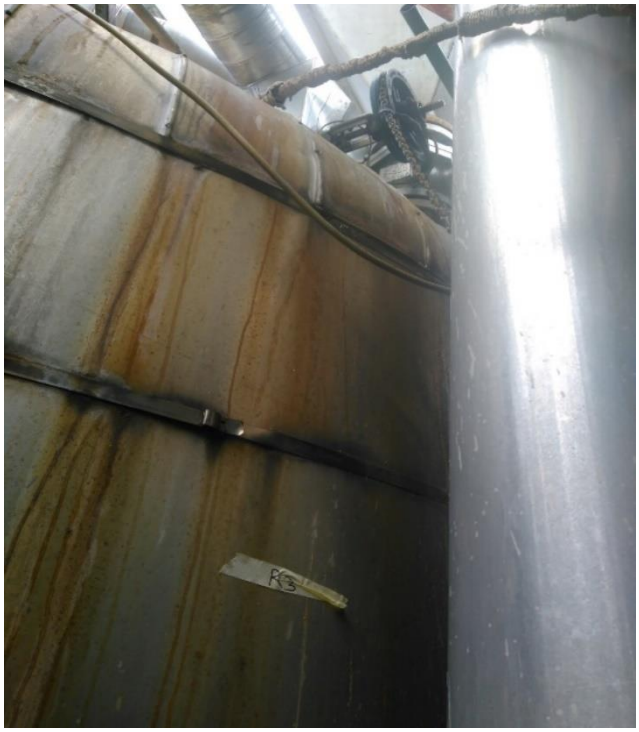

Photo 1: External view R3, in satisfactory condition

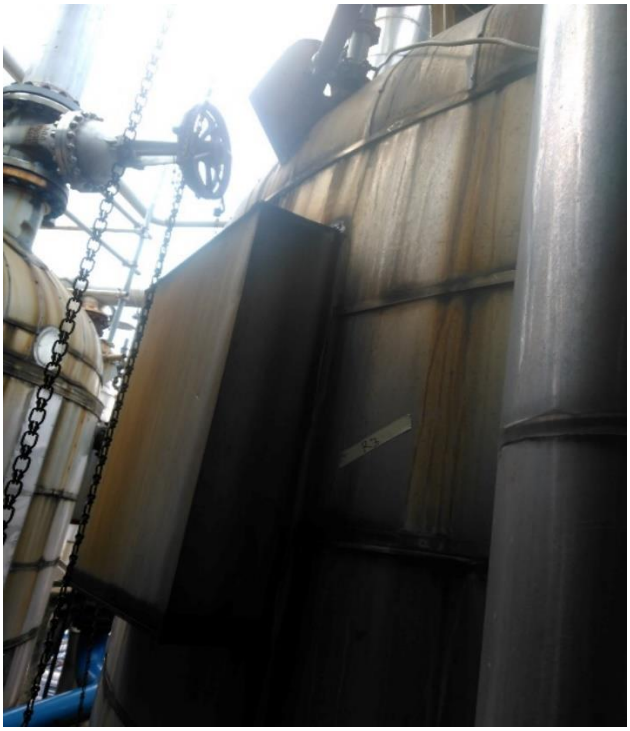

Photo 2: External view R3, in satisfactory condition

Photo 3: UTG measurement in Shell plates/ water jacket was done. External insulation was in satisfactory condition.

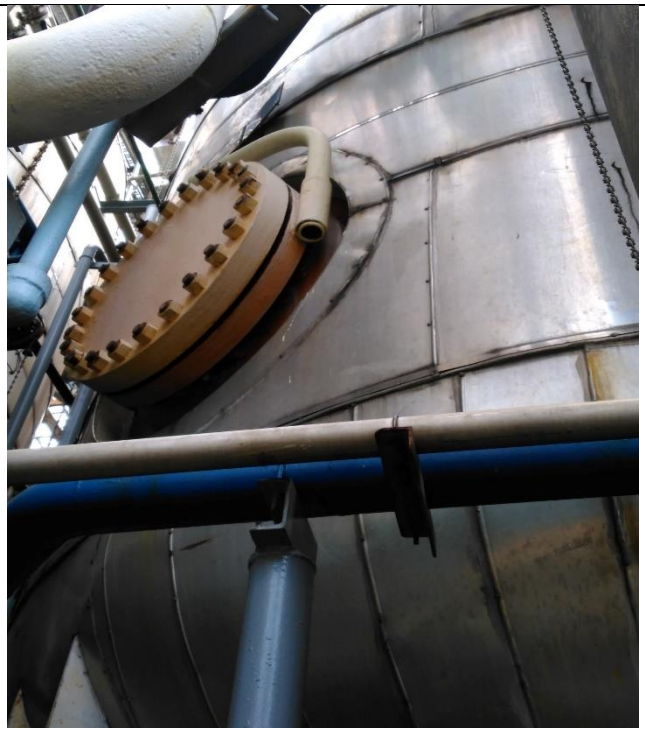

Photo 4: Manhole was in satisfactory condition

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Photo 5: UTG measurement in Shell plates/ water jacket was done. External insulation was in satisfactory condition.

Photo 6: Nozzles was observed in satisfactory condition

Photo 7: Bottom dish head/ water jacket was observed in satisfactory condition

Photo 8: Insulation was in satisfactory condition with stain marks.

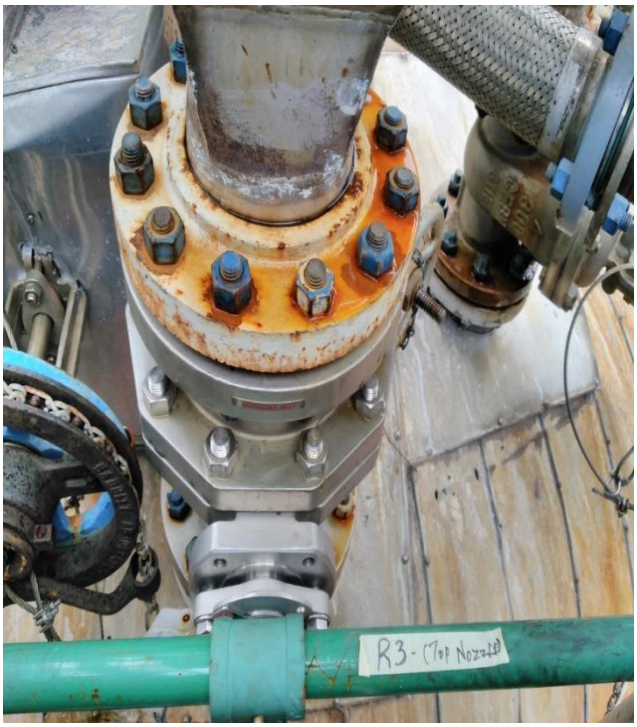


Photo 9: Top Shell nozzle was observed in satisfactory condition. Minor rust was observed on flange area.

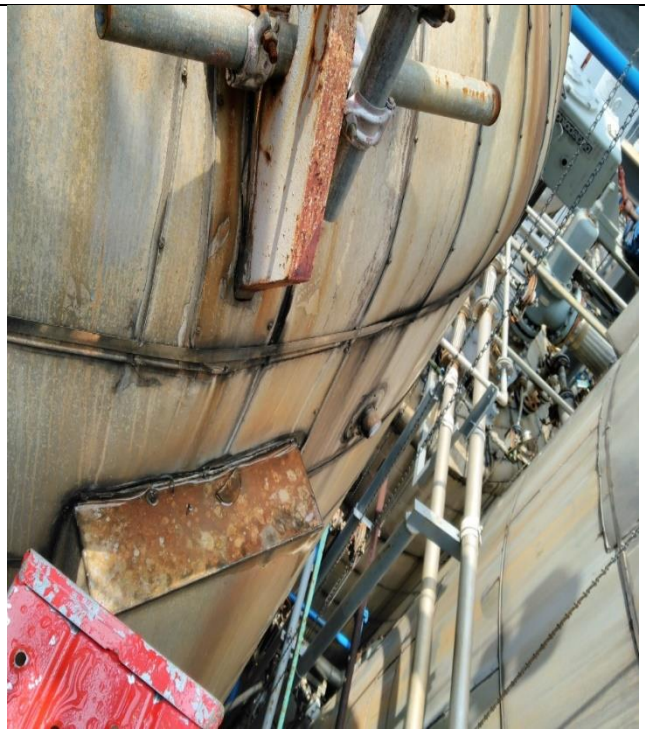


Photo 10: Support Bracket and Insulated area was observed with minor rust.

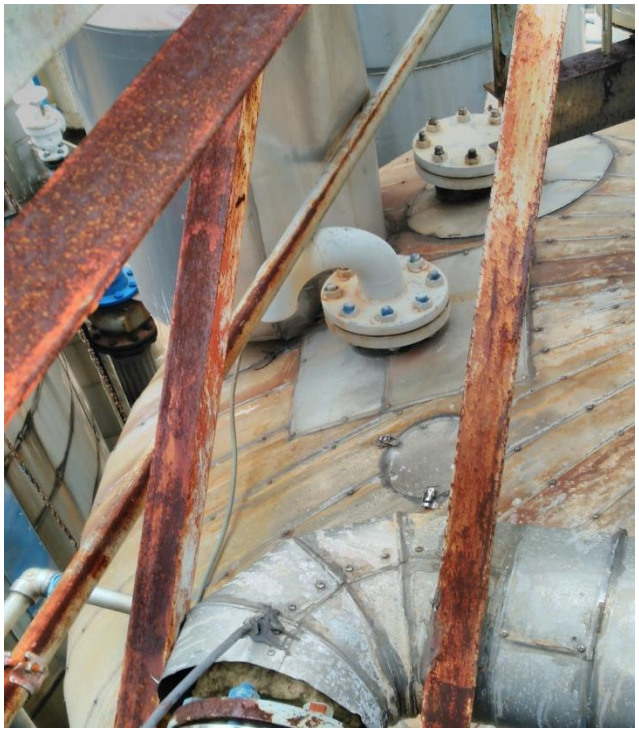


Photo 11: Top shell nozzle was observed with satisfactory condition.

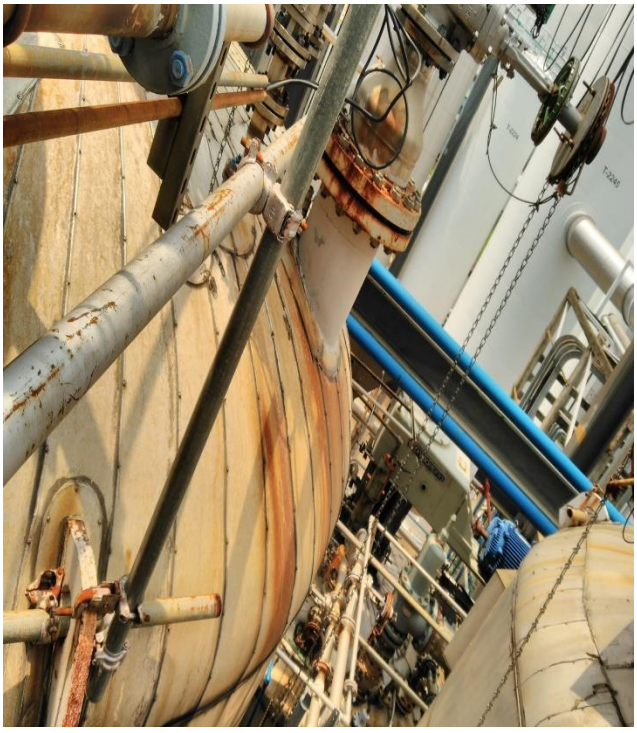


Photo 12: Top Shell nozzle was observed in satisfactory condition. Minor rust was observed on flange area.

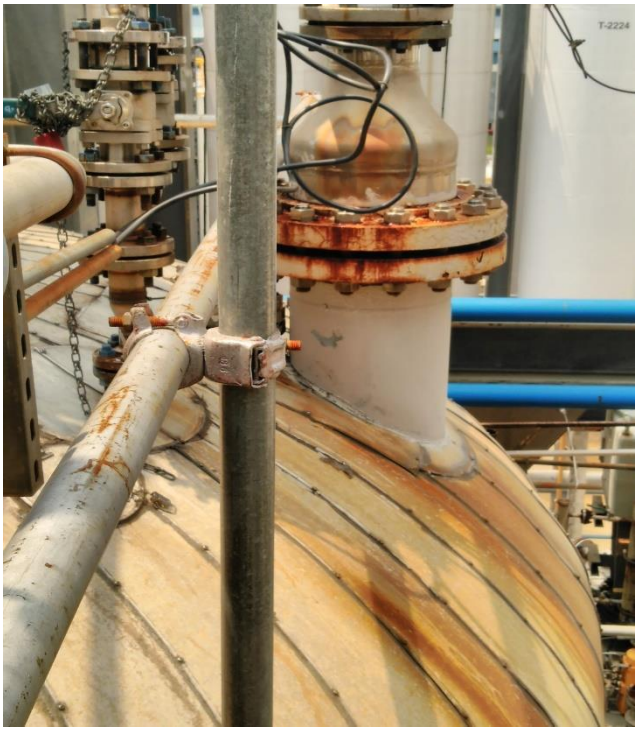


Photo 13: Top Shell nozzle was observed in satisfactory condition. Minor rust was observed on flange area.

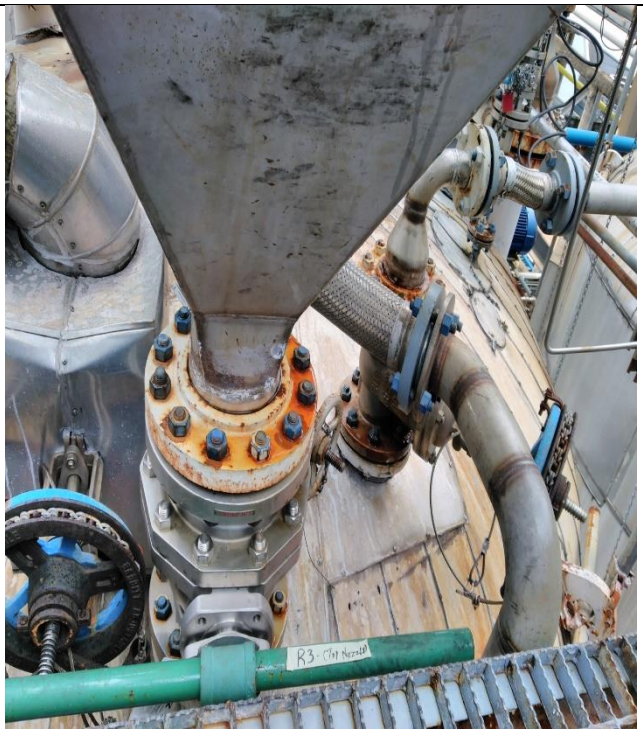


Photo 14: Top Shell nozzle was observed in satisfactory condition. Minor rust was observed on flange area.

4.2 Ultrasonic Thickness Measurement Report

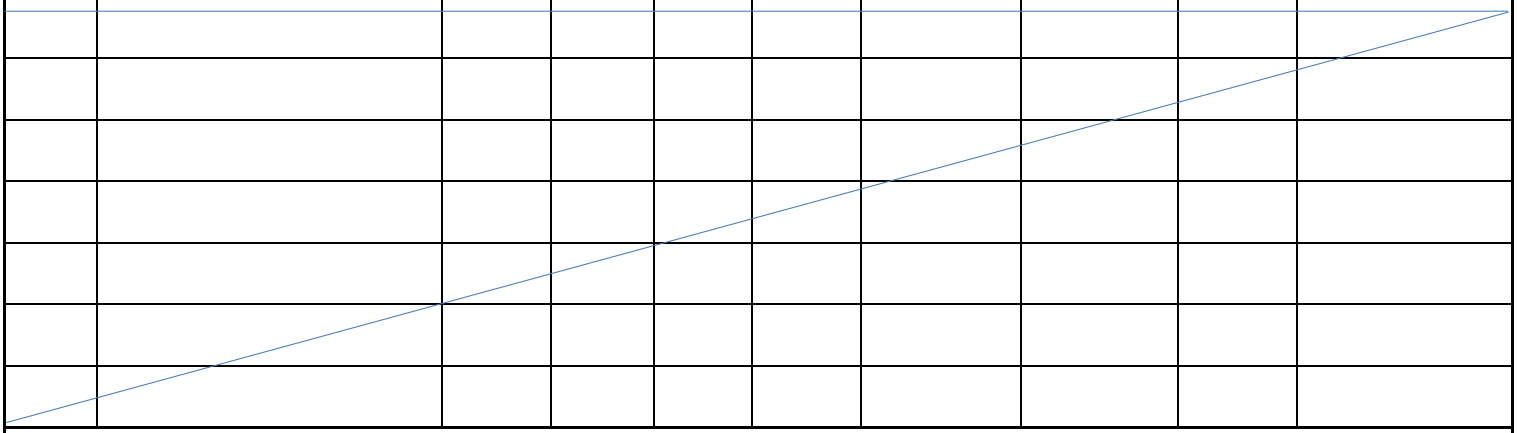
ULTRASONIC THICKNESS GAUGING REPORT

Accredited Laboratory SAC-SINGLAS LA-2016-0616-D

Client	: Chemical Specialties (Singapore) Pte Ltd	Report No.	: LEADS-23-CSL-UTG-015
Client Address	: 31 Ayer Merbau Rd, Singapore 627717	Inspection Date	: 05-05-2023
Project Name.	: R3 - Reactor	Report Date	: 06-05-2023
Location	: 31 Ayer Merbau Rd	Leads Ref No.	: LSS/23-05/029
Item Description	: R3 - Reactor	Client Request No.	: NA

Eq.Make / Model	: 38 DL PLUS	Test Mode	: Auto Echo to Echo	Procedure	: LEADS-IMSP-035 REV-02
Eq. Serial No	: 193390803	Screen Range	: 0-50mm	Standard	: ASME Sec V Art 23 SE-797 Ed 2019
Probe Frequency	: 5 MHZ	Material	: Carbon Steel	Drawing No.	: Refer attached Drawing
Probe Serial No	: 1123940	Surface Cond.	: Smooth	Couplant Type	: Wallpaper paste
Probe Size Ø	: 11mm	Probe Type	: Thru-Coat Dual / D7906	Cal Block(Sr.No)	: Step Wedge(3E/2-20mm/cs/24)

S/NO	Item Description	UTG Measurement (mm)				Min	Max	AVG	Remarks
		0˚	90˚	180˚	270˚	mm	mm		
1	Top Dish Head - Loc 1	47.12	47.09	47.15	47.26	47.09	47.26	47.16	
2	Top Dish Head - Loc 2	48.02	47.92	47.88	47.60	47.60	48.02	47.86	
3	Top Dish Head - Loc 3	47.40	46.98	47.31	47.09	46.98	47.40	47.20	
4	Bottom Dish Head - Loc 1	23.60	24.08	23.10	23.40	23.10	24.08	23.55	
5	Bottom Dish Head - Loc 2	23.90	24.30	23.35	23.43	23.35	24.30	23.75	
6	Bottom Dish Head - Loc 3	23.82	23.98	23.50	23.90	23.50	23.98	23.80	
7	Shell Course - 1	22.83	23.30	24.02	23.98	22.83	24.02	23.53	
8	Shell Course - 2	23.45	24.10	23.89	24.18	23.45	24.18	23.91	



Leads Address : Leads Specialist Services Pte Ltd, Platinum@Pioneer, 32F Tuas Ave 11, Singapore 636855

Inspected By (Signature)	Approved By (Signature)	NDT Levell III	CLIENT REP. (Signature)
AL-MAHMUD 06-05-2023	B. CHINNADURAI 06-05-2023	P. RAJESH 06-05-2023	

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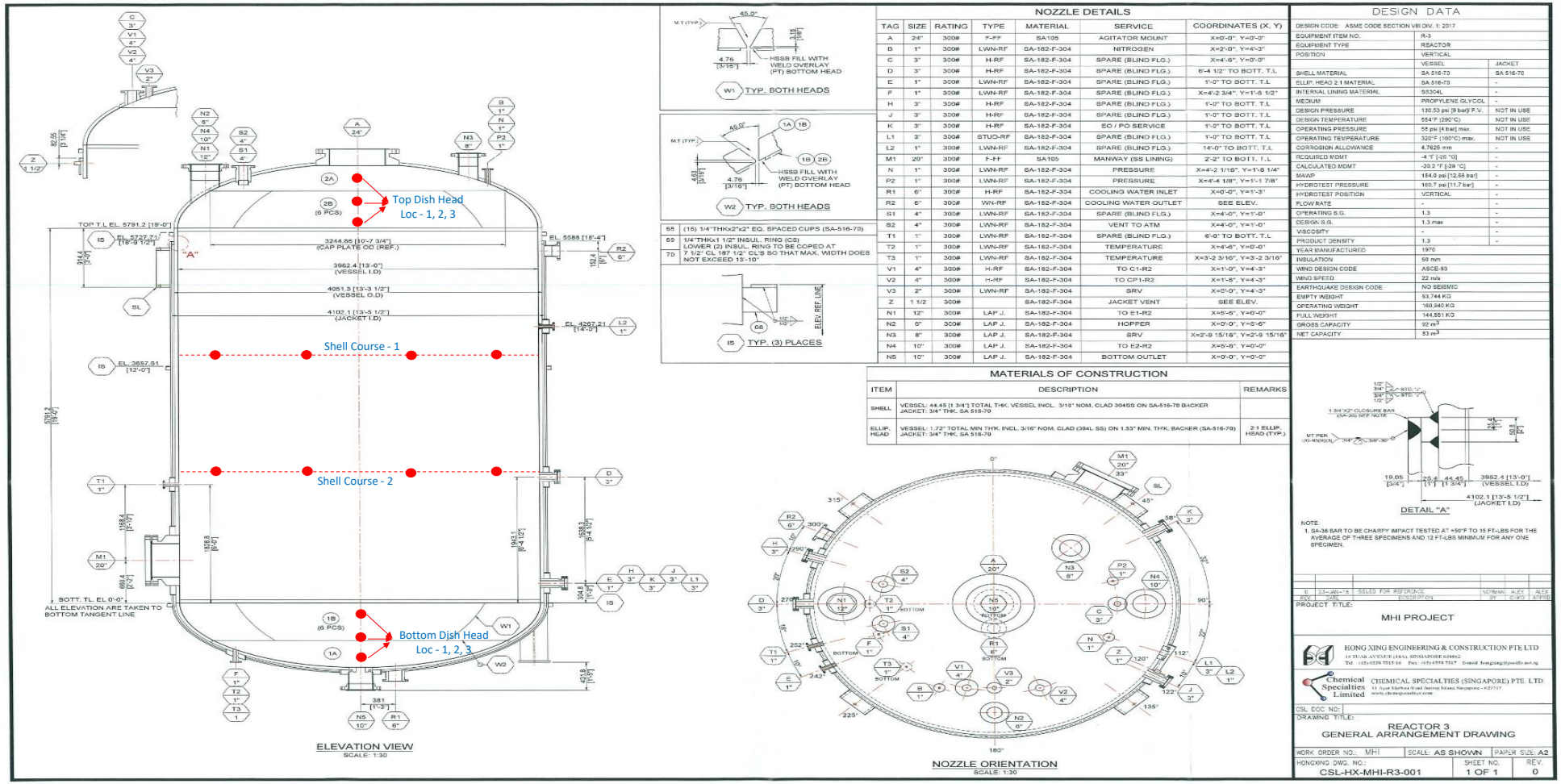
2.The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council.
3.Leads stand no responsibilities for changes in the quality of the same product tested in later stage with same variables but different conditions.

ULTRASONIC THICKNESS GAUGING REPORT

Accredited Laboratory SAC-SINGLAS LA-2016-0616-D

Client	: Chemical Specialties (Singapore) Pte Ltd	Report No.	: LEADS-23-CSL-UTG-015
Client Address	: 31 Ayer Merbau Rd, Singapore 627717	Inspection Date	: 05-05-2023
Project Name.	: R3 - Reactor	Report Date	: 06-05-2023
Location	: 31 Ayer Merbau Rd	Leads Ref No.	: LSS/23-05/029
Item Description	: R3 - Reactor	Client Request No.	: NA

UTG LOCATION MARKING



5.0 Equipment and Personnel Certificates

5.1 Equipment Calibration

5.2 Personnel Certification

5.1 Equipment Calibration

DIGITAL ULTRASONIC THICKNESS GAUGE CALIBRATION CERTIFICATE

Calibration Certificate No : LEADS-23-UTG-04

Date of Calibration : 29/12/2022

Client : LEADS

Equipment Details

Model & Make : 38DL PLUS & OLYMPUS

Product : DIGITAL ULTRASONIC THICKNESS GAUGE

Serial No : 193390803

Ambient Temperature : (24±2) ° C

Relative Humidity : (35 to 70) % RH

Calibration Accessories

Block Serial No : 5 Step Block

Certificate No. : BLD1903901-1S

This is to certify that the above instruments having serial no. 193390803 has been calibrated Under the ambient Conditions Stated according calibration Procedure ISO 16831:2012 the UTG was calibrated by comparison with a reference Calibration block the reference Standards are traceable to National Standards.

Calibration Date: 29/12/2022

Calibrated by

Name : M. Bharath

Signature :

Date : 29-12-2022

Calibration Due Date: 28/12/2023

Approved By

Name : P.Rajesh

Signature :

Date : 29-12-2022

S/No.	Reference Readings	Test Readings	Deviation	Results
1	12.5 mm	12.52	+0.02	Passed
2	10.0 mm	10.00	0.00	Passed
3	7.5 mm	7.51	+0.01	Passed
4	5.0 mm	5.02	+0.02	Passed
5	2.5 mm	2.52	+0.02	Passed

The expanded Uncertainty of measurement found to be 0. 02 mm at Confidence level is approximately 95% with coverage factor K = 2

Leads Specialist Services Pte Ltd
32F Platinum @ Pioneer
Singapore 636855

5.2 Personnel Certification

API INDIVIDUAL CERTIFICATION PROGRAMS

ANAB
ANSI National Accreditation Board
ACCREDITED
ISO/IEC 17024
PERSONNEL CERTIFICATION BODY

verifies that

Peramaiyan Rajesh

HAS MET THE ESTABLISHED AND PUBLISHED REQUIREMENTS FOR API CERTIFICATION AS AN

API 510 PRESSURE VESSEL INSPECTOR

IN ACCORDANCE WITH THE KNOWLEDGE DEFINED IN THE **API Standard 510**

CERTIFICATION NUMBER **61416**

ORIGINAL CERTIFICATION DATE	September 30, 2015
CURRENT CERTIFICATION DATE	September 30, 2021
EXPIRATION DATE	September 30, 2024

Director, Individual Certification Programs

API | ICP

NDT CERTIFICATION

Certificate Reference No: LEADS-IMSC-NDTC-048
Date of Issue: 29/01/2020
Date of Expiry: 28/01/2025

This is to certify and authorize **Al Mahmud Mohammad (G2712531Q)** Represent Leads Specialist Services Pte. Ltd, to work in the following NDT methods, as he satisfactorily met the qualification and certification requirements of company written practice LEADS-IMSP-0029 Rev 02, which is based on ASNT RP No SNT-TC-1A 2016 Ed.

Method	NDT Level	Scope/Sectors/Categories
Magnetic Particle Inspection	**Level II**	**Electromagnetic yoke, Visible/ Fluorescent, Dry/ Wet Particles**
Ultrasonic Test	**Level II**	**Flaw Detection**
Liquid Penetrant Inspection	**Level II**	**Visible/ Fluorescent**
Ultrasonic Thickness Gauging	**Level II**	**A Scan Thickness & Spot Measurement**
Radiography Test	**Level II**	**Radiography**

This record is only evidence of competence when supported by the following evidence a specified by the minimum requirements of leads specialist services pte ltd competence management system

- Valid eye test
- Prior experience
- Examination
- No Interrupted Services of the respective NDT Methods with the previous 6 months

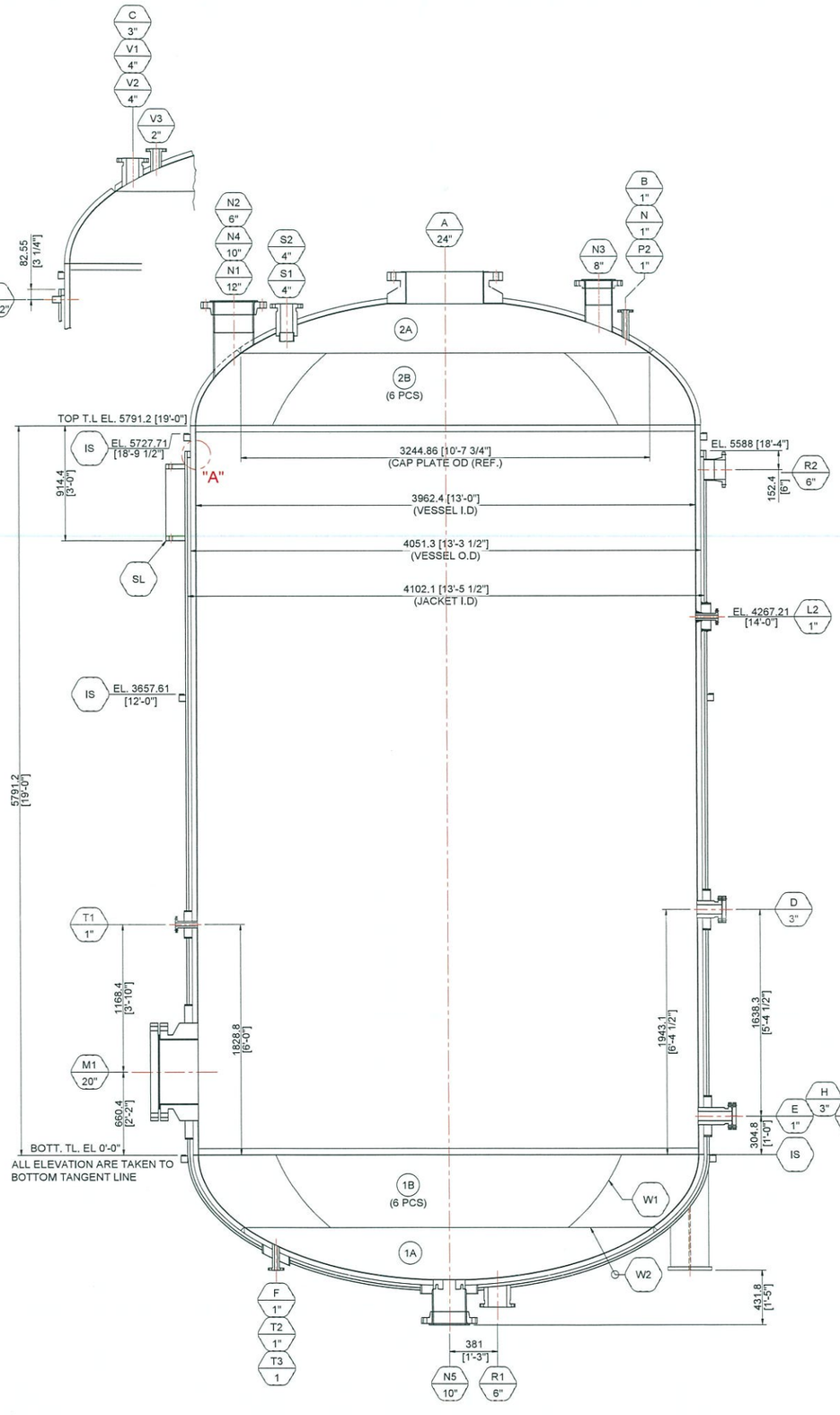
This inspector has meet lead's requirements for the respective methods: this record is only valid during employment with Leads Specialist services pte ltd

This document is uncontrolled if printed: authorization history can be provided on demand

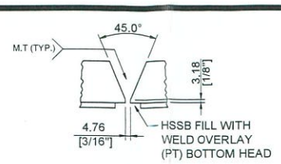
Authorized by	Position	Date	Signature
P. Sudhan	Operation Manager	29/01/2020	
Sengottaian Velmurugan	ASNT Level III	29/01/2020	

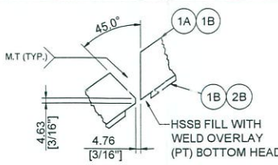
LEADS SPECIALIST SERVICES PTE LTD
NO.2 TUAS SOUTH AVE 2
SINGAPORE 637601
ops@leads1.com/www.leads1.com

6.0 General Arrangement Drawing

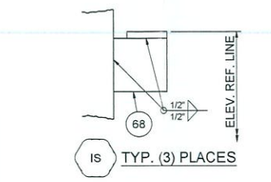


ELEVATION VIEW
SCALE: 1:30





68	(16) 1/4"THKx2"x2" EQ. SPACED CUPS (SA-516-70)
69	1/4"THKx1 1/2" INSUL. RING (CS) LOWER (2) INSUL. RING TO BE COPED AT 7 1/2° CL 187 1/2° CL'S SO THAT MAX. WIDTH DOES NOT EXCEED 13'-10"
70	

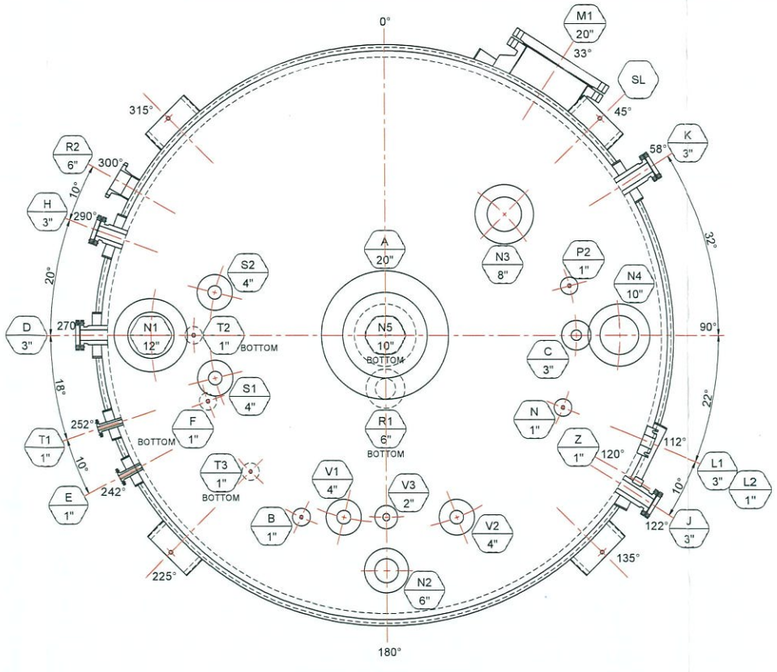


NOZZLE DETAILS

TAG	SIZE	RATING	TYPE	MATERIAL	SERVICE	COORDINATES (X, Y)
A	24"	300#	F-FF	SA105	AGITATOR MOUNT	X=0'-0", Y=0'-0"
B	1"	300#	LWN-RF	SA-182-F-304	NITROGEN	X=2'-0", Y=4'-3"
C	3"	300#	H-RF	SA-182-F-304	SPARE (BLIND FLG.)	X=4'-6", Y=0'-0"
D	3"	300#	H-RF	SA-182-F-304	SPARE (BLIND FLG.)	6'-4 1/2" TO BOTT. T.L
E	1"	300#	LWN-RF	SA-182-F-304	SPARE (BLIND FLG.)	1'-0" TO BOTT. T.L
F	1"	300#	LWN-RF	SA-182-F-304	SPARE (BLIND FLG.)	X=4'-2 3/4", Y=1'-6 1/2"
H	3"	300#	H-RF	SA-182-F-304	SPARE (BLIND FLG.)	1'-0" TO BOTT. T.L
J	3"	300#	H-RF	SA-182-F-304	SPARE (BLIND FLG.)	1'-0" TO BOTT. T.L
K	3"	300#	H-RF	SA-182-F-304	EO / PO SERVICE	1'-0" TO BOTT. T.L
L1	3"	300#	STUD-RF	SA-182-F-304	SPARE (BLIND FLG.)	1'-0" TO BOTT. T.L
L2	1"	300#	LWN-RF	SA-182-F-304	SPARE (BLIND FLG.)	14'-0" TO BOTT. T.L
M1	20"	300#	F-FF	SA105	MANWAY (SS LINING)	2'-2" TO BOTT. T.L
N	1"	300#	LWN-RF	SA-182-F-304	PRESSURE	X=4'-2 1/16", Y=1'-8 1/4"
P2	1"	300#	LWN-RF	SA-182-F-304	PRESSURE	X=4'-4 1/8", Y=1'-1 7/8"
R1	6"	300#	H-RF	SA-182-F-304	COOLING WATER INLET	X=0'-0", Y=1'-3"
R2	6"	300#	WN-RF	SA-182-F-304	COOLING WATER OUTLET	SEE ELEV.
S1	4"	300#	LWN-RF	SA-182-F-304	SPARE (BLIND FLG.)	X=4'-0", Y=1'-0"
S2	4"	300#	LWN-RF	SA-182-F-304	VENT TO ATM	X=4'-0", Y=1'-0"
T1	1"	300#	LWN-RF	SA-182-F-304	SPARE (BLIND FLG.)	6'-0" TO BOTT. T.L
T2	1"	300#	LWN-RF	SA-182-F-304	TEMPERATURE	X=4'-6", Y=0'-0"
T3	1"	300#	LWN-RF	SA-182-F-304	TEMPERATURE	X=3'-2 3/16", Y=3'-2 3/16"
V1	4"	300#	H-RF	SA-182-F-304	TO C1-R2	X=1'-0", Y=4'-3"
V2	4"	300#	H-RF	SA-182-F-304	TO CP1-R2	X=1'-8", Y=4'-3"
V3	2"	300#	LWN-RF	SA-182-F-304	SRV	X=0'-0", Y=4'-3"
Z	1 1/2	300#		SA-182-F-304	JACKET VENT	SEE ELEV.
N1	12"	300#	LAP J.	SA-182-F-304	TO E1-R2	X=5'-6", Y=0'-0"
N2	6"	300#	LAP J.	SA-182-F-304	HOPPER	X=0'-0", Y=5'-6"
N3	8"	300#	LAP J.	SA-182-F-304	SRV	X=2'-9 15/16", Y=2'-9 15/16"
N4	10"	300#	LAP J.	SA-182-F-304	TO E2-R2	X=5'-6", Y=0'-0"
N5	10"	300#	LAP J.	SA-182-F-304	BOTTOM OUTLET	X=0'-0", Y=0'-0"

MATERIALS OF CONSTRUCTION

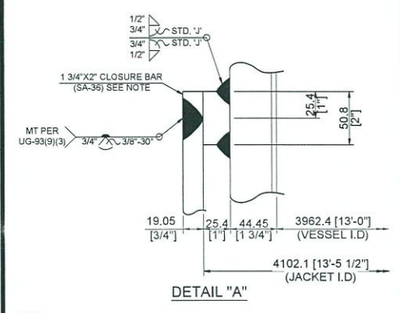
ITEM	DESCRIPTION	REMARKS
SHELL	VESSEL: 44.45 [1 3/4"] TOTAL THK. VESSEL INCL. 3/16" NOM. CLAD 304SS ON SA-516-70 BACKER JACKET: 3/4" THK. SA 516-70	
ELLIP. HEAD	VESSEL: 1.72" TOTAL MIN THK. INCL. 3/16" NOM. CLAD (304L SS) ON 1.53" MIN. THK. BACKER (SA-516-70) JACKET: 3/4" THK. SA 516-70	2:1 ELLIP. HEAD (TYP.)



NOZZLE ORIENTATION
SCALE: 1:30

DESIGN DATA

DESIGN CODE: ASME CODE SECTION VIII DIV. 1: 2017		
EQUIPMENT ITEM NO.	R-3	
EQUIPMENT TYPE	REACTOR	
POSITION	VERTICAL	
	VESSEL	JACKET
SHELL MATERIAL	SA 516-70	SA 516-70
ELLIP. HEAD 2:1 MATERIAL	SA 516-70	-
INTERNAL LINING MATERIAL	SS304L	-
MEDIUM	PROPYLENE GLYCOL	-
DESIGN PRESSURE	130.53 psi [9 bar]/ F.V.	NOT IN USE
DESIGN TEMPERATURE	554°F (290°C)	NOT IN USE
OPERATING PRESSURE	58 psi [4 bar] max.	NOT IN USE
OPERATING TEMPERATURE	320°F (160°C) max.	NOT IN USE
CORROSION ALLOWANCE	4.7625 mm	-
REQUIRED MDMT	-4 °F [-20 °C]	-
CALCULATED MDMT	-20.2 °F [-29 °C]	-
MAWP	184.0 psi [12.68 bar]	-
HYDROTEST PRESSURE	169.7 psi [11.7 bar]	-
HYDROTEST POSITION	VERTICAL	-
FLOW RATE	-	-
OPERATING S.G.	1.3	-
DESIGN S.G.	1.3 max	-
VISCOSITY	-	-
PRODUCT DENSITY	1.3	-
YEAR MANUFACTURED	1970	
INSULATION	50 mm	
WIND DESIGN CODE	ASCE-93	
WIND SPEED	22 m/s	
EARTHQUAKE DESIGN CODE	NO SEISMIC	
EMPTY WEIGHT	53,744 KG	
OPERATING WEIGHT	160,940 KG	
FULL WEIGHT	144,881 KG	
GROSS CAPACITY	92 m^3	
NET CAPACITY	83 m^3	



DETAIL "A"

NOTE:
1. SA-36 BAR TO BE CHARPY IMPACT TESTED AT +50°F TO 15 FT-LBS FOR THE AVERAGE OF THREE SPECIMENS AND 12 FT-LBS MINIMUM FOR ANY ONE SPECIMEN.

REV.	DATE	DESCRIPTION	BY	CHKD	APPRD
0	23-JAN-18	ISSUED FOR REFERENCE	NORMAN	ALEX	ALEX

PROJECT TITLE:

MHI PROJECT

HONG XING ENGINEERING & CONSTRUCTION PTE LTD
14 TUAS AVENUE (18A), SINGAPORE 638862
Tel : (65) 6558 7515/16 Fax : (65) 6558 7517 E-mail hongxing@pacific.net.sg

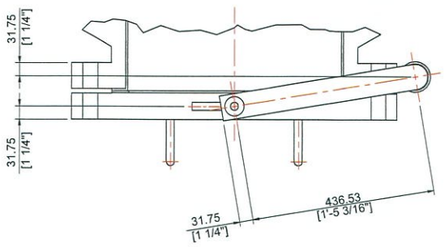
Chemical Specialties Limited
CHEMICAL SPECIALTIES (SINGAPORE) PTE. LTD.
31 Ayer Merbau Road Jurong Island Singapore - 627717
www.chemspecialties.com

CSL DOC NO:

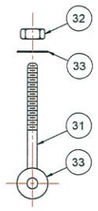
DRAWING TITLE:

REACTOR 3
GENERAL ARRANGEMENT DRAWING

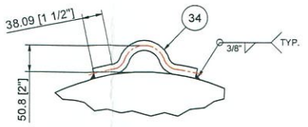
WORK ORDER NO.: MHI	SCALE: AS SHOWN	PAPER SIZE: A2
HONGXING DWG. NO.: CSL-HX-MHI-R3-001	SHEET NO. 1 OF 1	REV. 0



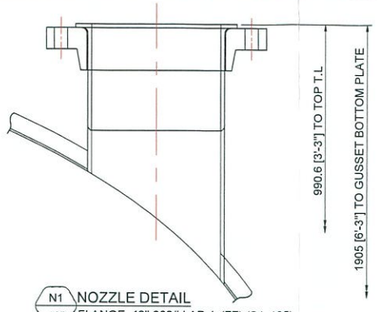
31	3/4" Ø STD. ROD END (CS)
32	3/4" -10UNC HEX. NUT (CS)
33	3/4" STD. WASHER (CS)
34	3/4" Ø ROD (CS)



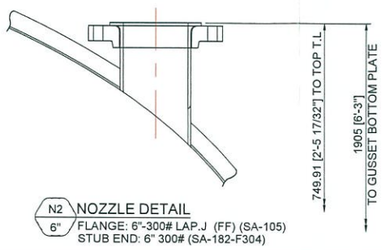
IB DETAIL



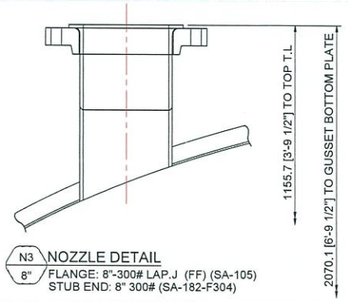
LR DETAIL



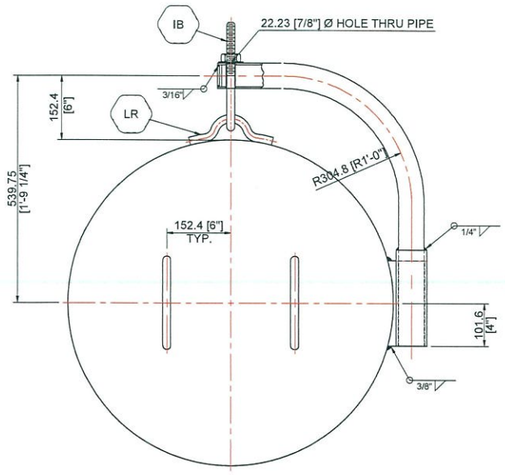
N1 / 12" NOZZLE DETAIL
FLANGE: 12"-300# LAP.J (FF) (SA-105)
STUB END: 12" 300# (SA-182-F304)



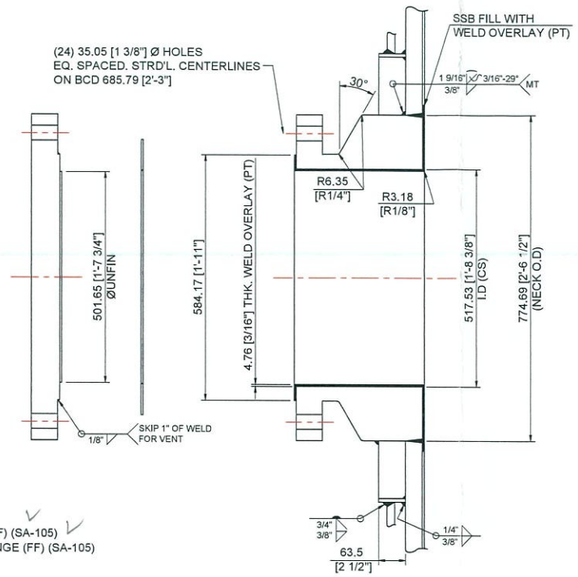
N2 / 6" NOZZLE DETAIL
FLANGE: 6"-300# LAP.J (FF) (SA-105)
STUB END: 6" 300# (SA-182-F304)



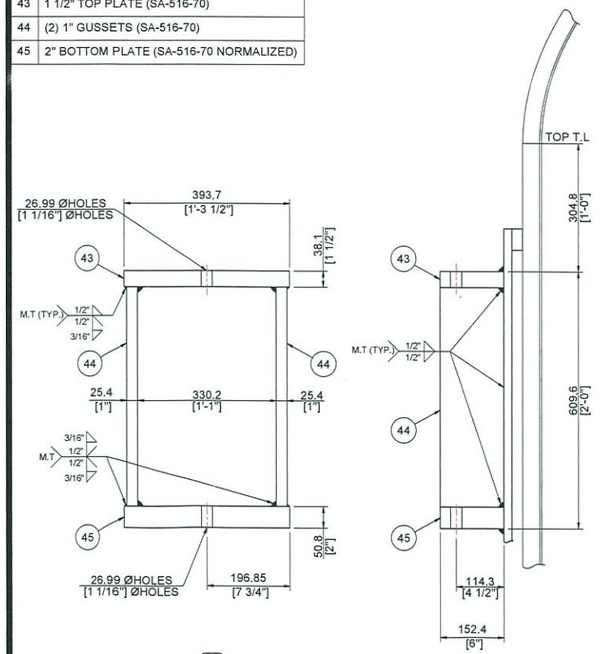
N3 / 8" NOZZLE DETAIL
FLANGE: 8"-300# LAP.J (FF) (SA-105)
STUB END: 8" 300# (SA-182-F304)



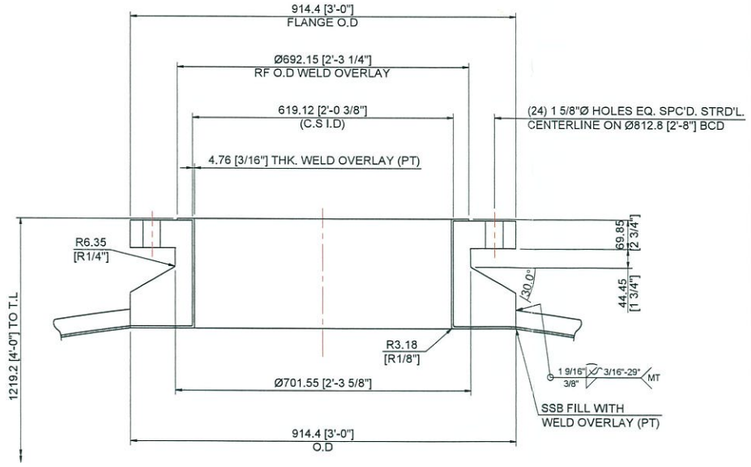
M1 / 20" MANHOLE DETAIL
FLANGE: 20"-300# TYPE 'F' (FF) (SA-105)
COVER: 20"-300# BLIND FLANGE (FF) (SA-105)



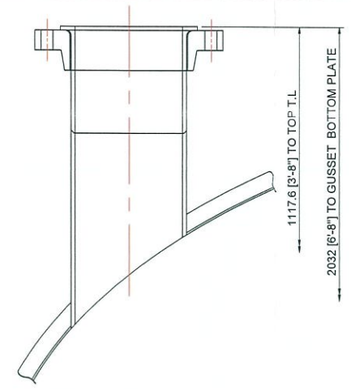
43	1 1/2" TOP PLATE (SA-516-70)
44	(2) 1" GUSSETS (SA-516-70)
45	2" BOTTOM PLATE (SA-516-70 NORMALIZED)



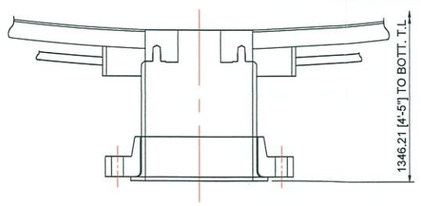
SL GUSSET LUG DETAIL (4) REQ'D.



A / 24" NOZZLE DETAIL
FLANGE: 24"-300# TYPE 'F' (SA-105)



N4 / 10" NOZZLE DETAIL
FLANGE: 10"-300# LAP.J (FF) (SA-105)
STUB END: 10" 300# (SA-182-F304)



N5 / 10" NOZZLE DETAIL
FLANGE: 10"-300# LAP.J (FF) (SA-105)
STUB END: 10" 300# (SA-182-F304)

REV.	DATE	DESCRIPTION	BY	CHKD	APPRD
0	23-JAN-18	ISSUED FOR REFERENCE	NORMAN	ALEX	ALEX

PROJECT TITLE:

MHI PROJECT

MANUFACTURE:

HONG XING ENGINEERING & CONSTRUCTION PTE LTD
14 TUAS AVENUE (18A), SINGAPORE 638862
Tel : (65) 6558 7515/16 Fax: (65) 6558 7517 E-mail :hongxing@pacific.net.sg

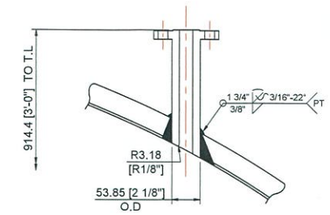
Chemical Specialties Limited
CHEMICAL SPECIALTIES LIMITED
31 Ayer Merbau Road Jurong Island Singapore - 627717
www.chemspecialties.com

CSL DOC NO:

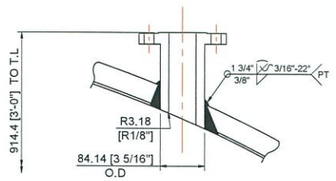
DRAWING TITLE:

REACTOR 3
NOZZLE DETAIL DRAWING (SHT 2 OF 2)

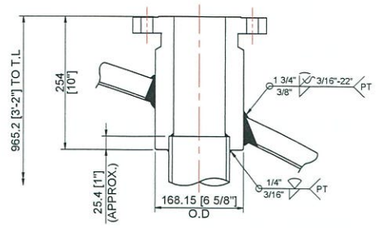
WORK ORDER NO.: MHI	SCALE: 1:10	PAPER SIZE: A2
HONGXING DWG. NO.: CSL-HX-MHI-R3-003	SHEET NO. 1 OF 1	REV. 0



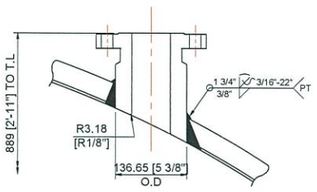
B 1" N 1" P2 1" NOZZLE DETAIL
FLANGE: 1"-300# LWN (RF) (SA-182-F304)



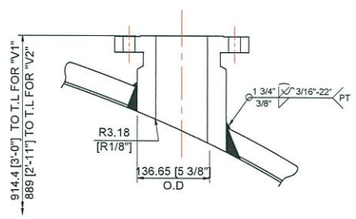
V3 2" NOZZLE DETAIL
FLANGE: 2"-300# LWN (RF) (SA-182-F304)



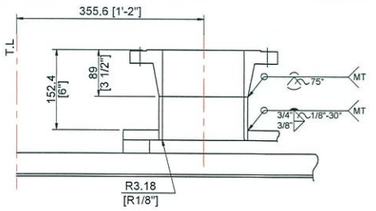
S1 4" S2 4" NOZZLE DETAIL
FLANGE: 4"-300# TYPE 'H' (RF) (SA-182-F304)
(3.83" BORE)



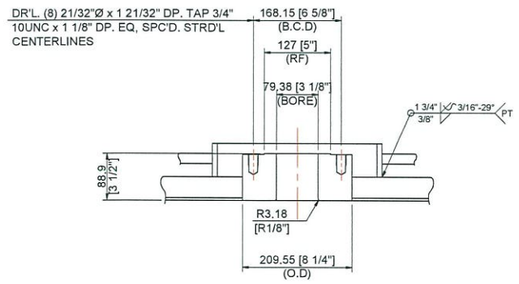
C 3" NOZZLE DETAIL
FLANGE: 3"-300# TYPE 'H' (RF) (SA-182-F304)
(2.9" BORE)



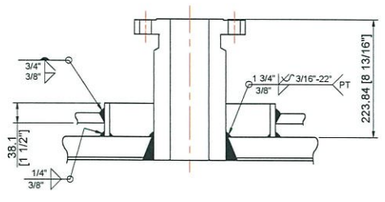
V1 4" V2 4" NOZZLE DETAIL
FLANGE: 4"-300# TYPE 'H' (RF) (SA-182-F304)
(3.83" BORE)



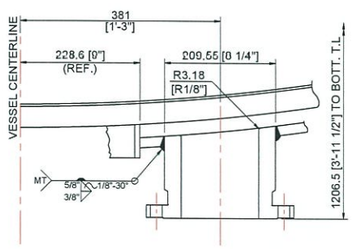
R2 6" NOZZLE DETAIL
FLANGE: 6"-150# WN (RF) (SA-105)
NECK: 6" XX-STRONG PIPE (SA-106-B)



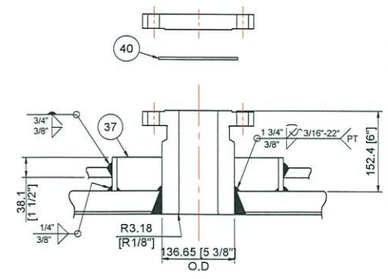
L1 3" NOZZLE DETAIL
FLANGE: 3"-300# STUDDING OUTLET (RF) (SA-182-F304)



J 3" K 3" NOZZLE DETAIL
FLANGE: 3"-300# TYPE 'H' (RF) (SA-182-F304)
(2.9" BORE)
COVER: 3"-300# BLIND FLANGE (RF) (SA-182-F304)

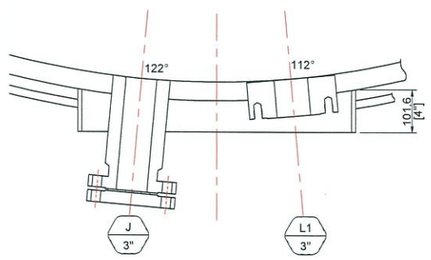


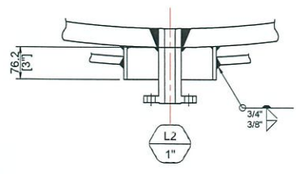
R1 6" NOZZLE DETAIL
FLANGE: 6"-150# TYPE 'H' (RF) (SA-105)
(5.76" BORE)

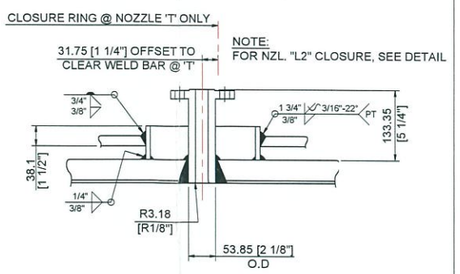


D 3" H 3" NOZZLE DETAIL
FLANGE: 3"-300# TYPE 'H' (RF) (SA-182-F304)
(2.9" BORE)
COVER: 3"-300# BLIND FLANGE (RF) (SA-182-F304)

37	12" STD. WT. PIPE 0.375 WALL (SA-106-B)
38	(8) 3/4"-10UNC x 4 1/2"LG. STUDS (SA-106-B7)
39	(16) 3/4"-10UNC NUTS (SA-194-2H)
40	0.175 THK. x 3"-300# SPIRAL WOUND GASKET (304/COMP. FIBER) WITH 0.125" THK. OUTER GAUGE RING (CS)

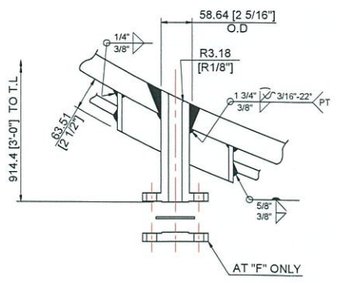






L2 1" E 1" T1 1" NOZZLE DETAIL
FLANGE: 1"-300# LWN (RF) (SA-182-F304)

41	8" STD. WT. PIPE (SA-106-B)



F 1" T2 1" T3 1" NOZZLE DETAIL
FLANGE: 1"-300# LWN (RF) (SA-182-F304)

REV.	DATE	DESCRIPTION	BY	CHKD	APPRD
0	23-JAN-18	ISSUED FOR REFERENCE	NORMAN	ALEX	ALEX

PROJECT TITLE:

MHI PROJECT

MANUFACTURE:

HONG XING ENGINEERING & CONSTRUCTION PTE LTD
14 TUAS AVENUE (18A), SINGAPORE 638862
Tel : (65) 6558 7515/16 Fax : (65) 6558 7517 E-mail :hongxing@pacific.net.sg

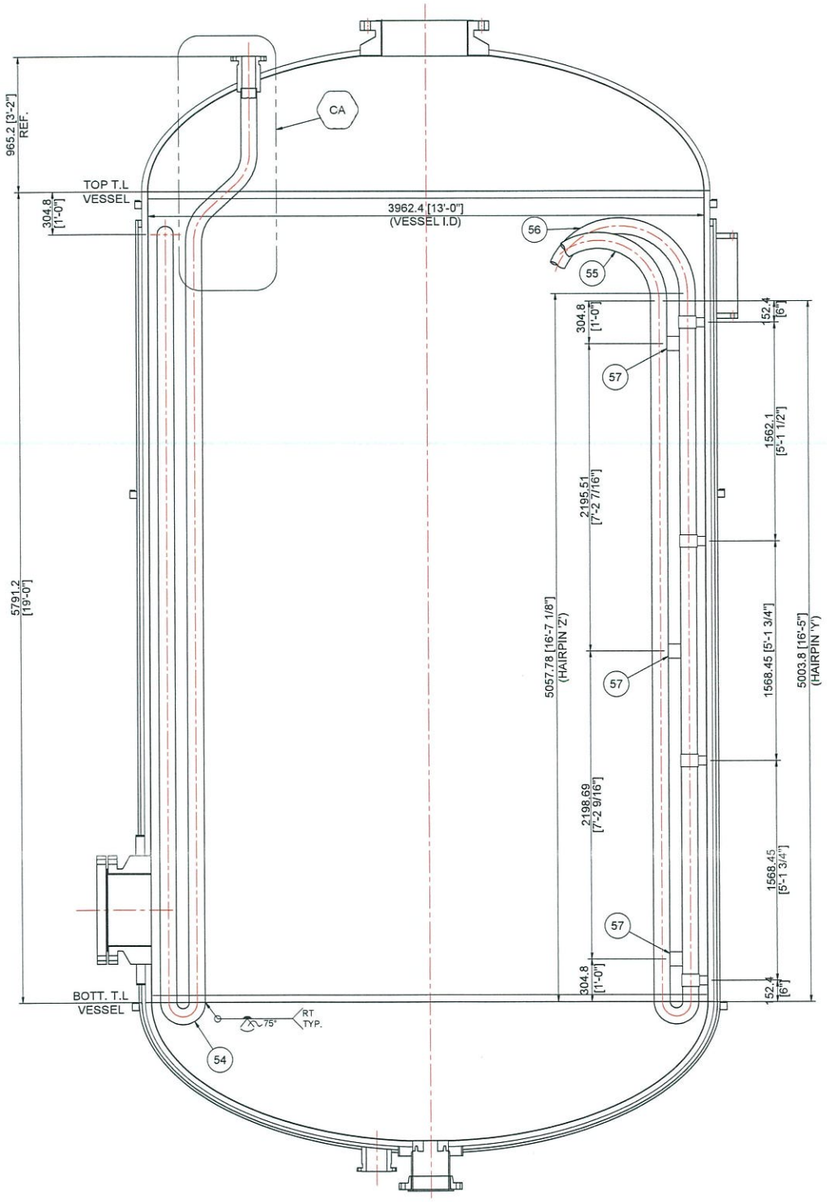
Chemical Specialties Limited
CHEMICAL SPECIALTIES LIMITED
31 Ayer Merbau Road Jurong Island Singapore - 627717
www.chemspecialties.com

CSL DOC NO:

DRAWING TITLE:

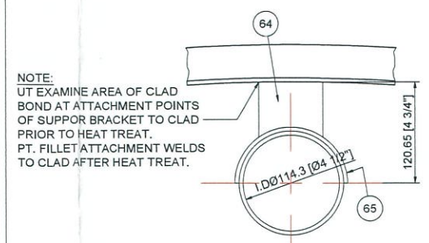
REACTOR 3
NOZZLE DETAIL DRAWING (SHT 1 OF 2)

WORK ORDER NO.: MHI	SCALE: 1:8	PAPER SIZE: A2
HONGXING DWG. NO.: CSL-HX-MHI-R3-002	SHEET NO. 1 OF 1	REV. 0

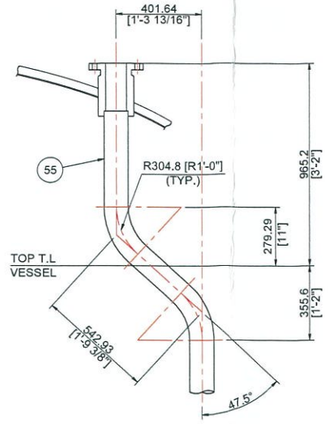


ELEVATION VIEW

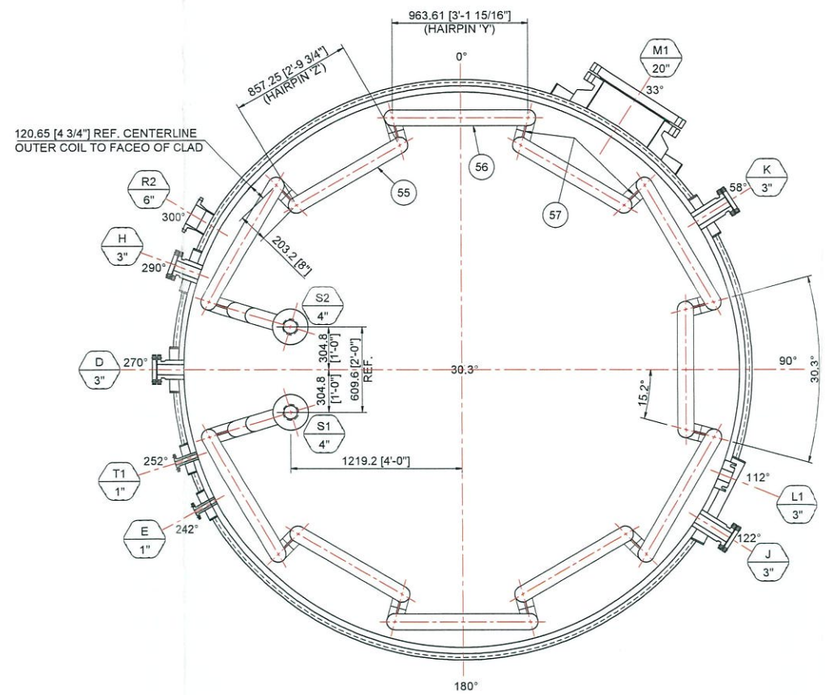
64	1/4 x 3 x 3 (304SS)
65	3/16" PLATE x 3 1/2" WD. (SA-240-304)



CS (12) REQ'D. (1) PER COIL



CA TYP. FOR S1 & S2



NOZZLE ORIENTATION

53	(2) 4" STD. WT. PIPE (SA-312TP-304)
54	(12) 4" STD. WT. S.R 180° RETURN (SA-403-304)
55	(5) 4" STD. WT. 180° RETURN (2'-9 3/4" CENTERLINE DIA.) (SA-312TP-304)
56	(6) 4" STD. WT. 180° RETURN (3'-1 15/16" CENTERLINE DIA.) (SA-312TP-304)
57	(36) 1/2" THK. x 4" WD. CLIPS (SA-240-304)

REV.	DATE	DESCRIPTION	BY	CHKD	APPRD
0	10-JAN-18	ISSUED FOR REFERENCE	NORMAN	ALEX	ALEX

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MHI PROJECT

MANUFACTURE:

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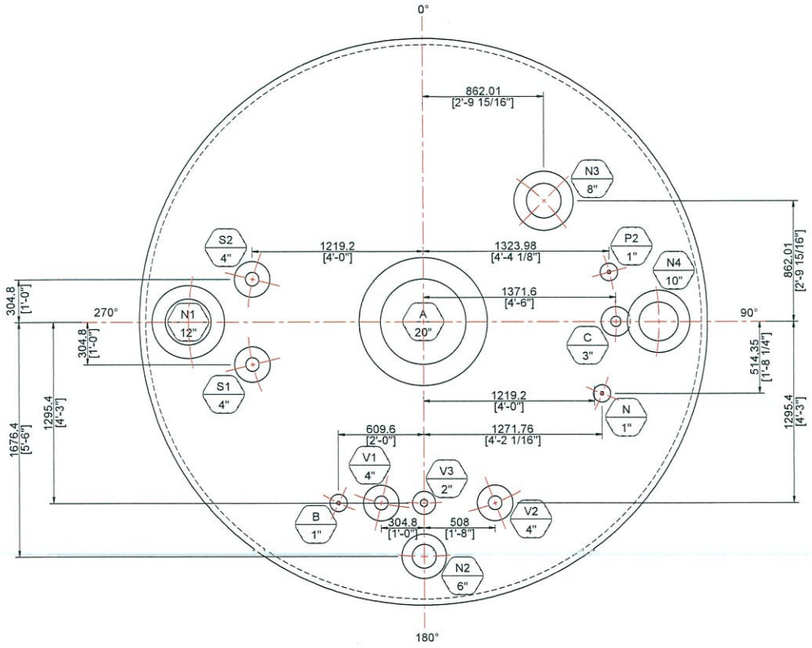
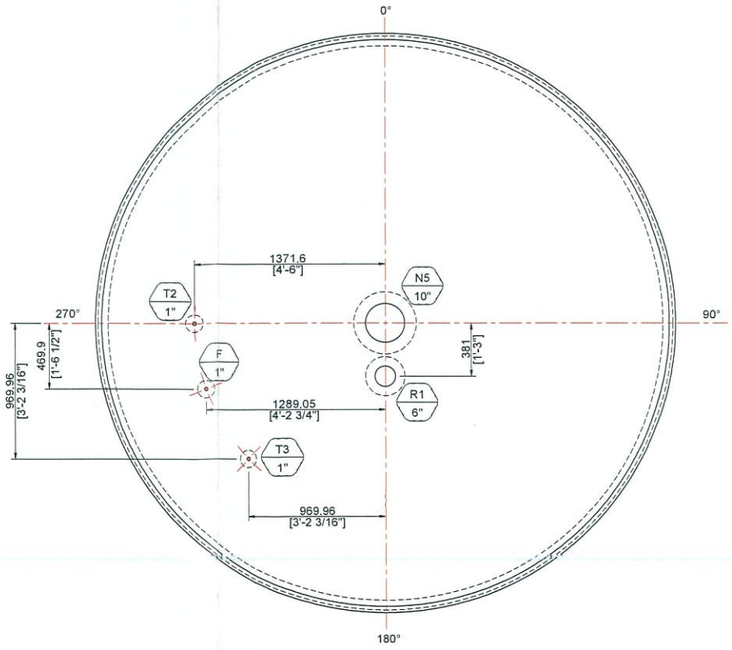
CSL DOC NO:

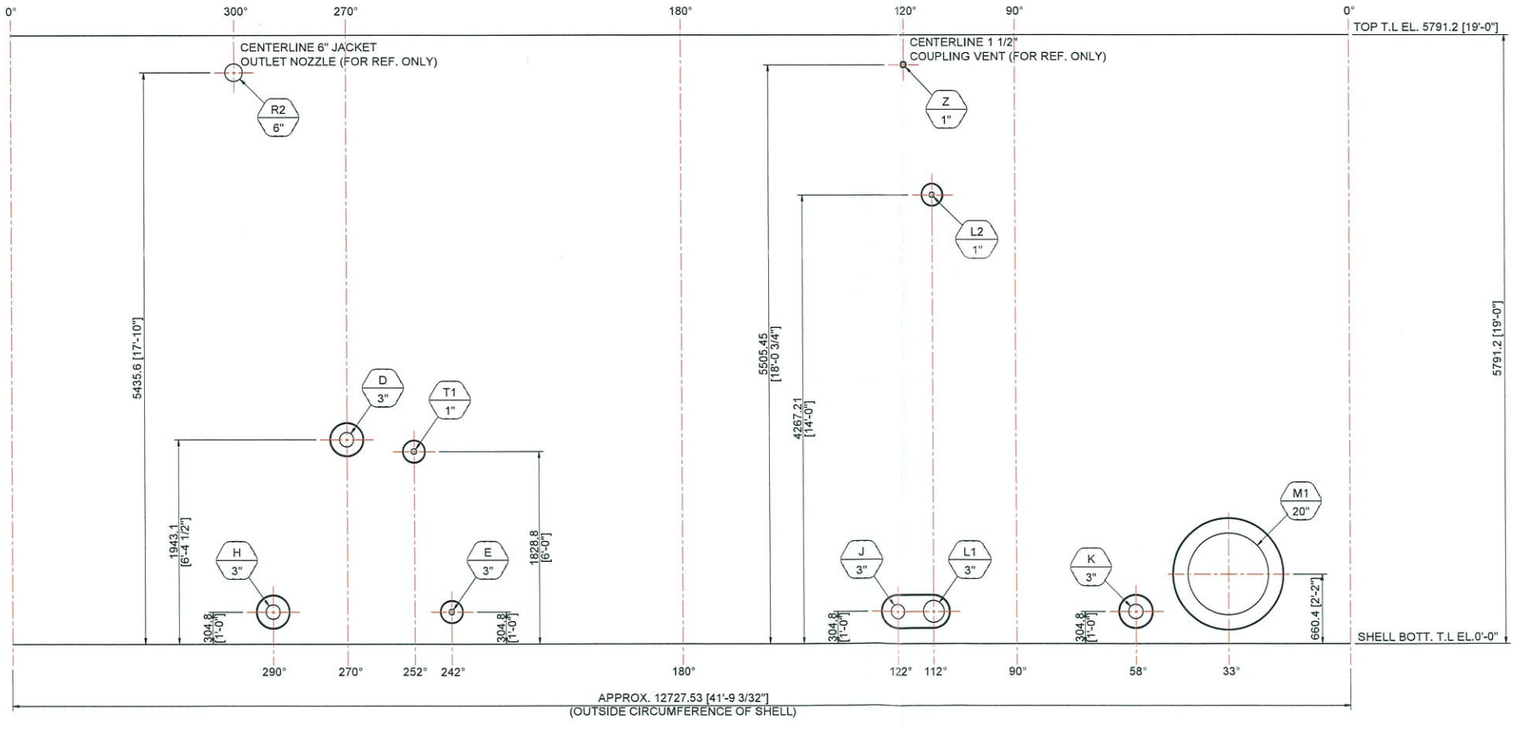
DRAWING TITLE:

REACTOR 3
INTERNAL DETAIL DRAWING

WORK ORDER NO.: MHI	SCALE: AS SHOWN	
HONGXING DWG. NO.: CSL-HX-MHI-R3-004	SHEET NO. 1 OF 1	REV. 0







ELEVATION VIEW

REV.	DATE	DESCRIPTION	BY	CHKD	APPRD
0	10-JAN-18	ISSUED FOR REFERENCE	NORMAN	ALEX	ALEX

PROJECT TITLE:

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CSL DOC NO:

DRAWING TITLE:

REACTOR 3
DEVELOPMENT DRAWING

WORK ORDER NO.: MHI	SCALE: AS SHOWN	
HONGXING DWG. NO.: CSL-HX-MHI-R3-005	SHEET NO. 1 OF 1	REV. 0