OIL & GAS DEVELOPMENT COMPANY LIMITED
PROCUREMENT DEPARTMENT (LOCAL), ISLAMABAD
SCHEDULE OF REQUIREMENT

Due Date:

Material :**DISMANTLING OF OLD TANK,REPAIR/RECONSTRUCTION OF CIVIL FOUNDATION & CONSTRUCTION,TESTING,INSTALLATION,COMMISSIONING & CALIBRATION OF NEW TANK**

Bid Bond Value : RS.1,200,000/-

Attachment(if any) : YES

Tender Enquiry No: **PROC/LF/PT/17917/2020**

EVALUATION WILL BE CARRIED OUT ON FULL

Sr No	Description	Quantity	Make/Brand offered	Unit	Unit Price (PKR) Inclusive Of All Taxes Except GST/PST	Unit Price (PKR) Inclusive of GST/PST	Total Price (PKR) Inclusive of GST/PST	Delivery Period Offered	deviation from Tender Spec. If Any
1	DISMANTLING OF OLD CRUDE STORAGE TANK, CAPACITY 6000 BBL'S, DETAIL SPECIFICATION ATTACHTED AT ANNEXURE 'A'.	1		Number					
2	REPAIR OF CIVIL FOUNDATION OF CRUDE STORAGE TANK CAPACITY 6000 BBL'S, DETAIL SPECIFICATION ATTACHTED AT ANNEXURE 'A' (IF REQUIRED AFTER INSPECTION).	1		Number					
3	RECONSTRUCTION OF CIVIL FOUNDATION OF CRUDE STORAGE TANK CAPACITY 6000 BBL'S, DETAIL SPECIFICATION ATTACHTED AT ANNEXURE 'A' (IF REQUIRED AFTER INSPECTION).	1		Number					
4	CONSTRUCTION OF NEW CRUDE STORAGE TANK, CAPACITY 6000 BBL'S, DETAIL SPECIFICATION ATTACHTED AT ANNEXURE 'A'.	1		Number					

Special Note: The prospective bidders also download the master set of Tender Document
- The prospective bidders may keep in touch with OGDCL web site for downloading the clarifications/amendments (if any) issued by OGDCL.
- BID VALIDITY 180 DAYS FROM TECHNICAL BID OPENING.PAYMENT TERMS AS PER CLAUSE NO.16.2. OF ANNEXURE A.

COMPLETION PERIOD 180 DAYS AS PER CLAUSE NO.15 ON FOR KUNNER FIELD BASIS, HYDERABAD FROM LPO ISSUE DATE.

Discount (if any) shall only be entertained on Schedule of Requirement of Bidding Document (Financial Proposal). If the discount is mentioned elsewhere in the bid, the same shall not be entertained.

OIL & GAS DEVELOPMENT COMPANY LIMITED
PROCUREMENT DEPARTMENT (LOCAL), ISLAMABAD
SCHEDULE OF REQUIREMENT

Mandatory Checklist

Please confirm the compliance of the following mandatory information along with the bid(s) (failing which bids(s) will not be accepted)

Documents	To be Attached with the Technical/Financial Bids	Compliance	
Original Bid Bond	Technical Bid	Yes ☐	No ☐
Copy of NTN Certificate	Technical Bid	Yes ☐	No ☐
Copy of GST Certificate	Technical Bid	Yes ☐	No ☐
Confirmation that the Firm is appearing on FBR's Active Taxpayer List	Technical Bid	Yes ☐	No ☐
Duly signed and stamped **Annexure–A (Un–priced)**	Technical Bid	Yes ☐	No ☐
Duly filled, signed and stamped **Annexure–B**	Technical Bid	Yes ☐	No ☐
Duly filled, signed and stamped **Annexure–D**	Technical Bid	Yes ☐	No ☐
Duly filled, signed and stamped **Annexure–L** on Company's Letterhead	Technical Bid	Yes ☐	No ☐
Duly signed and stamped **Annexure–M** on Company's Letterhead	Technical Bid	Yes ☐	No ☐
Duly signed and stamped **Annexure–N** on Non–Judicial Stamp Paper duly attested by Notary Public	Technical Bid	Yes ☐	No ☐
Duly filled, signed and stamped **Annexure–A (Priced)**	Financial Bid	Yes ☐	No ☐
Duly filled, signed and stamped **Annexure–C**	Financial Bid	Yes ☐	No ☐
Duly filled, signed and stamped **Annexure–E**	Financial Bid	Yes ☐	No ☐

OIL & GAS DEVELOPMENT COMPANY LIMITED
PROCUREMENT DEPARTMENT (LOCAL), ISLAMABAD
SCHEDULE OF REQUIREMENT

For the Vendors/Contractors who opt to submit Bank Draft/Call Deposit/Pay order against Bid Bond/Performance Bond, our Accounts Department has finalized an arrangement for online payment to such Vendors/Contractors, which will be processed through (IBFT & LFT) for which following information is required:

i.	IBAN No. (International Bank Account Number 24 Digits)	
ii.	Vendor Name as per Title of their Bank Account	
iii.	Contact No.of Company's CEO/ Owner (Mobile & Landline)	
iv.	Bank Name.	
v.	Bank Branch Name and Code	

Name, Sign and Stamp of the authorized official of the Bidder(s) _____

ANNEXURE "A"

1. BACKGROUND & GENERAL INFORMATION

OGDCL intends to hire the services of an experienced and well reputed contractor for re-construction of Crude storage tank having Capacity 6,000 BBLs in Kunnar facilities along with allied services as described at different sections of this tender documents. The scope of work includes civil, mechanical and all allied works i.e. Procurement of material, dismantling of tank structure, Construction, testing /inspection, and installation, Calibration and Commissioning of the crude storage Tanks. Successful contactor shall have to offer at least 10-year maintenance free guarantee of the installed system.

The said tank to be re-constructed on the same foundation after dismantling the tank structure (shell, roof, bottom etc.). The design and construction drawings of tank are available with Tender and shall be applicable for re-construction of tank.

Being an operational Plant and active condensate storage tank nearby, the re-construction of all necessary safety precautions & arrangements by contractor to be taken by contractor for safety of personals/plant/assets as per OGDCL safety policy.

2. CONTRACTORS' SCOPE (GENERAL).

The contractor shall be responsible for minimum but not limited to the following.

Tank dismantling, Civil / foundation repair/construction, Mechanical tank fabrication erection and installation. Procurement of material, earthling system, installation of anode flex, coating, painting, calibration, commissioning and testing etc. are in the scope of contractor. The tank is to be completed and tested as per applicable API 650 standard & CP System as per API 651 standard.

After dismantling of existing Tank the wreckage (Dismantled material) to be shifted to store yard of OGDCL) is also in the scope of contractor.

All the required material regarding plate, pipe, fittings, structure material and other allied equipment etc (as per design and data sheets) is included in this scope of supply of contractor.

All material to be supplied as per design that should be brand new and traceable to identify the manufacturer, grade, source, size and rating.

3. DESIGN

OGDCL has provided the design and drawings in this document for Civil, Mechanical & Works. All relevant reports are available with OGDCL.

4. **Scope of TPI/OGDCL Inspection:**

TPI/OGDCL intends to carry-out the inspection of tank during construction and post construction phase of project according to API 650 and API 653 latest editions. With minimum following but not limited to scope of work.

1. Material Identification through mill test certificates or through laboratory testing or other means.
2. Review / Witnessing of Procedure's qualification record and welder's qualification tests.
3. Inspection regarding construction of ring wall foundation and other related civil works.
4. Inspection of roof, shell and bottom plates materials, piping and fittings as per specification given in agreement
5. Inspection of welding consumables and to check the quality and suitability.
6. Inspection of Steel Structure assembly and welding.
7. Inspection of Shell Peaking, Bending, Roundness & Plumpness.
8. Inspection of Nozzle Orientation.
9. Witnessing of DPT where necessary.
10. Quality inspection of welding bottom, shell and roof plates.
11. Witnessing of vacuum box testing of bottom weld joints
12. Review results of radiography of horizontal, vertical and T-Joints of tank.
13. Stage inspections/hold points to be decided according to the Quality Inspection plan to be submitted by TPI.
14. Witnessing of Hydrostatic Testing.
15. Witnessing of Calibration of Tank.
16. Inspection of CP System installation.
17. Report of findings
18. Overall responsibility for the excellent workmanship guaranteed through the above inspections and continuous site supervision shall be carried out by third party inspection firm /OGDCL at site at OGDCL's cost.

Note:
The contractor would facilitate and support the TPI/OGDCL engineers / inspectors during all the phases of the project.

5. TERMS & CONDITIONS:

5.1. Fitness certificates of all the machinery required at site area must be available on site office of the contractor as per OGDCL HSEQ policy.

5.2. Company shall have right to inspect all equipment that shall be brought for work. Company has the right to reject any equipment it deems not fit for work. In that case contractor shall immediately remove and replace the equipment with no cost to the company.

5.3. If any damage occurred to any equipment due to miss handling, improper storage, wrong installation procedure etc. during the

project, that damage shall have to be rectified by the contractor without any cost to OGDCL.

5.4. The contractor is responsible for living arrangement of its manpower at his own account. Further he is also responsible for ensuring and using all necessary machinery at site required for construction, fabrication, installation and material handling during the entire project schedule at his own account.

5.5. A well versed experienced focal person having experience for the construction / fabrication must be appointed with all supporting supervisory staff, to look after all phases of project during construction and to communicate with OGDCL.

5.6. Bidder is required to provide the project team details and organization to OGDCL with its technical and financial proposal. Any change in organization and person of project team must be intimated to OGDCL for information / approval as required.

5.7. Any material or workmanship that does not meet the requirements of this engineering specification may be rejected.

5.8. Any defective material or works found after acceptance at the time of rolling, machining or during erection and testing of tank shall be replaced without charge even if it has been accepted previously.

5.9. Extent of Radiography shall be as specified in API-650. OGDCL/TPI at any time reserve the right to have any joint radiograph. All welds which are unacceptable shall be repaired and retested through radiograph at contractor's expenses.

5.10. All material required (Like water pneumatic air etc.) for the execution/testing would be arranged by the contractor at its own cost. It is not OGDCL responsibility.

5.11. Bidder is required to provide the project team details and organization to OGDCL with its technical and financial proposal. Any change in organization and person of the project team must be intimated to OGDCL for information/approval as required

6. MATERIAL PROCUREMENT / HANDLING / STORAGE.

6.1 Bidder /contractor is responsible for procurement of material, transportation form manufacturer's site to the site store already established by the contractor.

6.2 Plate material should be HR235 or equal with respect to the properties as per design specs.

will not provide any sort of transportation / loading / un-loading facilities. If in case OGDCL provide such facility on contractor's request, that will be charged as per actual.

6.3 To determine the originality & authenticity of the material being used for this project, all material shall be 100% traceable and suitably marked for easy identification of manufacturer or supplier, grade, source, size and rating.

6.4 Material Identification shall be carried out through mill test certificates or through laboratory Testing or other means up to satisfaction level of OGDCL/TPI.

6.5 All foreign and local procured material shall be inspected by OGDCL engineer(s). OGDCL inspection engineer(s) shall have full right to accept / reject any material / equipment.

6.6 The defected / sub-standard / rejected material not conforming to the OGDCL requirement will be replaced with the new one at bidder's account including transportation, handling demurrage etc.

6.7 The replaced material will be inspected once again and then be used by contractor after clearance form OGCL professional.

7. CONSTRUCTION AND INSTALLATION.

7.1 The bidder should be thoroughly familiar with the specifications of all the civil & mechanical works and shall ensure that all works are being completed in accordance with good industrial practice, relevant specifications and API standards. The approved bidder must submit the detailed scope of work of each task during erection.

7.2 Contractor shall be responsible for all Civil, Fabrication, Inspection, Testing and Calibration jobs required for completing the project as per approved design.

7.3 CIVIL WORKS.

The civil / mechanical / electrical and instrument jobs to be done according to drawings 2745-CIV-SP-01 and 2745-CIV-SP-02 and include:

Tank Ring Wall Foundation:

OPTION-1 Repair of Ring Wall.

- Visual Inspection of ring wall to carried out.
- Testing of ring wall to done by contractor/TPI/OGDCL.
- Testing results of ring wall foundation found satisfactory then only re-compaction will be done by contractor
- Minor repairs required will be accomplished by contractor if required.

- Installation of anode flex during sand compactness inside the ring wall as per API-Standard and as advised by CP consultant / OGDCL Corrosion Engineer and as per relevant section of this document

OPTION-2
Construction of Ring Wall (If foundation found unsatisfactory)

- Construction of Tank Ring Type foundation.
- Sand filling and its compactness inside the tank foundation ring.
- Layer by layer filling with compaction.
- Installation of anode flex during sand compactness inside the ring wall as per API-Standard and as advised by CP consultant / OGDCL Corrosion Engineer and as per relevant section of this document.
- During construction of ring wall conduit pipe installation for CP system be done as per instruction of CP consultant/OGDCL corrosion engineer.

Dyke Wall and Dyke Area:

- Dyke wall is already available.
- Damages to the dyke wall or any sort of to the already existing facility during reconstruction of said tank, will be repaired / reconstructed by the contractor at his own cost.
- Contractor to construct PCC flooring in the dyke wall and tank area. Keeping the levels maintained.
- Construction of drain channels.
- Construction of Concreted pit within the dyke wall area for removal / recovery of water / spilled oil in the area.
- Repair work of civil structure, if damaged by contractor during transportation/construction to be done by Contractor without any charge.
- All required material for the construction is the responsibility of contractor.

7.4 Scope of work for above-ground storage tank bottom's CP Systems.

- The scope of work for the installation is to install the anode flex at the bottom of the tank and to terminate the cables
- All the material related to the installation of CP system shall be provided by the client / OGDCL.
- Installation of anode flex shall be carried out by Certified CP technician and shall be supervised by OGDCL Corrosion engineer.
- Mechanical connection shall be made above ground only using cable lugs, nuts and serrated washers.
- Cables tags shall identify all the cables where they come above ground.

7.5 MECHANICAL WORKS.

The mechanical fabrication/construction, erection, installation and calibration as per DWG 2745-TK-SP-01 & 2745-TK-SP-03 scope of work is mentioned below but not limited to:

- Fabrication works according to mechanical construction drawings available in tender.
- Fabrication & welding of steel plates for tanks bottom, walls and roof.
- Fabrication and welding of tank structure (Internal / external stairs, top fence etc.)
- Fabrication and welding of all tank internals.
- Fabrication and welding of pipe and fitting for all required nozzles along with valves, gaskets stud / nuts, companion flanges.
- Placement of wind socks on tank roof.
- Installation of earthling system of tank.
- Installation of lightning arrester and system for tank.
- Installation of cooling water system.
- Installation of name plate completely describing size of tank, capacity of tank, date and year of manufacturing as per API 650 code.
- Installation of level indicator with floating system, the level indicator scale should be of steel grade scaled with bold letters in feet.
- Top roof railings and grating with support spiral staircase steps till access to the center of top tank.
- Installation of gate valves of ANSI Class 150 as per nozzle size. These valves and companion flanges to be provided by contractor and included in his scope of work. These valves to be of good quality and contractor is responsible to take prior approval of OGDCL before purchase of valves and supply.

Note: Contractor has to provide all the relative data of welding material & procedures to be used during project.

8. COATING & PAINTING

- Before the final handover of the tanks, the contractor would ensure the application of internal coating and external painting as per 2745-TK-SP-04 guidelines.
- The contractor shall use the branded industrial paint for application like ICI, BURGER KANSAI.

- Contractor has to provide MTC's for the brand which is to be used for painting.

- Further to this contractor to do FRP coating on bottom of the tank and first shell up to 2 meters height.

- Before painting / coating of the internal and external surface of the tank, contractor must ensure sand blasting / grit blasting and the ensure the surface profile of the tank.

- The contractor must paint / coat the sand blasted / grit blasted surface before sun set. And shall not be allowed to leave unattended.
- Unattended surface shall be re- blasted with sand / grit.

- Contractor has to ensure the minimum DFT (dry film thickness) level as per specification.

- After every coat /paint inspection shall be carried out by TPI / OGDCL representative and rejected coating / painting shall be removed and will be re coated / painted after complete surface preparation at his own cost.

- Paint / coating / FRP shall be carried out after satisfactory results of Hydrotesting.

- Bottom sheet of the tank shall be coated with red oxide / epoxy primer.

- All the associated nozzles welded with 1st shall be internally FRP coated.

- The gap between projection plate and the civil foundation shall be filled with sealant to avoid trapping of air / rain water etc.

9. INSPECTION, TESTING & COMMISSIONING.

9.1 Any material or workmanship that does not meet the requirements of this engineering specification may be rejected.

9.2 Any defective material or works found after acceptance at the time of rolling, machining or during erection and testing of tank shall be replaced without charge even if it has been accepted previously

9.3 Extent of Radiography shall be as specified in API-650. OGDCL/TPI at any time reserve the right to have any joint radiograph. All welds which are unacceptable shall be repaired and retested through radiograph at contractor's expenses

10. WORK SCHEDULE & REPORTS.

After the award of contractor, a detailed kick-off meeting to discuss the reporting channels and work schedule for timely completion of the project would be held in the OGDCL head office. OGDCL engineers would perform material inspection at the contractor's site; before mobilization for the material of construction, and contractor would intimate its schedule accordingly.

11. PROGRESS REPORTS.

The contractor shall prepare and submit to the company a monthly progress report detailing all actions that have occurred in the preceding month and actions anticipated in the coming month, the detail should be included but not limited to;

I. Work in progress in shape executive summary.
II. Work completed during the month.
III. Problem areas / bottle necks
IV. Proposal remedial actions associated with shortfalls / problems areas.
V. Outstanding matters
VI. All monthly reports will be submitted on or before 5th of every month with API Inspector signature as well.

12. FINAL INSPECTION.

OGDLC would undertake its routine site monitoring for the progress. However, it is the responsibility of Contractor to present the completed Tank in all respect for OGDCL Inspection. Only after acceptance of OGDCL regarding the completion of tank, tank will be handed over to OGDCL as per OGDCL handing / taking over procedure.

13. EXPERIENCE OF BIDDER/CONTRACTOR

The contractor who intends for participate in this project must have 7 years of fabrication and installation experience. Further the contractor should submit a list of recent projects of similar nature carried out by him with brief scope of work, cost and completion duration along the technical portion of the bid, otherwise his bid shall be considered Non-Responsive.

14. HIRRING OF SERVICES

In case Contractor hires the services of any activity for the project like designing, installation, fabrication, inspection etc. from other company. He must propose at least 03 Nos. of reputed companies at the time of submission of bids having at least 07 years relative experience. After approval of the bid no change regarding replacement of the sub-contractor can be made OGDCL would finally nominate one of the proposed sub-contractor.

15. DELIVERY OF TANKS.

Contractor is responsible to complete the tank in all aspects and handover to OGDCL in 180 days' time from that date of issuance of purchase order.

16. PRICING & PAYMENT SCHEDULE:

16.1 Bidder to quote the complete price for construction of tank at least in following break up:

a) Construction Cost: including dismantling of existing tank, material procurement fabrication, construction painting, commissioning, hydrostatic testing, CP system installation and other related jobs as per SOW.
b) Repair work cost for civil foundation (If required after inspection)
c) Complete reconstruction of ring wall foundation (if required after inspection)

NOTE

The financial evaluation will be done considering above given breakup from **point "a" to point "c"** and the contract will be awarded to the overall financially lowest bidder.

16.2 Following is the payment schedule:

Reconstruction Cost Payment Schedule:

- 15% Mobilization Advance against bank guarantee.
- 5% Dismantling of existing tank.
- 5% payment upon satisfactory installation of Anode Bed of CP System and sand filling as per drawings.
- 25% payment after procurement of material for tank plates and structure, nozzle etc.
- 25% payment after completion of fabrication/construction works (i.e bottom, roof, shell, stairs, completion of nozzle works etc.) and readiness of Hydrostatic Testing.
- 25% payment after handing over the tank upon killing all punch points upon completion of job.

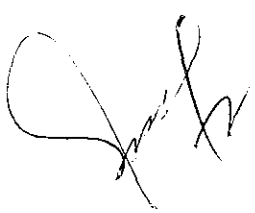
Civil Works Cost Payment Schedule:

OGDCL will only pay for inspection and **either point "b" or point "c" of clause 16.1** as per nature of work done after inspection of civil work/foundation.

Technical Evaluation Criteria

Sr. #	DESCRIPTION	PARAMETER	CONTRACTOR to Comply
1	SCOPE	Bidder to comply all sections of This SOW in totality.	
2	TPI/OGDCL Scope of Inspection	Section 4	
3	Compliance to the Sections 2 to Section 16	As per guidelines mentioned.	
4	Experience certificates of the Company (at least three references required, for the technical suitability). Clients guaranteed certificates in the company's name.	Bidders to provide complete details	
5	Above Ground API 650 tanks constructed by the contractor in its name and at least six (6) tanks on the contractor's credit in last 07 years in Pakistan for qualification.	Mandatory experience required.	
6	Organogram of Company and Organogram of proposed team for site execution.	Bidder to provide	
7	Delivery period, any bidder/contractor offering additional time that exceeds from given delivery period, would be asked to match this timeline for further evaluation.	180 days	
8	Any deviation to this specification, each deviation to be marked by section wise description (if any) from 1 to 16		
9	Provision of PEC registration certificate as proof of work experience in mechanical construction for min C4 category.	Valid PEC certificate to be attached for applicable category	
10	Provision of necessary experience showing competency for projects above PKR 70 Million.	Experience with client references, email, and telephone numbers to be provided	
12	An authority letter / JV letter in case of Joint bid submission clearly indicating the lead and supportive partner.	Bidder to provide authenticated letter of agreement clearly mentioning the portion of work to be carried out by each JV partner.	
16	1 year trouble free performance guarantee after commissioning of Tnak and allied systems	Bidder to confirm. (In case of JV bid the guarantee shall be submitted individually & jointly).	

TO BE FILLED IN COMPLETELY BY THE BIDDER / CONTRACTOR.



OIL & GAS DEVELOPMENT COMPANY LIMITED

2745: DETAIL DESIGN OF CRUDE OIL STORAGE TANK

(KUNNAR OIL FIELD)

CONSULTANT:

NOV, 2016

PETROCHEMICAL ENGINEERING CONSULTANTS

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Table of Content

1.0 INTRODUCTION

Oil & Gas Development Company Limited (OGDCL) intends to Detail design of Crude oil storage tanks at Thora Oil field. API – 650 storage tank to be designed over the existing foundation.

Kunnar gas/condensate field is located in the Hyderabad District at a distance of about 26 Kilometers from Hyderabad city. First exploratory well i.e. Kunnar well No. 1 was drilled and completed in Nov, 1987. In order to obtain reservoir data, extended production tests were conducted on Kunnar wells.

OGDCL acquired services of Petrochemical Engineering Consultants for detail design of Storage Tank for Thora Oil Well.

This package has included

PART-I (DETAIL DESIGN REPORT)

PART-II (CONTRACTOR SCOPE OF WORK, DETAIL DRAWINGS, DATA SHEETS, & PROJECT SPECIFICATIONS)

2.0 DEFINITION

Company	Oil & Gas Development Company Limited (OGDCL)
Supplier.	Entity with whom the Company will execute a Contract for supply of equipment/material as per this document
Project	Detail Design of Storage Tank for Thora Oil Well

3.0 COMPANY'S INTENTION

It is intention of the company to fabrication of Storage Tank based on Drawings, Data Sheet and specification document.

Supplier shall also obtain approval from company to buy any component of the package. Supplier shall also be responsible for all sub-supplier's coordination, data and other documents, provision of guarantees, provision of equipment and personnel for the trial assembly, and functional testing of complete package at SUPPLIER's works and packaging and delivery as specified in this document.

4.0 CODES AND STANDARDS

4.1 General

All specifications and publications shall be the current issue on the date of purchase order and it shall be the vendor's responsibility to comply with the same.

- The vendor shall ensure that the Storage Tank comply with requirements of all federal, provincial and regional acts, regulations and ordinances.

API Specification 5L	Specification for Line Pipe
	Venting Atmospheric and Low-Pressure Storage
API Standard 2000	Tanks: Non refrigerated and Refrigerated
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.11	Forged Steel Fittings, Socket-Welding and Threaded
ASME B18.2.1	Square and Hex Bolts and Screws, Inch Series
ASME B18.2.2	Square and Hex Nuts
ASME B31.1	Process Piping
ASME Boiler and	
Pressure Vessel Code	Section IX—Welding and Brazing Qualifications
ASTM A36	Standard Specification for Carbon Structural Steel
NFPA No. 30	Flammable and Combustible Liquids Code
Other Applicable	ANSI / ASME / ASTM Standards

Petrochemical Engineering Consultants

PART - I
(DETAIL DESIGN)

5.0 DETAIL DESIGN

The tank is designed as per API-650 and the loads are taken as per the area classification, it is observed in the design that Dia to height ratio satisfied the Unanchoring Requirement of API-650 Tanks therefore it will be placed self sustained over the Existing Foundation.

5.1 DESIGN BASIS

5.2 GENERAL

Unless otherwise stated on the data sheets, Storage tank will be located in an open exposed area.

5.3 AREA CLASSIFICATION

All instrumentation and electrical equipment shall be explosion proof Ex'd' type suitable for use in Class I, Zone 1 & Zone 2, with temperature classification T4.

5.4 DESIGN PARAMETER

Tank Geometric Capacity	6000 bbl
Design Code	API 650
Service	Crude Oil
Diameter (inside) mm	11582
Height mm	9754
Wind Velocity. mph	90
Design Temperature (deg C) Max	55
Failure Pressure (in of Water Column)	3

5.5 DESIGN REPORT

Detailed design Report is attached as the Appendix-A

Petrochemical Engineering Consultants

PART - II
(CONTRACTOR SCOPE OF WORK)

6.0 CONTRACTOR'S SCOPE OF WORK

1) Verification of Existing Tank Foundation

The Dimensions for the Existing Tank foundation to be first verified by the contractor before starting any tank fabrication.

2) Dismantling of Existing Tank

Decommissioning of all the existing piping then Dismantling of Existing Tank and relocation of all the scrap material to the place assigned by the client in all respect complete with the cleaning of debris and maintaining proper housekeeping practices, All the work to be as per part ***2747-CIV-SP-02 (Specification for Dismantling of Steel, Concrete and Masonry structures)*** of the Document.

3) Testing and Inspection of Existing Ring Wall Foundation with Third Party Approval

The existing RCC Foundation to be inspected properly as per the requirements given below and all the earth works to be carried out as per part ***2747-CIV-SP-01 (Specifications for Site Clearing, Area Grading, Excavation and Earth Work)*** of the Document.

6.1 REQUIREMENTS:

All the work on the Existing Foundation to be started after achieving Ring wall foundation Strength certificate from any Third Party.

The Ring wall foundation should be of Reinforced Concrete. Ring wall foundation of Masonry will not be accepted and to be reconstructed to RCC Foundation as per Civil Foundation Design.

Core cutting test should be performed for each Ring wall foundation; the test should be in accordance with ASTM C42/C42 M – 04 (Appendix-A). fc' (compressive strength of concrete) should not be less than 3000Psi

Core tests having an average of 85% of the specified strength are realistic .To expect core test to be equal to fc' (compressive strength of concrete) is not realistic, since differences in the size of specimens, conditions of obtaining samples, and procedure for curing, do not permit equal values to be obtained.

Crack propagation Tests to be performed through proper scanning procedure UT scanning or any other relevant procedure in order to trace any further crack propagation to avoid and reduce creep and fatigue failures.

All exposed to earth concrete surface should be coated with bitumen and the Slopes for Filling shall be adjusted as per bottom plate layout.

The existing infilled material under the Ring Wall foundations should met the specification given below, otherwise it should be removed and the standard specified material should be filled with proper compaction.

The material for infilling within the RCC Ring wall shall be coarse sand from approved source with maximum aggregate size not exceeding 10 mm and generally falling within the following grading limits:

BS Standard Sieve	Percentage Passing (%)
10.00 mm	100
5.00 mm	90-100
2.36 mm	75-100
1.18 mm	55-90
600 micron	35-59

300 micron	8-30
150 micron	0-10

6.2 FIELD COMPACTION CONTROL (Within Ring Wall Foundation):

The sand pad must be placed in 150mm thick layers & compacted to 95% modified AASHTO density. During compaction moisture content will be controlled so that it is within ±2% of optimum moisture as the compaction proceeds, frequent field density tests must be performed on each layer to ensure that the degree of compaction is satisfactory.

The contractor shall provide the qualified personnel and approved to control the compaction of all material in accordance with the standards.

Density tests shall be carried out at every course of foundation sand fill and at a frequency not less than one test per 150 m2 or as directed by the owner's representative.

Compaction of excavation bottom must be carried out by 10 tons vibratory roller.

4) Supply, Fabrication, Inspection and Testing of Tank

Supply, fabrication, inspection, testing and calibration of the welded steel storage tanks, including full compliance with all applicable design codes and standards, as listed in specification. Construction of Storage tank should be as per drawings and specification provided and 2747-TK-SP-01 (Specification for Storage Tank) and 2747-TK-SP-02 (Specification for Welding)

5) Calibration of Tank

Carrying out calibration of Vertical Atmospheric Steel Storage Tanks by optical method. All material, labor, tools, ropes, planks, water meter etc. shall be provided by the Contractor at his own cost and responsibility, which shall be considered included in the rates quoted by the Contractor. All work should be as per 2747-TK-SP-03 (Specification for Tank Calibration)

6) Painting of Tank

Supply of painting and Epoxy coating materials, application of painting and coating materials on storage tank, above ground/underground piping, structure and platforms. The painting works to be performed by the Contractor shall include all necessary steps like supply of material, surface preparation to S.A. 2.5 “near White Metal”, protection of the other works, application of primers, intermediate and top (finish) coats, cleaning of the working area as well as all intermediate and final inspection works. All work should be as per 2747-TK-SP-04 (Specification for Painting)

6.3 REFERNCE DOCUMENTS

ANNEXURE-I **DETAIL DRAWINGS**

ANNEXURE-II **DATA SHEETS**

ANNEXURE-IIA **BREATHER VALVE DATASHEET**

ANNEXURE-IIB **EMERGENCY VENT DATASHEET**

ANNEXURE-IIC **LEVEL SWITCH DATA SHEET**

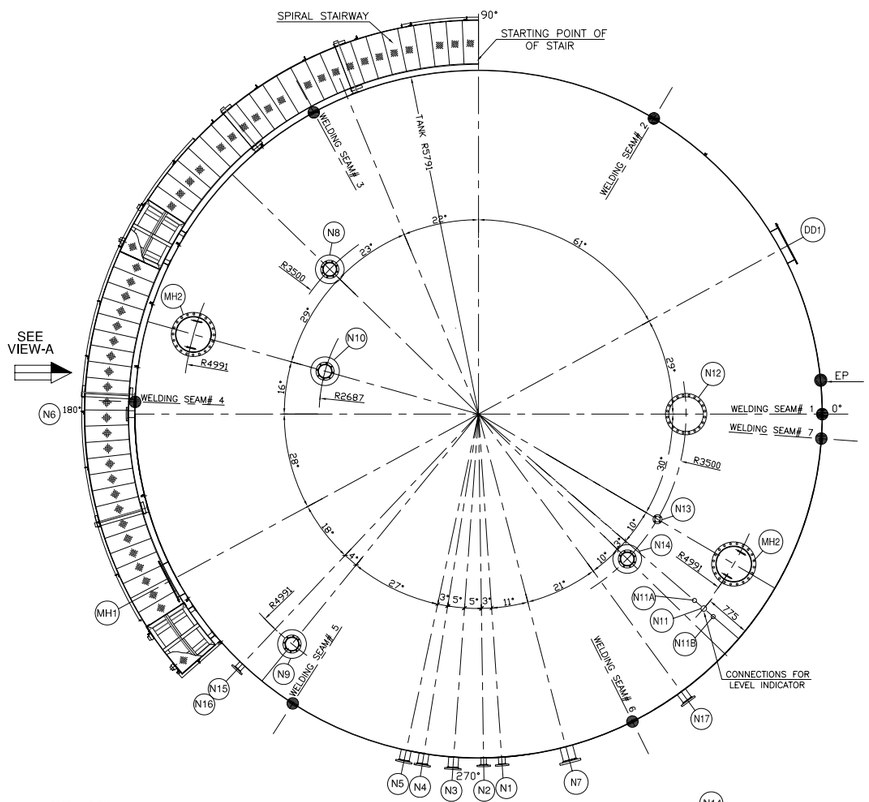
ANNEXURE-III **SPECIFICATIONS**

APPENDIX-A **DESIGN REPORT**

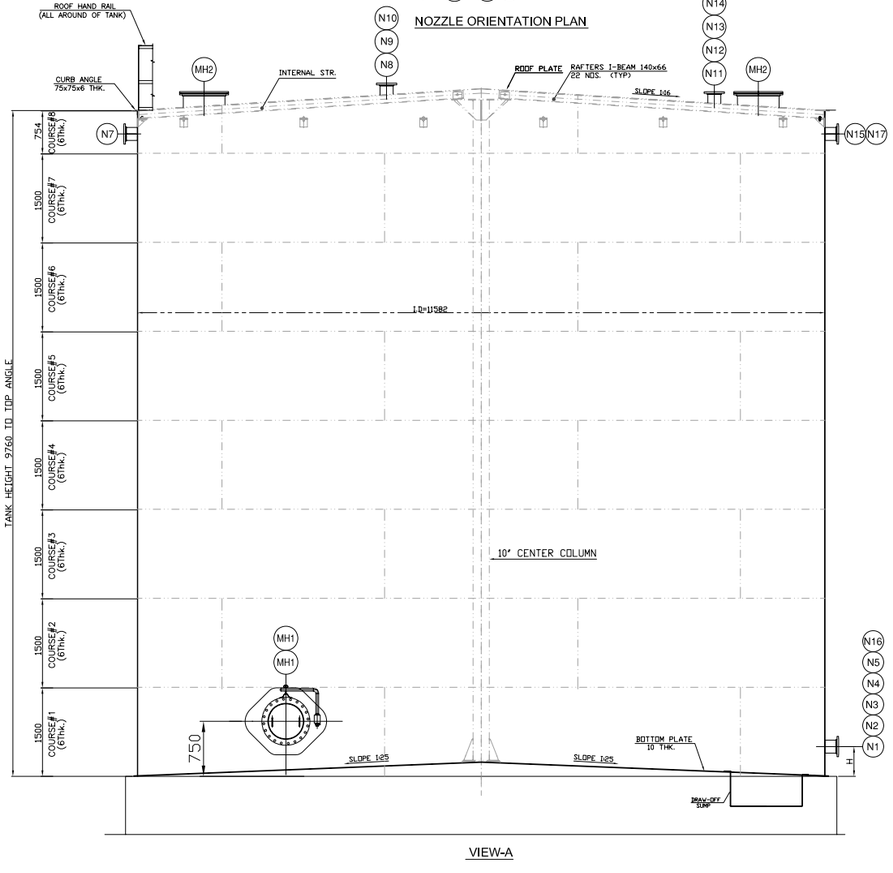
APPENDIX-B **CONCRETE CORE TESTING MANUAL**

ANNEXURE-I

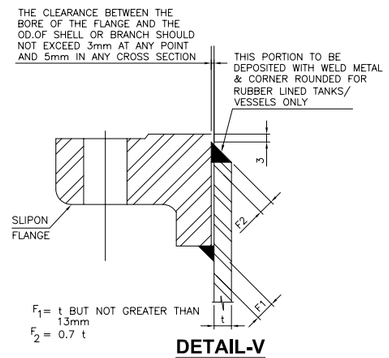
(DETAIL DRAWINGS)



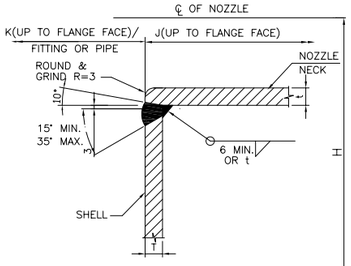
NOZZLE ORIENTATION PLAN



VIEW-A

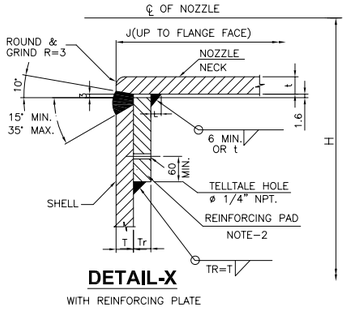


DETAIL-V



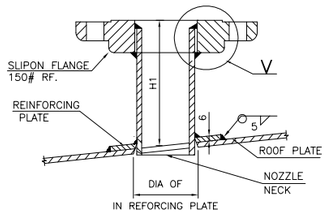
DETAIL-U

WITH OUT REINFORCING PLATE



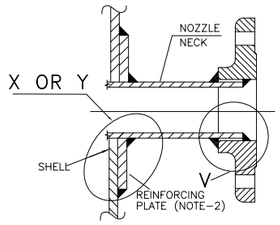
DETAIL-X

WITH REINFORCING PLATE



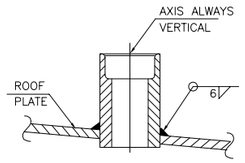
DETAIL-T

(CONNECTION DETAIL FOR ROOF NOZZLE WITH REINFORCING PLATE)



DETAIL-S

(CONNECTION DETAIL FOR SHELL NOZZLE WITH REINFORCING PLATE)



DETAIL-W

(CONNECTION DETAIL FOR ROOF NOZZLE WITHOUT REINFORCING PLATE)

NOZZLES SCHEDULE(KUNNAR)

NOZZLE NO.	QTY.	SIZE INCH	BRANCH DETAIL		WELD FLANGE AS DETAIL	WELD TO TANK					REINF.PAD		SERVICES	REMARKS
			NECK THK. t	FLANGE TYPE		AS DETAIL	H (NOTE-3)	H1	J	K	DIA. mm	THK.TR mm		
N-1	1	4	SCH,80	S.O RF	V	X	225	–	175	–	305	6	SUMP DRAIN	AT SHELL
N-2	1	3	SCH,80	S.O RF	V	X	225	–	175	–	265	6	RECYCLE	AT SHELL
N-3	1	4	SCH,80	S.O RF	V	X	260	–	175	–	305	6	DESALTER	AT SHELL
N-4	1	4	SCH,80	S.O RF	V	X	225	–	175	–	305	6	PLANT RUNDOWN	AT SHELL
N-5	1	4	SCH,80	S.O RF	V	X	225	–	175	–	305	6	BLUE SEP. RUNDOWN	AT SHELL
N-6	1	4	SCH,80	S.O RF	V	X	770	–	175	–	305	6	OUT LET	AT SHELL
N-7	1	6	SCH,80	S.O RF	V	X	9450	–	200	–	400	6	FOAM POURER	AT SHELL
N-8	1	6	SCH,80	S.O RF	V	T	–	200	–	–	400	6	BREATHER VALVE	AT ROOF
N-9	1	6	SCH,80	S.O RF	V	T	–	200	–	–	400	6	GAUGE HATCH	AT ROOF
N-10	1	6	SCH,80	S.O RF	V	T	–	200	–	–	400	6	SPARE NOZZLE	AT ROOF
N-11	1	1	SCH,160	COUPLING	V	U	–	150	–	–	–	–	LEVEL INDICATOR	AT ROOF
N-11A	1	3/4	SCH,160	COUPLING	–	W	–	–	–	–	–	–	L.I CABLE ANCHORE	AT ROOF
N-11B	1	3/4	SCH,160	COUPLING	–	W	–	–	–	–	–	–	L.I CABLE ANCHORE	AT ROOF
N-12	1	20	SCH,30	S.O RF	V	T	–	275	–	–	1055	6	EMERGENCY VENT	AT ROOF
N-13	1	2	SCH,80	S.O RF	–	W	–	150	–	–	–	–	NITROGEN BLANKETING	AT ROOF
N-14	1	6	SCH,80	S.O RF	V	T	–	200	–	–	400	6	SPARE NOZZLE	AT ROOF
N-15	1	3	SCH,80	S.O RF	V	X	9000	–	175	–	265	6	LEVEL SWITCH HIGH	AT SHELL
N-16	1	3	SCH,80	S.O RF	V	X	690	–	175	–	265	6	LEVEL SWITCH LOW	AT SHELL
N-17	1	6	SCH,80	S.O RF	V	X	9250	–	200	–	400	6	SPARE NOZZLE	AT SHELL
MH1	1	24	REFER DETAIL DRAWING/2745-TK-APST-001										SHELL MANHOLES	AT SHELL
MH2	2	24	REFER DETAIL DRAWING/2745-TK-APST-002										ROOF MANHOLES	AT ROOF
DD1	1	24	REFER DETAIL DRAWING/2745-TK-APST-003										CLEANOUT DOOR	AT SHELL

DESIGN DATA

DESIGN CODE	API 650
CAPACITY (GEOMETRIC) (Oil Barrel)	6000
CAPACITY (OPERATING) (Oil Barrel)	–
SERVICE	CRUDE OIL
DIAMETER (INSIDE) mm	11582
HEIGHT mm	9754
SPECIFIC GRAVITY	–
WIND VELOCITY (mph)	90
DESIGN TEMPERATURE °C (MAX.)	55
FAILURE PRESSURE (IN OF WC)	3
DESIGN PRESSURE	ATM
TYPE OF VENT	FREE

ISSUED FOR REVIEW

NOTES

1. ALL DIMENSIONS ARE IN mm. UNLESS OTHERWISE STATED.
2. REINFORCING PLATE ARE NOT REQUIRED UPTO 2" UNLESS OTHERWISE STATED.
3. "H" IS THE HEIGHT FROM TOP OF THE BOTTOM PLATE TO THE CENTERLINE OF NOZZLE.
4. NOZZLE ORIENTATION SHALL BE FINALIZED AS PER THE EXISTING PIPING.

REV.	DATE	DESCRIPTION OF REVISION	PREP'D	CHECK	APPR.
0	25-11-2016	ISSUED FOR REVIEW	S.F.R	BA	AJ

PETROCHEMICAL ENGINEERING CONSULTANTS
C-2, BLOCK NO. 17, GULSHAN-E-IQBAL, NEAR NATIONAL STADIUM, KARACHI-75300. PAKISTAN.
TEL. +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E-Mail: contact@pcec.com.pk web site: www.pcec.com.pk

CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

TITLE : GENERAL ARRANGEMENT FOR CRUDE OIL TANK KT-601

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
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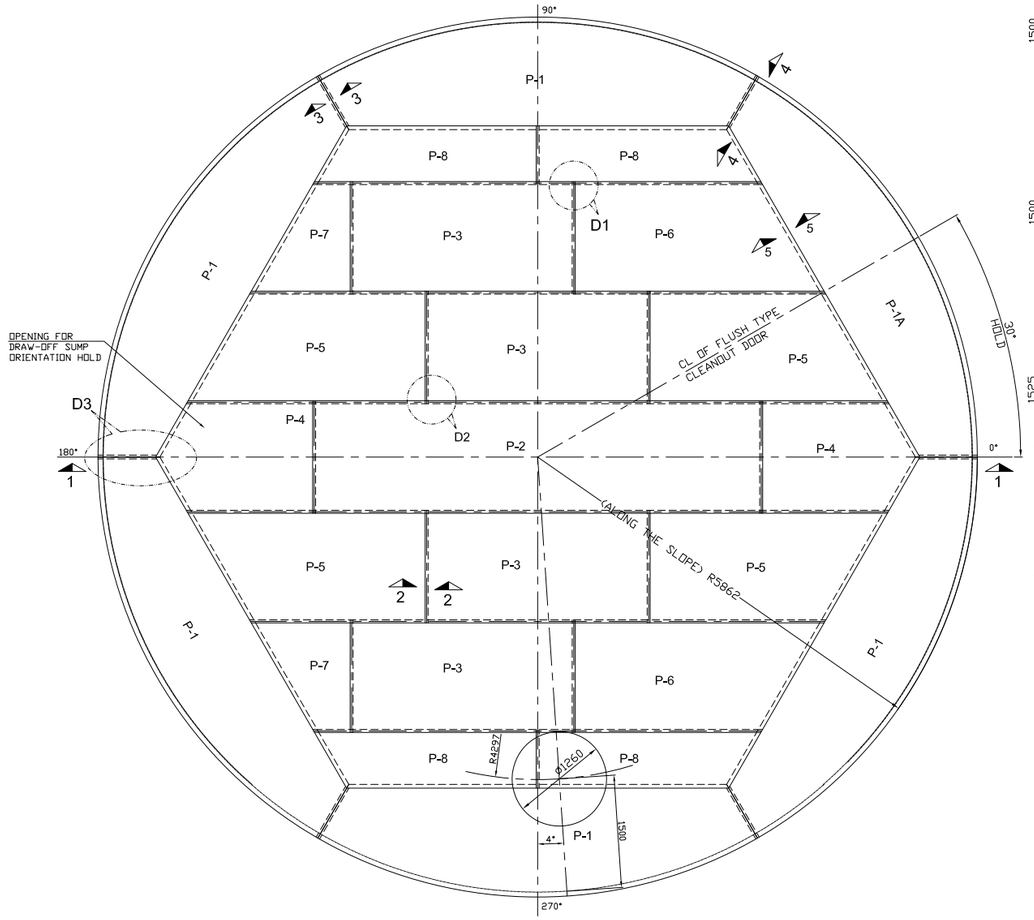
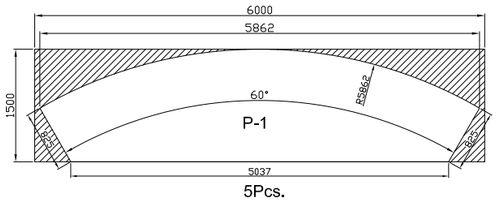
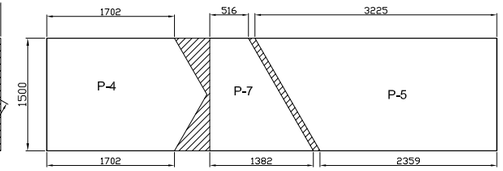
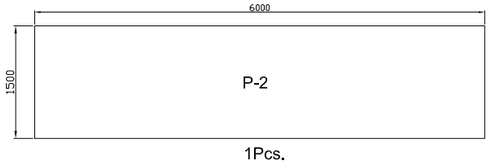
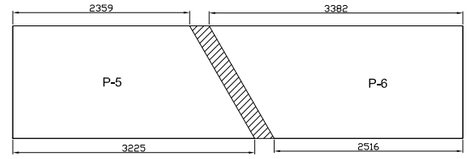


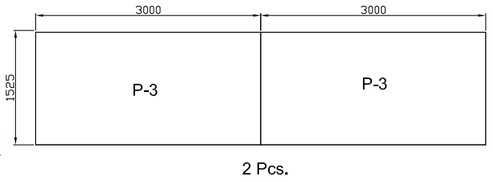
DEVELOPED PLAN OF BOTTOM PLATES

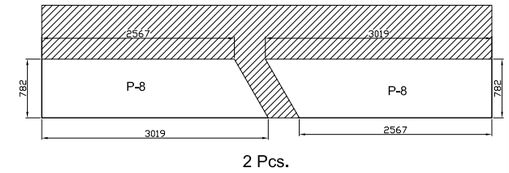


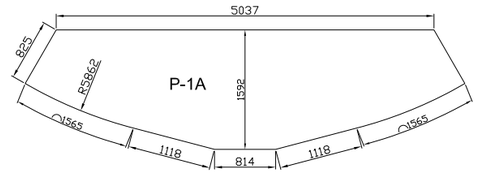




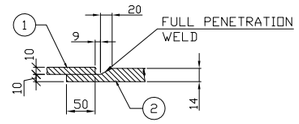




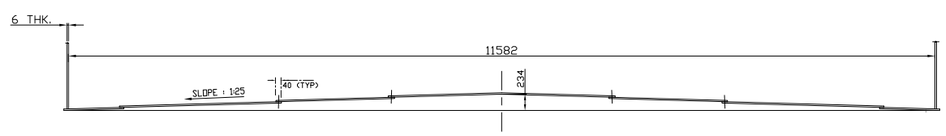




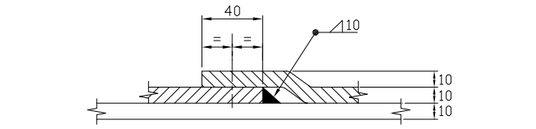
DETAIL OF BOTTOM REINFORCING PLATE

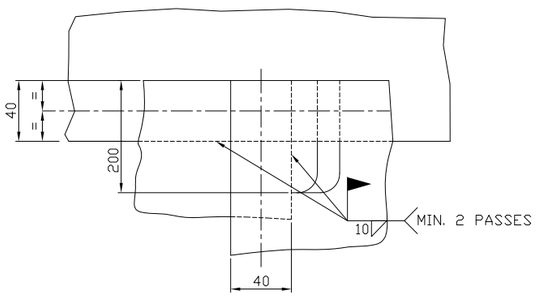


SECTION 5-5

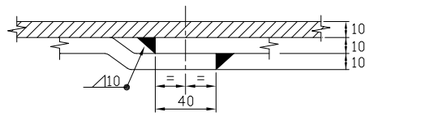


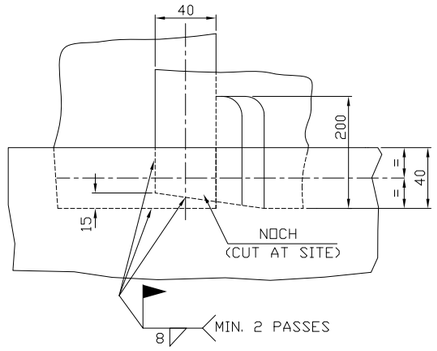
SECTION 1-1





DETAIL 'D1'





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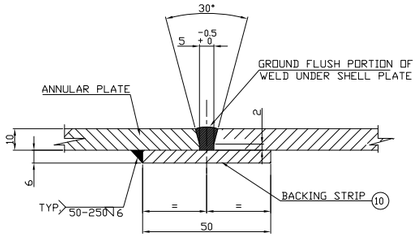

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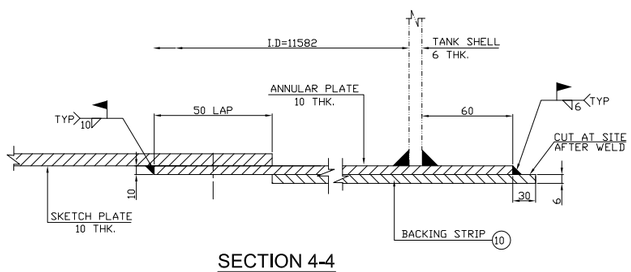
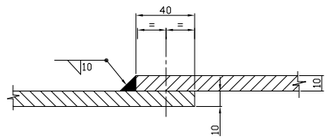
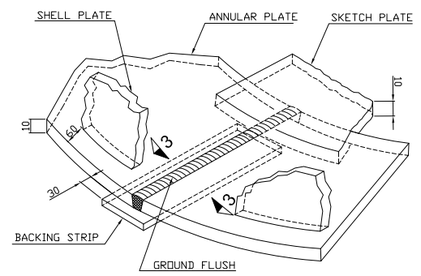


SECTION 4-4



SECTION 2-2



DETAIL-D3

ISSUED FOR REVIEW

NOTES:

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. GRIND ALL SHARP EDGES, REMOVE ALL BURRS AND WELD SPATTERS.
3. SHRINKAGE ALLOWANCE TO BE CONSIDERED DURING FABRICATION.
4. A SLOPE OF 1:25 MUST BE MAINTAINED IN THE BOTTOM PLATE BEFORE WELDING OF SHELL TO BOTTOM.
5. ALL DIMENSIONS & ORIENTATIONS TO BEVERIFIED BY THE CONTRACTOR BEFORE UNDERTAKING ANY KIND OF FABRICATION, CONSTRUCTION & INSTALLATION WORK AT SITE.
6. TANK IS DESIGNED FABRICATED INSPECTED/TESTED & ACCEPTED AS PER API 650 11TH EDITION.

ITEM	DESCRIPTION	QTY.	MATERIAL	WT./UNIT	TOTAL(Kg)
10	BACKING STRIP 782x50x6 THK.	6	HR-235	1.84 Kg/PC	11
9	PLATE P-8 10 THK.	4	HR-235	78.5 Kg/M²	686
8	PLATE P-7 10 THK.	2	HR-235	78.5 Kg/M²	223
7	PLATE P-6 10 THK.	2	HR-235	78.5 Kg/M²	694
6	PLATE P-5 10 THK.	4	HR-235	78.5 Kg/M²	1315
5	PLATE P-4 10 THK.	2	HR-235	78.5 Kg/M²	452
4	PLATE P-3 10 THK.	3	HR-235	78.5 Kg/M²	1413
3	PLATE P-2 10 THK.	1	HR-235	78.5 Kg/M²	707
2	BOTTOM REINFORCING PLATE P-1A 14 THK	1	HR-235	109.9 Kg/M²	787
1	ANNULAR PLATE P-1 10 THK.	5	HR-235	78.5 Kg/M²	2750
				TOTAL WT(Kg)	9038

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25-11-2016	ISSUED FOR REVIEW	S.F.R	BA	AJ

PETROCHEMICAL ENGINEERING CONSULTANTS
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TEL. +92 (21) 34827786, 34963086, FAX: +92 21 34963089, E-Mail: contact@pcec.com.pk web site: www.pcec.com.pk

CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

TITLE : BOTTOM PLATES LAYOUT & DETAILS FOR CRUDE OIL TANK KT-01

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
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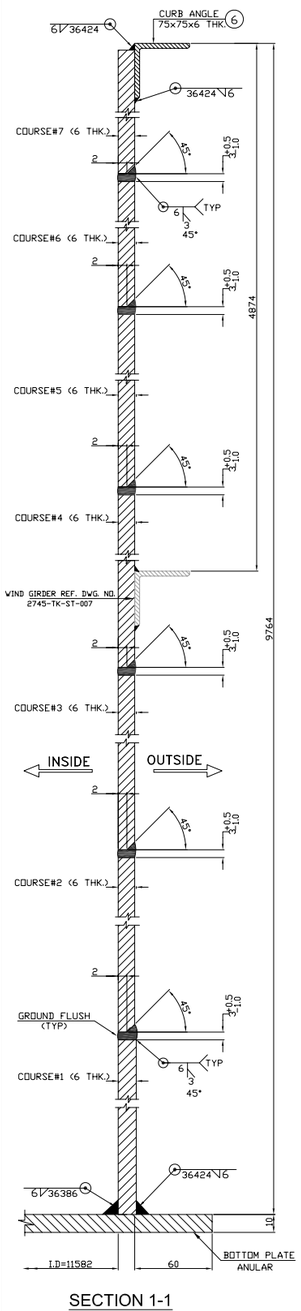
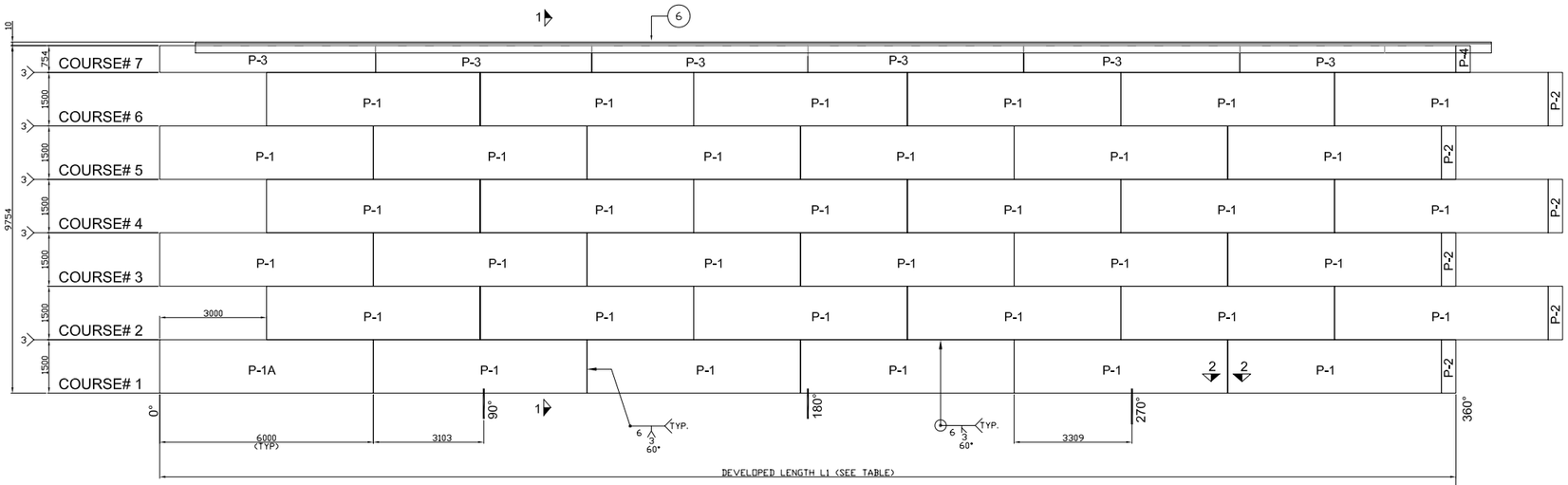
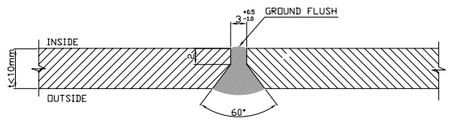


SECTION 1-1

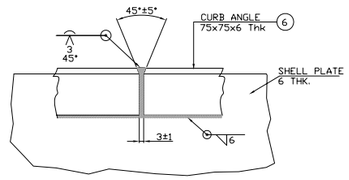


DEVELOPMENT OF SHELL PLATES

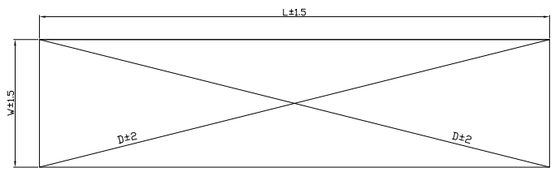
1-7	36405	6
COURSE NO.	DEVELOPED LENGTH L1	THK. mm



SECTION 2-2



TYPICAL WELD OF CURB ANGLE



TOLERANCES FOR SHELL PLATES

ISSUED FOR REVIEW

NOTES:

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. GRIND ALL SHARP EDGES, REMOVE ALL BURRS AND WELD SPATTERS.
3. TOP COURSE TO BE CUT TO MAINTAIN THE TOTAL HEIGHT OF TANK.
4. END PLATES TO BE CUT TO MAINTAINEN THE I.D OF TANK.
5. SHRINKAGE ALLOWANCE TO BE CONSIDERED DURING FABRICATION.
6. ALL DIMENSIONS & ORIENTATIONS TO BEVERIFIED BY THE CONTRACTOR BEFORE UNDERTAKING ANY KIND OF FABRICATION, CONSTRUCTION & INSTALLATION WORK AT SITE.
7. TANK IS DESIGNED FABRICATED INSPECTED/TESTED & ACCEPTED AS PER API 650 11TH EDITION.

ITEM	DESCRIPTION	QTY.	MATERIAL	WT./UNIT	TOTAL(Kg)
6	CURB ANGLE 75x75x6 THK.	37M	ASTM A36	6.85 Kg/M	253
5	PLATE P-4 405x754x6 THK	1	HR-235	47.1 Kg/M²	14
4	PLATE P-3 6000x754x6 THK	6	HR-235	47.1 Kg/M²	1278
3	PLATE P-2 405x1500x6 THK	6	HR-235	47.1 Kg/M²	172
2	PLATE P-1A 6000x1500x10 THK	1	HR-235	78.5 Kg/M²	706
1	PLATE P-1 6000x1500x6 THK	35	HR-235	47.1 Kg/M²	14836
				TOTAL WT(Kg)	17259

REV.	DATE	DESCRIPTION OF REVISION	PREP'D.	CHECK	APPR.
0	25-11-16	ISSUED FOR REVIEW	S.F.R	BA	AJ

PETROCHEMICAL ENGINEERING CONSULTANTS
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TEL. +92 (21) 34827780, 34961086, FAX: +92 21 34961089, E-Mail: contact@pce.com.pk web site: www.pce.com.pk

CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

TITLE : SHELL PLATES LAYOUT & DETAILS FOR CRUDE OIL TANK KT-01

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
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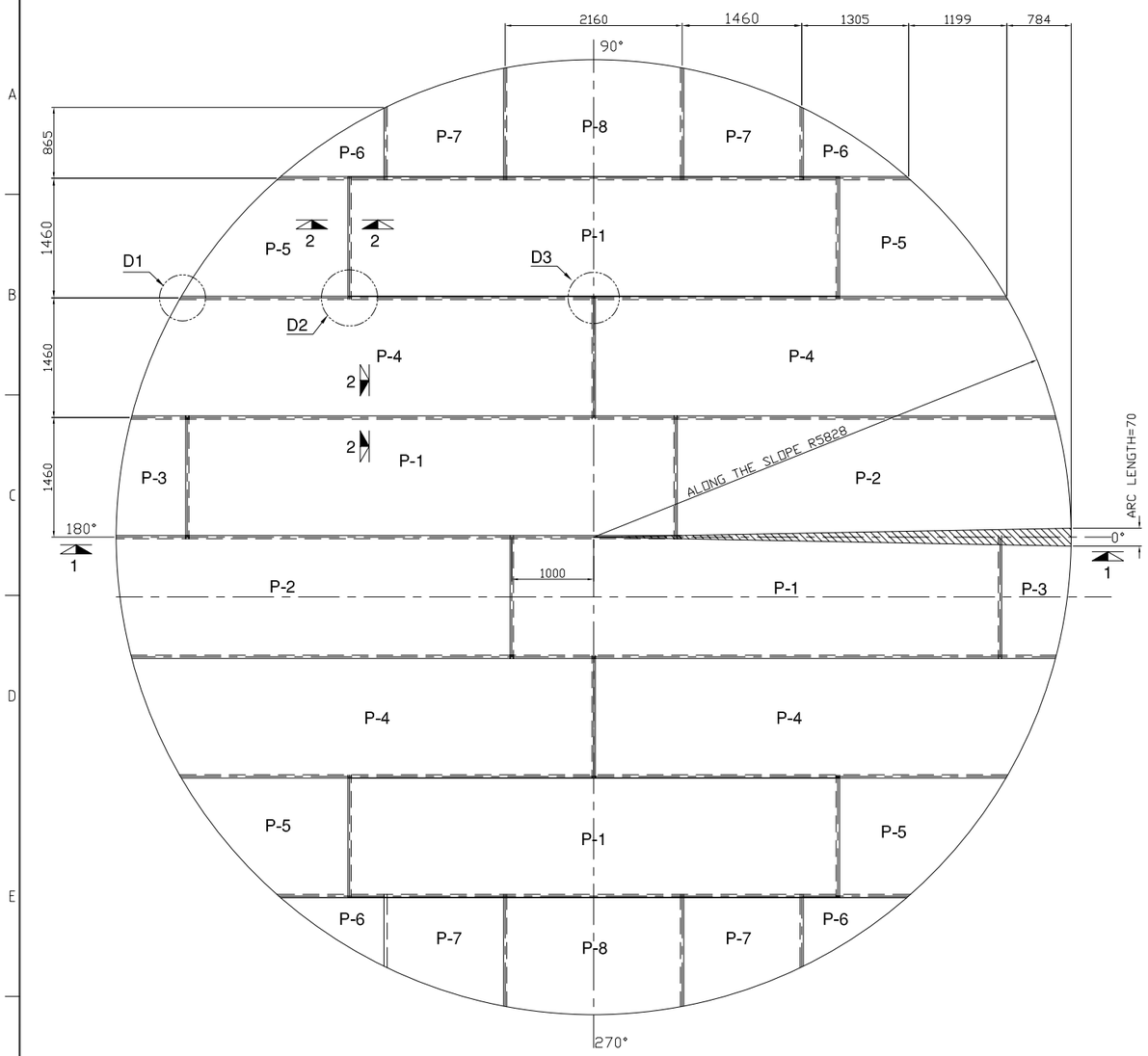
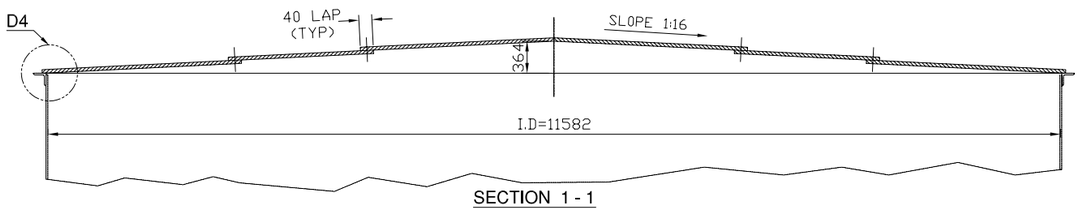
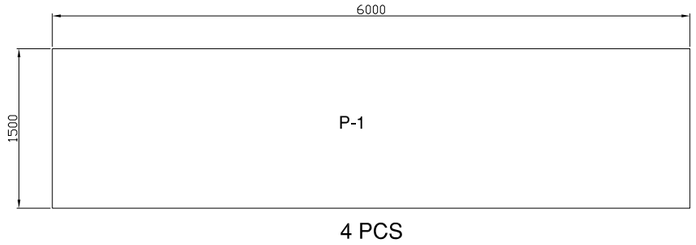


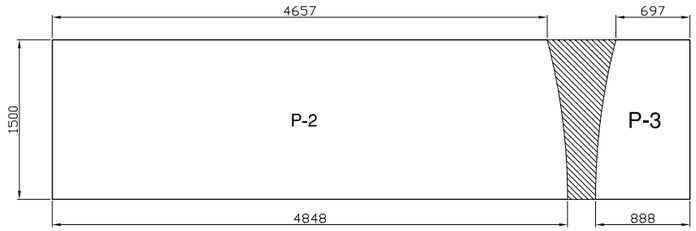
DEVELOPED PLAN OF ROOF PLATES



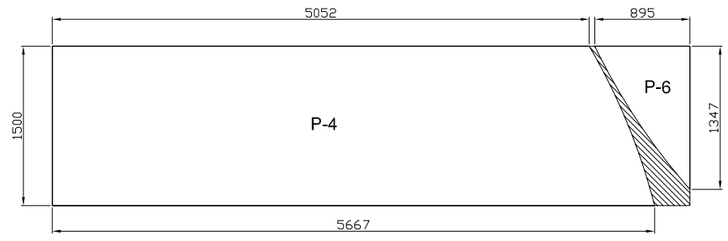
SECTION 1 - 1
SCALE 1:50



4 PCS



2 PCS



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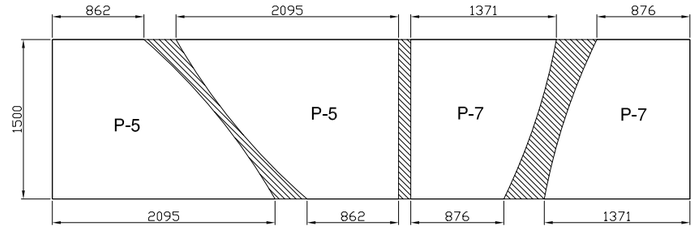

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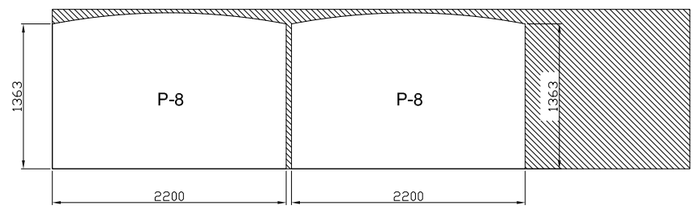
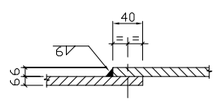
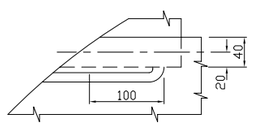


1 PC

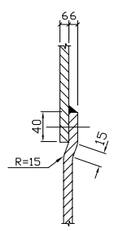
8	PLATE P-8 6 THK.	2	HR-235	47 Kg/m²	295
7	PLATE P-7 6 THK.	4	HR-235	47 Kg/m²	355
6	PLATE P-6 6 THK.	4	HR-235	47 Kg/m²	125
5	PLATE P-5 6 THK.	4	HR-235	47 Kg/m²	436
4	PLATE P-4 6 THK.	4	HR-235	47 Kg/m²	1518
3	PLATE P-3 6 THK.	2	HR-235	47 Kg/m²	116
2	PLATE P-2 6 THK.	2	HR-235	47 Kg/m²	672
1	PLATE P-1 6 THK.	4	HR-235	47 Kg/m²	1687
ITEM	DESCRIPTION	QTY.	MATERIAL	WT./UNIT	TOTAL(Kg)
				TOTAL WT(Kg)	5204

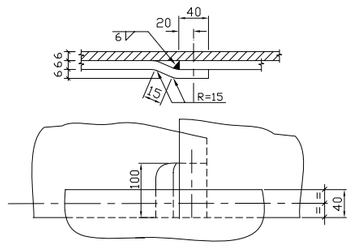


SECTION 2-2

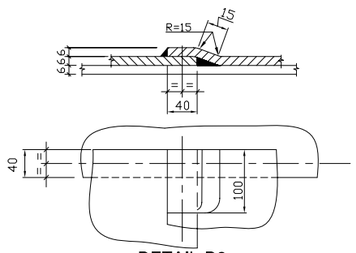


DETAIL-D1

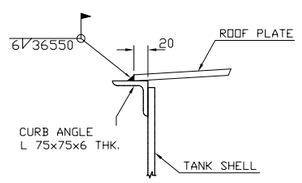




DETAIL-D2



DETAIL-D3



DETAIL-D4

ISSUED FOR REVIEW

NOTES:

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. GRIND ALL SHARP EDGES, REMOVE ALL BURRS AND WELD SPATTERS.
3. SHRINKAGE ALLOWANCE TO BE CONSIDERED DURING FABRICATION.
4. SLOPE OF 1:16 MUST BE MAINTAINED IN THE ROOF PLATE BEFORE WELDING OF SHELL TO ROOF.
5. ALL DIMENSIONS & ORIENTATIONS TO BEVERIFIED BY THE CONTRACTOR BEFORE UNDERTAKING ANY KIND OF FABRICATION, CONSTRUCTION & INSTALLATION WORK AT SITE.
6. TANK IS DESIGNED FABRICATED PER API 650 AND SHOULD BE TESTED/INSPECTED ACCORDINGLY.

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25-11-16	ISSUED FOR REVIEW	S.F.R	BA	AJ

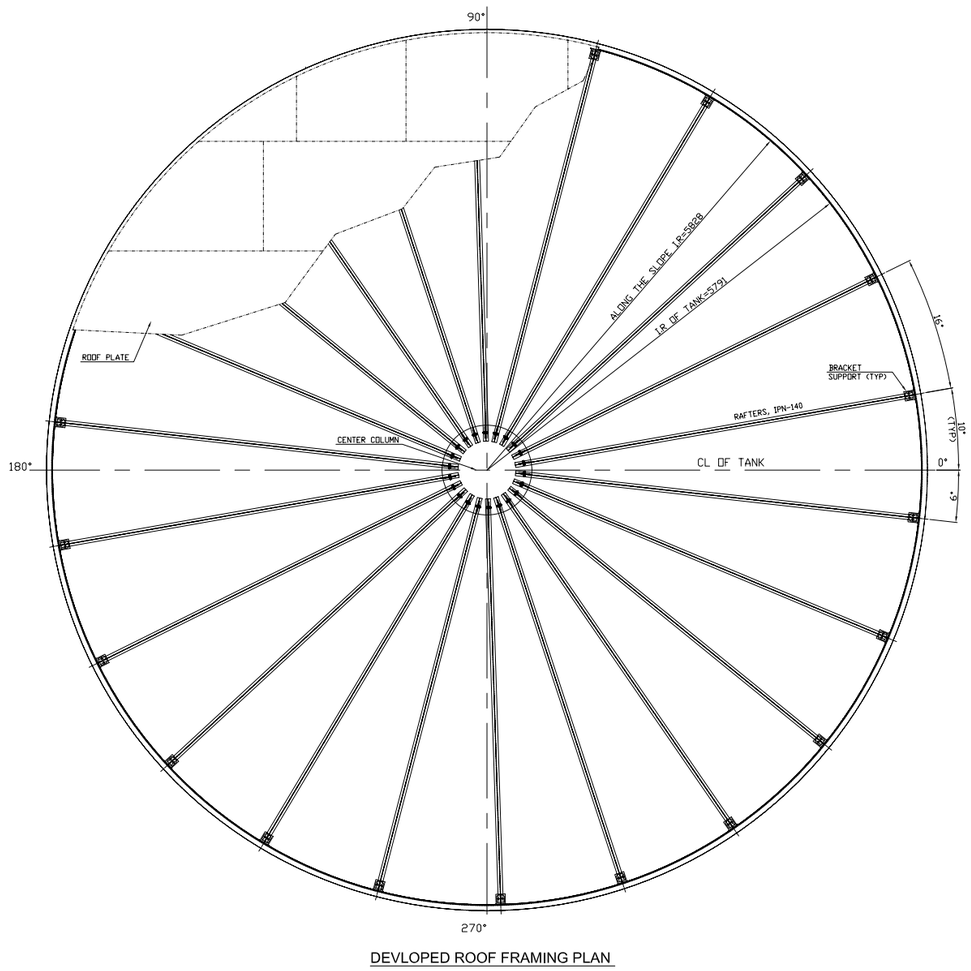
PETROCHEMICAL ENGINEERING CONSULTANTS
C-2, BLOCK NO. 17, GULSHAN-E-IQBAL, NEAR NATIONAL STADIUM, KARACHI-75300, PAKISTAN.
TEL. +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E-Mail: contact@pcec.com.pk web site: www.pcec.com.pk

CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

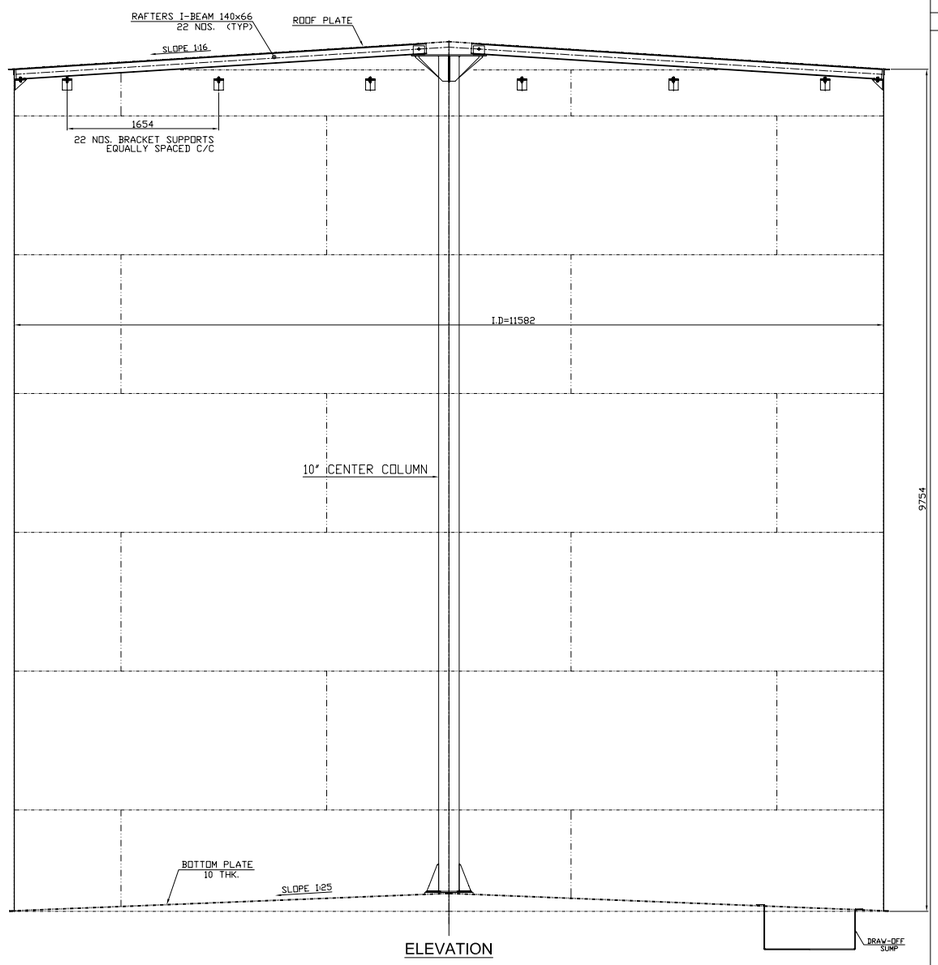
PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

TITLE : ROOF PLATES LAYOUT & DETAILS FOR CRUDE OIL TANK KT-01

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745-TK-ST-003	1 OF 1	–	A2	0



DEVLOPED ROOF FRAMING PLAN



ELEVATION

REFERENCE DRAWING	
DESCRIPTION	DWG. NO
RAFTERS & BRACKET DETAILS	XXX-TK-ST-XXX
CENTER COLUMN DETAILS	XXX-TK-ST-XXX

ISSUED FOR REVIEW

NOTES:

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25-11-16	ISSUED FOR REVIEW	S.F.R	BA	AJ

PETROCHEMICAL ENGINEERING CONSULTANTS
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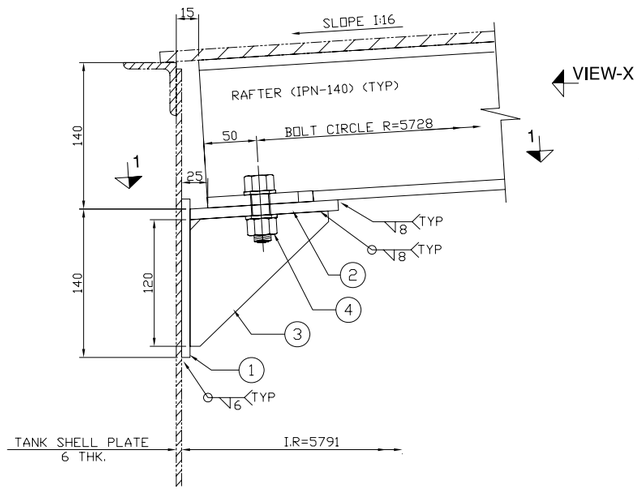
TEL. +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E-Mail: contact@pcec.com.pk web site: www.pcec.com.pk

CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

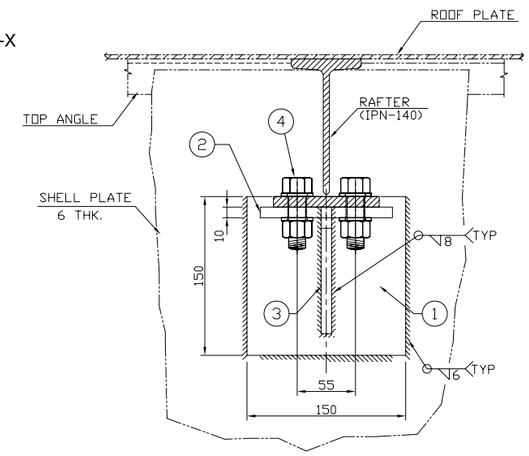
PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

TITLE : ROOF STRUCTURE LAYOUT FOR FOR CRUDE OIL TANK KT-01

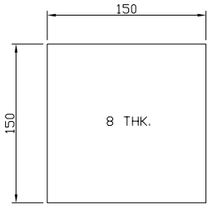
JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745-TK-ST-004	1 OF 1	–	A2	0



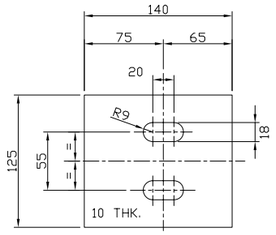
BRACKET SUPPORT DETAIL



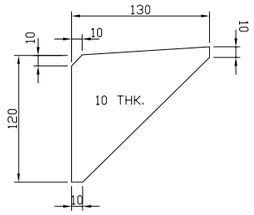
VIEW-X



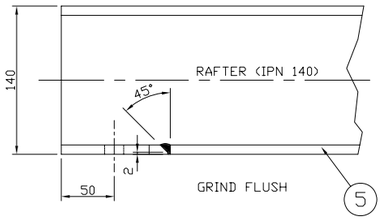
ITEM-1

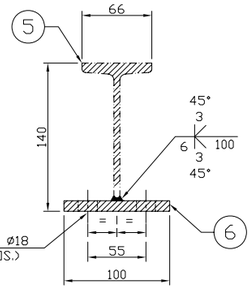


ITEM-2

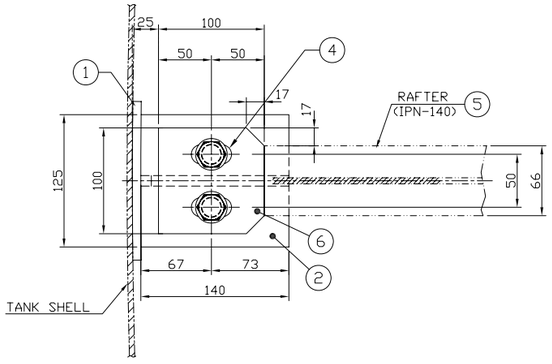


ITEM-3

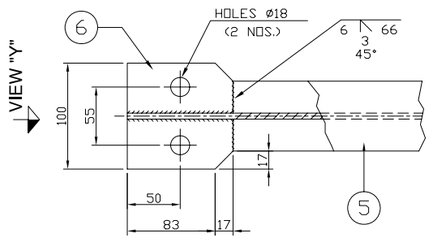




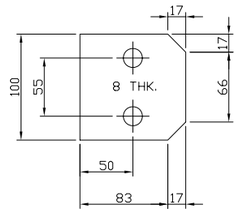
VIEW -Y



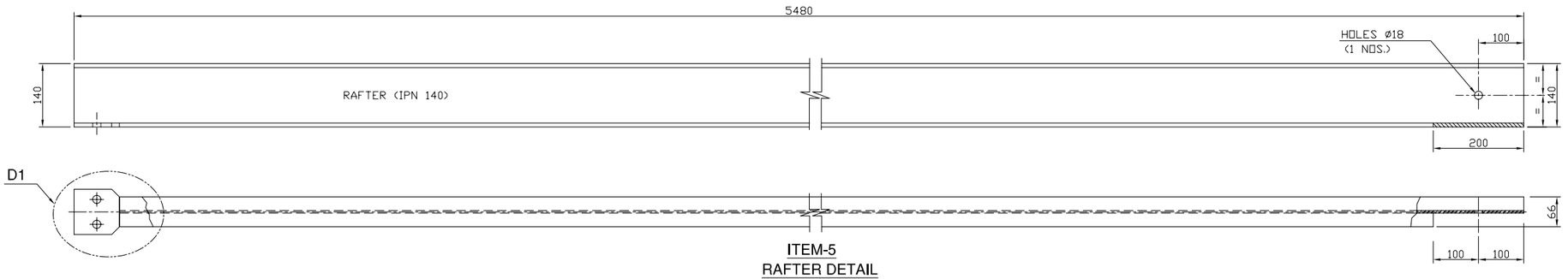
SECTION 1-1



DETAIL-D1



ITEM-6



ITEM-5
RAFTER DETAIL

NOTES:

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. GRIND ALL SHARP EDGES, REMOVE ALL BURRS AND WELD SPATTERS.
3. ALL DIMENSIONS & ORIENTATIONS TO BEVERIFIED BY THE CONTRACTOR BEFORE UNDERTAKING ANY KIND OF FABRICATION, CONSTRUCTION & INSTALLATION WORK AT SITE.

ISSUED FOR REVIEW

ITEM	DESCRIPTION	QTY.	MATERIAL	WEIGHT/UNIT	TOTAL WT.Kg.
6	PLATE 125x100x8 THK.	22	HR-235	62.8 Kg\m²	17
5	RAFTER IPN-140 x 5480 LONG	22	ASTM A36	14.3 Kg\m	1724
4	BOLT M16, 70 LG. WUTH NUT & TWO WASHER	44/SET	ASTM A307	–	–
3	GUSSET PLATE 10 THK.	22	HR-235	78.5 Kg\m²	16
2	PLATE 125x140x10 THK.	22	HR-235	78.5 Kg\m²	30
1	REINFORCING PLATE 150x150x8 THK.	22	HR-235	62.8 Kg\m²	31
					1818

BILL OF MATERIAL

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25-11-16	ISSUED FOR REVIEW	S.F.R	BA	AJ

PETROCHEMICAL ENGINEERING CONSULTANTS
C-2, BLOCK NO. 17, GULSHAN-E-IQBAL, NEAR NATIONAL STADIUM, KARACHI-75300. PAKISTAN.
TEL. +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E-Mail: contact@pcec.com.pk web site: www.pcec.com.pk

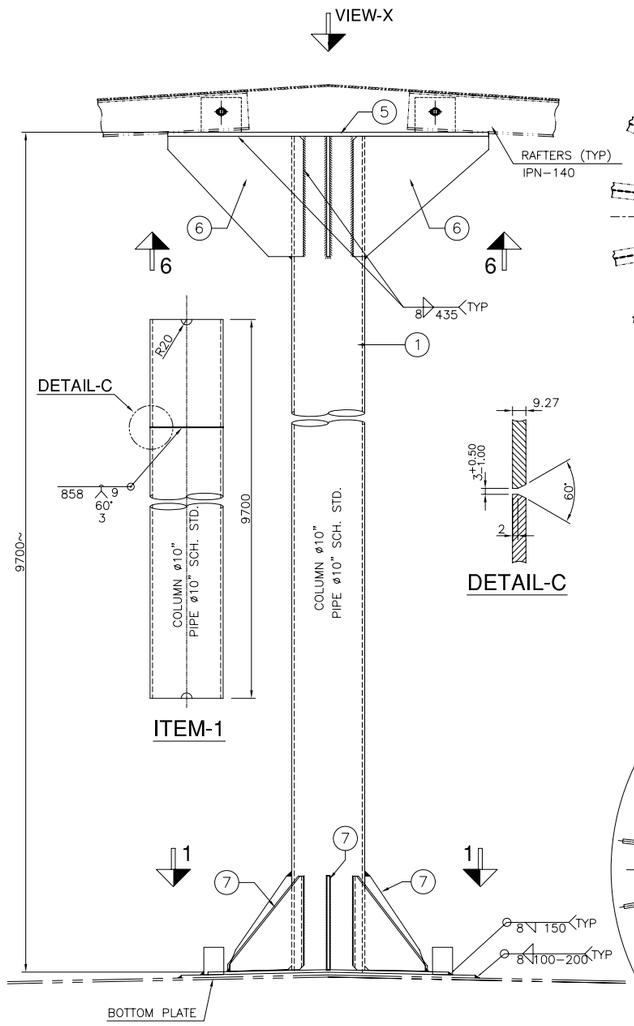
CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

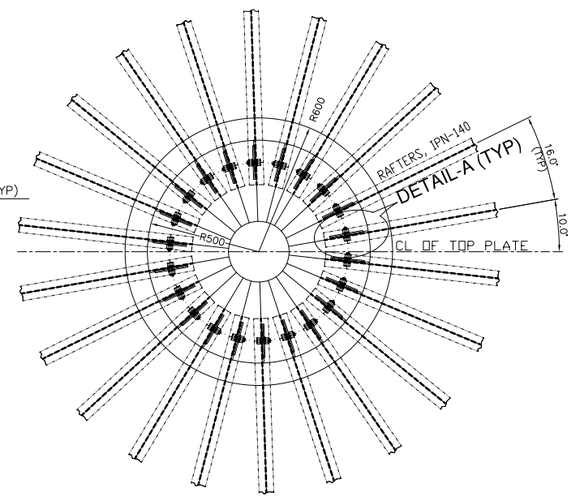
PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

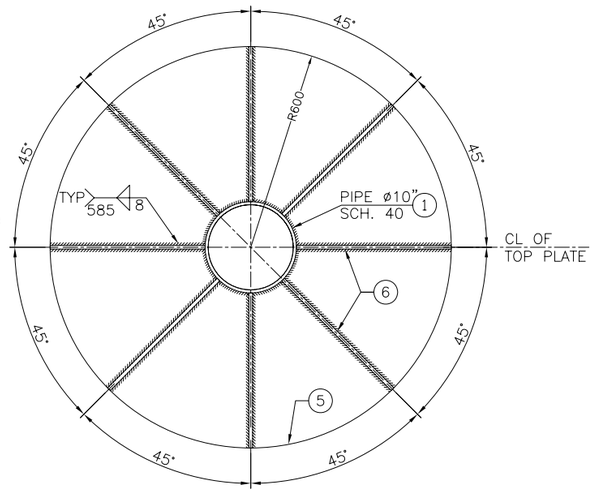
TITLE : BRACKET SUPPORT & RAFTER DETAIL FOR FOR CRUDE OIL TANK (DIA = 11.582 M , HT = 9.754 M)

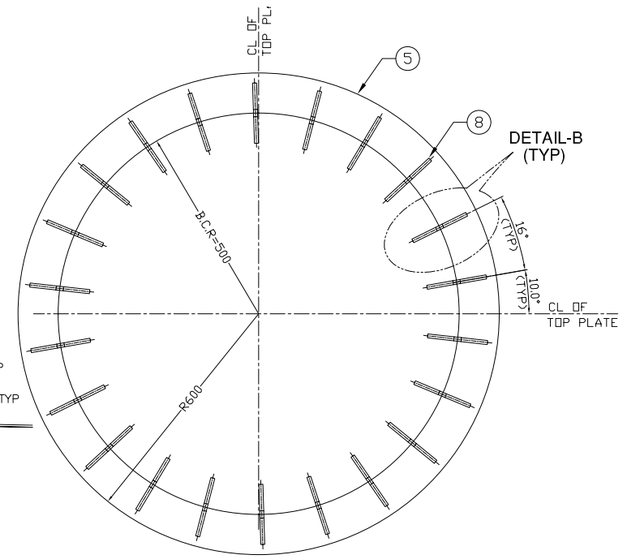
JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745-TK-ST-005	1 OF 1	–	A2	0

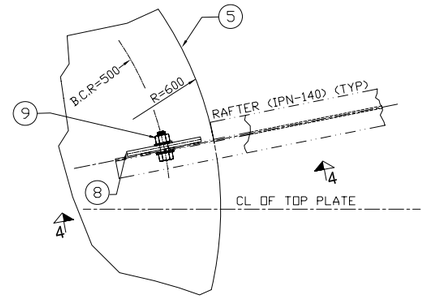
ITEM NO.	DESCRIPTION	QTY.	MATERIAL	UNIT/WT	TOTAL
9	BOLT M16x70 LONG WITH NUT & 2 WASHER	22/SET	ASTM A-307	–	–
8	CLEAT PLATE 130x150x10 THK.	22	PAK STEEL HR-235	78.5 Kg/m²	34
7	GUSSET PLATE 10 THK.	6	PAK STEEL HR-235	78.5 Kg/m²	25
6	GUSSET PLATE 10 THK.	8	PAK STEEL HR-235	78.5 Kg/m²	86
5	COLUMN TOP PLATE ø1000x16 THK	1	PAK STEEL HR-235	125.6 Kg/m²	142
4	COLUMN BASE PLATE 900x900x16 THK.	1	PAK STEEL HR-235	125.6 Kg/m²	102
3	BEARING PLATE 1100 x 1100 x 10 THK.	1	ASTM A-36	78.5 Kg/m²	95
2	BASE GUIDE L=70x70x10 (100 LONG)	4	ASTM A-36	10.30 Kg/m	4
1	PIPE ø273x9.27 STD. W.T , 9700 LONG	1	ASTM API 5L Gr B	60.31Kg/m²	585
				UNIT/WT	TOTAL
				TOTAL WT=1073 Kg.	

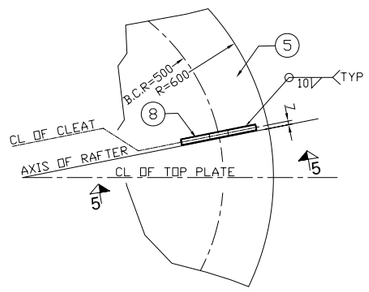


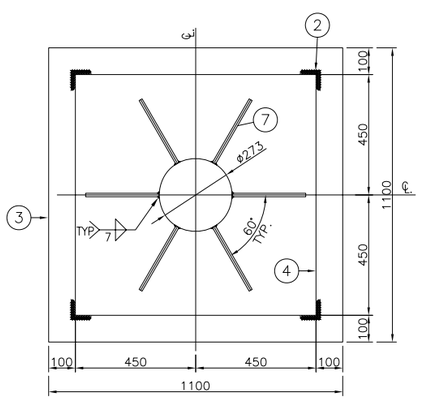


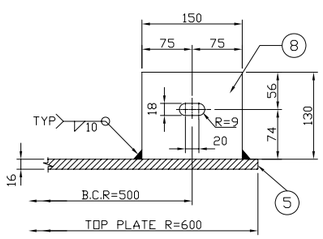


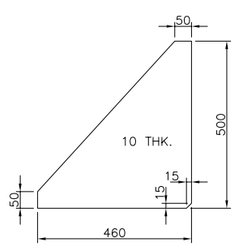


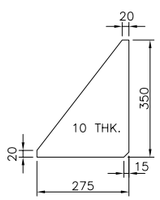


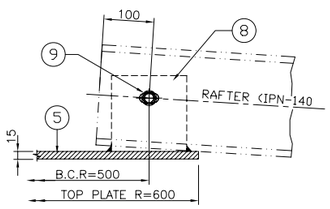












ISSUED FOR REVIEW

NOTES:

1. ALL DIMENSIONS ARE IN mm. UNLESS OTHERWISE STATED
2. ALL DIMENSIONS TO BE VERIFIED BY CONTRACTOR BEFORE START OF ANY FABRICATION WORK.

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25-11-16	ISSUED FOR REVIEW	S.F.R	BA	AJ

PETROCHEMICAL ENGINEERING CONSULTANTS
C-2, BLOCK NO. 17, GULSHAN-E-IQBAL, NEAR NATIONAL STADIUM, KARACHI-75300. PAKISTAN.
TEL. +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E-Mail: contact@pcec.com.pk web site: www.pcec.com.pk

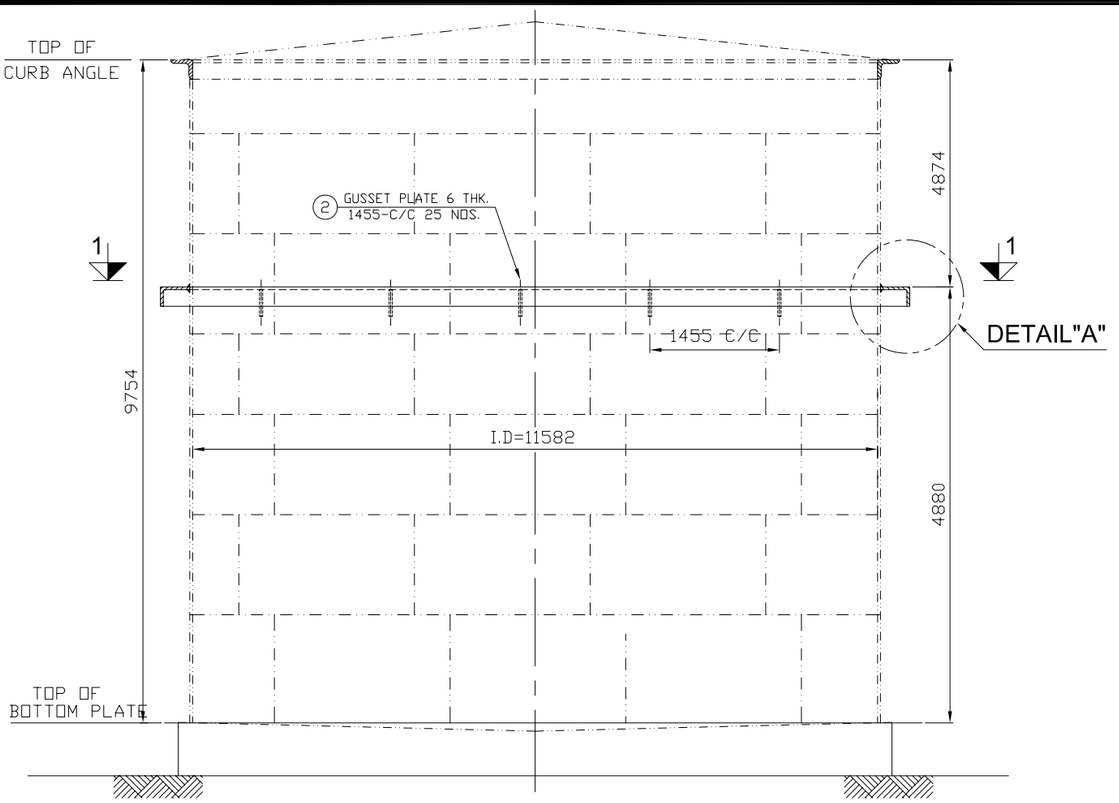
CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

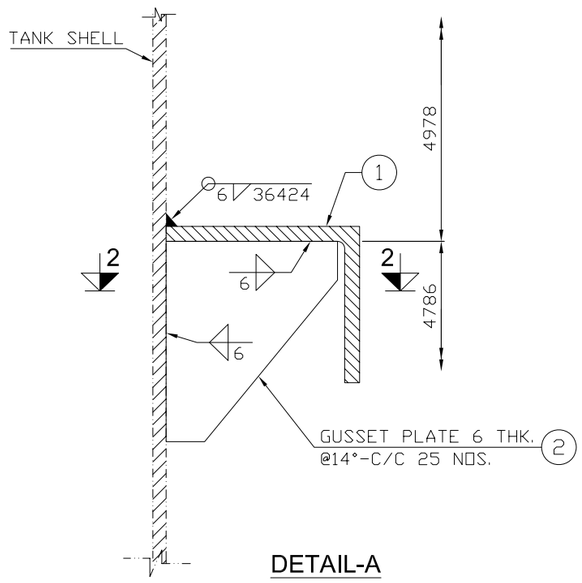
TITLE : Ø10" CENTER COLUMN DETAILS FOR FOR CRUDE OIL TANK (DIA = 11.582 M , HT = 9.754 M)

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745-TK-ST-006	1 OF 1	–	A2	0

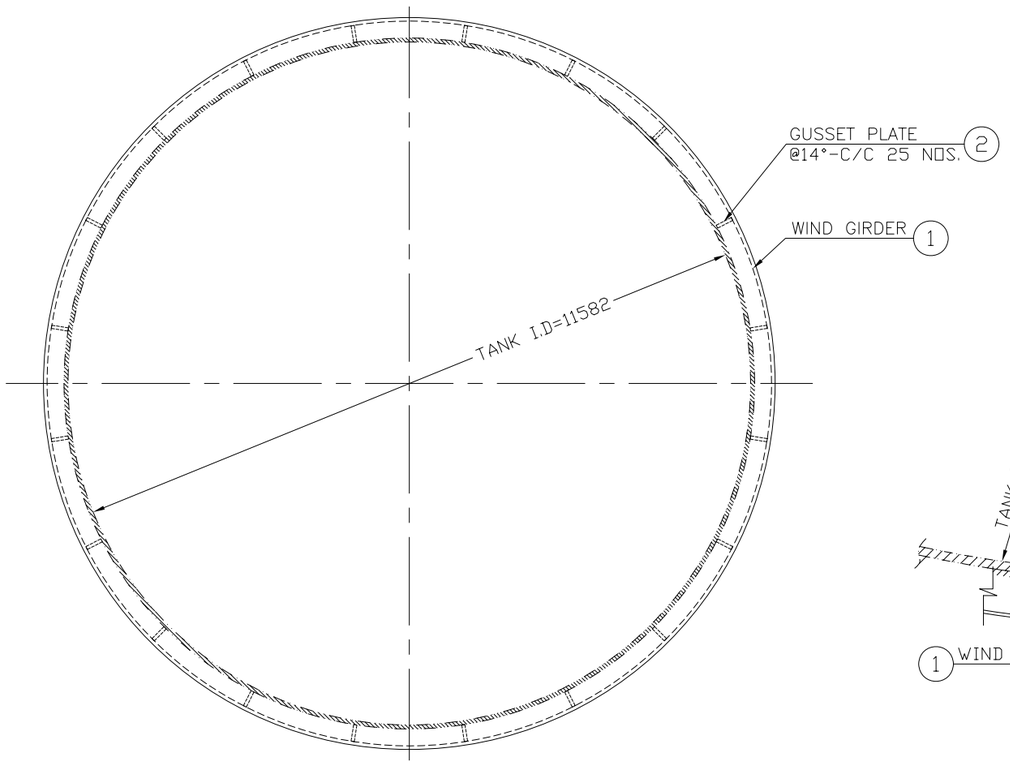
\\Farrukh\project\2016\OGDCL (THORA & KUNNAR TANK)\38 FT\KUNNAR OIL FIELD\2745-TK-ST-006 (Center Column).dwg Nov 25, 2016 - 6:22pm azeem



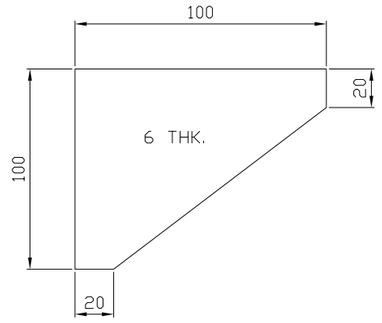
ELEVATION



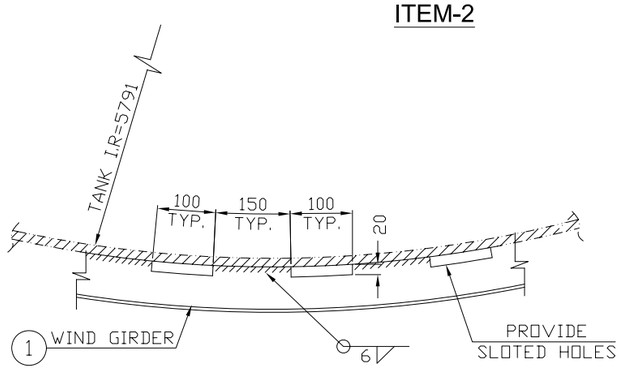
DETAIL-A



SECTION 1-1



ITEM-2



SECTION 2-2

ITEM	DESCRIPTION	QTY.	MATERIAL	WT./UNIT	TOTAL(Kg)
2	GUSSET PLATE 6 THK.	25	HR-235	47.1 Kg/m²	8
1	WIND GIRDER 3"x3"x1/4" THK.	37M	ASTM A36	6.85 Kg./m	253
				TOTAL WT(Kg)	261

BILL OF MATERIAL

ISSUED FOR REVIEW

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25-11-16	ISSUED FOR REVIEW	S.F.R	BA	AJ

PETROCHEMICAL ENGINEERING CONSULTANTS
C-2, BLOCK NO. 17, GULSHAN-E-IQBAL, NEAR NATIONAL STADIUM, KARACHI-75300. PAKISTAN.
TEL. +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E-Mail: contact@pcec.com.pk web site: www.pcec.com.pk

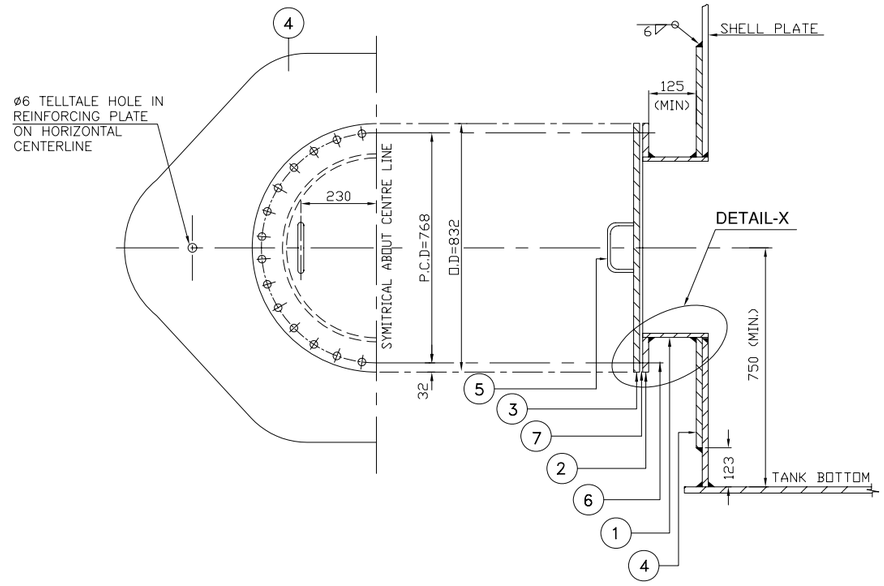
CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

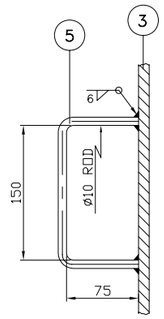
TITLE : WIND GIRDER DETAILS FOR FOR CRUDE OIL TANK

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745-TK-ST-007	1 OF 1	-	A2	0

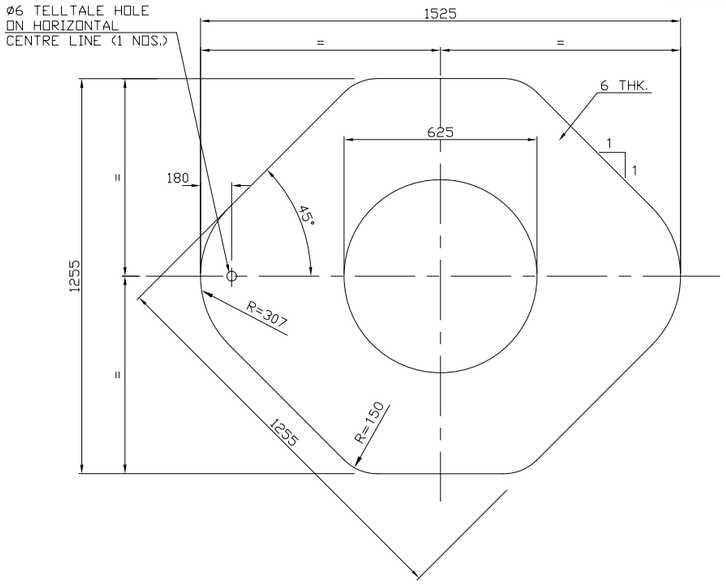
ITEM	DESCRIPTION	QTY.	MATERIAL	W.T/UNIT	TOTAL(Kg)
7	GASKET OD=746, ID=610, 3 THK.	1	NON ASBESTOS FILLED	-	-
6	STUD BOLTS WITH 2 NUTS (M20x80 LONG)	28	A 307	-	-
5	LIFTING LUGS (ø10x332 LONG ROD)	2	A 36	1.0 Kg/m	1
4	REINFORCING PLATE 6 THK.	1	HR-235	47.1 Kg/m^2	52
3	COVER PLATE ø832 x 11 THK.	1	A-283 Gr.C	86.35 Kg/m^2	47
2	BOLTING FLANGE OD=832 x ID=625 x11 THK.	1	A-283 Gr.C	86.35 Kg/m^2	20
1	NECK1935 x 150 x 6mm (ROLLED PLATE CYLINDER)	1	HR-235	47.1 Kg/m^2	14
				TOTAL WT.(Kg)	134



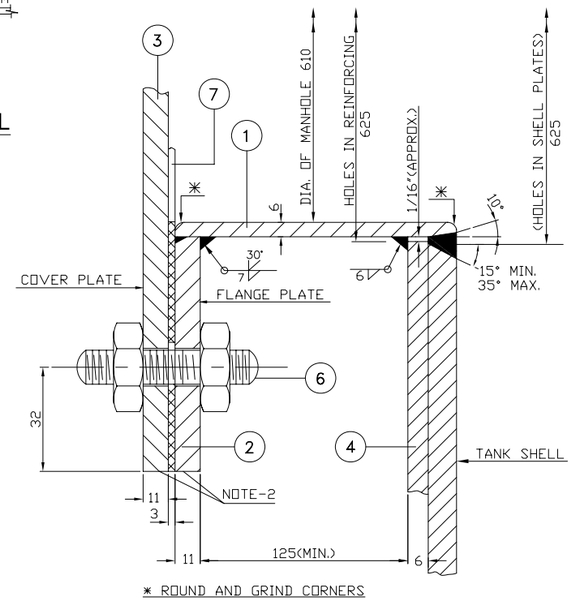
SHELL MANHOLE DETAIL



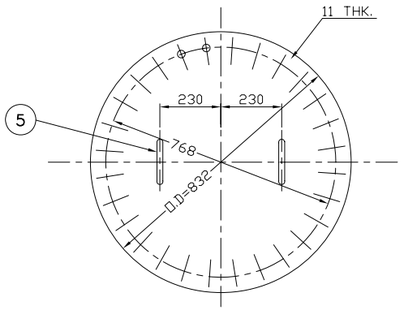
ITEM-5



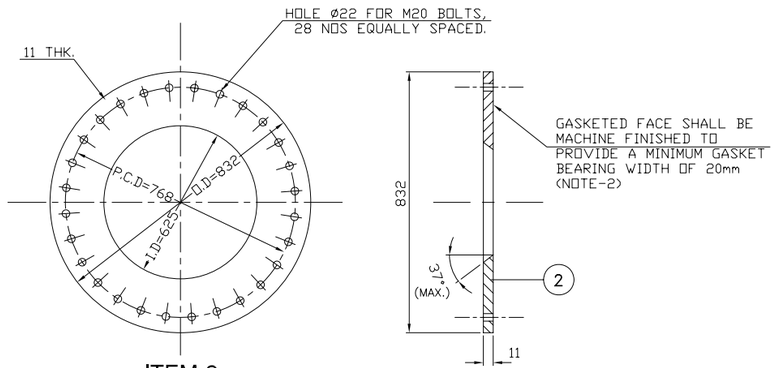
ITEM-4



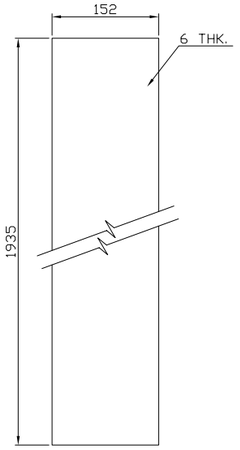
DETAIL-X



ITEM-3



ITEM-2



ITEM-1

ISSUED FOR REVIEW

NOTES:

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. 1mm - 1.5mm MACHINING ALLOWANCE SHALL BE CONSIDER FOR GASKET SEAT.

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25-11-16	ISSUED FOR REVIEW	S.F.R	BA	AJ

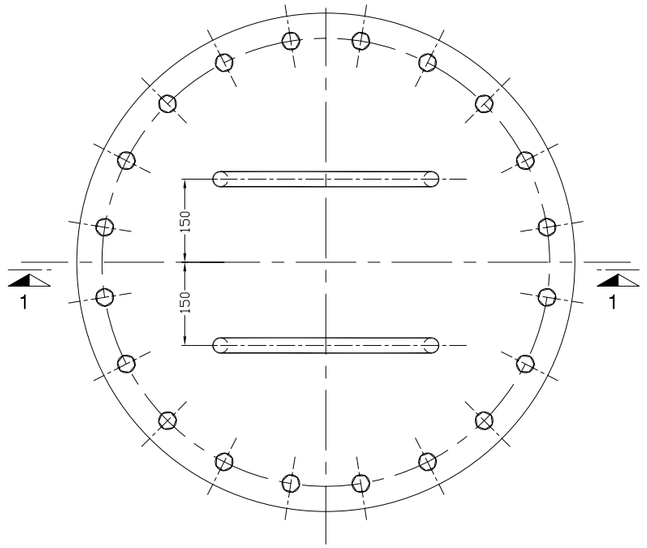
PETROCHEMICAL ENGINEERING CONSULTANTS
C-2, BLOCK NO. 17, GULSHAN-E-IQBAL, NEAR NATIONAL STADIUM, KARACHI-75300. PAKISTAN.
TEL. +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E-Mail: contact@pcec.com.pk web site: www.pcec.com.pk

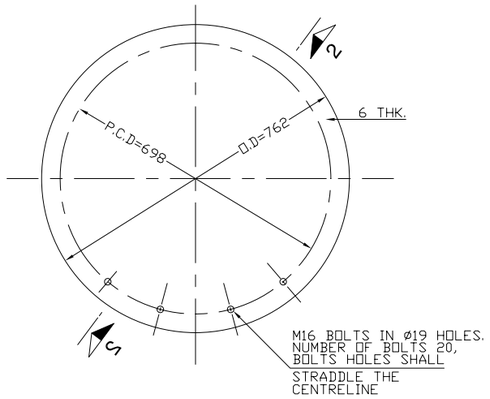
CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

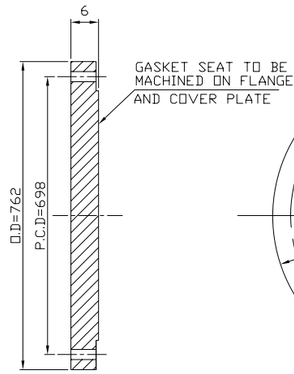
TITLE : SHELL MANHOLE DETAIL Ø24" FOR FOR CRUDE OIL TANK KT-01

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745-TK-APST-001	1 OF 1	-	A2	0

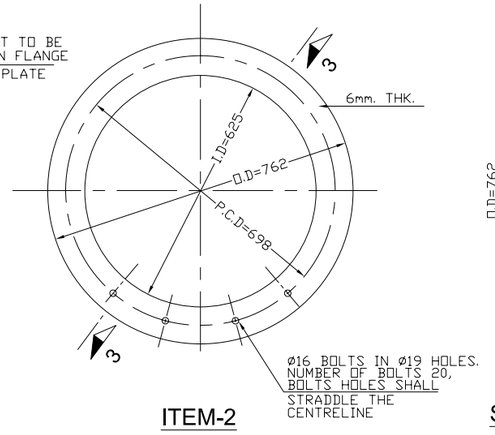




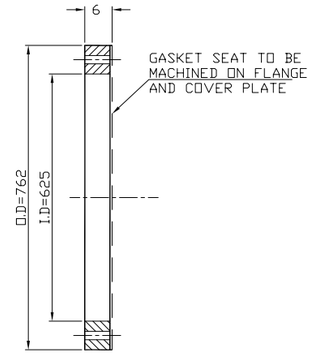
ITEM-3



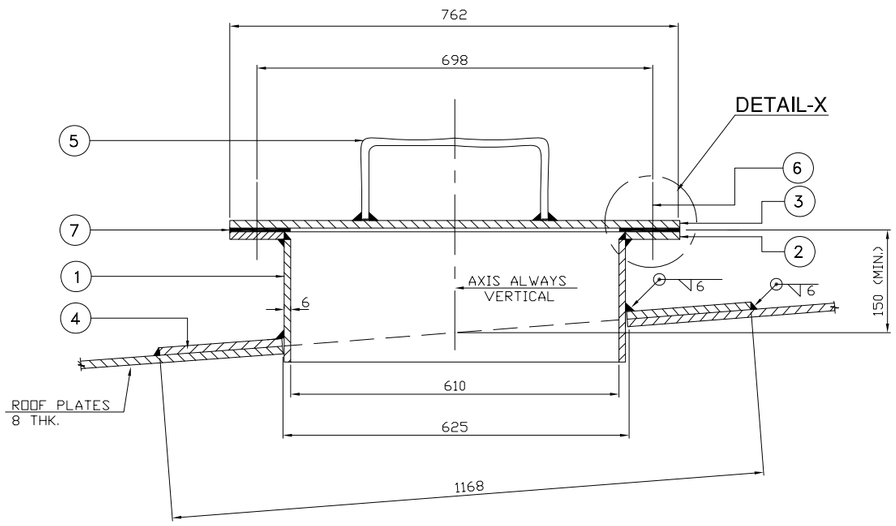
SECTION 2-2



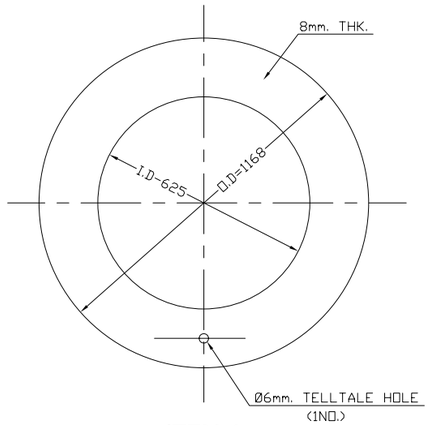
ITEM-2



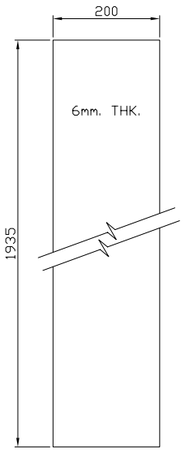
SECTION 3-3



SECTION 1-1



ITEM-4



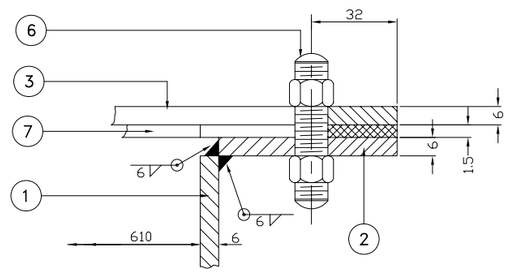
ITEM-1

7	GASKETS, (O.D=762 x I.D=610)	1	C.A.F	-	-
6	STUD BOLTS WITH 2 NUTS (M16 x 60 LONG)	20 Sets.	ASTM A 193 Gr.B7 ASTM A 194 Gr.2H	15.6 Kg/100 PC.	3
5	LIFTING LUGS,ROD ø 16	2	ASTM A-36	1.5 Kg/m.	1
4	REINFORCING PLATE 8 THK	1	PAK STEEL HR-235	62.8 Kg/m^2	39
3	COVER PLATE, 6 THK.	1	PAK STEEL HR-235	47.1 Kg/m^2	21
2	BOLTING FLANGE 6 THK.	1	PAK STEEL HR-235	47.1 Kg/m^2	7
1	NECK PLATE 1935x200x6mm. THK (ROLLED PLATE CYLINDER)	1	PAK STEEL HR-235	47.1 Kg/m^2	18
ITEM	DESCRIPTION	QTY.	MATERIAL	UNIT/W.T	TOTAL(Kg)
				TOTAL WT.(Kg)	89

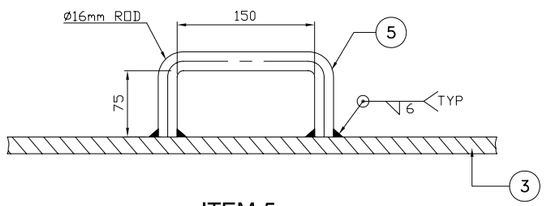
ISSUED FOR REVIEW

NOTE:

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.



DETAIL - X



ITEM-5

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25-11-16	ISSUED FOR REVIEW	S.F.R	BA	AJ

PETROCHEMICAL ENGINEERING CONSULTANTS
C-2, BLOCK NO. 17, GULSHAN-E-IQBAL, NEAR NATIONAL STADIUM, KARACHI-75300. PAKISTAN.
TEL. +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E-Mail: contact@pcec.com.pk web site: www.pcec.com.pk

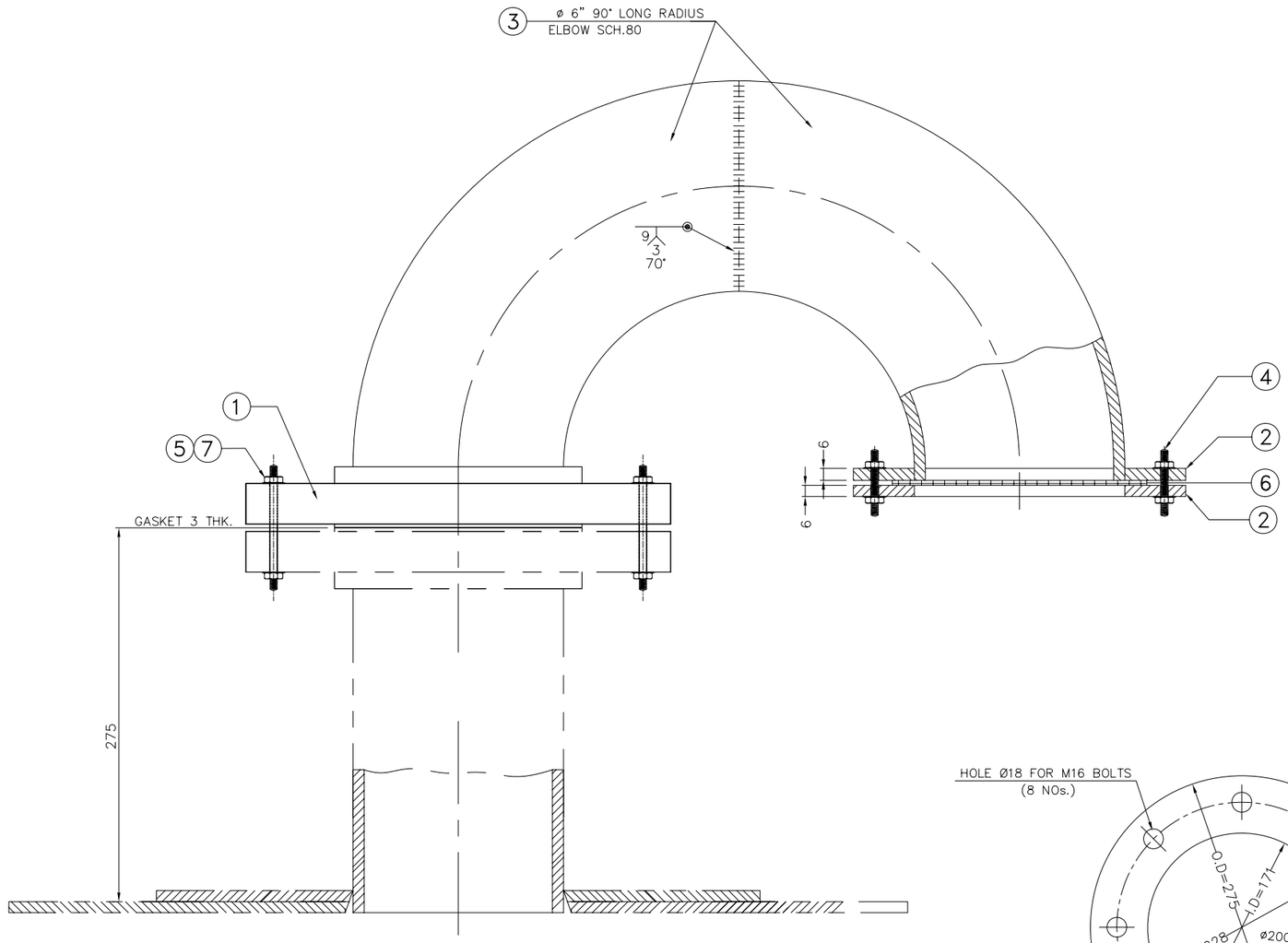
CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

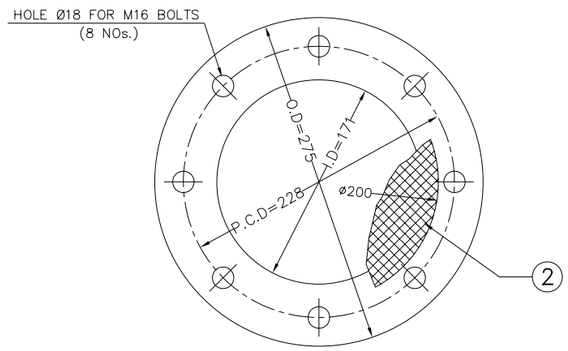
TITLE : ROOF MANHOLE DETAIL Ø24" FOR FOR CRUDE OIL TANK KT-01

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745-TK-APST-002	1 OF 1	-	A2	0

ITEM	DESCRIPTION	QTY.	MATERIAL	UNIT/W.T	TOTAL(Kg)
7	GASKET 1/8" TH.	1	NON ASBESTOS	–	–
6	ALUMINIUM EXPANDED METEL SCREEN	1	–	–	–
5	STUD–BOLTS M16x100 LONG WITH 2 NUTS & WASHER	8	ASTM A 307 OR EQUIVALENT	21.0 Kg/100 pc	2
4	STUD–BOLTS M16x70 LONG WITH TOW NUTS & WASHER	8	ASTM A 307 OR EQUIVALENT	15.6 Kg/100 pc	2
3	ELBOW 6"NPS, 90° SCH.40	2	ASTM A234 GR. WPB ANSI B 16.5	10.43 Kg/pc	8
2	PLATE FLANGE O.D 275, I.D 171X6 THK	2	PAK. STEEL HR–235	47.1 Kg/m^2	3
1	FLANGE 6"NPS, 150#, S.0, RF.	1	ASTM A105 ANSI B16.5 CLASS 150#	8.62 Kg/m^2	7
				TOTAL WT.(Kg) 22	



VENT NOZZLE



FLANGE PLATE
ITEM-2

ISSUED FOR REVIEW

NOTE:

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25–11–2016	ISSUED FOR REVIEW	S.F.R	BA	AJ

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TEL. +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E–Mail: contact@pcec.com.pk web site: www.pcec.com.pk

CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

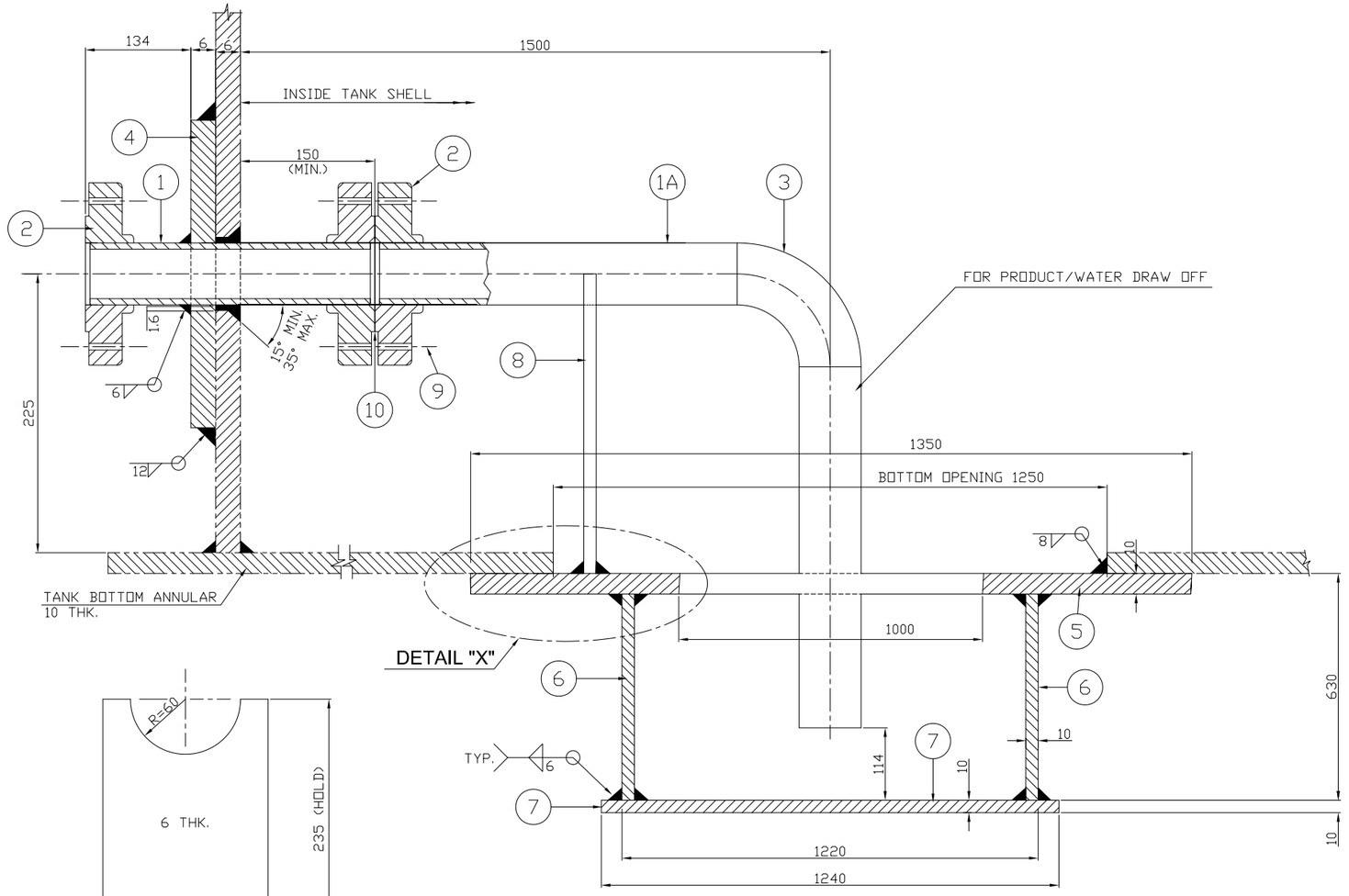
PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

TITLE : Ø6" FREE VENT DETAILS FOR FOR CRUDE OIL TANK KT-01

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745–TK–APST–003	1 OF 1	–	A2	0

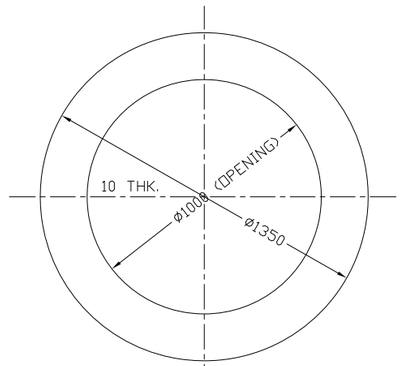
ITEM NO	DESCRIPTION	QTY.	MATERIAL	WEIGHT/UNIT	TOTAL WT. Kg.
10	GASKET Ø4" #150 R.F x 3mm THK.	1	NON ASBESTOS	–	–
9	STUD BOLT M16x100 LONG WITH 2 NUTS	8	ASTM A 193 Gr.B7 ASTM A 194 Gr.2H	21 kg/100 Pcs	2
8	SUPPORT PLATE, 6 THK.	1	PAK STEEL HR-235	47.1 Kg/m²	2
7	SUMP BOTTOM PLATE Ø1240, 10 THK.	1	PAK STEEL HR-235	78.50 Kg/m²	98
6	SUMP SHELL PLATE, 3802x620x10 THK.	1	PAK STEEL HR-235	78.50 Kg/m²	185
5	TOP RING PLATE Ø1050x10 THK.	1	PAK STEEL HR-235	78.50 Kg/m²	51
4	REINFORCING PLATE OD=305, I.D=117, 6 THK.	1	ASTM A36	125.6 Kg/m²	3
3	ELBOW 90° L.R Ø4" STD.WT.	1	ASTM A-234 Gr.B	5.49 kg/Pc	4
2	S.O. FLANGE Ø4" 150#,R.F	3	ASTM A-105	5.9 Kg/Pc	18
1A	PIPE Ø4" Sch. 40 x 1500mm LONG	1	ASTM A-106 GrB	22.9 Kg/m	34
1	PIPE Ø4" Sch. 80 x 350mm LONG	1	ASTM A-106 GrB	16.06 Kg/m	6

DIA 4" DRAW OFF SUMP. TOTAL WT. (KG.) = 403 Kg.

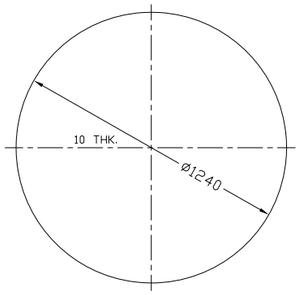


DRAW-OFF SUMP (C1)

SUPPORT PLATE
ITEM-8



SUMP TOP RING PLATE
ITEM-5

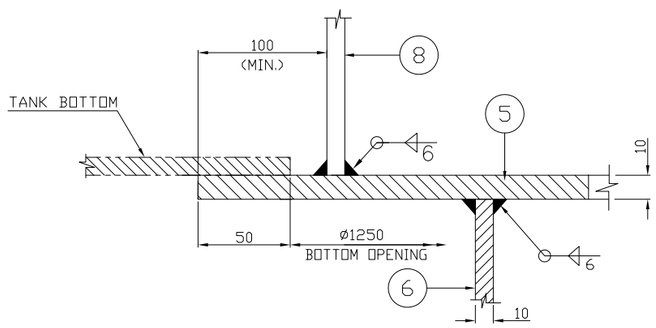


SUMP BOTTOM PLATE
ITEM-7

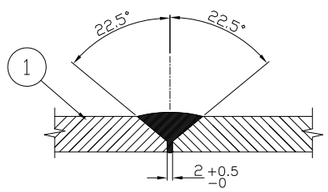
ISSUED FOR REVIEW

NOTES:

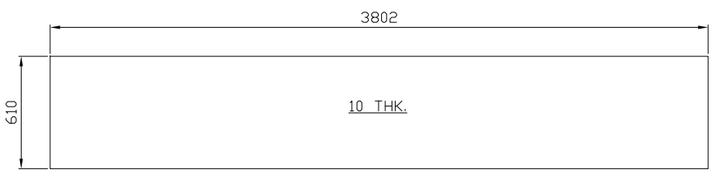
1. ALL DIMENSIONS ARE IN m.m. UNLESS OTHERWISE STATED.
2. PIPE LENGHT TO BE ADJUSTED AS PER SITE CONDITION.
3. DESIGN AND DRAWING IS IN ACCORDANCE WITH API–650. 12TH EDITION.
4. THE SUMP LOCATION TO BE VERIFIED AND FINALIZED AS PER THE SUMP DRAIN ORIENTATION.



DETAIL-X



WELDING DETAIL
OF PIPE JOINT



SUMP SHELL PLATE DETAIL
ITEM-6

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25–11–2016	ISSUED FOR REVIEW	S.F.R	BA	AJ

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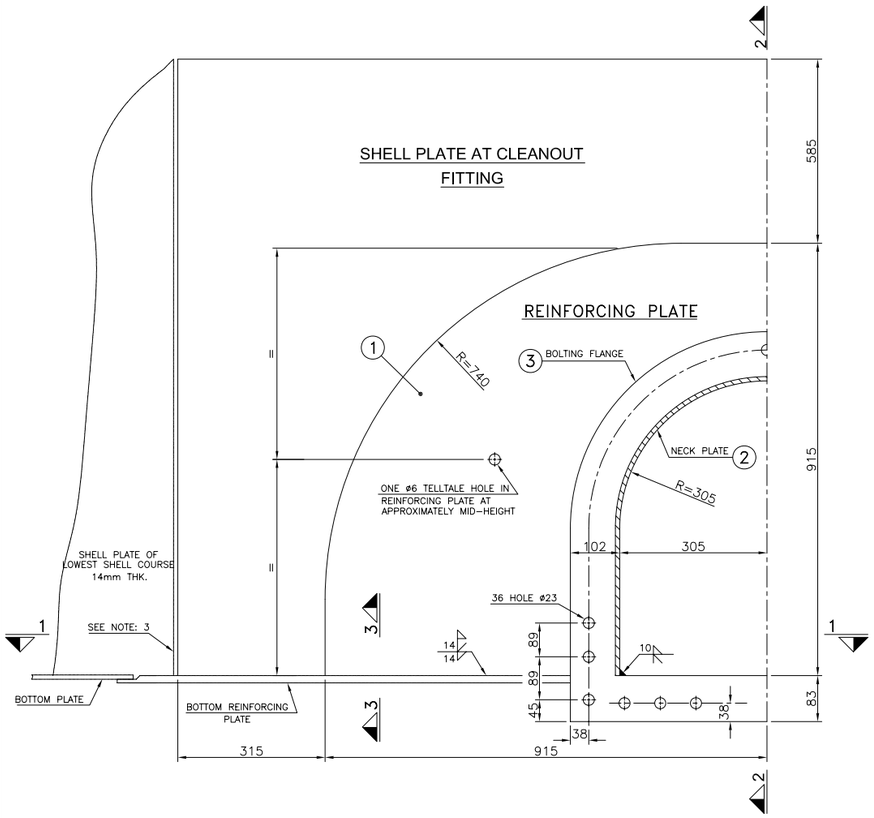
TEL +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E–Mail: contact@pcec.com.pk web site: www.pcec.com.pk

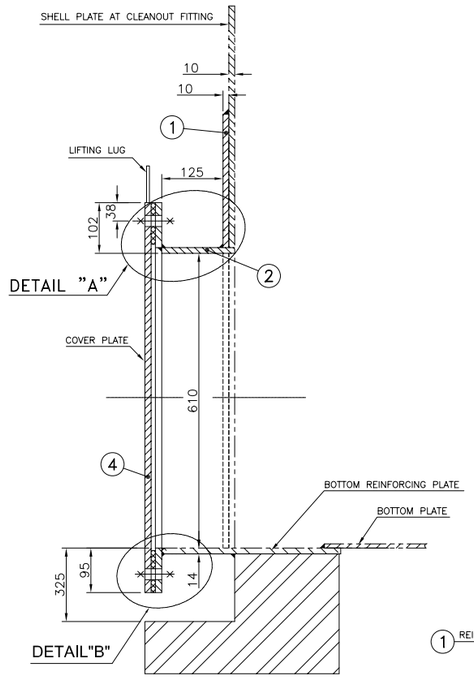
CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

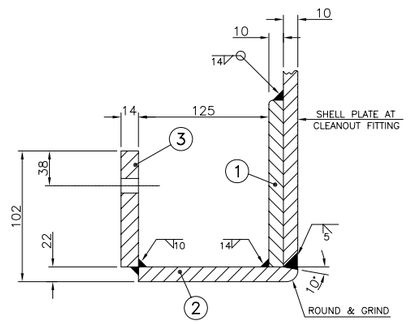
TITLE : Ø4" DRAW OFF NOZZLE & SUMP DETAILS FOR CRUDE OIL TANK KT-01

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745–TK–APST–004	1 OF 1	–	A2	0

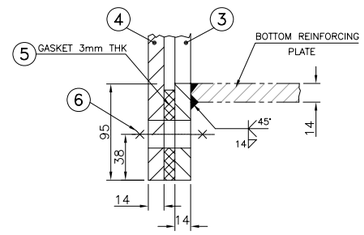




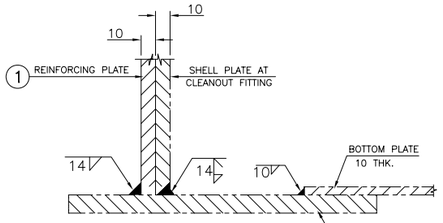
SECTION 2-2



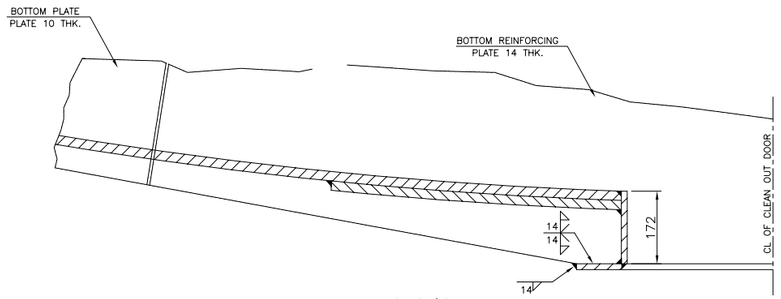
DETAIL-A



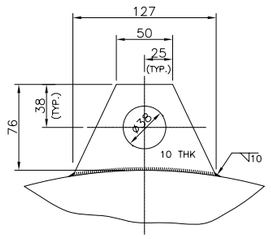
DETAIL-B



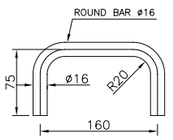
SECTION 3-3



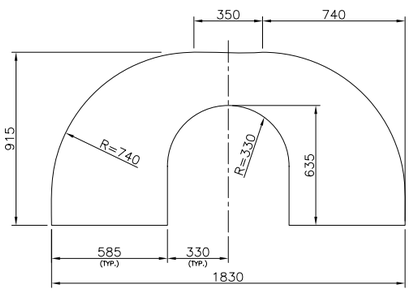
SECTION 1-1



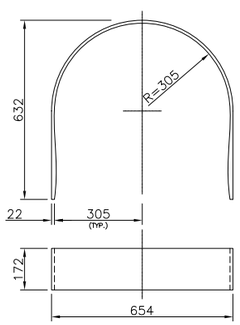
ITEM-8
DETAIL OF LIFTING LUG



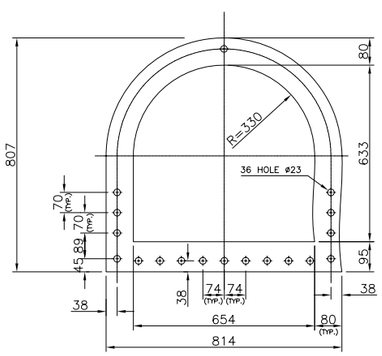
ITEM-7



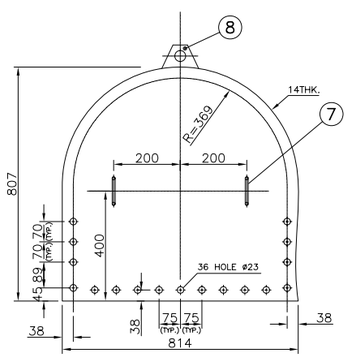
DETAIL OF REINFORCING PLATE
ITEM-1



DETAIL OF NECK PLATE
ITEM-2



DETAIL OF BOLTING FLANGE
ITEM-3



DETAIL OF COVER PLATE
ITEM-4

ITEM	DESCRIPTION	QTY.	MATERIAL	WT./UNIT	TOTAL(Kg)
8	LIFTING LUG	1	A-36	0.4 Kg/PC	–
7	HANDLE ROUND BAR ø16x310 LONG	2	A-36	0.49 Kg/PC	1
6	STUD BOLTS WITH TWO NUT & WASHER M20X110 LONG	36	ASTM A93 Gr. B7 ASTM A194 Gr. 2H	38.7 Kg/100 PC	14
5	GASKET	1	NON ASBESTOS FILLED	–	–
4	COVER PLATE 14THK.	1	A-36	109.9 Kg./m²	64
3	BOLTING FLANGE 14THK.	1	A-36	109.9 Kg./m²	24
2	NECK PLATE 10 THK.	1	A-36	78.5 Kg./m²	22
1	REINFORCING PLATE 10 THK.	1	A-36	78.5 Kg./m²	84
				TOTAL WT(Kg)	210

BILL OF MATERIAL

ISSUED FOR REVIEW

NOTES:

1. ALL DIMENSIONS ARE IN mm. UNLESS OTHERWISE STATED.
2. COMPLETE D-DOOR ASSEMBLY SHALL BE FEBRICATED WITH SHELL PLATE AND COMPLETE ASSEMBLY SHALL BE STRESS RELIEVE PRIOR TO WELDING WITH SHELL.

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25-11-16	ISSUED FOR REVIEW	S.F.R	BA	AJ

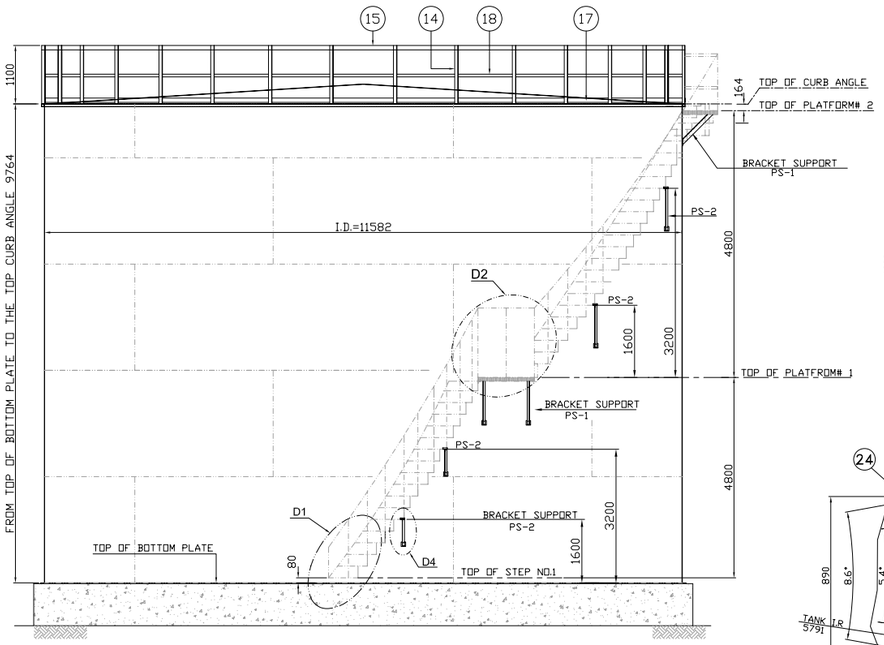
PETROCHEMICAL ENGINEERING CONSULTANTS
C-2, BLOCK NO. 17, GULSHAN-E-IQBAL, NEAR NATIONAL STADIUM, KARACHI-75300. PAKISTAN.
TEL: +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E-Mail: contact@pcec.com.pk web site: www.pcec.com.pk

CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

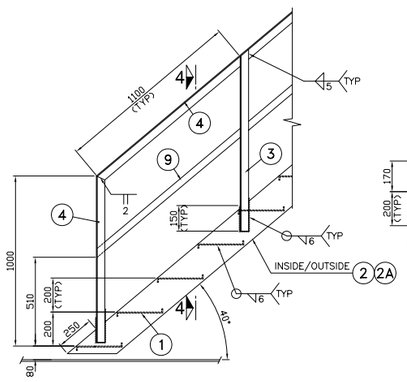
PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

TITLE : 24x24" FLUSH TYPE CLEANOUT DOOR FOR FOR CRUDE OIL TANK KT-01

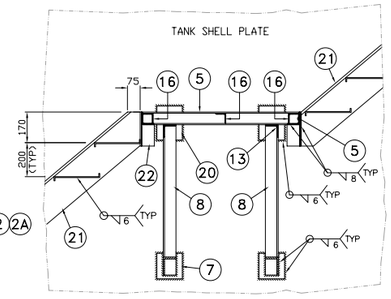
JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745-TK-APST-005	1 OF 1	–	A2	0



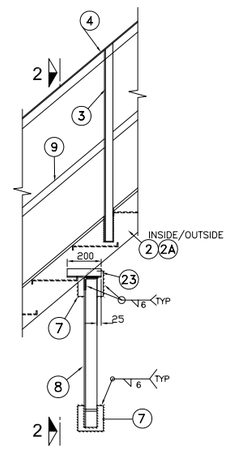
ELEVATION



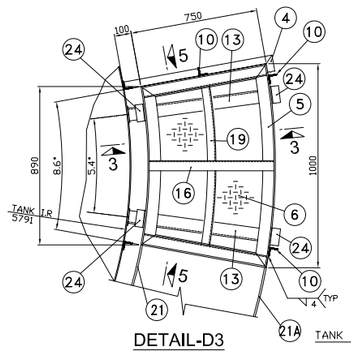
DETAIL-D1



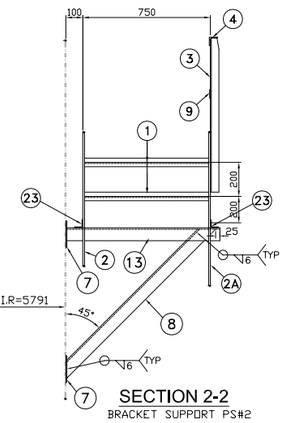
DETAIL-D2



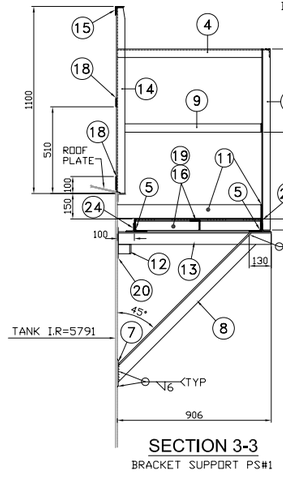
DETAIL-D4
BRACKET SUPPORT PS#2



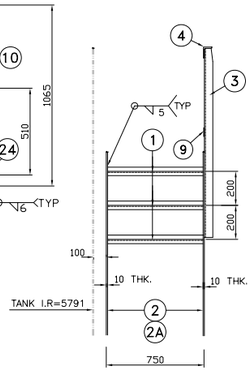
DETAIL-D3



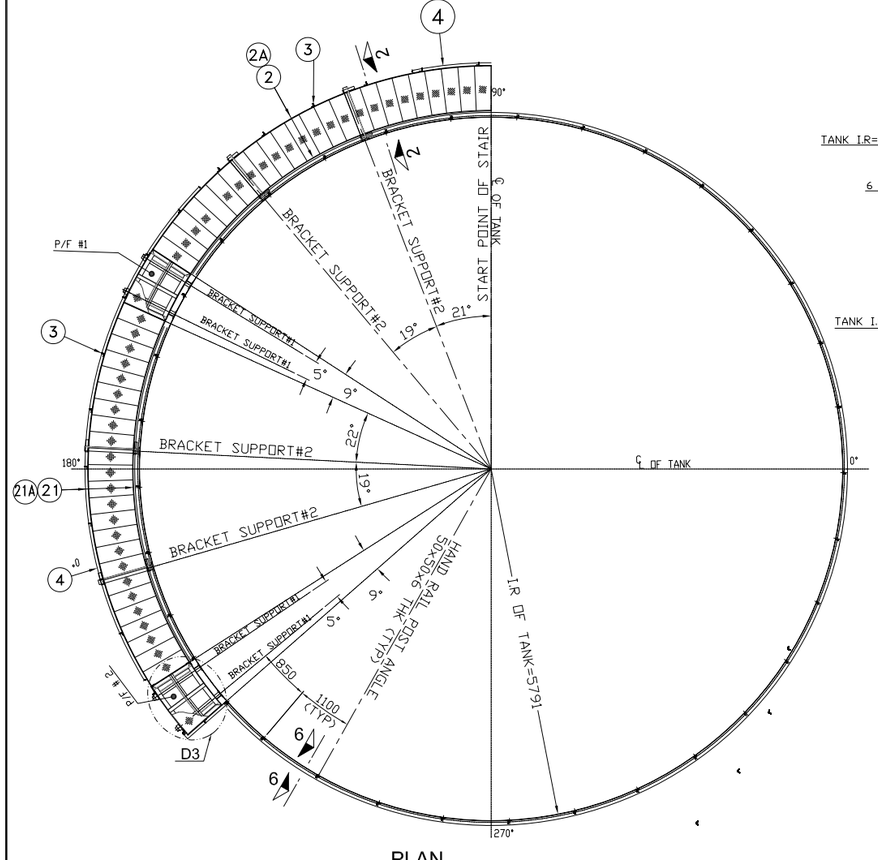
SECTION 2-2
BRACKET SUPPORT PS#2



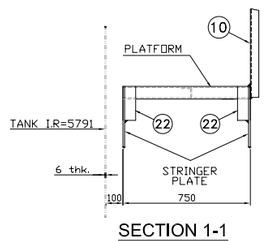
SECTION 3-3
BRACKET SUPPORT PS#1



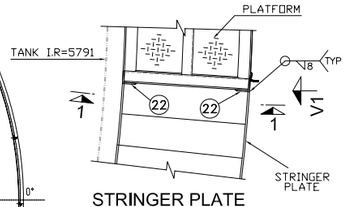
SECTION 4-4



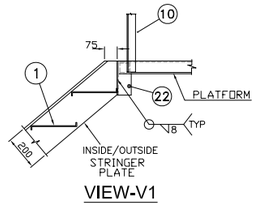
PLAN
FOR ORIENTATION SEE G.A DWG.



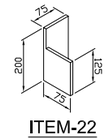
SECTION 1-1



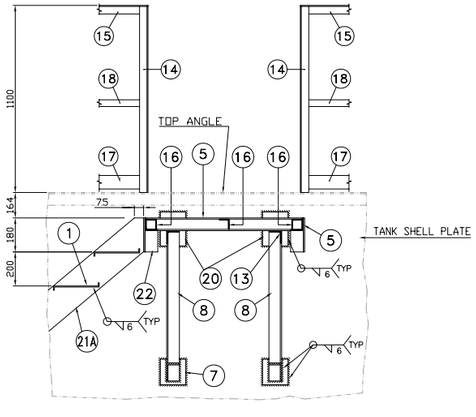
STRINGER PLATE CONNECTION DETAIL



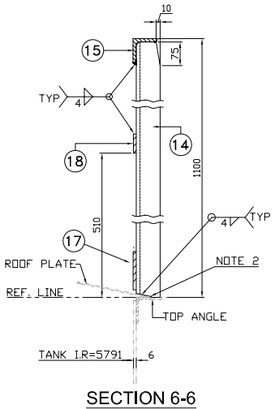
VIEW-V1



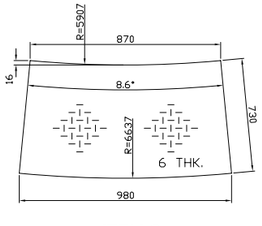
ITEM-22
CUTTING FOR LEFT OR RIHT SIDE ADJUSTED AT SITE



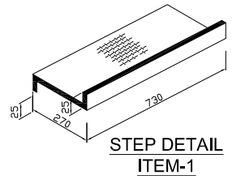
SECTION 5-5



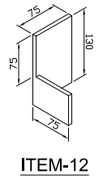
SECTION 6-6



ITEM-6



STEP DETAIL
ITEM-1



ITEM-12
CUTTING FOR LEFT OR RIHT SIDE ADJUSTED AT SITE

24	ANGLE 50x50x6 THK. 100 LG.	8	ASTM A36	4.47 Kg/m	4
23	ANGLE 50x50x6 THK. 200 LG.	8	ASTM A36	4.47 Kg/m	7
22	ANGLE 75X75X8 THK. 200 LONG	4	ASTM A36	8.99 Kg/m	7
21A	OUTER STRINGER PLATE 8850x180x10 THK.	1	HR-235	78.5 Kg/m²	125
21	INNER STRINGER PLATE 7850x180x10 THK.	1	HR-235	78.5 Kg/m²	111
20	REINFORCING PLATE 200x150x6 THK.	4	HR-235	47.1 Kg/m²	6
19	ANGLE 60x60x6 THK. 810 LG.	2	ASTM A36	5.42 Kg/m	9
18	KNEE BAR 40x4 THK. (AT ROOF)	36m	HR-235	1.25 Kg/m	45
17	TOE BAR 80x4 THK. (AT ROOF)	36m	HR-235	2.51 Kg/m	90
16	ANGLE 60x60x6 THK. 735 LONG	2	ASTM A36	5.42 Kg/m	12
15	HANDRAIL, ANGLE 50x50x6 THK. (AT ROOF)	36m	ASTM A36	4.47 Kg/m	161
14	POST, ANGLE 50x50x6 THK. 1100 LONG	34	ASTM A36	4.47 Kg/m	167
13	ANGLE 75x75x8 THK. 900 LONG	8	ASTM A36	8.99 Kg/m	65
12	CLEAT ANGLE 75X75X8 THK. 130 LONG	4	ASTM A36	8.99 Kg/m	5
11	TOE BAR 80x4 THK.	3m	HR-235	2.51Kg/m	8
10	POST, ANGLE 50x50x6 THK. 1065 LONG	5	ASTM A36	4.47 Kg/m	24
9	KNEE BAR (FOR STAIR) 50x4 THK.	21m	HR-235	1.57 Kg/m	33
8	ANGLE 75x75x8 THK. 1165 LONG	8	ASTM A36	8.99 Kg/m	84
7	PLATE 150x150x6 THK.	12	HR-235	1.0Kg/Pc	12
6	CHEQUERED PLATE, (FOR PLATFORM SEE DETAIL)	2	HR-235	47.1 Kg/m²	64
5	ANGLE 75x75x8 THK.	7m	ASTM A36	8.99 Kg/m	63
4	STAIR HANDRAIL, ANGLE 50x50x6 THK.	21m	ASTM A36	4.47 Kg/m	94
3	POST, ANGLE 50x50x6 THK. 1170 LONG	13	ASTM A36	4.47 Kg/m	68
2A	OUTER STRINGER PLATE 8605x180x10 THK.	1	HR-235	78.5 Kg/m²	121
2	INNER STRINGER PLATE 7635x180x10 THK.	1	HR-235	78.5 Kg/m²	107
1	CHEQUERED PLATE, 730x320x6 THK. (FOR STEP SEE DETAIL)	48	HR-235	47.1 Kg/m²	528
ITEM	DESCRIPTION	QTY.	MATERIAL	W.T/UNIT	TOTAL(Kg)
				TOTAL WT. 2020 Kg.	

NOTE:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. ALL DIMENSIONS, ELEVATIONS AND ORIENTATIONS TO BE VERIFIED BY THE CONTRACTOR BEFORE UNDERTAKING ANY KIND OF FABRICATION WORK AT SITE.
3. NOTCH SHALL BE CUT TO PROVIDE CLEARANCE FOR ROOF PLATE IN ITEM NO.14
3. GRIND ALL SHARP EDGES, REMOVE ALL BURRS AND WELD SPATTERS.

ISSUED FOR REVIEW

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25-11-16	ISSUED FOR REVIEW	S.F.R	BA	AJ

PETROCHEMICAL ENGINEERING CONSULTANTS
C-2, BLOCK NO. 17, GULSHAN-E-IQBAL, NEAR NATIONAL STADIUM, KARACHI-75300. PAKISTAN.
TEL. +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E-Mail: contact@pce.com.pk web site: www.pce.com.pk

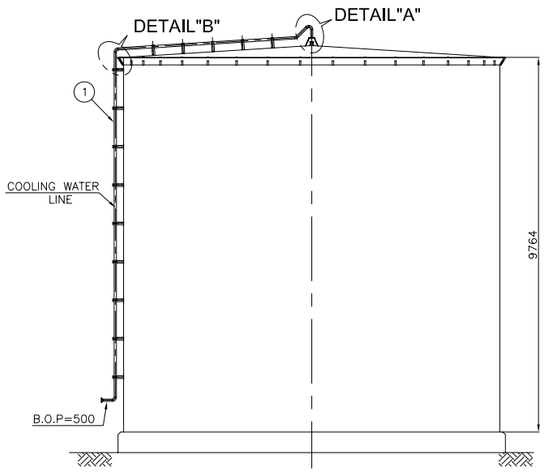
CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

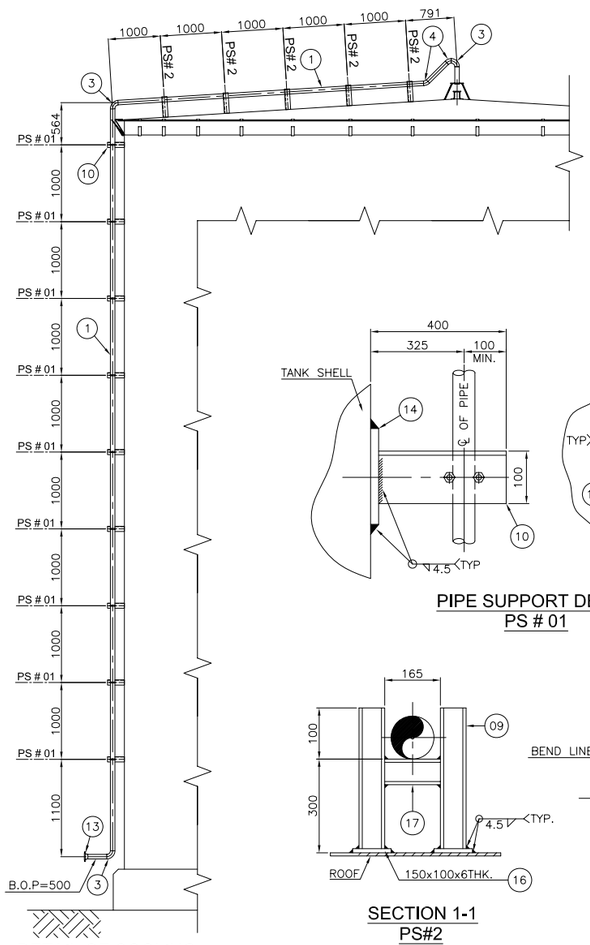
TITLE : SPIRAL STAIRCASE & HANDRAIL DETAIL FOR CRUDE OIL TANK (DIA = 11.582 M , HT = 9.754 M)

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745-TK-APST-006	1 OF 1	–	A3	0

ITEM NO.	DESCRIPTION	QTY.	MATERIAL	UNIT/WT	TOTAL
				TOTAL WT=1363 Kg.	
17	UPN–100 (138mm LONG)	5	A –36	10.6 KG/M	7
16	PLATE 150x100x6 THK.	14	HR–235	47.1 Kg/M^2	10
15	U BOLT WITH 2 NUTS FOR PIPE ø2" STD.WT.	9	A – 307	–	–
14	PLATE 250x250x6 THK.	9	HR–235	47.1 Kg/M^2	27
13	WELD NECK. RF. FLANGE ø3"–150#	1	A – 105	4.5 Kg/PC	5
12	BRACKET PLATES 760x60x8THK.	28	HR–235	62.8KG/M^2	82
11	SPLASH PLATE 6000x375x6THK.	9	HR–235	47.1KG/M^2	954
10	L 100x100x10 THK. 330mm LONG	9	A –36	14.584 KG/M	43
9	UPN–100 (400mm LONG)	10	A –36	10.6 KG/M	43
8	REINFORCING PLATE OD=230 x ID=120 x 10THK	1	HR–235	78.5 KG/M^2	2
7	PLATE ø250x10 THK.	1	HR–235	78.5 KG/M^2	3
6	ROD ø20 x 346 LONG	4	A – 36	2.46KG/M	3.5
5	PLATE OD=250 x ID=95 x 10THK	1	HR–235	78.5 KG/M^2	3
4	ELBOW 45°, ø3" STD.WT.	2	A – 234 GR.WPB	1.02 KG/PC	2.04
3	ELBOW 90°, ø3" STD.WT.	3	A – 234 GR.WPB	2.03 KG/PC.	6
2	PIPE ø4" STD.WT.x154 LONG	1	API 5L GR.B	16.07 KG/M	3
1	PIPE ø3" STD.WT.	15M	API 5L GR.B	11.29 KG/M	170



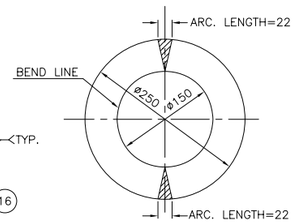
ELEVATION



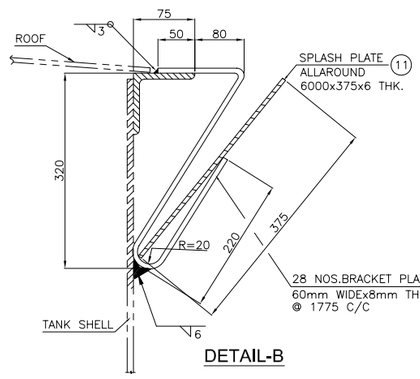
DETAIL OF COOLING WATER LINE

PIPE SUPPORT DETAIL
PS # 01

SECTION 1-1
PS#2



ITEM-07

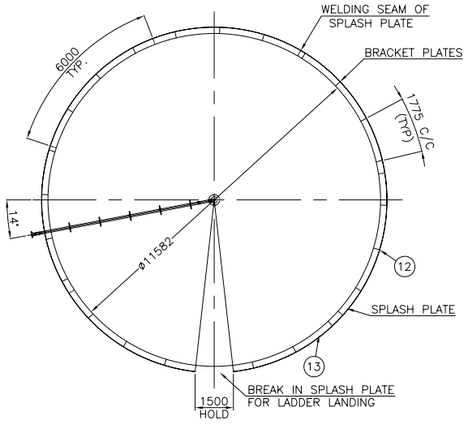


DETAIL-B

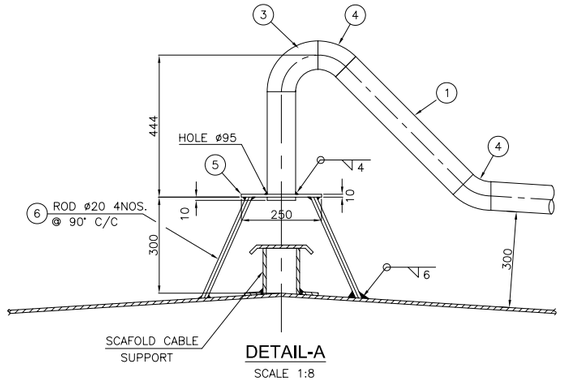
ISSUED FOR REVIEW

NOTES:

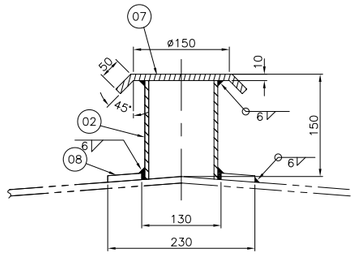
1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. THE SPLASH PLATE SHALL BE TERMINATED AT SPIRAL STAIR CASE.



PLAN



DETAIL-A
SCALE 1:8



SCAFOLD CABLE SUPPORT

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25–11–16	ISSUED FOR REVIEW	S.F.R	BA	AJ

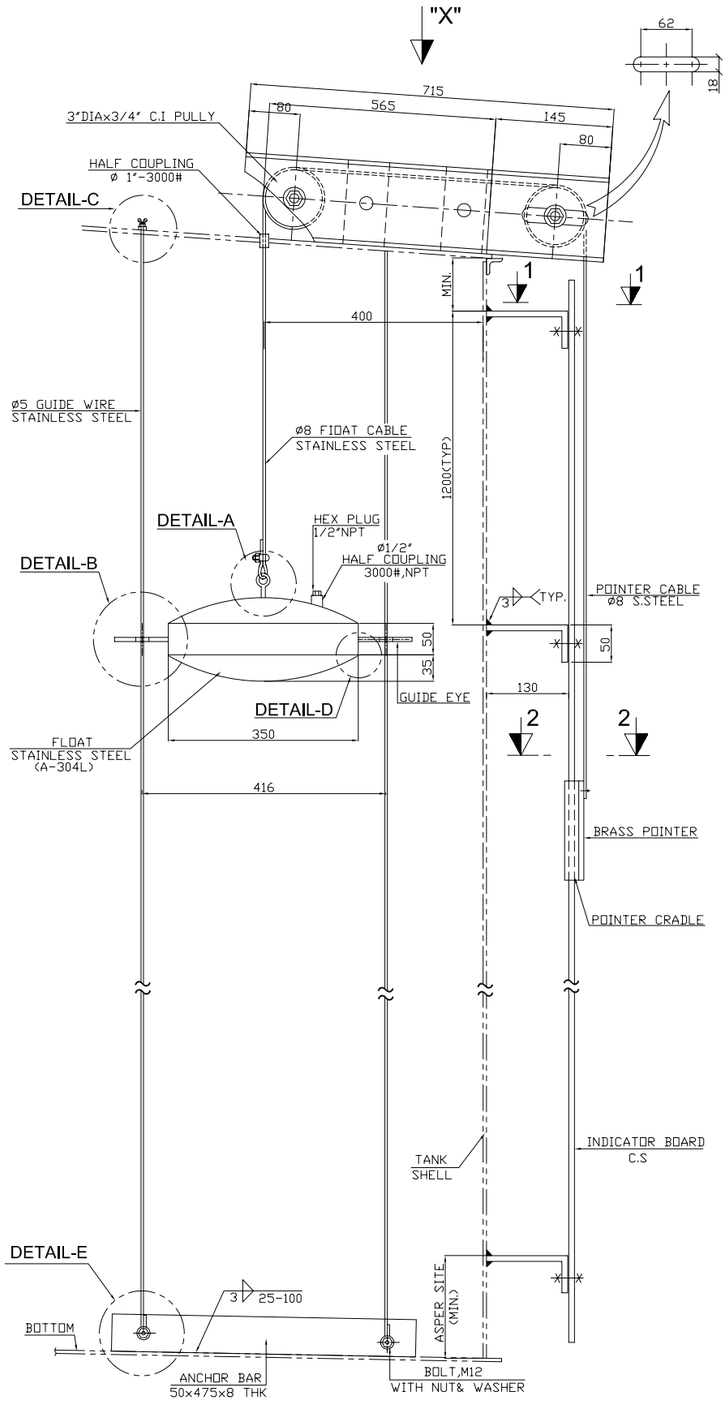
PETROCHEMICAL ENGINEERING CONSULTANTS
C–2, BLOCK NO. 17, GULSHAN–E–IQBAL, NEAR NATIONAL STADIUM, KARACHI–75300. PAKISTAN.
TEL. +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E–Mail: contact@pcec.com.pk web site: www.pcec.com.pk

CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

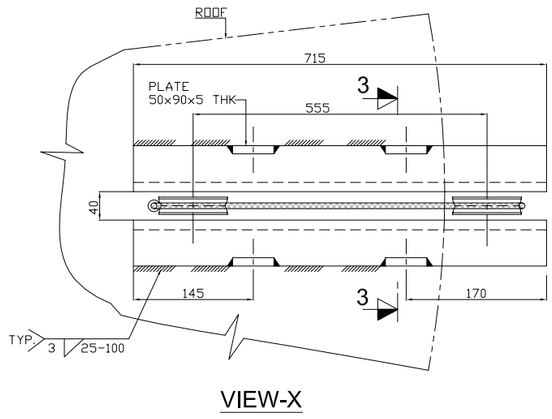
PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

TITLE : COOLING WATER SYSTEM FOR CRUDE OIL TANK (DIA = 11.582 M , HT = 9.754 M)

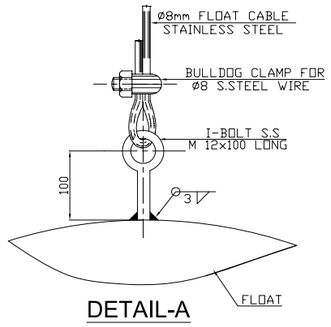
JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745–TK–APST–007	1 OF 1	–	A3	0



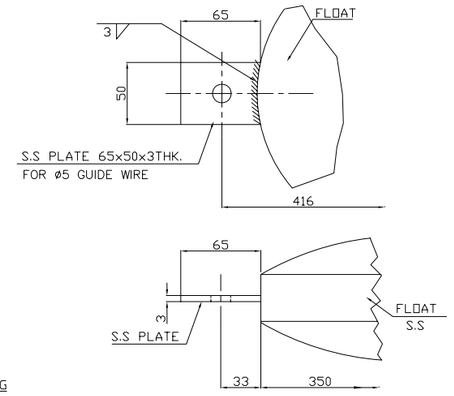
ELEVATION



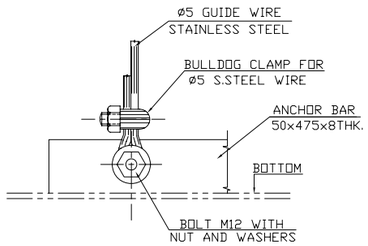
VIEW-X



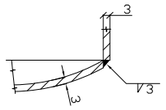
DETAIL-A



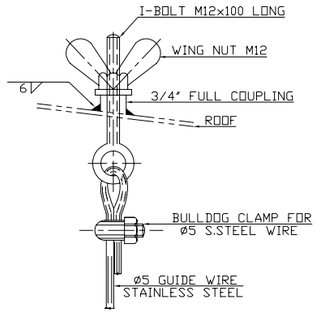
DETAIL-B



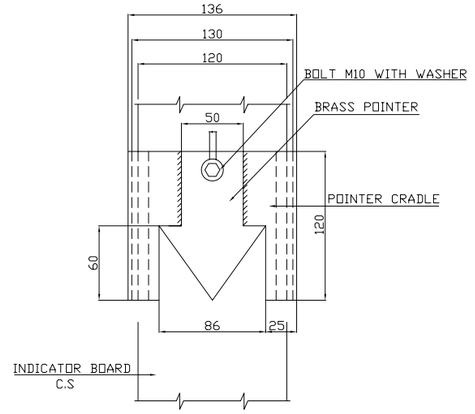
DETAIL-E



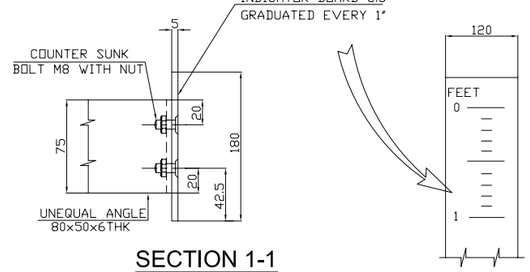
DETAIL-D



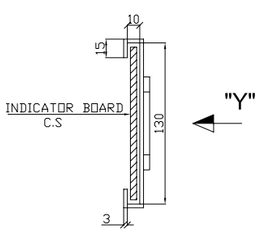
DETAIL-C



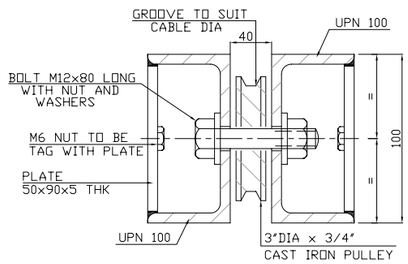
VIEW-Y



SECTION 1-1



SECTION 2-2



SECTION-3-3

NOTE:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. LOCATION AS PER SITE CONDITION.

ISSUED FOR REVIEW

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25-11-16	ISSUED FOR REVIEW	S.F.R	BA	AJ

PETROCHEMICAL ENGINEERING CONSULTANTS
C-2, BLOCK NO. 17, GULSHAN-E-IQBAL, NEAR NATIONAL STADIUM, KARACHI-75300. PAKISTAN.
TEL: +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E-Mail: contact@pcec.com.pk web site: www.pcec.com.pk

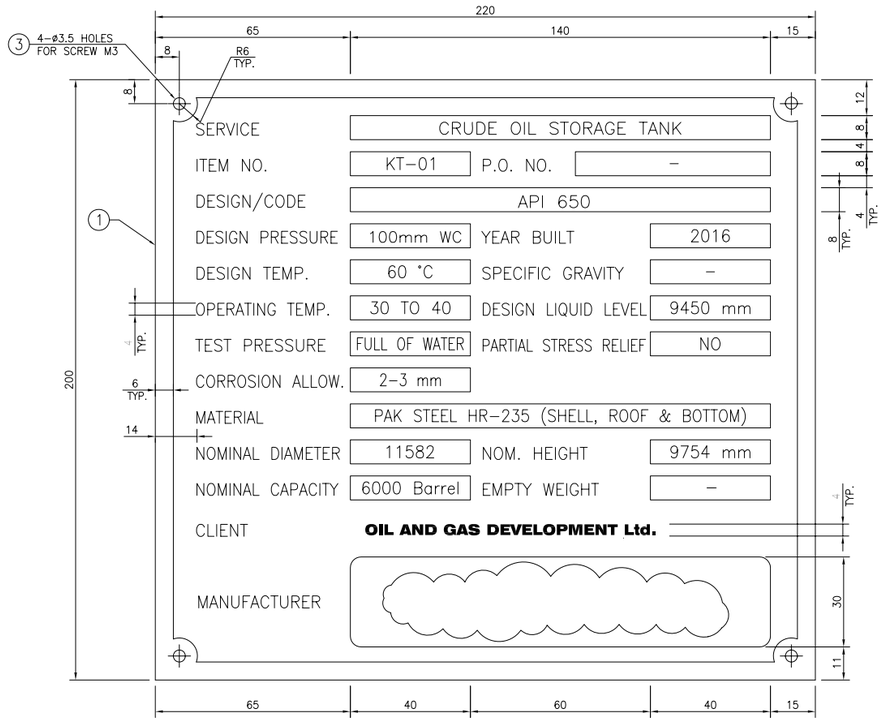
CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

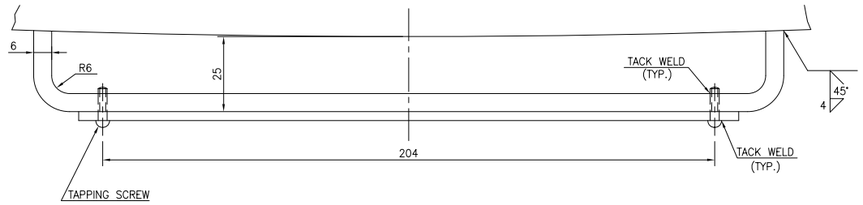
TITLE : LEVEL INDICATOR DETAILS FOR CRUDE OIL TANK (DIA = 11.582 M , HT = 9.754 M)

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745-TK-APST-008	1 OF 1	-	A3	0

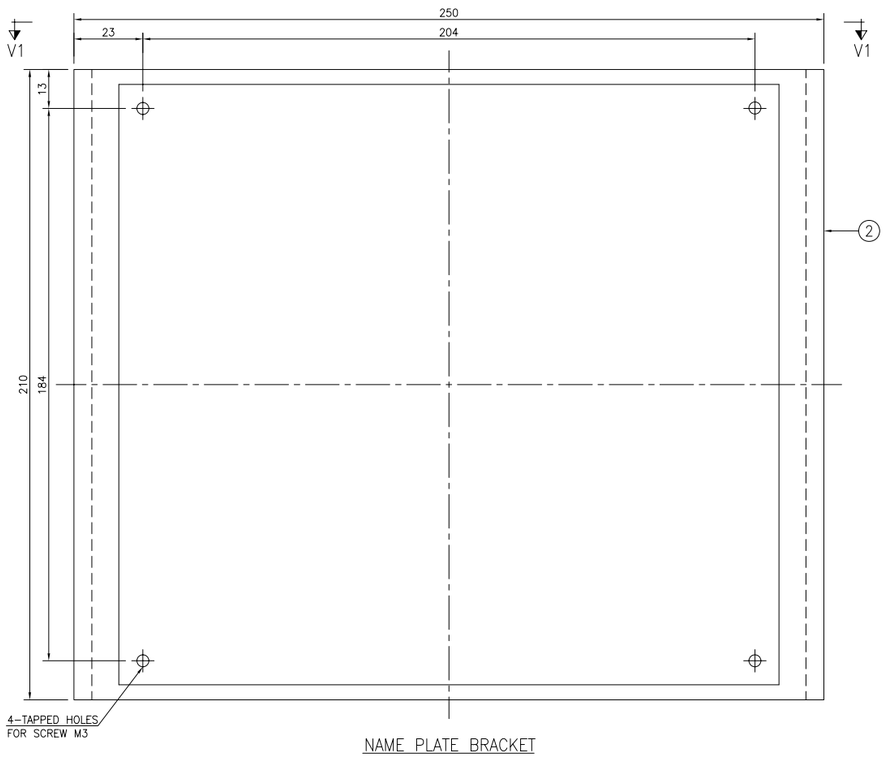
PART NO.	DESCRIPTON	QTY.	MAT.	WT (KG)	SIZE/REF.DWG
3	ROUND HEAD SCREW M3 x 15 LG	8	SS	0.2	
2	PLATE 6THK x 210 x 285	2	A36	5.6	BRACKET
1	PLATE 3THK x 220 x 200	2	SS304	2.0	NAME PLATE



NAME PLATE



VIEW V1–V1



NAME PLATE BRACKET

ISSUED FOR REVIEW

GENERAL NOTES:–

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. ALL THE SURFACE EXCEPT OUTLINE, LETTERS AND SPACE TO BE STAMPED FIGURES SHALL BE ETCHED 0.2mm IN DEPTH.
3. THE ETCHED PARTS SHALL BE COATED BY PACKING BLACK ENAMEL.
4. THE RAISED PART SHALL BE POLISHED BY BUFFING.

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25–11–16	ISSUED FOR REVIEW	S.F.R	BA	AJ

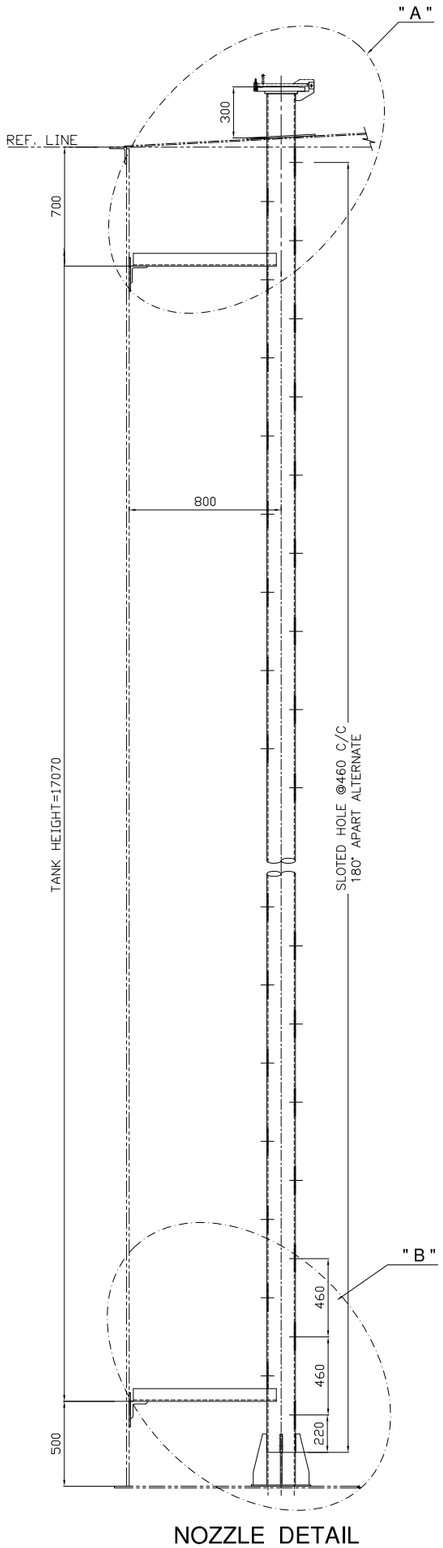
PETROCHEMICAL ENGINEERING CONSULTANTS
C–2, BLOCK NO. 17, GULSHAN–E–IQBAL, NEAR NATIONAL STADIUM, KARACHI–75300. PAKISTAN.
TEL. +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E–Mail: contact@pcec.com.pk web site: www.pcec.com.pk

CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

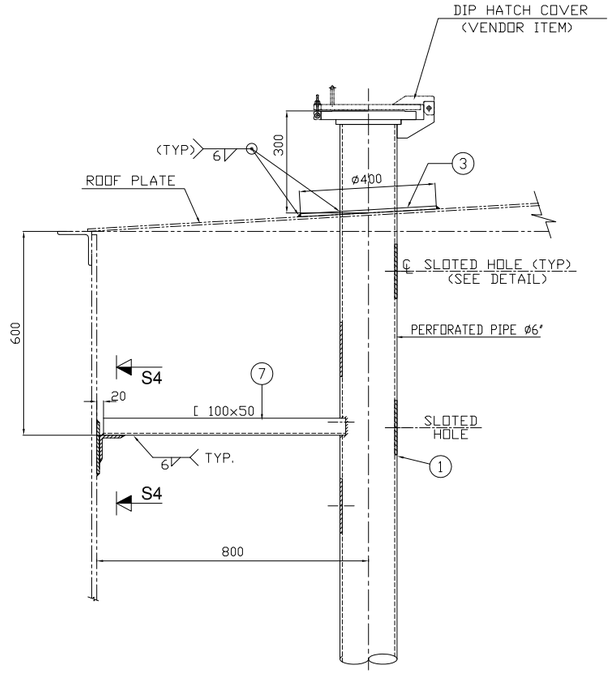
PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

TITLE : NAMEPLATE & BRACKET DETAILS FOR CRUDE OIL TANK (DIA = 11.582 M , HT = 9.754 M)

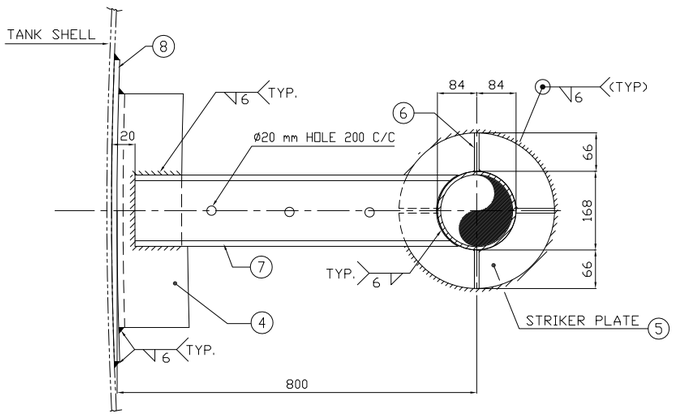
JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745–TK–APST–009	1 OF 1	–	A3	0



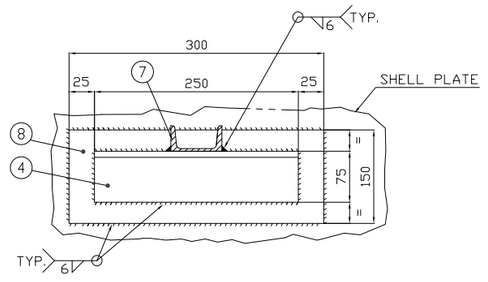
NOZZLE DETAIL



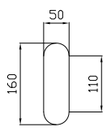
DETAIL-A



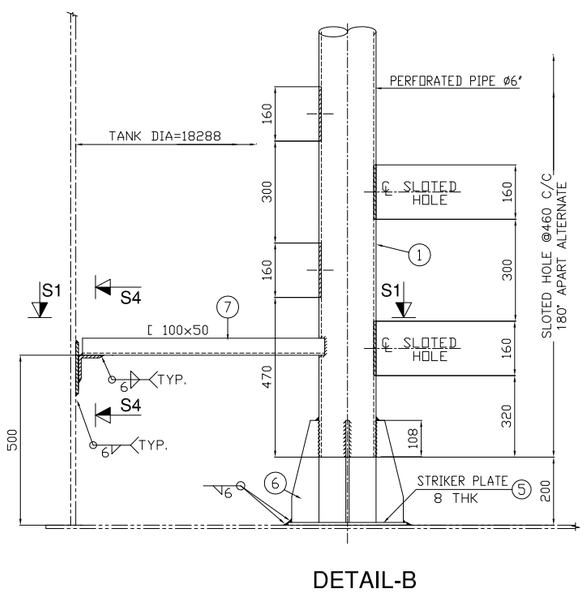
SECTION S1-S1



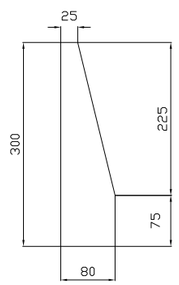
SECTION S4 - S4



SLOTED HOLE DETAIL



DETAIL-B



ITEM-6

8	REINFORCING PLATE 300x150x8 THK	2	A-36	62.8 Kg/m²	6
7	[100x50x810mm LONG	2	ASTM A-36	18.6 Kg/m	28
6	CLEAT 8 THK.	4	A-36	62.8 Kg/m²	4
5	STRIKER PLATE ø350 x 8THK	1	A-36	62.8 Kg/m²	6
4	SUPPORT L 75x5x8 THK. 250 MM LONG	2	ASTM A-36	15.0 Kg/m²	8
3	REINFORCING PLATE O.D 400xI.D 171.6 THK	1	A-36	47.1 Kg/m²	5
2	FLANGE ø6" 150# S.O. R.F	1	ASTM A-105	8.5 kg/Pc	9
1	PIPE ø6" STD. WT.	18M	API 5L Gr.B	28.23 kg/m	508
ITEM NO.	DESCRIPTION	QTY.	MATERIAL	UNIT/WT.	TOTAL(KG)
				TOTAL WT. 574 Kg.	

ISSUED FOR REVIEW

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. ALL DIMENSIONS TO BE VERIFIED BY CONTRACTOR BEFORE START OF ANY FABRICATION WORK.

REV.	DATE	DESCRIPTION OF REVISION	PREP'D:	CHECK	APPR.
0	25-11-2016	ISSUED FOR REVIEW	S.F.R	MZ	SMS

PETROCHEMICAL ENGINEERING CONSULTANTS
C-2, BLOCK NO. 17, GULSHAN-E-IQBAL, NEAR NATIONAL STADIUM, KARACHI-75300. PAKISTAN.
TEL. +92 (21) 34827780, 34961088, FAX: +92 21 34961089, E-Mail: contact@pcec.com.pk web site: www.pcec.com.pk

CLIENT : OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT : DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD

TITLE : Ø6" DIP HATCH NOZZLE DETAIL FOR TANK KT-601

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
2745	2745-TK-APST-010	1 OF 1	-	A3	0

ANNEXURE-II

(DATASHEETS)

ANNEXURE-IIA

(BREATHER VALVE)

BREATHER VALVE
DATA SHEET

PROJECT	: DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD	**SPEC. NO.**	: 2745-TK-DS-001		
JOB NO.	: 2747	**DATE**	: 29/11/16	**REV.**	: 0
CLIENT	: OIL & GAS DEVELOPMENT COMPANY LIMITED	**PREP. BY**	: MUF	**APP. BY**	: AJ
UNIT	:	**SHEET NO.**	: 1 of 1		
LOCATION	: SINDH				

GENERAL				
Item No.	PVSV			
Tank No.	T-001			
Tank Typr	Vertical			
Diameter ft	38			
Height/Length ft	32			
Capacity of Tank bbl	6000			
Quantity	01			
SERVICE CONDITION				
Fluid	Crude			
Flash Point (^{o}F)	60-80			
Inert Gas Blanket (SCFH)	23260			
Temp. Oper./Max. (^{o}F)	100 / 130			
Tank Pressure Oper./ Max (^{o}	Atm /			
VENTING CAPACITY				
Filling Flow Rate (USGPM)	800			
Out-Breathing Due to				
a) Filling (NCMH)	6857			
b) Thermal Effect (NCMH)	3636			
Total Out-Breathing (NCMH)	10493			
Pressure Setting	3" of WC			
Emptying Flow Rate (UGPM)	1500			
In-Breathing Due to				
a) Emptying (NCMH)	1200			
b) Thermal Effect (NCMH)	6060			
Total In-Breathing (NCMH)	18060			
Vacuum Setting	1" of WC			
Discharge to	ATMOSPHERE			
Vapor to be Vented				
Sizing with Flame Arrester	NO			
BODY				
Body Material	Aluminum			
Seat and Trim Material	Aluminum			
Diaphragm Material	Teflon			
Inlet Conn./ Outlet Conn.	FLANGED /			
Facing	F.F.			
Size	6" - 150# *			
QUANTITY	**01 NOS.**			

NOTES :	*** - Vendor to confirm**

ANNEXURE-IIB

(EMERGENCY VENT)

EMERGENCY PRESSURE RELIEF VALVE
DATA SHEET

PROJECT	:	DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD	**SPEC. NO.**	:	2747-TK-DS-002
JOB NO.	:	2747	**DATE**	:	29/11/16
CLIENT	:	OIL & GAS DEVELOPMENT COMPANY LIMITED	**PREP. BY**	:	MUF
LOCATION	:	SINDH	**APP. BY**	:	AJ
			SHEET NO.	:	1 of 1

GENERAL				
Tag No.				
Tank No.		A		
Tank Type		Vertical		
Tank Diameter	ft	38.0		
Tank Height	ft	32.0		
Capacity of Tank	bbl	6000		
Quantity	No.	01		
AMBIENT CONDITIONS:				
Ambient Temperature Min./Max.	(^{o}F)	80-100		
Special Conditions				
SERVICE CONDITION				
Fluid		Crude		
Specific Gravity		0.789		
Inert Gas Blanket		Yes		
Flash Point	(^{o}F)	60-80		
Temp. Oper./Max.	(^{o}F)	100 / 130		
Tank Design Pressure	(Inch of W.C.)	3		
Tank Design Vacuum	(Inch of W.C.)	1		
Tank Wetting Surface Area	(ft^2)	3581		
VENTING CAPACITY				
Emergency Flow	(SCFH)	**369096**		
Pressure Setting	(Inch of W.C.)	2		
CONSTRUCTION				
Base		Carbon Steel		
Seat		Carbon Steel		
Cover		Carbon Steel		
Screws and Nuts		Stainless Steel		
Facing		150#, R.F		
Size		20"		
Self Closing		Yes		

ANNEXURE-IIC

(LEVEL SWITCH)

CONSULTANT	DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD	DOCUMENT NO.	
PETROCHEMICAL ENGINEERING CONSULTANTS		2745-T-IDS-001	
		REV.	DATE.
		0	26/11/2016
CLIENT	INSTRUMENT DATA SHEET	BY	APPR.
OIL AND GAS DEVELOPMENT COMPANY LTD.	LEVEL SWITCH LOW	ZUA	SAG
		SHEET	1 OF 1

GENERAL	1	Tag Number		LSL-001				
	2	Service / Location		Crude Oil Storage Tank (KT-01)				
	3	Area Classification						
	4	P & ID Drawing Number		2745-T-PID-001				
PROCESS CONDITIONS	5	Upper Liquid		Crude Oil				
	6	Lower Liquid		-				
	7	Specific Gravity Upper	Specific Gravity Lower	1.019	-	1.019	-	
	8	Oper. Temperature	Max. Temperature	135	°F	150	°F	
	9	Oper. Pressure	Max. Pressure	Atm.	psi-g	Atm.	psi-g	
BODY/CAGE	10	Body/Cage Material		CS				
	11	Rating		150#				
	12	Mounting		SIDE 3" ANSI 150# RF				
	13	Type		RF				
	14	Connection Size & Location Lower		N/A				
	15	Type		N/A				
	16	Case Mounting		N/A				
	17	Rotatable Head		Yes				
	18	Orientation		Up/Down				
	19	Cooling Extension		N/A				
	20	Connection from bottom		N/A				
FLOAT	21	Select Standard Span		N/A				
	22	Insertion Depth		N/A				
	23	Float Extention		STD				
	24	Float Material		316ss				
	25	Spring Material	Tube Material	INCONEL 600		INCONEL 600		
	26	Float Function		VTA				
SWITCH	26	Output		On/Off				
	27	Control Modes		N/A				
	28	Differential		Fixed				
	29	Output Action on Switch Activation		Local Alarm/Indication				
	30	Mounting		Integral				
	31	Electrical Enclosure Class		IP 65 or better				
	32	Electric Power		Yes				
	33	Configuration and Calibration		N/A				
	34	Electrical Entries		3/4" NPT(F)				
	35	Certifiaction		Eex 'ia' IIA T3				
OPTIONS	36	Airset	Supply Guage	NA		N/A		
	37	Guage Glass Connection		NA				
	38	Guage Glass Model No.		NA				
	39	Contacts:No	Form	SPDT				
	40	Contact Rating		24V DC 5 AMPS / 240 V AC				
	41	Float Adjustable		Yes-Field				
PURCHASE	42	Manufacturer		Fisher (Emerson) / Murphy / Equivalent				
	43	Model						
	44	Purchase Orde Type	Material					
	45	Price	Item Number					
	46	Serial Number						

NOTES :

1	All wetted parts shall be NACE MR01-75
2	Level switch to be supplied with stainless steel wire and tag with stamping of tag no. (LSL-001) in 5mm lettering.

CONSULTANT	DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD	DOCUMENT NO.	
PETROCHEMICAL ENGINEERING CONSULTANTS		2745-T-IDS-002	
		REV.	DATE.
		0	26/11/2016
CLIENT	INSTRUMENT DATA SHEET	BY	APPR.
OIL AND GAS DEVELOPMENT COMPANY LTD.	LEVEL SWITCH HIGH	ZUA	SAG
		SHEET	1 OF 1

GENERAL	1	Tag Number		LSH-001				
	2	Service / Location		Crude Oil Storage Tank (KT-01)				
	3	Area Classification						
	4	P & ID Drawing Number		2745-T-GA-001				
PROCESS CONDITIONS	5	Upper Liquid		Crude Oil				
	6	Lower Liquid		-				
	7	Specific Gravity Upper	Specific Gravity Lower	0.79	-	1	-	
	8	Oper. Temperature	Max. Temperature	100-130	°F	150	°F	
	9	Oper. Pressure	Max. Pressure	Atm.	psi-g	Atm.	psi-g	
BODY/CAGE	10	Body/Cage Material		CS				
	11	Rating		150#				
	12	Mounting		SIDE 3" ANSI 150# RF				
	13	Type		RF				
	14	Connection Size & Location Lower		N/A				
	15	Type		N/A				
	16	Case Mounting		N/A				
	17	Rotatable Head		Yes				
	18	Orientation		Up/Down				
	19	Cooling Extension		N/A				
	20	Connection from bottom		N/A				
FLOAT	21	Select Standard Span		N/A				
	22	Insertion Depth		N/A				
	23	Float Extention		STD				
	24	Float Material		316ss				
	25	Spring Material	Tube Material	INCONEL 600		INCONEL 600		
	26	Float Function		VTA				
SWITCH	26	Output		On/Off				
	27	Control Modes		N/A				
	28	Differential		Fixed				
	29	Output Action on Switch Activation		Local Alarm/Indication				
	30	Mounting		Integral				
	31	Electrical Enclosure Class		IP 65 or better				
	32	Electric Power		Yes				
	33	Configuration and Calibration		N/A				
	34	Electrical Entries		3/4" NPT(F)				
	35	Certifiaction		Eex 'ia' IIA T3				
OPTIONS	36	Airset	Supply Guage	NA		N/A		
	37	Guage Glass Connection		NA				
	38	Guage Glass Model No.		NA				
	39	Contacts:No	Form	SPDT				
	40	Contact Rating		24V DC 5 AMPS / 240 V AC				
	41	Float Adjustable		Yes-Field				
PURCHASE	42	Manufacturer		Fisher (Emerson) / Murphy / Equivalent				
	43	Model						
	44	Purchase Orde Type	Material					
	45	Price	Item Number					
	46	Serial Number						

NOTES :

1	All wetted parts shall be NACE MR01-75
2	Level switch to be supplied with stainless steel wire and tag with stamping of tag no. (LSH-001) in 5mm lettering.

ANNEXURE-III

(SPECIFICATIONS)

SPECIFICATIONS FOR
SITE CLEARING, AREA GRADING, EXCAVATION AND EARTH WORK

DOCUMENT NO. : 2745-CIV-SP-01

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 This specification covers site clearing, grubbing, excavating, area filling, back filling in and around structure and in plinths, blasting, if required, hauling, dumping and spreading of soil, undercutting to remove unstable soil areas, compacting existing soil surfaces and bottom of excavated areas to receive fills, compacting excavated areas for subgrade, pumping to keep excavated areas dry, final grading of designated areas, disposing of unsuitable and excess excavated materials and incidentals thereof for areas designated on the drawings.

2.0 SITE CONDITIONS

2.1 The characteristics of soils and the results of field and laboratory tests will be indicated in the soil report.

2.2 The Contractor shall familiarize himself with the soil report to ensure that the equipment / tools / terminals to be used are suitable to carry out the specified work.

2.3 Boring and sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawings or otherwise furnished to the Contractor shall be taken as for guidance only.

2.4 The Contractor must satisfy himself regarding the character and volume of all works under this contract and expected surface, sub-surface and / or sub-soil water to be encountered.

2.5 The Contractor must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the Contract so that he may evolve a realistic programme of execution.

2.6 Prior to commencement of work, the method of working, programme, and type of terminal to be used shall be submitted to the Employer/Owner's Engineer for approval.

3.0 CODES AND STANDARDS

All work under this specification, unless specified otherwise, shall conform to the latest editions and supplements of following Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Standard Specification, any other standard practice as may be specified by the Employer/Owner's Engineer shall be followed. Some of the international specifications and codes are as under:

ASTM D420	Investigation and sampling soil and rock for Engineering purposes.
ASTM D422	Particle size analysis of soils
ASTM D698	Moisture-Density relations of soil (Proctor density test using 5.5 kg rammer)
ASTM D854	Specific gravity of soils
ASTM D1194	Bearing capacity of soils for static load and spread footing
ASTM D1556	Density of soils place by sand code method
ASTM D1557	Moisture density relations of soils (Proctor density test using 4.54 kgs rammer)
ASTM D2487	Classifications for soil for Engineering purposes
ASTM D2937	Test methods for density of soil in place by dry cylinder method
BS 5930	Code of practice for site investigations.
BS 6031	Code of practice for earthworks.

4.0 MATERIALS TO BE USED

4.1 All materials required for the work shall be of best commercial variety and as approved by the Employer/Owner.

4.2 Borrow material required for area filling shall be excavated from approved locations and levels and shall consist of selected granular material free from roots, vegetation, decayed organic matter, harmful salts and chemicals, lumps and clods.

4.3 Clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material, if specified in drawings.

5.0 SITE DATUMS

5.1 Initial levels either in a definite grid pattern or as directed by the Employer/Owner's Engineer shall be taken by the Contractor over the original ground prior to starting actual work.

5.2 The ground levels shall be taken at 5 to 15 meter intervals in level or uniformly sloping ground and at closer intervals where local mounds, pits or undulations are met with, as directed by the Employer/Owner's Engineer.

5.3 The ground levels shall be recorded in field books and plotted on a plan, which shall be signed by the Contractor and the Employer/Owner's Engineer before earthwork is started.

5.4 These initial levels shall be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from measurements.

6.0 SETTING OUT

6.1 Prior to the commencement of work, the Contractor shall prepare and submit to the Employer/Owner's Engineer, detailed drawings for excavation and filling work, as proposed to be executed by him, showing the details of slopes, approaches, dewatering sumps, berms etc.

6.2 On receiving the approval from the Employer/Owner's Engineer with modifications and corrections if necessary, the Contractor shall set-out and construct permanent base lines and bench marks indicated in the drawings or as required by the Employer/Owner's Engineer. These permanent points will be checked and certified by the Employer/Owner's Engineer for Contractor to proceed with the work.

6.3 Necessary profiles with pegs, bamboo and strings shall be made to show the correct formation levels before the work is started.

6.4 Employer/Owner shall be provided with necessary men, material and instruments for such checking. It should be noted that this checking by the Employer/Owner prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines, levels and grades as per drawing and subsequent corrections, if any.

7.0 CLASSIFICATION OF EXCAVATED MATERIALS

7.1 Materials involved in earthwork shall be classified under the following categories. No distinction will be made whether the material is dry or wet. The Employer/Owner's Engineer decision with regard to such classification shall be final and binding on the Contractor:

a) Ordinary and hard soil

This shall include the top soil supporting terminal growth, clay, silt, sand, moorum, shingle, kankar, gravel, loam, peat, ash and other similar materials in soft, hard or dense state which can generally be excavated with ordinary spade, pick axe, shovel etc. and does not require the use of wedges, pneumatic breaking equipment and/or blasting for removal. It shall also include loose rock boulders present in the soil, with dimensions not exceeding 500 mm in any direction.

Breaking of consolidated brick ballast and mud concrete shall be considered equivalent to excavation work under this type of soil.

b) Soft and decomposed rock

This shall include rocks like chalk, slate, mica schist, Laterite and other similar materials which in the opinion of the Employer/Owner's Engineer is rock, but does not require blasting for removal and could be removed with picks, hammers, crow bars, pneumatic hammers, scrapers equipped with rock ripping teeth, tractor

mounted rippers, face shovels, crane excavators, etc. It shall also include boulders with dimensions greater than 500 mm but not exceeding 1000 mm in any direction.

The mere fact that the Contractor resorts to blasting for his own convenience shall not mean that the rock material will be classified as hard rock.

Excavation in macadam, roads and pathways, brickwork etc. shall be considered equivalent to this type of soil.

c) Hard rock requiring blasting

This shall include rocks occurring in large masses which cannot be removed only by drilling and blasting. Harder varieties of rock such as trap, with or without veins and secondary mineral which in the opinion of the Employer/Owner's Engineer require blasting for removal shall also be considered as hard rock. It shall also include boulders bigger than 1000 mm in any direction.

Construction in concrete, both reinforced and unreinforced, which is required to be dismantled during earthwork, shall be considered equivalent to this type of soil, unless a separate provision is made in for the same.

d) Hard rock requiring blasting but where blasting is prohibited, this shall include hard rock's which will normally require blasting for their removal but blasting is prohibited and removal has to be done by chiseling, wedging or any other suitable method.

8.0 CLEARING AND GRUBBING

8.1 The area to be excavated shall be cleared out of fences, logs stumps, bush vegetation, rubbish, slush, etc. and leveled up. Trees upto 300-mm girth shall be uprooted. Trees above 300 mm girth that are required to be cut, shall be got identified by the as marked, and are to be cut only after specific return approvals.

8.2 Existing foundations, drainage, pits, manholes (if any) which are no longer required, shall be broken out and the excavations filled and compacted.

8.3 Felling of trees shall include taking out roots upto 1000 mm below ground level. After the tree is cut and roots taken out, the pot-holes formed shall be filled with good earth in 250 mm layers and compacted to acceptable degree unless directed by the Employer/Owner's Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Employer/Owner's Engineer and transported to the Employer/Owner's store or any other space as directed by the Employer/Owner's Engineer.

8.4 Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed as directed by the Employer/Owner's Engineer.

8.5 Useful materials, saleable timber, firewood, etc. shall be the property of the Employer/Owner and shall be stacked properly at the worksite in a manner as directed by the Employer/Owner's Engineer, and to be transported to the Employer/Owner's stores or any other place as directed by the Employer/Owner's Engineer.

9.0 EARTHWORK IN EXCAVATION

9.1 ROUGH EXCAVATION

Excavation not requiring dressing of sides and bottom and reduction to exact levels, such as obtaining earth from borrow-pits, hill side cutting, etc. shall be covered under this category.

9.2 Excavation in trenches for foundations/pipes/cables, etc. open cuts and bulk excavation.

9.2.1 All excavations shall be done to the minimum dimensions necessary to carry out the work safely. Prior approval of the Employer/Owner's Engineer shall be obtained by the Contractor, in each case, for the method he proposes to adopt for the

excavations including dimension, side slopes, dewatering, disposal etc. This approval, however, shall not in any way make the Employer/Owner responsible for any consequent loss or damage.

9.2.2 Excavation shall be carried out to such widths, lengths, depths and profiles shown on the project drawings or such other lines and grades specified by the Employer/Owner.

9.2.3 Rough excavation shall be carried out to a depth 150 mm above the final level. The balance shall be excavated with special care just prior to laying of leveling course of concrete.

9.2.4 Soft pockets shall be removed even below the final level and extra excavation made up to the required level as directed by the Employer/Owner's Engineer.

9.2.5 If the excavation is done to a depth greater than that shown on the drawing, due to the Contractor's fault, the excess depth shall be filled up to the required level at the latter's cost with selected earth and compacted to 95% of modified Proctor Density.

9.2.6 As the excavation reaches the required dimensions, the work will be checked by the Employer/Owner's Engineer and the balance work shall be carried out carefully to avoid any over-excavation.

9.2.7 In case where excavation in soil, soft and decomposed rock and/or hard rock are involved, the soil or soft and decomposed rock layers shall be removed by turn and levels of the underlying rock surfaces observed to enable measurements. Further work shall be resumed after getting clearance from the Employer/Owner.

9.2.8 Suitable berms shall be left at the appropriate places with necessary approach ramps for installation of dewatering pumps or other purposes, as required and or as directed by the Employer/Owner.

9.2.9 The berms shall be excavated later and the excavation finished to the lines and grades shown in the drawings and to the satisfaction of the Employer/Owner.

9.3 STRIPPING BLUFFS AND LOOSE ROCK

9.3.1 All loose boulders, semi-detached rocks not directly in the excavation but so close to the area to be excavated which in the opinion of the Employer/Owner's Engineer could endanger the workmen, equipment, or the work shall be stripped off and removed away from the areas of the excavation.

9.3.2 Any material not requiring removal as contemplated in the work, but which in the opinion of the Employer/Owner, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed as directed by the Employer/Owner.

9.4 STABILITY OF EXCAVATION

9.4.1 The methods of excavation shall in each case be approved by the Employer/Owner's Engineer. The work shall be carried out without endangering the safety of nearby structures, works, roads, railway tracks, cables pipelines etc if any, and without causing hindrance to other activities in the area.

9.4.2 Unless otherwise agreed by the Employer/Owner's Engineer, all excavations shall have vertical sides and shall be safely supported.

9.4.3 The Contractor shall have full responsibility for the stability of excavation and safety of workmen. If any slip occurs, the Contractor shall remove all the slipped material from the excavated area/pit, at his own cost. Also, if any damage to the built up structure occurs because of the slip, the Contractor shall make it good at his own cost.

9.5 SHORING OF THE EXCAVATED AREA

9.5.1 Shoring shall be close or open type depending on the nature of soil and the depth of pit or trench. Contractor shall take all necessary steps to prevent the sides of trenches and pits from collapsing.

9.5.2 Close Shoring / Bracing

a) 'Close' type shoring shall be as specified in IS: 3764 or as per International safety codes for excavation work. Shoring required for deep excavations shall be designed by the Contractor and got approved by the Employer/Owner's Engineer prior to its use in the work.

b) The withdrawal of the shoring material shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and preceded systematically to the other end. No part of the work should be damaged during the removal of the shoring material.

c) No claim will be entertained for any shoring material or installation that of.

9.5.3 Open Shoring / Bracing

a) In case of open shoring / bracing the entire surfaces of the side of trench or pit is not required to be covered.

b) Vertical boards of minimum 250 mm x 40 mm sections or equivalent section shall be spaced sufficiently apart to eave unsupported strips of maximum 500 mm average width.

c) The detailed arrangements, sizes of the shoring material and the spacing shall be subjected to the approval of the Employer/Owner. In all other aspects, specification for close shoring shall apply to open shoring also.

9.5.4 Left in shoring Material

If the Employer/Owner's Engineer directs any shoring to be left in place for the safety of the structure or otherwise for reasons commensurate with the type of construction necessitating such decision.

9.6 CLEARING OF EXCAVATION

9.6.1 Excavation shall be cleaned, trimmed to exact shape and all disturbed materials and other debris removed.

9.6.2 When the excavations have been taken out to the lines specified or shown on the drawings and the surface cleaned as specified, the contractor shall notify the Employer/Owner's Engineer that the excavation is ready for inspection and no further work shall be done with concrete or backfill until it has been inspected and approved by the Employer/Owner.

9.6.3 Cost of this work is deemed to have been included in bid price.

9.7 PRECIOUS OBJECT, RELICS, OBJECTS OF ANTIQUITY, ETC.

All gold, silver, oil, minerals, archaeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or on the site shall be the property of the Government and Contractor shall duly preserve the same to the satisfaction of the Employer/Owner's Engineer and deliver the same to such person or persons authorized to receive the same.

9.8 USE OF EXCAVATED MATERIAL AS FILL

9.8.1 Excavated material suitable for use in a particular section of the work as fill or backfill shall be selected, loaded, hauled, placed spread and used to construct the fill or backfill to the lines and grades specified for the work.

9.8.2 As far as possible, the most suitable of the materials excavated for the work shall be used to construct the fill and backfill, embankment, roads, and storage areas where required.

9.8.3 The useful rock available shall be stacked at locations as decided by the Employer/Owner's Engineer.

9.9 DISPOSAL OF SURPLUS MATERIAL

9.9.1 All surplus materials shall be carried away from the site and disposed at dumping sites specified or selected by the Employer/Owner's Engineer.

9.9.2 The Contractor shall dump the excavated materials in regular heaps, bunds, blankets, riprap with regular slopes as directed by the Employer/Owner's Engineer. As a rule, all softer material shall be laid along the centre of heaps, the harder and more weather resisting materials forming the casing on the sides and the top.

9.9.3 Excavated rocks which can be used in soling, as road metal or for making concrete aggregates, shall be stacked separately as directed by the Employer/Owner's Engineer.

9.9.4 All works as mentioned above is deemed to have been taken into account while quoting for the excavation and no extra shall be claimed by the Contractor for the above works.

9.9.5 If the Contractor wants to use the rock excavated from pits, he shall obtain approval for the same from the Employer/Owner's Engineer.

9.10 STOCKPILES

9.10.1 The excavated materials shall be stockpiled at approved locations adjacent to the work until their use is authorized for placement in backfill.

9.10.2 As a general rule the excavated material shall not be deposited within 1.5m from the top edge of the excavation or within a distance equal to the depth of excavation, whichever is higher.

9.11 SPOIL AREAS

9.11.1 Unsuitable materials either excavated from the works or brought from borrow pits shall be disposed of in spoil areas shown on the drawings or as specified by the Employer/Owner, to a maximum lead.

9.11.2 The spoil areas shall be left in a neat and good condition and sloped to drain properly as may be directed by the Employer/Owner.

9.12 DEWATERING

9.12.1 All areas shall be kept free of water. Grading around the excavations shall be to prevent surface water running into excavated areas.

9.12.2 The Contractor shall remove by pumping or other means approved by the Employer/Owner's Engineer any water inclusive of rain water and sub-soil water accumulated in the pit/trench/area without any extra cost. Contractor shall get Method of dewatering approved by the Employer/Owner's Engineer.

9.12.3 If pumping is necessary, precautions shall be taken to prevent the removal of fine materials from the excavated bottom or sides during dewatering operations.

9.12.4 If necessary, excavated level shall be further excavated to a sound bottom and backfilled to level with mass concrete or compacted granular material.

9.13 TREATMENT OF SLIPS

9.13.1 The Contractor shall take all precautions to avoid high surcharges and provide proper

surface drainage to prevent flow of water over the sides. These precautions along with proper slope, berms and control of ground water should cause no slips to the excavated trench.

9.13.2 Slips caused during construction work shall be cleared and backfilled later by Contractor.

9.14 EXCAVATION IN HARD ROCK

9.14.1 In case where excavation, both in ordinary soil and hard rock, are involved, the ordinary soil comprising of soft, hard and dense soils and weathered disintegrated rocks which can be excavated without blasting, shall be completely stripped off and the starting levels of hard rock surface taken to enable measurements. Further work in hard rock shall be resumed after clearance from the Employer/Owner's Engineer.

9.14.2 Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracing or bulkheads shall be provided and maintained during the period of construction.

9.14.3 In case where blasting is prohibited for some reason, though otherwise required, the excavation shall be carried out by chiseling, wedging or any other approved method.

9.14.4 In trenches, pits and drains where blasting is not prohibited, the excavation in hard rock shall be carried out by blasting in the first instance and finally by chiseling so as to obtain the correct section of the trench as per drawing.

9.14.5 Blasting operations, if required and permitted by the Employer/Owner's Engineer, shall be carried out as per Standard international specifications and safety codes.

10.0 EARTHWORK IN FILLING

10.1 AREA FILLING FOR GRADING

10.1.1 The material to be used for area filling shall be selected material, approved by the Employer/Owner's Engineer. This material can be obtained from nearby stockpiles or borrow pits.

10.1.2 Crushed rock shall be graded with sufficient fine material to ensure proper binding on compaction.

10.1.3 Fill shall not be placed on frozen surfaces.

10.1.4 No earth fill shall commence until surface water discharges and streams have been properly intercepted.

10.1.5 Filling shall start at the lowest level of the slope and progress up the slope in horizontal layers. Under no circumstances shall fill be placed in sloping layers.

10.1.6 Before commencement of area filling, the existing topsoil shall be removed upto a minimum depth of 150mm, or more, in order to clear the surface from undesirable materials. After this, the filling operation shall be performed with earth in layers not exceeding 250mm, loose thickness. Each layer shall be watered and properly compacted to 95% modified Proctor Density unless otherwise permitted/directed by the Employer/Owner's Engineer.

10.1.7 When rock material is used, the thickness of the layer may be increased to 450mm loose depth provided that the material grading is within that specified or approved by the Employer/Owner's Engineer.

10.1.8 Fill shall be compacted with approved machine. Manual compaction shall not be allowed unless authorized by the Employer/Owner's Engineer. Manual compaction

may be with wooden or steel rammers of 7 to 10 kg weight having a base of 200mm square or 200mm diameter.

10.1.9 Since the degree of compaction depends on the moisture content of the soil, a close watch shall be kept on this aspect and corrections done to optimize the moisture content.

The adequacy of the compaction and moisture control of the soil shall be determined by performing field density tests and other tests as and when directed by the Employer/Owner's Engineer and shall conform to the stipulations laid down in IS : 4701 / or any standard international codes.

10.1.10 Field compaction test shall be carried out at different stages of filling and also after completing filling to the entire height. This shall hold good for embankments as well.

10.1.11 Filling shall be carried out to the dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

10.2 FILLING AND COMPACTION IN PITS AND TRENCHES AROUND STRUCTURES

10.2.1 As soon as the work in foundations has been accepted and measured, the space around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with selected earth in layers not exceeding 150mm. Each layer shall be watered, rammed and properly consolidated to the satisfaction of the Employer/Owner's Engineer.

10.2.2 Earth shall be rammed with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Employer/Owner's Engineer. The final surface shall be trimmed and leveled to proper profile as desired by the Employer/Owner's Engineer.

10.2.3 Since the degree of compaction depends largely on the moisture content, a close watch shall be kept to ensure optimum moisture content.

10.3 FILLING IN DISPOSAL AREAS

10.3.1 The earth shall not be dumped haphazardly but shall be spread in horizontal layers not exceeding 500mm in thickness and nominal compaction done to the satisfaction of the Employer/Owner's Engineer.

10.3.2 All lumps and clods shall be broken before placing the fill. Earthmoving machinery including dumpers, dozers and trucks shall be allowed to ply over the fill to permit compaction to take place.

10.3.3 In wide areas, rollers may be employed and nominal compaction done to the satisfaction of the Employer/Owner's Engineer.

11.0 LIGHTING

11.1 Full-scale area lighting is to be provided if night work is permitted or directed by the Employer/Owner's Engineer.

11.2 Even if no night work is in progress, red-warning lights should be provided at the top edges of excavated area and of the fill, unless otherwise permitted by the Employer/Owner's Engineer.

12.0 TESTING AND ACCEPTANCE CRITERIA

12.1 EXCAVATION

12.1.1 On completion of excavation, the dimensions of the area will be checked as per the drawings after the area is completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by compacted earth or other means, at the Contractor's cost. Over excavation of the sides will be made good free of cost by the Contractor.

12.1.2 The excavation work will be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

12.2 AREA FILLING AND BACK FILLING

The degree of compaction required will be as per the stipulations laid down in appropriate sections of this specification. The work of area filling will be accepted after the Employer/Owner's Engineer is satisfied with the profile of the fill and degree of compaction achieved.

SPECIFICATIONS FOR
DISMANTLING AND DEMOLITION OF EXISTING CONCRETE STEEL AND MASONRY STRUCTURES
DOCUMENT NO. : 2745-CIV-SP-02

TABLE OF CONTENT

1.0 SCOPE

1.1 This specification deals with the procedures to be adopted while demolishing, dismantling of existing concrete, steel and masonry structures.

1.2 While the intent is not to specify each and every details of the dismantling activity, the contractor shall take every possible care while executing the works and as per directions of the Employer/Owner's Engineer.

2.0 SAFETY AND SECURITY

2.1 Safety and security of the structures, site, or the field personnel shall be solely the responsibility of the Contractor. The Contractor shall take all necessary safety measures to prevent mishaps or accidents during dismantling work.

2.2 For important and critical structures/buildings as directed by the Employer/Owner's Engineer, an advanced/improved demolition/dismantling technique/control demolition technique shall be adopted after carrying out collapse analysis as and when required. This shall be done such that the ground vibrations caused during demolishing/dismantling shall not unduly disturb/damage the adjacent/neighboring buildings/structures.

2.3 As far as possible for dismantling, core cutting techniques that uses cutting tools which produces less vibration/noise shall be used.

2.4 Wherever applicable, approval of statutory body/concerned environmental agencies shall be obtained before starting of the dismantling/demolishing work.

3.0 WORKMANSHIP AND SPECIFIC REQUIREMENTS

3.1 METHOD STATEMENT

3.1.1 Before taking up any dismantling/demolishing activity, a clear and detailed method statement indicating the detailed procedure adopted shall be prepared and submitted to the Employer/Owner's Engineer for approval. The document approved by the Employer/Owner's Engineer does not absolve or dilute the Contractor's responsibilities towards safety precautions. Any liabilities/injuries/accidents arising due to defective safety practices of the Contractor shall be solely to the Contractor's accounts.

3.2 GENERAL REQUIREMENTS

3.2.1 All materials obtained from dismantling/demolishing operations shall be the property of the Employer, under otherwise specified and shall be kept in the safe custody until handed over to the Employer.

3.2.2 Where it becomes necessary to disconnect any existing service lines such as Electrical, Piping etc., during dismantling/demolishing operation and where so required by the Employer/Owner's Engineer, suitable alternate arrangement shall be made by the Contractor to maintain the continuity and proper functioning of the affected service linkage.

3.2.3 Standard Specification for Site Clearing, Area Grading, Excavation and earthwork as per document 2747-CIV-SP-01 of this document shall be referred to the extent applicable.

3.3 WORKMANSHIP

3.3.1 Dismantling activity implies carefully taking up or down and removing without damage; the articles shall be passed by hand, where necessary, and lowered to the ground, and not thrown. Where these are fixed by nails, screws, bolts etc., these shall be taken out with proper tools and not by tearing or ripping off. This shall consist

of dismantling one or more parts of the building as specified or shown on the drawings.

3.3.2 Demolition activity implies taking up or down or breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown in the drawings.

3.3.3 Prior to commencement of activity, the structures to be dismantled shall be studied carefully and the works procedure planned out. The permission to dismantle shall be obtained in writing from the Employer/Owner's Engineer. Adequate warning/sign posts shall be provided locations. The entire area shall be cordoned off after prior intimation. Where the plant is in operation, the operating staff of the plant shall be informed of the dismantling activity.

3.3.4 The demolition shall always be planned before hand and shall be done in reverse order of the one in which the structure was constructed. The scheme of demolition shall be got approved from the Employer/Owner's Engineer before starting the work. Necessary propping, shoring and under pinning shall be provided for the safety of the adjoining work or property, which is to be left intact, before demolition is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining properties. Necessary precaution shall be taken to keep the dust nuisance down as and where necessary.

3.3.5 The dismantling shall be commenced in a systematic manner. Chipping of concrete shall precede taking adequate care as not to cause damage to the existing structures. Use of sledge hammer shall be limited so as not to cause damage to adjacent structures/equipment. Floor slabs shall be chiselled around the perimeter to enable removal of slabs in units. The area identified for chiselling shall be suitably assessed so as not to cause any damage to floor below, if any. The reinforcement shall be subsequently cut and the debris shall then be moved to the location identified by the Employer/Owner's Engineer and as per his instructions. Masonry

units shall be dismantled in such a way so that collapse of entire units is avoided. The bricks shall be removed in units. These shall be then moved to a location as directed by Employer/Owner's Engineer.

3.3.6 Adequate supports wherever necessary shall be provided to the area adjacent to the dismantling activity so as to protect any damage or collapse. Shuttering shall be provided below the slabs where chipping is envisaged. If necessary, blinds shall be erected to avoid dust and flying of the chipped particles.

3.3.7 Any serviceable material, obtained during dismantling or demolition, shall be separated out and stacked properly as directed by Employer/Owner's Engineer within a lead of 500 metres. All unserviceable materials rubbish etc. shall be disposed off as directed by Employer/Owner's Engineer.

3.3.8 Where structural steel Tanks are to be dismantled, these shall be either carefully cut or if it is a bolted structure such as platforms, be dismantled to enable reuse of these units for a different location.

3.3.9 After the dismantling or demolishing work is complete, all loose debris etc. shall be removed and the area swept clean or washed with water.

SPECIFICATIONS FOR
STORAGE TANKS

DOCUMENT NO. : 2745-TK-SP-01

TABLE OF CONTENTS

1.0 GENERAL

1.1 Scope

This specification covers the minimum requirements for supply, fabrication, erection, installation, inspection, testing, calibration and painting of storage tank.

The Contractor shall be responsible for supply, fabrication, inspection, testing and calibration of the welded steel storage tanks, including full compliance with all applicable design codes and standards, as listed in Section 2.0 of this specification.

1.2 Definition

OWNER	**:** Oil and Gas Development Company Limited
ENGINEER	**:** Petrochemical Engineering Consultants
CONTRACTOR	**:** The Company named as such in the deed.
SUB CONTRACTOR / VENDOR	**:** The Manufacturer / Supplier engaged by Contractor
SHALL/MUST/IS TO BE	**:** A mandatory requirement
SHOULD	**:** A non-mandatory requirement, advisory or Recommendation

1.3 Errors or Omissions

1.3.1 The review and comment by the Client of any contractor's or its manufacturer's drawings, procedures or documents shall only indicate acceptance of general requirements and shall not relieve the Contractor of its obligations to comply with the requirements of this specification and other related parts of the contract documents.

1.3.2 Any errors or omissions noted by the Contractor in this Specification shall be immediately brought to the attention of the Client.

1.4 Deviations

All deviations to this Specification, other specifications or attachments shall be brought to the knowledge of the owner in the bid. All deviations made during the procurement, design, manufacturing, testing and inspection shall be with written approval of the owner prior to execution of the work. Such deviations shall be shown in the documentation prepared by the contractor.

1.5 Conflicting Requirements

In the event of conflict, inconsistency or ambiguity between the contract scope of work, this Specification, National Codes & Standards referenced in this Specification or any other documents, the Contractor shall refer to the Client whose decision shall prevail.

1.6 Reporting Procedure

1.6.1 A reporting and documentation system shall be agreed between the Client and the contractor for the status of procurement, design, manufacturing, inspection, testing and shipment of the equipment/material to be supplied under this specification. Contractor's manufacturer shall provide reports and summaries for production performance and testing operations in conformance with a manufacturing schedule approved by Client.

1.6.2 Daily, weekly monthly and run summaries of all major aspects of the production process shall be provided as reports to the Client.

2.0 Codes, Standards & specifications

Unless otherwise specified, minimum requirements are to be in accordance with latest editions of the following standards, codes and statutory regulations (where applicable):

–	API 650	Welded Steel Tanks for Oil Storage (12th Edition)
–	ASME Section-IX	Welding and Brazing qualifications (Only where referenced in API 650)
–	ASME Section-VIII	Unfired Pressure Vessel (Only where referenced in API 650)
–	ASME Section-V	Non-destructive Examination (Only where referenced in API 650
–	ASME B16.5	Steel Pipe Flanges, Flanged Valves and Fittings
–	ASME B 16.21	Non-metallic Flat Gaskets for Pipe Flanges
–	ASME B31.3	Petroleum Refinery Piping
–	API 2000	Guide for Venting
–	API 2550	Measurement and Calibration of Storage Tanks
–	API 2555	Method for Liquid Calibration of Tanks
–	Other Project Specifications as applicable	

3.0 Contractor's Responsibility

The services to be provided by the Contractor will include but not limited to the following, including full compliance with all applicable design codes and standards including those listed in Section 2.0 of this document.

- Preparation of working area as required bringing the equipment/material at job site.
- Supply of all materials, consumable items required for the execution on site of tanks e.g. air, electricity, hydrostatic test water and its additives, gouging rods, welding rods and flux, cutters, gas cylinders, grinding disks, brushes, oil and grease, shims etc.

- Provision and installation of necessary cranes, hoists, poles, welding equipment, grinders, cables, scaffolding, tools and fixtures and other facilities required for fabrication, erection of tanks, and for rectification of all damages, minor modification related to the tank.
- Supply of plates, structural steel, nozzles/appurtenances, Internal floating cover with seals, Mechanical spring seals for external floating roof tanks, emergency vent, breather vents, flame arrestor, level gauge, heating coils, insulation, paint and lighting system complete in all respect.
- Fabrication, erection, installation, testing, painting, electrical and instrument works related to storage tanks.
- Checking of dimensions of each section of tanks.
- Welding shall be carried out according to qualified welding procedures.
- Only qualified welders shall be allowed to work-on-the-job.
- Maintenance of all inspection records.
- The Contractor shall include adequate replacement for spare materials and components such as packings and gaskets, which may be consumed during the commissioning phase.
- Provision of equipment and measuring instruments required for tests and inspection.
- Preheating of welding rods and electrodes and their proper storage.
- Vacuum testing and Hydrostatic testing of tank (including all necessary works, like preliminary internal inspection, blinding, temporary connection for water and air lines, compressor and pumps for water and air filling, installation of temporary vents and pressure gauges etc., employing and cleaning of tank after tests.

- Provision of any fabrication, erection, installation, inspection, testing, examination certificates specified in API 650 12th edition.
- Calibration (Optical method) of tank with approval of local/statutory body.
- Removal of all fixtures and equipment employed in erection/fabrication and removal of all debris and waste material from site after completion of job.
- Cleaning and uplifting of area after completion of work.
- All the safety and security measures for personnel and property.

4.0 TECHNICAL

4.1 Materials

- All materials shall be in accordance with the requirement of API Std. 650 (12th Edition).
- All materials shall be subjected to acceptance by the Owner/Engineer.
- All materials shall be selected to meet service conditions.
- All materials shall be listed in ASME, Section-II, Material Specifications.
- All materials shall be clearly identified and provided with Mill Test Certification.
- Contractor shall provide the following material certificates/tests reports to Client for approval:
  - Chemical analysis
  - Product analysis
  - Physical tests
- All pipes shall be seamless.
- All attachments welded directly to be tanks shall be constructed of weldable steel of similar quality to the tank shell and roof.

- Gaskets:
  - Gaskets shall conform to ASME B 16.21.
  - Service gaskets shall be supplied in good condition i.e. not those used for test.
  - Where nozzles are connected to external pipe work or valving, gaskets shall be in accordance with the relevant piping material class.

4.2 Fabrication

4.2.1 General

No fabrication shall begin until the Contractor has received approval of proper material certification, detailed fabrication drawings, calculations, weld procedures, plus welder performance and weld procedure qualifications from the Owner or the Owner′s authorized representative.

Shop fabrication details shall be complete with all dimensions, thickness and details of construction including dimensional location of weld seams and nozzles. All welds and weld preparations shall be detailed and annotated to the relevant weld procedure specification.

No fabrication shall be sub-contracted without the prior written approval of the Owner/Engineer.

No holes shall be made in either the bottom or shell plates for the purposes of erection.

All lugs attached by welding to facilitate erection shall be removed prior to final inspection and the plate surface crack detected.

4.2.2 Welding

a) This specification covers the requirements and procedures for welding and does not relieve the Contractor from his responsibilities and guarantees with respect to welding results.

The layout of all welded seams shall permit both internal and external inspection of all main tank seams where possible.

All Butt welds shall be full penetration welds as shown in the applicable code or specified in this specification. No lap joints are permitted on shells.

Backing rings shall not be used on butt welds. Shop fabricated tanks shall have bottom plates Butt-welded throughout.

All welds of lugs, brackets, structural steel, etc. shall be located so as to miss all tank welds by a minimum distance between the edges of the welds of 100mm, or 3 times the thickness of the thicker part being welded, whichever is greater.

Where tanks are to be internally lined, weld joints shall be smooth and free from sharp edges and corners.

No welding shall be performed when the metal temperature is 5ºC and below without the application of preheat.

All fillet welds shall be continuous.

b) Welding Procedures and Procedure Qualifications

The Contractor shall submit weld procedures, qualifications and weld details for all new weld types utilized for Clientreview and approval prior to commencing any production welding.

Each procedure shall be qualified in accordance with procedures previously approved by the Owner/Engineer. Cauking is not permitted.

c) Welding Processes

The scope of application of welding processes shall require the approval of the Owner. High heat input processes such as electroslag welding are prohibited. In all cases the heat input of the welding process shall be limited to a maximum of 5 KJ/mm.

d) Welding Consumables and Deposited Metal Properties

The deposited weld metal shall have yield strength of not less than the minimum specified for the parent material.

All consumables shall be stored and handled in accordance with manufacturer's recommendations. Any unidentifiable consumable or those showing signs of damage or deterioration shall be discarded.
Low hydrogen electrodes shall be dried or baked at the temperature level and times specified by the manufacturer and shall be used within 8 hours when stored in quivers. Electrodes stored in quivers, but not used within the specified times shall be restored in ovens.

No electrodes shall be left lying about the site or in workshops. Electrodes so left shall be scrapped.

e) Welder Performance Qualification

All welders and welding machine operators shall be qualified in accordance with ASME IX. These welders and operators shall only be allowed to weld using the approval welding process and in the position for which they are qualified.

4.3 Erection

a) Contractor shall be responsible for site erection and supervision. When the Contractor is unable to provide a suitable workforce for site erection, he shall make available erection/commissioning engineer(s) to assume full responsibility for erection and commissioning in accordance with the approved requirements.

b) Contractor shall submit full details of sequence of erection including any site welding for Owner′s review.

c) No holes shall be made in either the bottom or shell plates for the purposes of erection.

d) All lugs attached by welding to facilitate erection, shall be removed prior to final inspection and the plate surface crack detected.

e) Contractor shall inform the Clientat least 2 weeks prior to commencement of erection, of the site facilities required for the erection and commissioning.

4.4 Inspection, Tests and Acceptance

4.4.1 Inspection of Material

QA/QC procedure shall be submitted for approval. Approved QA/QC procedures shall be followed through the tank construction.

- Inspection by Client shall not relieve the Contractor of the responsibility to replace any inadequate material and to repair any poor workmanship found on site.
- Any defective material or works found after acceptance at the time of rolling, machining or during erection and testing of tank shall be replaced without change even if it has been accepted previously.
- Material identification and certificates shall be submitted to the Owner/Engineer.

4.4.2 Inspection of Welds

- Welding procedure qualification and welder qualification tests shall be carried out in the test facility to be approved.
- Butt welds shall be full penetration and fusion. Quality of shell welded joints shall be evidenced by radiographic inspection, as specified in API-650 (12th Edition).
- Extent of Radiography shall be as specified in API-650 (12th Edition).

  Client at any time reserves the right to have any joint radiographed. All welds which are unacceptable shall be repaired and re-tested radiographically at contractors expenses.

  Completed tanks shall require final approval before hand-over to Owner's.
- All radiographic reports along with the films shall be submitted for approval.
- Surface preparation for painting shall have to be approved prior to the application of paint.
- Welding procedure specification shall be submitted for approval, prior to welding procedure qualification.
- All welds shall be visually inspected after completed.
- Corner joints and butt welds in tank plates shall be 100% inspected by MPI (magnetic particle inspection) methods.
- Nozzles and reinforcing pad welds shall be subjected to 100% MPI.
- All inspection shall be conducted and interpreted by qualified persons utilizing proven techniques. Results shall be sustained by charts, and repots which shall be submitted to the owner.

4.5 Testing

As a minimum requirement the testing of tanks covered by this specification shall be in accordance with API standard 650 (12th Edition).

a) Testing of Tank Bottom

Bottom of the tank shall be tested by applying a vacuum chamber to the plate welded joints and checking for leaks, using a suitable soap film solution. This can be done using a vacuum box, which enables any leaks in the seams to be positively located by visual examination.
The bottom plates shall in any case be tested before water is let into the tank for hydrostatic testing.

b) Tank Shell

- Testing shall be done by filling the tanks with fresh water to the level at bottom edge of the overflow nozzle.
- All connection shall be blinded off external piping shall be connected after successful completion of shell and floatation tests.

c) Tank Roof

After the tank erection is finished, the welds of the roof shall be tested by an inner pressure, which shall not exceed roof plate weight or by vacuum chamber applied on weld outer surface. Welding seams shall be lubricated with soap solution, flax oil or other liquid suitable to detect leakage.

d) Pressure Testing

- All tanks shall be subjected to a hydrostatic test.
- All hydrostatic tests shall be carried out using potable water, in the presence of an authorized inspector and subject to his approval. After

successful testing, all water shall be drained and the equipment thoroughly dried.

- Tank shall be properly vented during filling for hydrostatic testing so as to prevent the formation of air pockets before any test pressure is applied.
- Tanks shall be re-tested if any repairs are found.The re-test shall be performed after completion of repairs. All subject to the approval and in the presence of the owner's representative.
- Steam coils shall be hydrostatic pressure tested.

4.6 Tolerances

The tanks shall be within the following tolerances as required by API-650:

a) Maximum deviation from vertical line (lead line) between top angle and shell bottom shall be 1/200 of total tank height.

a) Deviation from vertical line for each shell plate shall not exceed the values specified for rolled plates in tables 14 to 15 under ASTM-A6 or in table 10 or 13 under ASTM-A20, as per applicable.

b) The thickness of the plate ordered shall not be less than the computed design thickness or the minimum permitted thickness. Negative mill tolerance is not permitted.

d) Roundness: Radial measurement at 300 mm above lap weld between shell and bottom shall not exceed the following tolerance:

Diameter	**Radius Tolerance**
0 to 12.2m exclusive	+ 12.7mm
12.2 to 45.7m exclusive	+ 19.0mm
45.7 to 76.2m exclusive	+ 25.0mm
76.2 and over	+ 32.0mm

e) Peaking: Using a horizontal mould to radius of 1m long peaking in any area of inside shell surface shall not exceed 12.7mm.

f) Banding: With a vertical sweep board 1m long, banding shall not exceed 12.7m. Measurements for tank shell shall be performed before hydraulic test.

4.7 Tank Calibration

Upon completion of the tank, this is to be calibrated in accordance with API 2550/ 2552 after hydrostatic testing. However, tank calibration shall be carried out before any insulation/painting work.

After successful completion of hydrostatic test, Contractor shall consult local statutory body to witness and certify the calibration work of each tank.

The actual calibration work shall be performed in the presence and to the satisfaction of the owner's representative and under supervision of qualified and experienced engineer to be assigned by the Contractor at his cost.

The Contractors shall also be responsible to get approval of calibration work of each tank from local/statutory body.

4.8 Nameplate

Tank shall be identified by a nameplate similar to that shown in drawing.

4.9 Painting

Tanks shall be painted in accordance with painting specifications
Doc. No. 2747-CIV-SP-07.

4.10 Box-up

After testing and calibration, all tanks shall be emptied and water disposed of as per instruction of Owner/Engineer. Tanks shall be thoroughly cleaned internally and

boxed-up, including mounting, fitting, fixing and bolting of all tank fittings and accessories. The cost of this work shall be considered included in the Contractor's rates for fabrication of tanks

5.0 HANDLING & STORAGE

All handling, loading and unloading shall be done in such a manner as to minimize mechanical damage and corrosion.

All handling shall be done with slings, padded hooks or brass-lined end hooks approved by Owner/Engineer.

Rail cars, trucks, lighters, ships or other conveyances shall be cleaned of debris or any substance that may damage the materials, prior to loading.

Suitable timber shall be used to protect the plates against damage in transit.

No on-deck overseas shipment shall be allowed without the prior written approval of Owner.

Finished plates to be stored for a significant period of time at the mill or marshalling yard, shall be stored in a manner such as to prevent corrosion.

5.1 Guarantee and Warranty

5.1.1 General

The Contractor will warrant the equipment to be free of defects in material and workmanship, and that it is of adequate size and capability to fulfill the design and operating conditions specified herein. The Contractor shall replace and install, without cost to the Owner, any materials, supplies, or equipment which fails under design conditions due to defects in material or workmanship, if the defect is observed and/or such failure occurs within one (1) year from the date such equipment or material is put in operation. Acceptance of this order will signify acceptance of all conditions of this guarantee.

SPECIFICATIONS FOR
WELDING

DOCUMENT NO. : 2745-TK-SP-02

TABLE OF CONTENT

1 GENERAL

1.1 Scope

This specification shall govern the electric arc welding processes permitted for use in the fabrication of all pressure piping.

This specification shall apply to all suppliers, sub contractors, vendors, manufacturers, and fabricators of welded pipes. The Contractor is responsible for all and shall ensure that all components to be incorporated into the work meeting this specification.

No supplier, sub contractors, vendor, manufacturer or fabricator shall subcontract the welding fabrication of any item without written approval from the Owner/Engineer, and the Owner/Engineer will not issue such an approval unless the proposed welding fabricator has received prior Owner/Engineer approval for the type of welding to be carried out.

1.2 CODES, STANDARDS AND REGULATIONS

All welding performed under this Specification shall meet or exceed the requirements specified by the latest revisions of the following applicable Codes and Regulations

a) AWS - (American Welding Society)

1. A2.4 (Symbols for Welding and Nondestructive Testing)
2. A3.0 (Standard Welding Terms and Their Definitions)
3. A5.1 (Specification for Mild Steel Covered Arc Welding Electrodes).
4. A5.5 (Specification for Low-Alloy Steel Covered Arc Welding Electrodes).
5. A5.17 (Specification for Bare Carbon Steel Covered Electrodes).
6. A5.18 (Specification for Carbon Steel Filler Metals for Gas Shielded Arc Welding).
7. A5.20 (Specification for Mild Steel Electrodes for Flux Cored Arc Welding Electrodes).

b) Applicable Local Boilers and Pressure Vessels Act and Regulations.
c) ASME B31.3 Chemical Plant and Petroleum Refinery Piping.
d) ASME Sec. VIII Div. 1 - Pressure Vessels.
e) ASME Sec. IX - Welding.
f) ASME B31.4 - Pipeline transportation systems for liquid hydrocarbons and other liquids.
g) API STD 1104 Standard for Welding Pipelines and Related Facilities.
h) AWS D1.1

All welding procedures used by Contractor / fabricator shall have been established and qualified in accordance with the appropriate sections of one or more of the codes and standards listed above and approved by the Owner/Engineer.

These Specifications apply to materials found in the P-1 grouping of Section IX of the ASME Codes and the equivalent material in the API Standards. The Owner/Engineer, on an individual basis, shall review all other “P” groupings.

Where a conflict occurs between these specifications and / or any of the above codes or Standards the more stringent shall apply.

2.0 WELDING PROCEDURES

2.1 GENERAL

The Contractor / Sub Contractor / Vendor as applicable shall submit to the Owner/Engineer for review and approval all welding procedures.

The Contractor / Sub Contractor / Vendor as applicable shall have a separate welding procedure for each method of welding he intends to employ.

A procedure qualification record (PQR) shall be included for each WPS. The PQR shall be witnessed and shall be supported with the lab report from the pre

approved testing laboratory, if so previously agreed to by the Owner/Engineer.

All testing shall be performed by Contractor / Sub Contractor / Vendor as the case may be and certified by an Owner/Engineer approved testing laboratory, agency or equivalent. The minimum acceptable written procedure shall detail information on the following parameters.

1. The scope of work performed under the procedures.
2. The base metals and applicable specifications.
3. The welding process.
4. Type, size, classification, and composition of filler metals. (The specific brand name(s) of the flux-wire shall become an essential variable of the procedure qualification).
5. Type and range of current and voltage.
6. Width of electrode weave or oscillation.
7. Joint preparation and cleaning procedures.
8. Tack welding procedures. Method of marking the location of tack welds to facilitate post weld inspection shall also be included.
9. Electrode polarity.
10. Applicable welding positions.
11. Preheat and inter pass temperatures. (Control method)
12. Welding travel speed.
13. Root preparation prior to welding from second side, (where applicable).
14. Wire feed speed, rate of travel (GMAW & SAW)
15. Removal methods for weld defects and stray arc strikes.
16. Inter pass-cleaning method.
17. Repair welding,
18. Post welding heat treatments (if required).
19. Type of (GMAW & GTAW) shielding gas, and flow rates
20. Type of (GTAW) electrode, size and tip angle.
21. Welders qualified and deployed in production welds shall always bear an identity card in the manner so approved by Owner/Engineer.

The Contractor / Vendor shall only employ welders who have a valid welding certificate for the procedures being used.

The Contractor shall have all welders tested in accordance with the applicable code or standard. Testing shall be at the Contractor's / Vendor's expense including test pieces. Irrespective of pre-qualification all welders proposed to be deployed in the work shall be tested and qualified afresh.

No welder shall be allowed to make any weld for which he is not qualified.

2.2 WELDING METHODS

The following welding processes are permitted, provided satisfactory evidence is submitted that the procedure has been qualified in accordance with the applicable Codes:

1. Shielded Metal-Arc Welding (SMAW).
2. Gas tungsten Arc Welding (GTAW).
3. Submerged Arc Welding (SAW).
4. Gas metal arc welding (GMAW)

The following processes are acceptable for the fabrication of piping by welding with limitations as noted.

Shielded metal arc welding (SMAW): may be used on all ferrous P1 & P8 materials with the following restrictions:

1. For low-hydrogen electrodes: 4.0 mm (5/32 inch) for out-of-position welding 2G, 3G, and 4G and 5.0 mm (3/16 inch) for flat welding 1G.

2. For other non-low-hydrogen electrodes: 5.0 mm (3/16 inch) for out-of-position welding 2G, 3G, and 4G) and 6.0 mm (7/32 inch) for flat welding 1G.

3. Welding with larger-size electrodes for specific applications may be allowed

only if each welder qualifies with the largest-size electrode to be used in production. This option is strictly at the Owner/Engineer discretion. The Owner/Engineer shall specify the details of the welder qualification tests if required.

Gas tungsten arc welding (GTAW) may be used on all ferrous P1 & P8 materials.

1. GTAW is required for the butt joint root pass of P-8 material.

2. SAW of carbon steel (P-1) materials shall not utilize active (Mn-Si) fluxes.
3. As-deposited weld metal for carbon steel (P-1) materials shall meet A-1 weld metal analysis.
4. For carbon steel (P-1) material; flux / wire combinations shall be chosen such that the deposited hardness of the cap pass shall not exceed 240 BHN. For low-temperature materials and other materials heat input shall be minimized and comply with the WPS parameters.
5. The carbon arc gouging process may be used. All carbon arc gouged surface areas shall be ground to clean bright metal prior to subsequent welding.
6. The Contractor may propose alternate process in addition to those listed. Any proposed process shall require written Owner/Engineer approval and qualification prior to implementation. Contractor and Owner/Engineer shall agree on tests, results, and other criteria before Owner/Engineer approval is granted.

Gas metal arc welding (GMAW) may be used on all P1 & P8 materials with the following restrictions:

1. GMAW in the short-circuiting transfer mode is limited to 10.0 mm (3/8-inch) maximum material thickness.
2. GMAW in the spray transfer mode shall be used in the flat position 1G only.

3. GMAW in the globular transfer mode is not acceptable.

4. GMAW in the vertical position 3G shall be uphill, except for the root pass on butt joints, which may be downhill.

5. GMAW welds that require radiography shall be Radio graphed with extra fine grain film.

6. The Owner/Engineer reserves the right to utilize ultrasonic inspection to confirm any GMAW welds interpreted to have lack of fusion defects (sidewall or inter pass).

7. If the as deposited weld exceeds 1.60 percent Mn, then all such welds shall not exceed 200 BHN. If these welds exceed 240 BHN, then they shall be removed.

All fillet welds, including weldolets, threadolets, and socket welds, shall be made as below:

The root and hot with two subsequent pass by GTAW and rest are by Shielded Metal Arc Welding (SMAW) process.

All butt welds in pipe smaller than 60.3 mm O/D (NPS 2” inch) Schedule 40 shall be made by GTAW and shielded metal arc process. Root pass by gas metal arc is acceptable for pipe larger than 60.3 mm O/D NPS (2”) inch.

All welds in pressure equipment must be qualified for Charpy impact testing when the code requirements indicate that the parent material requires impact testing.

When impact tests are required, tests shall be taken from the weld and heat affected zone.

The Contractor shall give special attention to welding of dissimilar base metals (different P numbers). Choice of electrodes / filler metals preheats, and the Contractor shall propose post weld heat treatment to Owner/Engineer for approval. Welds between carbon steel (P-1) and austenitic stainless steel (P-8) shall utilize

ENiCrFe-2, ENiCrFe-3, ERNiCr-3, E309L, ER309L or equivalent filler metal approved by the Owner/Engineer.

Permanently installed backing rings shall not be used.

All butt welds in pressure equipment shall have the same chemical and mechanical properties as the parent metal.

All welding procedures must be qualified for Charpy impact testing when the Code requirements indicate that the parent material requires impact testing.

2.3 MATERIALS AND EQUIPMENT

2.3.1 The work under this section covers welding on materials listed under Material Group P-1, Section IX, Welding Qualifications, ASME Boiler and Pressure Vessel Code, latest edition.

Welding electrodes shall conform to the appropriate of ASME Boiler and Pressure Vessel Code II Part C and / or the appropriate section of - Welding Electrodes as follows:

a) SMAW to SFA 5.1 covered carbon steel arc welding electrodes Class E7016, E7018, or E7018-1.
b) GTAW to SFA 5.18 carbon steel filler metals for gas shielded arc-welding class ER70-S2
c) SAW to SFA 5.17 carbon steel electrodes and fluxes for submerged arc welding, wire / flux classification EM 12K with a suitable neutral flux.

2.3.2 Welding Consumables.

The use of all welding consumables shall be subject to the Owner/Engineer's approval.

All coated metal arc-welding electrodes shall comply with AWS specification A 5.5, A 5.1. Submerged arc wire and flux shall comply with AWS A 5.17. Flux shall be of the non-active type unless approved otherwise by the Owner/Engineer.

All welding consumables, including fluxes shall be supplied in sealed containers and stored in a dry location at a minimum temperature of 68ºF, and a maximum relative humidity of 60%. Low-hydrogen electrodes, after removal from factory seal containers, shall be baked at 250º C for 2 hours and then stored / handled in portable ovens at a minimum temperature of 150ºF prior to use.

The welding filler metals shall have a chemical composition as near as possible to the parent metals to be welded. The finished weld as deposited, or after post weld heat treatment (PWHT) when required, shall be at least equal to the parent metal as to unit strength, ductile, and other physical properties and in resistance to corrosion, hydrogen attack, or other operating environment factors as required. Permission to change filler metals to those other than the ONES QUALIFIED IN ACCORDANCE WITH THIS SPECIFICATION must be obtained in writing, from the Owner/Engineer.

Electrode and rod diameters shall conform to the parameters of the weld procedure.

The Contractor / Vendor shall provide adequate drying ovens and take proper precautions in the storage and handling of low-hydrogen electrodes.

The Contractor / Sub Contractor / Vendor shall provide suitable wind guards, welder's platforms or bell holes when conditions warrant their use.
Electrodes and filler rods shall be protected from mechanical damage or deterioration. All unidentified, damaged or deteriorated electrodes or filler wires shall be removed from the working area and rejected. Any low hydrogen type SMAW electrodes not contained in heated quivers shall be removed from the site. Electrodes shall not be exposed to wet or high humid conditions.

Care of welding consumables is the responsibility of the Contractor; however, the following are minimum requirements:
Low-hydrogen SMAW electrodes shall be kept in commercial electrode ovens after the factory container has been opened. The electrode holding oven temperature shall be maintained between 175ºF (79ºC) and 250ºF (121ºC). Any low-hydrogen SMAW electrodes that have been exposed for more than 4 hours prior to restocking into the holding oven or any SMAW low-hydrogen electrodes that have become wet or have damaged coatings shall not be used and the same shall be rejected and removed from site.

Other (non-low-hydrogen) SMAW electrodes shall be kept in a dry and dust-free enclosure after opening of the factory container. These non-low-hydrogen electrodes shall be held at a temperature below 150ºF (66ºC).

SAW fluxes and FCAW electrodes shall be stored in the factory containers in a dry and relatively dust-free area. Un-fused SAW fluxes may not be recycled for high strength, low alloy, or high alloy materials unless recycle procedures are Owner/Engineer approved.

Bare wire (SAW and GMAW) and bare filler rod (GTAW and FGW) filler metals shall be stored in a dry and relatively dust-free area.

Extreme care shall be taken to ensure that electrode separation by classification is maintained in the Contractor's inventory. All storage bins and ovens for welding consumables shall be clearly labeled. In addition, all GTAW bare rod filler metals shall be tagged with the AWS designation of the filler metal. Any welding consumables, which are not readily identifiable, shall not be used.

All pressure containing welds shall be of a minimum of two passes with overlap of starts and stops. This shall include socket welds and seal welds of threaded connections.

Weld stops and starts shall be staggered so that adjacent weld passes do not

contain stops / starts within 25mm (1 inch) of each other.

The electrodes shall be purchased from the list of approved manufacturer's OR well known & reliable manufacturer and the same shall be supplied with proper certificates and batch certificates.

The width of weave during production welding shall be within the acceptable limit of the Owner/Engineer approved and qualified welding procedure, qualification certificates, and production welding operating sheets. As a norm this will be limited to a maximum of 3 times the core diameter of SMAW electrodes, whichever is the lesser.

Each weld pass / layer shall be completed in one full cycle / circumference before proceeding with the next. Blocking out or segmental welding is not permitted.

All tools and equipment used in the welding operations shall be in first class operating condition and shall be of sufficient capacity to ensure welds of the specified quality are achieved throughout the work. It shall be the right of the Owner/Engineer to request at any times the re-calibration of gauges and meters, etc. to ensure compliance with welding procedure operating sheets / WPS.

2.4 JOINT PREPARATION

The surface of the pipe at the weld area shall be free from dirt, grease, scale, paint, grit or any other foreign material, which may adversely affect the final weld quality. Bevels shall be 37½ º and all field cuts shall be normal to the axis of the pipe.

Miter welds are prohibited. All pipes shall be beveled for welding with an approved mechanical beveling machine.

Damage to bevels, which could possibly affect the quality of the weld, shall be rectified prior to welding. If beyond repair the pipe shall be cut and the pipe end re beveled.

Where welding a pipe to a flange or another pipe or component, there must be a band of at least 25.0 mm (1" inch) wide around the internal / external joint weld preparation that is ground to bright metal, and is free of all foreign matter.
To assure proper spacing and alignment in accordance with the applicable Code, an approved lineup clamp shall be used.

All welded joints shall conform to the straightness and alignment specified herein. Correction of improperly fitted parts shall be accomplished by disassembly and refitting. Reworking by hammering or flame straightening shall not be permitted.
The ends of piping components to be joined shall be aligned as accurately as is practicable within existing commercial tolerance on diameters, wall thickness, and out of roundness. Maximum bore mismatch shall not exceed 1/16 inch (1.6 mm). Alignment shall be preserved during welding.

When joints of unequal thickness are joined, the internal offset shall not exceed 1.6 mm (1/16"). If this value is exceeded, the excess thickness of the heavier end shall be machined or ground back from the bevel on a one-to-four (1:4) taper.

Maximum bore mismatch shall not exceed 0.8mm (1/32 inch). Where ends are to be joined and the internal misalignment due to difference in wall thickness, etc. exceeds 1.6 mm (1/6 inch), the wall extending internally shall be internally trimmed. Internal machining shall be performed so that the inside diameters of the components coincide.

When cutting pipe to length, it should be cut by mechanical means, if practical. Ends that are to have flanges attached either in the shop or field must be cut true and square.

2.5 PREHEATING

Preheat for pressure piping and furnace tubes shall be in accordance with ASME B31.3 and B31.4.

All pipe joints having a wall thickness greater than 9.5 mm (0.375") shall be preheated to 100°C (212°F) prior to welding.

Preheating shall be carried out with an approved torch system or with electrical induction coils, which will provide uniform heating.

The preheat area shall be at least 200 mm (8") wide centered about the weld and shall extend around the entire circumference of the pipe.

Preheat temperatures shall be checked with temperature sensitive crayons (such as "Tempilstick") or by other approved methods.

If a joint requires preheating, the same temperature requirements shall be maintained for each succeeding pass.

2.6 WELDING DETAILS

2.6.1 All pressure welding shall be performed in accordance with approved and qualified welding procedures as required per code.

2.6.2 Each weld shall be uniform in width and size throughout its full length.

2.6.3 Each layer of welding shall be smooth and free of slag, cracks, pinholes, undercuts (internal and external), porosity and excessive bead shall be completely fused to the adjacent weld beads and base metal.

2.6.4 The cover pass shall be free of coarse ripples, irregular surface, non-uniform pattern, high crown, deep ridges or valleys undercut, arc strikes, porosity, undercut, slag, or spatter.

2.6.5 Butt welds shall be slightly convex, of uniform height, and have full penetration, unless otherwise approved.

2.6.6 For piping, limitations on weld reinforcement shall apply to the internal surfaces as

well as to the external.

2.6.7 Fillet welds shall be of a specified size with full throat and the legs of uniform length.

2.6.8 Arcs shall only be struck in the weld groove. A controlled arc must be maintained while welding. Should an arc strike occur, it shall be removed by grinding and the area shall be etched (10% Nital) to confirm heat affected area removal, and MPT examined to ensure absence of any surface cracking?

2.6.9 After each pass, the layer of weld metal must be cleaned to remove all slag, scale, dirt, etc. Wire brushes, grinder, or chipping hammer shall be used as needed to prepare proper surface for each succeeding weld pass.

2.6.10 Repair, chipping or grinding of welds shall be done in such a manner as not to gouge, groove, or reduce the base metal thickness.

2.6.11 No welding shall be done if the temperature of the base metal is below 50ºF. Nor shall there be any welding done if there is moisture, grease, or any foreign material on the joint to be welded.

2.6.12 An ASME qualified welder shall make tack welds. Cracked tack welds shall be completely ground out and NDE by MPT / DPT prior to re-welded.

2.6.13 The Contractor shall make no substitution of materials or modifications to details without the prior written approval of the Owner/Engineer.

2.6.14 Welders and welding operators shall not be qualified on production welds.

2.6.15 The Contractor shall ensure that welders and welding operators are only employed on those parts of the work for which they are qualified.

2.6.16 Each welder and welding operator shall possess an appropriate temperature-measuring device. All supervision shall possess a copy of the approved welding procedures.

2.6.17 Alternatively, welding procedures may be clearly displayed at each welding location. Welders shall be familiar with the requirements of the appropriate approved welding procedures. Any welder found not complying with the approved welding procedures during production welding shall be removed from the work and the non-conforming weld(s) may be completely rejected, at the discretion of the Owner/Engineer.

Welder having repairs more than 3% in his production weld shall be given a warning and if no improvement after first warning shall be removed from the project or requalified, at the discretion of the Owner/Engineer.

2.6.18 No welding shall be undertaken without approved WPS and qualification of welding procedure.

2.6.19 The Owner/Engineer will not provide any WPS for the Contractor.

2.7 WELDING TECHNIQUES

2.7.1 General

a) All welding shall be performed in accordance with an approved and qualified welding procedure.

b) Each weld shall be uniform in width and size throughout its full length.

c) The cover pass shall be free of coarse ripples, irregular surface, non-uniform bead pattern, high crown, and deep ridges or valleys between beads.

Butt welds shall be slightly convex, of uniform height, and have full penetration.

2.7.2 Horizontal Roll Welds

When Shielded Metal Arc Welds are made in the horizontal (1G) rolled position, the root pass shall be deposited by the "down hill" method of welding while the pipe remains in a horizontally fixed position. For all remaining passes, the pipe may be horizontally rotated as the weld metal is deposited in the approximate top quadrant in the "uphill" progression method.

2.7.3 Horizontal Fixed Welds

When Shielded Metal Arc welds are made with the pipe in the horizontal fixed position, all passes shall be deposited by the "up hill" method of welding.

2.7.4 Vertical Welds

When Shielded Metal Arc welds are made with the pipe in a vertical position, (2G), the deposition of the weld metal shall be multiple beads in a horizontal plane.

2.7.5 Fillet Welds

a. All fillet welds shall be slightly concave and the length of each leg nearly equal.
b. Socket welds shall have a minimum of 2 weld beads – root+3 pass by GTAW remainder by SMAW. The length of each leg of the fillet weld shall be equal.
The width of the weld shall extend to the outer rim of the fitting where practical.

2.7.6 Treatment of Underside of Weld

a. The use of backing rings for butt welds is prohibited.
b. Excessive burn through shall be removed.

2.7.7 Cleaning

a. All weld impurities shall be removed between passes. Cleaning may be done with either hand or power tools.
b. All rough irregularities in the cover pass and weld spatter shall be removed.

2.7.8 Weld Identification

Each finished weld shall be clearly marked to identify the portion made by each welder.

2.8 Defects And Repairs

Welds containing defects not exceeding an aggregate of five (5) percent of the length of the root bead may be removed by grinding, chipping or arc gouging and re-welded in accordance with an approved procedure. Welds containing defects exceeding that amount shall be cutout and replaced.

When defects are ground out the entire weld shall be preheated to a temperature of 150 °C (300 °F) prior to welding.

All repaired welds shall be radio graphed or by the same method of original defect detection.

2.9 Post Weld Heat Treatment (PWHT)

2.9.1 Contractor / Sub Contractor / Vendor is responsible for all PWHT requirements, which shall be performed as specified in accordance with ASME B31.3.

2.9.2 PWHT of pressure piping and furnace tubes shall be in accordance with ASME B31.3, B31.4 and the specification for Post Weld Heat Treating.

2.9.3 Controlled atmosphere furnaces are preferred for heat treatment. Procedures using electric resistance, induction, or flame burner rings are acceptable for shop or field heat treatment. The Contractor must take an approval from Owner/Engineer prior to go for heat treatment.

2.9.4 Contractor / Sub Contractor / Vendor must notify the Owner/Engineer prior to starting PWHT operations.

2.9.5 Following Owner/Engineer approval, Contractor / Sub Contractor shall permanently stamp each weld receiving PWHT with “HT” on two locations of the weld. If piping orientation is known, the stamping shall be on the top and north sides.

2.9.6 The Contractor / Sub Contractor shall furnish a PWHT record chart. The chart must be dated, numbered, and labeled with job identification, Contractor / Sub Contractor name, and person responsible for the PWHT. Heat-treated line, welds and spool numbers shall be identified on the chart.

2.9.7 The completed PWHT record chart shall be submitted for Owner/Engineer approval following completion of heat treatment.

2.9.8 Stress relieving of piping shall be performed as per ASME B31.3 / ASME B31.4, as applicable.

2.9.9 Stress relieving may be performed by electrical induction or by electric resistance heating devices, or by furnace that has a large enough capacity to accommodate the entire piece being heat-treated.

2.9.10 The stress relieving temperature to be attained shall be 1100ºF minimum, 1150ºF maximum. The soak period at this temperature shall be one hour per 25.0 mm (1 inch) of pipe wall thickness and in no case shall the soak period be less than one hour.

2.9.11 Rate of heating and cooling shall be in accordance with the requirements for thermal stress relief presented in Section VIII of the ASME Boiler and Pressure Vessel Code. In any event, the rate of heating above 600ºF may not be more than 400ºF per hour, nor the rate of cooling more than 500ºF per hour when above 600ºF.

2.9.12 For field stress relieving, a continuous temperature record Log shall be furnished of

the program from heating, soaking and cooling to 600ºF. A minimum of two thermocouples shall be installed at each weld so that continuous readings can be assured in the event of thermocouple failure.

2.9.13 Local heat treatment of welds shall consist of heating 1D pipe length completely around the circumference of the pipe welds or pipes as required to eliminate thermally induced stresses. A continuous record of time and temperature shall be maintained for at least two points on each weld during the course of heat treatment with methods other than exothermic kits.

2.9.14 During heat treatment, the ends of the pipe shall be temporarily plugged to minimize air-cooling. Sufficient insulation shall be applied to maintain the required heat treatment temperature. The full thickness of 75mm (3”-inch) insulation shall be continued for a minimum distance of 610 mm (2 feet) on each side of the heating elements, and shall be left in place until the weld has cooled to below 100ºF.

2.9.15 When local heat treatment is used, care shall be exercised with restrained piping so that no upsetting will be caused by thermal expansion.

2.9.16 A minimum 10% of all locally (field) heat-treated welds shall require Brinell hardness testing.

2.9.17 Unless otherwise indicated by Owner/Engineer, Brinell hardness limits apply to welds after PWHT. The hardness of the weld shall be determined by the average value of three tests (of 3 indentations) taken per 120 degrees quadrant around the weld. The test areas of the weld shall be ground or filed to provide a suitable surface for testing. If a Telebrineller is used to measure the hardness, the bar shall be as close as practical to the anticipated weld hardness. If a poor indention is obtained on an individual test, a retest shall be made on an adjacent area.

2.9.18 Hardness tests other than Brinell may be used if the values obtained can be

equated to the Brinell hardness numbers, and the proposed equipment and procedures have received prior Owner/Engineer approval.

2.9.19 Flange facing and threaded connections must be adequately protected against oxidation during stress relieving and must be cleaned and free of defects after stress relieving.

2.9.20 No heating or welding may be applied to any piping or weld joint after stress relieving is complete.

2.9.21 All stress relieving equipment and execution shall be supplied at Contractor's expense.

2.10 INSPECTION

2.10.1 The Contractor / Sub Contractor / Vendor shall extend all facilities, assistance and co-operate fully in all aspects of inspection and NDE and shall give adequate notice of any required fabrication inspection stages, together with sufficient time for thorough inspection. The Owner/Engineer shall have the right to establish hold points at any point in the fabrication sequence.

2.10.2 Although it is the Contractor's primary responsibility to perform weld examination, the Owner/Engineer shall have the right to observe the examination of all welds by non-destructive means. The inspection may be at any time before, during, and after fabrication. The Contractor shall conduct daily NDE percentage of welds to assess weld quality. Up to- date examinations are required to identify and prevent the re-occurrence of weld defects on subsequent welds. Records and evidence of all weld examinations shall be available at all times for the Owner/Engineer to review and approve.

2.10.3 Owner/Engineer may use any method of inspection necessary to establish quality control and ensure adherence to welding procedures. Owner/Engineer shall have

the right to accept or reject any weld not meeting the requirements of this specification, or if Owner/Engineer terms a weld unacceptable to the service for which it is intended.

2.10.4 Repair rates in excess of 5% by joint basis may result in stoppage of work by Owner/Engineer until the Contractor demonstrates that the welding problem has been resolved.

2.10.5 The Owner/Engineer reserves the right to perform additional inspection of production welds made using GMAW in the short-circuiting transfer mode. The Owner/Engineer may:

a) Perform ultrasonic inspection for the purpose of detecting lack of fusion. This inspection shall not replace any radiographic or other non-destructive examination requirement.
b) Perform a shop inspection to evaluate the capability of shop procedures and personnel to make acceptable welds.
c) Require re-qualification of procedures and / or personnel. This option will be exercised only in the presence of a significant number of weld repairs.

2.10.6 Any discrepancies between the approved WPS and the production welds noted by the Owner/Engineer, any or all of the work made under these conditions is subject to rejection.

2.10.7 Welds made by unqualified welders shall be rejected and shall be completely removed by the Contractor.

2.10.8 Welds that are not welder-identified shall be rejected.

2.10.9 The completed weld shall be presented in a uniform and workman like appearance and shall be symmetrical to the centerline of the weld.

2.10.10 The Contractor shall submit a daily production weld count report, itemized by ISO drawing number, diameter, weld number, and welder I.D. in addition to a weekly defect classified repair percentage report based on joint count.

2.10.11 The weld quality of branch connections shall meet the acceptance standards of this specification.

2.10.12 Welds between dissimilar materials shall be examined by the method and to the extent required for the material requiring the more stringent examination.

2.10.13 When examination of welds requiring random NDE (RT, UT, MT) reveals defects requiring repair, then two additional welds of the offending welder production shall be examined. For each rejected weld of the two welds, two more additional welds made by that welder shall be examined. If any of these welds are rejected, then the welder shall be re-tested or removed from the fabrication at the Owner/Engineer's option, and all welds (represented by the original group) made by the welder shall be 100 percent NDE (RT, UT, MT).

SPECIFICATIONS FOR
TANK CALIBRATION

DOCUMENT NO. : 2745-TK-SP-03

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1.0 SCOPE

This specification covers the minimum requirements for carrying out calibration of Vertical Atmospheric Steel Storage Tanks by optical method.

All material, labor, tools, ropes, planks, water meter etc. shall be provided by the Contractor at his own cost and responsibility, which shall be considered included in the rates quoted by the Contractor.

2.0 APPLICABLE STANDARD

Calibration shall be carried out according to the requirements of this specification. Where specific details about the execution of any item of work are not included, work shall be carried out according to the requirements of the latest edition of the following standards:

- API Standard 2555: Method for liquid calibration of tanks
- API Standard 2550: Method for measurement & calibration of upright cylinder tank

3.0 PROCEDURE FOR APPROVAL

Upon completion of the tank, which is to be calibrated, it should be hydrostatically tested. However, tank calibration shall be carried out before any insulation/painting work.

The actual strapping/bottom calibration work shall be performed in the presence and to the satisfaction of the Engineer and under supervision of qualified and experienced Engineer to be assigned by the Contractor at his cost.

After all that data is collected, calibration charts shall then be prepared by the Contractor with this data and submitted to the concerned authority for approval.

The Contractors shall also be responsible to get approval of calibration work of tank from concerned authority.

4.0 CIRCUMFERENCE MEASUREMENT

4.1 General

4.1.1 Circumference shall be measured on all courses only after the tank has been filled at least once but may be measured when the tank is 3/4 full. The dip, temperature and specific gravity or density of any liquid in the tank at the time of strapping shall be recorded.

4.1.2 Circumference shall be measured by three strapping per course at the following levels:

a. The upper level shall be 27 - 33 cm below the horizontal seam or the top angle.

b. At the middle position of each course.

c. The upper level shall be 27 - 33 cm above the horizontal seam or the bottom plates.

If for any reason it is impracticable, even with the use of a step over to take a strapping at the normal level, then a strapping shall be taken as close to this level as practicable, but not nearer the bottom or top angle or any seam than is specified.

If the tape is not in close contact with the surface of the tank throughout its whole path, a step-over shall be applied so that a correction may be calculated to adjust the gross circumference for this effect.

4.1.3 The Contractor shall provide tape from his own resources and his own cost.

4.2 Strapping Procedure

4.2.1 The tape shall be placed on its correct path, which shall be parallel to the horizontal seams of the tank. A tension of 4.5 kgf ± 0.5 kgf shall be applied to the tape using tensioning handles and spring balances. This tension shall be transmitted throughout the length of the tape.

4.2.2 If the tape used is not long enough to encircle the tank completely, then after level of the tape path has been chosen, the circumferences shall be measured in sections. Scribed lines shall be drawn not nearer than one-third of a plate length from a vertical seam.

4.2.3 If the tape used is long enough to encircle the tank completely, then after level of the tape path has been chosen, the tape shall be passed around the circumference and held so that the zero graduation is not nearer than one-third of a plate length from a vertical seam.

4.3 Repetition of Measurement

4.3.1 After a circumference has been measured the tension shall be released and the tape brought again to level and tension as in 4.2.1. The readings shall then be repeated and recorded.

4.3.2 Measurements shall be read to the nearest millimeter and shall be considered satisfactory if repetition as above shows agreement within the following tolerances:

Measure in Meters	Tolerance in mm
Upto 30	2
30 - 50	4
Over 50	6

4.3.3 If agreement is not obtained further measurements shall be taken and recorded until two consecutive readings are within the specified tolerances. The average of these two readings shall be taken as the circumferences.

4.4 Step- overs

4.4.1 If the tape path crosses obstructions such as projections, fittings, etc. which will cause it to deviate from a true circular path, an erroneous circumferential measurement will result. In order to avoid such an error, a step-over shall be used to measure the correction to be applied for such obstructions.

4.4.2 The step-over constant shall be determined separately for each course. The readings for determining this constant shall be repeated on four places equally spaced around the circumferences, and the average of the results rounded-off to the nearest 0.2 mm shall be taken and recorded as the step-over constant for the course concerned.

4.4.3 For vertical seams an average step-over correction shall be determined for each course and multiplied by the number of seams per course to obtain the total correction to be applied to the measured circumference of that course.

5.0 HEIGHT OF TANK SHELL

5.1 Course heights shall be measured externally and the vertical distances obtained shall be recorded to the nearest 5 mm.

5.2 The course heights should be measured at, at least three positions around the periphery. The results obtained shall then be averaged and recorded. The total of the separate course heights shall agree with the total height of the tank shell which shall be separately measured and recorded.

5.3 Any difference in level between the dip point and the datum point shall be determined

by suitable surveying methods.

6.0 DEADWOOD

6.1 The dimensions of the deadwood shall be measured whenever possible and the heights of the lowest and highest points of such deadwood measured in relation to the datum point of the tank. These measurements shall be recorded to the nearest 5 mm.

6.2 When physical measurements cannot be obtained, details of deadwood shall be taken from the tank drawings.

7.0 TANK BOTTOM

7.1 The bottom shall be calibrated by filling into the tank quantities of water or other non-volatile liquid which have been accurately measured, until the highest point of bottom or heating coil is just covered.

Quantities of known volume shall first be added until the dip point is just covered. The total quantity shall be recorded. Measured quantities of water or any other non-volatile liquid shall be added to the tank and the corresponding dips recorded. Three dips shall be taken for each level and the average shall be used for computations. This procedure shall be continued till the highest point of bottom or heating coil is just covered. Dips shall be taken at intervals not exceeding 2 cm.

7.2 The temperature of liquid shall be recorded at the beginning and end of calibration work every day. Liquid level shall be adjusted every day before filling the tank to account for liquid expansion or contraction.

7.3 Measurements of volumes shall be recorded to the nearest litter and the

corresponding dips to the nearest 1 mm.

8.0 MEASUREMENT OF TILT

Measurements shall be taken to determine the degree, if any, by which the tank is tilted. This shall be done by suspending a plumb line from the top angel and measuring at a sufficient number of points the maximum offset at the tank bottom.

9.0 COMPUTATION OF TANK CAPACITY TABLES

The procedures laid-down in the API Standards shall be followed for the computation of the tank capacity tables.

SPECIFICATIONS FOR
PAINTING

DOCUMENT NO. : 2745-TK-SP-04

	DETAIL DESIGN OF STORAGE TANKS FOR KUNNAR OIL FIELD **Mechanical / Structural**	
Doc. No. 2745-TK-SP-04	**SPECIFICATION FOR PAINTING**	Revision No. 0

TABLE OF CONTENTS

1.0 SCOPE

1.1 This specification covers the minimum requirements for supply of painting and Epoxy coating materials, application of painting and coating materials on storage tank, above ground/underground piping, structure and platforms.

1.2 The painting works to be performed by the Contractor shall include all necessary steps like supply of material, surface preparation to S.A. 2.5 “near White Metal”, protection of the other works, application of primers, intermediate and top (finish) coats, cleaning of the working area as well as all intermediate and final inspection works.

2.0 CODES AND STANDARDS

The acceptable standard for surface preparation of storage tanks, piping and structures shall be ISO 8501-1 “SA 2 ½ “or SSPC-“SP10, near white metal".

3.0 MATERIALS

3.1 Painting and finishing products for all work shall be best grade produced for each particular kind of material.

3.2 Before supply the Contractor will provide samples of primer and paints for Owner/ Engineer's approval.

3.3 Material for primers and paints will be supplied in 20 liters containers.

3.4 Materials for primer and succeeding coats shall preferably be the products of the same manufacturer. Compatibility of primer and succeeding coats shall be checked before execution of work.

3.5 The storage and preparation of paints and coating materials shall be strictly in accordance with the manufacturer's instructions.

4.0 SURFACE PREPARATION

4.1 Prior to the commencement of the work, Contractor shall submit for Owner /Engineer's review a blast cleaning procedure, details of equipment and personnel assigned to the blast cleaning operation. Blast cleaning shall be done for all piping, storage tanks and structure.

4.2 Abrasive material for blast cleaning shall be of a particle size to achieve the anchor profile/surface cleanliness detailed in 4.19 and 4.20.

4.3 Steel surfaces to be blast cleaned shall be free from grease, oil, dirt, weld slag or any other contamination. Oil and grease shall be removed with a suitable solvent. Only approved safety solvents, which do not leave a residue, shall be used. Pipes which have been subjected to salt spray in transportation shall be water washed and dried.

4.4 Surface shall be prepared generally during the day hours. When the surfaces show traces of condensation and if the relative humidity of the ambient air is higher than 80 to 85% the work shall be interrupted.

4.5 All metal parts which show traces of oxidation after cleaning and before painting shall be cleaned again, Greasy substances on surfaces to be re-cleaned and shall be removed through solvent scrubbing before re-cleaning.

4.6 All tools shall be used so as not to leave rough or sharp surfaces. No cuts shall be made on steel surface.

4.7 After bevelling, rolling and cleaning plates should be transferred to a shot-blasting area remote from other cleaning or coating operations.

4.8 During transportation and coating care shall be taken to avoid damage to bevels, and the steel surface.

4.9 Particle size and abrasive contamination shall be regularly checked.

4.10 The surface shall then be cleaned of all remaining grit and residual dust in a manner such that no contamination of the steel surface, or any other surface, which will affect coating quality, will occur. The surface shall be regularly tested for cleanliness by applying white tape and examining the tape for residue.

4.11 After grinding, any ground area larger than 50 mm in diameter shall be re-blasted to attain the desired profile.

4.12 A primer coat should be immediately applied on the proper cleaned surfaces.

4.13 Before primer application Owner/ Engineer or Coating Manufacturer's representative shall approve preparation of the surfaces.

4.14 Cleaning should be stopped each day leaving sufficient time to permit the surfaces cleaned to be primed before the end of the working day.

4.15 The Contractor shall immediately review any defect produced in primer coat due to handling or any reason.

4.16 Any blast-cleaned surface not primed before any apparent surface oxidation occurs, or not primed, within 4 hours after blasting, shall be re-blasted.

4.17 Second primer coat, two finish coats and shades for pattern will be applied after fabrication, erection and welding works.

4.18 All damaged and loosely adhering paint shall be removed and the surface thoroughly cleaned, preferably by sandblasting or if not practical then by mechanical devices such as with brushes or descalers to "near white metal" finish.

4.19 Blasted surfaces shall conform to SA 2.5 by visual comparison.

4.20 An average surface amplitude of 50 microns peak height shall be obtained (±25 microns), every hour and tested every hour with a Testex Press-o-Film and retained with the inspection records.

5.0 APPLICATION

5.1 The painting and coating work shall be performed carefully in accordance with the manufacturer's instructions using skilled labour. In particular dripping, corrugations and other application defects shall be avoided.

5.2 Painting shall not be carried out during following weather conditions:

- Rain
- Fog
- Relative humidity of air causing condensation on the metal surface at ambient temperature
- Temperature of metal surface higher than $60^{o}C$.
- Rainy weather.

5.3 Each coat of each painting /coating sequence shall be of a slightly different shade so as to ensure the complete covering by means of the next coat.

5.4 Approved Paint/Coating Manufacturer are as under:

- ICI Pakistan
- Kansai Paint

5.5 Paint / Coating Manufacturer's inspector shall supervise and witness the surface preparation and application of primer / paint /coating without incurring any additional cost from Paint manufacturer.

5.5.1 Technical/Application training at the job site will be provided before project commence if needed.

5.5.2 Paint testing like (Adhesion test with Dolly meter, Gloss test, Thickness test) on applied sample should be done at job site before project start.

5.5.3 All the work shall be fully guaranteed by the paint manufacturer. If client is not satisfied with the standard of work for whatever reason, Paint manufacturer shall always endeavor to remedy the situation and rectify any short comings as part of our commitment to provide a high standard of service.

5.5.4 Paint manufacturer shall provide test reports of every batch of paint if required by the client.

6.0 PAINTING SEQUENCE

The following sequence shall be applied: Necessary number of layers is as follows:

6.1 PIPING

6.1.1 PIPING Above Ground

High temperature (90°C) Insulated

1st Coat	Inorganic Zinc Silicate	75 microns DFT
Total dry film thickness (DFT)		75 microns minimum

6.1.2 PIPING Above Ground

Normal temperature (50°C)

1st Coat	Inorganic Zinc Silicate	75 microns DFT
2nd Coat	Micaceous Iron Oxide Epoxy	100 microns DFT
3rd Coat	Aliphatic Polyurethane	50 microns DFT
4th Coat	Aliphatic Polyurethane	50 microns DFT
Total dry film thickness (DFT)		275 microns minimum

Painting / coating scheme shall be as per Client requirement.

6.1.3 PIPING Under Ground

Normal temperature (50°C)

1st Coat	Organic Zinc Primer	75 microns DFT
2nd Coat	Coal Tar Epoxy C-200	150 microns DFT
3rd Coat	Coal Tar Epoxy C-200	150 microns DFT
Total dry film thickness (DFT)		375 microns minimum

6.2 STORAGE TANK

Painting Material Selection

Painting system	Application	Surface prep		paint	Number of coat	DFT (m/coat
P1	Temp. up to 100℃ Not insulated surface	Sa2 1/2	Primer	Epoxy iron oxide primer	1	25
			Inter coat	Epoxy MIO intercoat	1	70
			Top coat	Acrylic modified	2	40
P2	Temp. 101℃ to 200℃ Not insulated surface	Sa2 1/2	Primer	Inorganic zinc rich primer	2	50
			Top coat	Organic silicone heat resistant top coat(200℃)	2	20
P3	Temp. 201℃ to 400℃ Not insulated surface	Sa2 1/2	Primer	Inorganic zinc rich primer	2	50
			Top coat	Organic silicone heat resistant top coat(400℃)	2	20
P3	Temp. 401℃ to 600℃ Not insulated surface	Sa2 1/2	Primer	Organic silicone heat resistant primer (600℃)	2	20
			Top coat	Organic silicone heat resistant top coat (600℃)	2	20
P4	Temp. 101℃ to 200℃	Sa2 1/2	Primer	Inorganic zinc rich primer	2	50
P5	Temp. 201℃ to 400℃	Sa2 1/2	Primer	Inorganic zinc rich primer	1	50
P6	Temp. 401℃ to 600℃	Sa2 1/2	Primer	Organic silicone heat resistant primer (600℃)	1	20
P7	Temp. -101℃ to 60℃ Cold insulated	St3	Primer	Cold asphalt and diesel	2	100

6.3 Steel Structure

1st Coat	Inorganic Zinc Silicate	75 microns DFT
2nd Coat	Micaceous Iron Oxide Epoxy	100 microns DFT
3rd Coat	Aliphatic Polyurethane	50 microns DFT
4th Coat	Aliphatic Polyurethane	50 microns DFT
Total dry film thickness (DFT)		275 microns minimum

Painting / coating scheme shall be as per Client requirement.

6.4 Pipe Racks R120 Rating

1st Coat	Epoxy Zinc Primer	75 microns DFT
2nd Coat	Fire Retardant Coating	1000 microns DFT
3rd Coat	Aliphatic Polyurethane	50 microns DFT
Total dry film thickness (DFT)		1125 microns

Painting / coating scheme shall be as per Client requirement.

7.0 INSPECTION

7.1 All works and materials applied under this specification shall be subject to inspection by Owner / Engineer / Manufacturer representative.

7.2 All parts of the work shall be readily accessible for inspection.

7.3 Approval of each of the following shall be obtained before proceeding with any subsequent phase:

- Location of Work.
- Equipment.

- Surface Preparation.
- First Coat.
- Each Subsequent Coat.

7.4 Applicator shall correct work found defective under this specification at no cost to the Owner/ Engineer.

7.5 Micro-test thickness gauge or comparable instrument shall determine coating thickness.

Petrochemical Engineering Consultants

APPENDIX - A
(DETAIL DESIGN REPORT)

PG 1::> ETANK FULL REPORT - OGDCL KUNNAR TANK
ETank2000 Full 1.9.14

PG 2::>ETANK SETTINGS SUMMARY

To Change These ETank Settings, Go To Tools->Options, Behavior Tab.

No 650 Appendix F Calcs when Tank P = 0	-> Default : False -> This Tank : False
Show MAWP / MAWV Calcs	: True
Enforce API Minimum thicknesses	: True
Enforce API Maximum Roof thickness	: True
Enforce Minimum Self Supp. Cone Pitch (2 in 12)	: True
Force Non-Annular Btm. to Meet API-650 5.5.1	: False
Set t.actual to t.required Values	: False
Maximum 650 App. S or App. M Multiplier is 1	: True
Enforce API Maximum Nozzle Sizes	: True
Max. Self Supported Roof thickness	: 0.5 in.
Max. Tank Corr. Allowance	: 0.5 in.
External pressure calcs subtract C.A. per V.5	: False
Use Gauge Material for min thicknesses	: False
Enforce API Minimum Live Load	: True
Enforce API Minimum Anchor Chair Design Load = Bolt Yield Load	: True

PG 3::>SUMMARY OF DESIGN DATA and REMARKS

Job : OGDCL KUNNAR TANK
Date of Calcs. : 11/24/2016 , 10:13 PM
Mfg. or Insp. Date : 12/15/2016
Design Basis : API-650 11th Edition, Addendum 2, Nov 2009

- TANK NAMEPLATE INFORMATION

- Operating Ratio: 0.4
- Design Standard:
- API-650 11th Edition, Addendum 2, Nov 2009
- API-650 Appendices Used: V
- Roof : A-283 Gr C: 0.7296in.
- Shell (7): A-283 Gr C: 0.1875in.
- Shell (6): A-283 Gr C: 0.1875in.
- Shell (5): A-283 Gr C: 0.1875in.
- Shell (4): A-283 Gr C: 0.1875in.
- Shell (3): A-283 Gr C: 0.1875in.
- Shell (2): A-283 Gr C: 0.1875in.
- Shell (1): A-283 Gr C: 0.1875in.
- Bottom : A-285 Gr C: 0.354in.
- Annular Ring : A-36: 0.354in.

Design Internal Pressure = 0.1 PSI or 2.77 IN. H2O
Design External Pressure = -0.145 PSI or -4.02 IN. H2O

MAWP = 0 PSI or 0 IN. H2O
MAWV = -0.1478 PSI or -4.10 IN. H2O

OD of Tank = 38 ft
Shell Height = 32 ft
S.G. of Contents = 0.85
Max. Liq. Level = 32 ft

Design Temperature = 130 °F
Tank Joint Efficiency = 0.85

Ground Snow Load = 0 lbf/ft^2
Roof Live Load = 20 lbf/ft^2
Design Roof Dead Load = 0 lbf/ft^2

Basic Wind Velocity = 90 mph
Wind Importance Factor = 1
Using Seismic Method: API-650 10th Ed.
  Seismic Zone = 1
  Site Amplification Factor = 1.5
  Importance Factor = 1

DESIGN NOTES

  NOTE 1 : Tank is not subject to API-650 Appendix F.7

PG 4::>SUMMARY OF RESULTS

Shell Material Summary (Bottom is 1)

Shell #	Width (ft)	Material	Sd (psi)	St (psi)	Weight (lbf)	CA (in)
7	2	A-283 Gr C	20,000	22,500	1,826	0.0625
6	5	A-283 Gr C	20,000	22,500	4,564	0.0625
5	5	A-283 Gr C	20,000	22,500	4,564	0.0625
4	5	A-283 Gr C	20,000	22,500	4,564	0.0625
3	5	A-283 Gr C	20,000	22,500	4,564	0.0625
2	5	A-283 Gr C	20,000	22,500	4,564	0.0625
1	5	A-283 Gr C	20,000	22,500	4,564	0.0625
Total Weight					29,210	

Shell API 650 Summary (Bottom is 1)

Shell #	t.design (in.)	t.test (in.)	t.external (in.)	t.seismic (in.)	t.required (in.)	t.actual (in.)
7	0.0688	0.0064	0.1817	N.A.	0.1875	0.1875
6	0.0935	0.0322	0.1817	N.A.	0.1875	0.1875
5	0.1182	0.058	0.1817	N.A.	0.1875	0.1875
4	0.1429	0.0838	0.1817	N.A.	0.1875	0.1875
3	0.1676	0.1097	0.1817	N.A.	0.1875	0.1875
2	0.1923	0.1355	0.1817	N.A.	0.1923	0.1875
1	0.217	0.1613	0.1817	N.A.	0.236	0.1875

Structurally Supported Conical Roof
Plate Material = A-283 Gr C,
Struct. Material = A-283 Gr C

t.required = 0.2381 in.
t.actual = 0.7296 in.
Roof Joint Efficiency = 0.85

Plate Weight = 33,714 lbf

Rafters:
22 Rafters at Rad. 19 ft.: IPN-140

Rafters Weight = 4,389 lbf

Girders:

Girders Weight = 0 lbf

Columns:
1 Column at Center: 6 INCH SCH 40 PIPE

Columns Weight = 597 lbf

PG 5::>Bottom Type: Flat Bottom: Annular
Bottom Floor Material = A-285 Gr C
t.required = 0.354 in.
t.actual = 0.354 in.
Bottom Joint Efficiency = 0.85

Annular Bottom Plate Material : A-36
Minimum Annular Ring Thickness = 0.236 in.
t_Annular_Ring = 0.354 in.
Minimum Annular Ring Width = 24 in.
W_Annular_Ring = 24 in.

Total Weight of Bottom = 16,667 lbf

ANCHOR BOLTS: (6) 2.376in. UNC Bolts, A-325

TOP END STIFFENER: L3x3x3/16, A-36, 445. lbf
QTY (1) INTERMEDIATE STIFFENER: A-36
L70x70x7, 595. lbf, Elev. = 16 ft.

PG 6::>SUPPORTED CONICAL ROOF (from Brownell & Young)

Roof Plate Material: A-283 Gr C, Sd = 20,000 PSI, Fy = 30,000 PSI (API-650 « Table 5-2b)
Structural Material: A-283 Gr C, Sd = 20,000 PSI, Fy = 30,000 PSI (API-650 « Table 5-2b)

R = 19 ft
pt = 0.75 in/ft (Cone Roof Pitch)

Theta = ATAN(pt/12) = ATAN(0.0625) = 3.5763 degrees

Ap_Vert = Vertical Projected Area of Roof
= pt*OD^2/48
= 0.75*38^2/48
= 22.563 ft^2

Horizontal Projected Area of Roof (Per API-650 5.2.1.f)

Xw = Moment Arm of UPLIFT wind force on roof
= 0.5*OD
= 0.5*38
= 19 ft
Ap = Projected Area of roof for wind moment
= PI*R^2
= PI*19^2
= 1,134 ft^2

S = Ground Snow Load = 0 lbf/ft^2
Sb = Balanced Design Snow Load = 0 lbf/ft^2
Su = Unbalanced Design Snow Load = 0 lbf/ft^2

Dead_Load = Insulation + Plate_Weight + Added_Dead_Load
= (8)(2/12) + 29.7642 + 0
= 31.0975 lbf/ft^2

Roof Loads (per API-650 Appendix R)

Pe = PV*144 = 0.145*144 = 20.88 lbf/ft^2

e.1b = DL + MAX(Sb,Lr) + 0.4*Pe
= 31.0975 + 20 + 0.4*20.8800
= 59.449 lbf/ft^2

e.2b = DL + Pe + 0.4*MAX(Sb,Lr)
= 31.0975 + 20.8800 + 0.4*20
= 59.977 lbf/ft^2

T = Balanced Roof Design Load (per API-650 Appendix R)
= MAX(e.1b,e.2b)
= 59.977 lbf/ft^2

e.1u = DL + MAX(Su,Lr) + 0.4*Pe
= 31.0975 + 20 + 0.4*20.8800
= 59.449 lbf/ft^2

e.2u = DL + Pe + 0.4*MAX(Su,Lr)
= 31.0975 + 20.8800 + 0.4*20
= 59.977 lbf/ft^2

PG 7::> U = Unbalanced Roof Design Load (per API-650 Appendix R)

= MAX(e.1u,e.2u)
= 59.977 lbf/ft^2

Lr_1 = MAX(T,U) = 59.977 lbf/ft^2

P = Max. Design Load = Lr_1
= 59.977 lbf/ft^2
= 0.4165 PSI

l = Maximum Rafter Spacing (Per API-650 5.10.4.4)
= (t - ca) * SQRT(1.5 * Fy / P)
= (0.7296 - 0.04)*SQRT(1.5*30,000/0.4165)
= 226.67 in.

MINIMUM # OF RAFTERS

< FOR OUTER SHELL RING >

l = 84 in. since calculated l > 84 in. (7 ft)

N_min = 2*PI*R/l = 2*PI*(19)(12)/84 = 17.05

N_min = 18

Actual # of Rafters = 22

Minimum roof thickness based on actual rafter spacing

l = 65.12 in. (actual rafter spacing)

t-Calc = l/SQRT(1.5*Fy/p) + CA
= 65.12/SQRT(1.5*30,000/0.4165) + 0.04
= 0.2381 in.
NOTE: Governs for roof plate thickness.

RLoad_Max = Maximum Roof Load based on actual rafter spacing

RLoad_Max = 216(Fy)/(l/(t - ca))^2
= 216(30,000)/(65.12/(0.7296 - 0.04))^2
= 968.9 lb/ft^2

Let Max_T1 = RLoad_Max

P_ext_1 (Vacuum limited by actual rafter spacing)
= -[Max_T1 - DL - 0.4 * Max(Snow_Load,Lr)]/144
= -[968.9 - 31.0975 - 0.4 * Max(0,20)]/144
= -1 PSI due to actual rafter spacing

Pa_rafter_1 = P_ext_1
= -1 PSI or -27.71 IN H2O.

t.required = MAX(t-Calc, 0.1875 + 0.04)
= MAX(0.2381,0.2275)
= 0.2381 in.

PG 8::>RAFTER DESIGN

Maximum Rafter Span = 19 ft
Average Rafter Spacing on Shell = 5.408 ft
Average Plate Width = (5.408)/2 = 2.704 ft

Mmax = Maximum Bending Moment
Mmax = wl^2/8
where, w = (0.4165)(2.704)*12 + 10.5/12 = 14.39 lbf/in
l = (19)(12) = 228.00 in.
Mmax = (14.39)(228.00)^2/8 = 93506. in-lbf

Z req'd = Mmax/20,000 = 93506./20,000 = 4.68 in^3
Actual Z = 5.82 in^3 using IPN-140

W_Max (Max. stress allowed for each rafter in ring 1)
= Z * Sd * 8 / l^2
= 5.82 * 20,000 * 8 / 228.00^2
= 17.9132 lbf/in.

Max_P (Max. Load allowed for each rafter in ring 1)
= (W_Max - W_Rafter/12)/(Average Plate Width*12)
= (17.9132 - 10.5/12)/(2.704*12)
= 0.5251 PSI

Let Max_T1 = Max_P * 144

P_ext_2 (Vacuum limited by Rafter Type)
= -[Max_T1 - DL - 0.4 * Max(Snow_Load,Lr)]/144
= -[75.6144 - 31.0975 - 0.4 * Max(0,20)]/144
= -0.2536 PSI or -7.03 IN. H2O
Pa2_rafter_1 = P_ext_2
(limited by Rafter Type)

PG 9::>COLUMN DESIGN

CENTER COLUMN

l = Column Length
= 398 in = 33.17 ft (as computed)

r = Radius of gyration

if l/r must be less than 180, then

r req'd = l/180 = 398/180 = 2.21 in.
Actual r = 2.246 in. using 10 INCH SCH 40 PIPE

P = Total load supported by center column
= [(rafter length)(rafter load)(# of inner rafters)]/2
= [(19 ft)(12 in/ft)(14.39 lbf/in)(22)]/2
= 36,090 lbf

Fa = Allowable Compressive Stress (Per API-650 5.10.3.4)

Per API-650 5.10.3.3,
R = L/r = 177.2 (actual)

Cc = Column Slenderness Ratio
= SQRT[2PI^2E/Fy]
= SQRT[2PI^2(28,799,999)/(30,000)]
= 137.7

FS = Factor of Safety
= 5/3 + 3*(177.2)/(8*(137.7)) - (177.2)^3/(8*(137.7)^3)
= 1.8829

Since R > 120, Using API-650 Formulas in 5.10.3.4.

```
        Fa = [(12*PI^2(E))/(23*R^2)]/(1.6 - R/200)
           = [(12*PI^2(28,799,999))/(23*(177.2)^2)]/(1.6 - 177.2/200)
           = 6,615 PSI

        Fa is not modified Since Design Temp. <= 200 °F.
   (API-650 M.3.5 N.A.)
        Fa = 6,615 * 1
           = 6,615 PSI

        A_reqd = P/Fa
               = [36,090 + (398/12)(18)]/6,615
               = 5.55 in^2

        F = actual induced stress for the column
          = P/A = [ 36,090 + (398/12)(18) ] / 5.58
          = 6,575 PSI

        W_Max (Max. weight allowed for each column in ring 1)
               = 36,315 lbf

      Max_P (Max. Load allowed for each column in ring 1)
        Let Max_T1 = Max_P * 144


PG 10::>        P_ext_3 (Vacuum limited by Column Type)
         = -[Max_T1 - DL - 0.4 * Max(Snow_Load,Lr)]/144
         = -[60.3792 - 31.0975 - 0.4 * Max(0,20)]/144
         = -0.1478 PSI or -4.10 IN. H2O
        Pa_column_1 = P_ext_3
                                  (limited by Column Type)

Roof_Area = 36*PI*OD^2/COS(Theta)
          = 36*PI*(38)^2/COS()
          = 163,631 in^2

  ROOF WEIGHT

      Weight of Roof Plates
             = (density)(t)(PI/4)(12*OD - t)^2/COS(Theta)
             = (0.2833)(0.7296)(PI/4)(456 - 0.7296)^2/COS(3.5763)
             = 33,714 lbf   (New)
             = 31,865 lbf   (Corroded)

      Weight of Roof Plates supported by shell
             = 33,714 lbf   (New)
             = 31,865 lbf   (Corroded)

      Weight of Rafters = 4,389 lbf   (New)
      Weight of Girders = 0 lbf   (New)
      Weight of Columns = 597 lbf   (New)

      Total Weight of Roof = 38,700 lbf   (New)
                           = 36,851 lbf   (Corroded)


<Actual Participating Area of Roof-to-Shell Juncture>

   (From API-650 Figure F-2)
   Wc = 0.6 * SQRT[Rc * (t-CA)]    (Top Shell Course)
      = 0.6 * SQRT[227.8125 * (0.1875 - 0.0625)]
      = 3.2018 in.

   (From API-650 Figure F-2)
```

Wh = 0.3 * SQRT[R2 * (t-CA)] (or 12", whichever is less)
= 0.3 * SQRT[3,655 * (0.7296 - 0.04)]
= MIN(15.0616, 12)
= 12 in.

Top End Stiffener: L3x3x3/16
Aa = (Cross-sectional Area of Top End Stiffener)
= 1.09 in^2

Using API-650 Fig. F-2, Detail d End Stiffener Detail

L = Length of Angle Leg Parallel to Shell
= 3 in.
Ashell = Contributing Area due to shell plates
= (Wc-L)*(t_shell - CA)
= (3.2018 - 3)*(0.1875 - 0.0625)
= 0.025 in^2

PG 11::> Aroof = Contributing Area due to roof plates
= Wh*(t_roof - CA)
= 12 * (0.7296 - 0.04)
= 8.275 in^2

A = Actual Part. Area of Roof-to-Shell Juncture (per API-650)
= Aa + Aroof + Ashell
= 1.09 + 8.275 + 0.025
= 9.39 in^2

< Uplift on Tank > (per API-650 F.1.2)

NOTE: This flat bottom tank is assumed supported by the bottom plate.
If tank not supported by a flat bottom, then uplift calculations
will be N.A., and for reference only.

For flat bottom tank with structural roof,
Net_Uplift = Uplift due to design pressure less
Corroded weight of shell and corroded roof weight.

= P * PI / 4 * D ^ 2 * 144 «
- Corr. shell - [Corr. roof weight + Structural weight]
= 0.1 * 3.1416 / 4 * 1,444 * 144 «
- 19,475 - [31,865 + 4,389 + 0 + 597]
= -39,995 lbf

< Uplift Case per API-650 1.1.1 >

P_Uplift = 16,331 lbf
W_Roof_Plates (corroded) = 31,865 lbf
W_Roof_Structure = 4,986 lbf
W_Shell (corroded) = 19,475 lbf
Since P_Uplift <= W_Roof,
Tank Roof does not need to meet App. F requirements.

< API-650 App. F >

Fy = Min(Fy_roof,Fy_shell,Fy_stiff)
= Min(30,000,30,000,36,000)
= 30,000 psi

A_min_a = Min. Participating Area due to full Design Pressure.
(per API-650 F.5.1, and Fig. F-2)

= [OD^2(P - 8*t)]/[0.962*30,000*TAN(Theta)]
= [38^2(2.77 - 8*0.7296)]/[0.962*30,000*0.0625]
= -2.455 in^2
= 0 in^2 (since can't be negative)

P_F51 = Max. Design Pressure, reversing A_min_a calculation.
= A * [0.962*30,000*TAN(Theta)]/OD^2 + 8*t_h
= 9.39 * [0.962*30,000*0.0625]/38^2 + 8*0.6896
= 0.6224 PSI or 17.25 IN. H2O

P_Std = Max. Pressure allowed (Per API-650 App. F.1.3 & F.7)
= 2.5 PSI or 69.28 IN. H2O

PG 12::> P_max_internal = MIN(P_F51, P_Std)
= MIN(17.25, 69.28)
= 0.6224 PSI or 17.25 IN. H2O

P_max_external = -0.1478 PSI or -4.10 IN. H2O

PG 13::>SHELL COURSE DESIGN (Bottom Course is #1)

VDP Criteria (per API-650 5.6.4.1)
L = (6*D*(t-ca))^0.5
= (6*38*(0.1875-0.0625))^0.5
= 5.3385
H = Max Liquid Level =32 ft
L / H <= 2

Course # 1
Material: A-283 Gr C; Width = 5 ft.
Corrosion Allow. = 0.0625 in.
Joint Efficiency = 0.85

API-650 ONE FOOT METHOD

Sd = 20,000 PSI (allowable design stress per API-650 Table 5-2b)
St = 22,500 PSI (allowable test stress)

DESIGN CONDITION
G = 0.85 (per API-650)

< Design Condition G = 0.85 >

H' = Effective liquid head at design pressure
= H + 2.31*P(psi)/G
= 32 + 2.31*0.1/0.85 = 32.27ft

t-Calc = 2.6*OD*(H' - 1)*G/(Sd*E) + CA (per API-650 5.6.3.2)
= 2.6*38*(32.27 - 1)*0.85/(20,000*0.85) + 0.0625
= 0.217 in.

hMax_1 = E*Sd*(t_1 - CA_1)/(2.6*OD*G) + 1
= 0.85*20,000*(0.1875 - 0.0625) / (2.6 * 38 * 0.85) + 1
= 26.3036 ft.

Pmax_1 = (hMax_1 - H) * 0.433 * G

= (26.3036 - 32) * 0.433 * 0.85
= -2.0965 PSI

Pmax_int_shell = Pmax_1
Since Pmax_int_shell < 0, Pmax_int_shell = 0 PSI

HYDROSTATIC TEST CONDITION

< Design Condition G = 1 >

H' = Effective liquid head at design pressure
= H + 2.31*P(psi)/G
= 32 + 2.31*0.1/1 = 32.23ft

t.test = 2.6*38*(32.23 - 1)/(22,500*0.85) = 0.1613 in.

Course # 2
Material: A-283 Gr C; Width = 5 ft.
Corrosion Allow. = 0.0625 in.
Joint Efficiency = 0.85

PG 14::> API-650 ONE FOOT METHOD

Sd = 20,000 PSI (allowable design stress per API-650 Table 5-2b)
St = 22,500 PSI (allowable test stress)

DESIGN CONDITION
G = 0.85 (per API-650)

< Design Condition G = 0.85 >

H' = Effective liquid head at design pressure
= H + 2.31*P(psi)/G
= 27 + 2.31*0.1/0.85 = 27.27ft

t-Calc = 2.6*OD*(H' - 1)*G/(Sd*E) + CA (per API-650 5.6.3.2)
= 2.6*38*(27.27 - 1)*0.85/(20,000*0.85) + 0.0625
= 0.1923 in.

hMax_2 = E*Sd*(t_2 - CA_2)/(2.6*OD*G) + 1
= 0.85*20,000*(0.1875 - 0.0625) / (2.6 * 38 * 0.85) + 1
= 26.3036 ft.

Pmax_2 = (hMax_2 - H) * 0.433 * G
= (26.3036 - 27) * 0.433 * 0.85
= -0.2563 PSI

Pmax_int_shell = Min(Pmax_int_shell, Pmax_2)
= Min(0, -0.2563)
Since Pmax_int_shell < 0, Pmax_int_shell = 0 PSI

HYDROSTATIC TEST CONDITION

< Design Condition G = 1 >

H' = Effective liquid head at design pressure
= H + 2.31*P(psi)/G
= 27 + 2.31*0.1/1 = 27.23ft

t.test = 2.6*38*(27.23 - 1)/(22,500*0.85) = 0.1355 in.

Course # 3

Material: A-283 Gr C; Width = 5 ft.
Corrosion Allow. = 0.0625 in.
Joint Efficiency = 0.85

API-650 ONE FOOT METHOD

Sd = 20,000 PSI (allowable design stress per API-650 Table 5-2b)
St = 22,500 PSI (allowable test stress)

DESIGN CONDITION
G = 0.85 (per API-650)

< Design Condition G = 0.85 >

H' = Effective liquid head at design pressure
   = H + 2.31*P(psi)/G
   = 22 + 2.31*0.1/0.85 = 22.27ft

PG 15::> t-Calc = 2.6*OD*(H' - 1)*G/(Sd*E) + CA (per API-650 5.6.3.2)
        = 2.6*38*(22.27 - 1)*0.85/(20,000*0.85) + 0.0625
        = 0.1676 in.

hMax_3 = E*Sd*(t_3 - CA_3)/(2.6*OD*G) + 1
       = 0.85*20,000*(0.1875 - 0.0625) / (2.6 * 38 * 0.85) + 1
       = 26.3036 ft.

Pmax_3 = (hMax_3 - H) * 0.433 * G
       = (26.3036 - 22) * 0.433 * 0.85
       = 1.584 PSI

Pmax_int_shell = Min(Pmax_int_shell, Pmax_3)
               = Min(0, 1.584)

Pmax_int_shell = 0 PSI

HYDROSTATIC TEST CONDITION

< Design Condition G = 1 >

H' = Effective liquid head at design pressure
   = H + 2.31*P(psi)/G
   = 22 + 2.31*0.1/1 = 22.23ft

t.test = 2.6*38*(22.23 - 1)/(22,500*0.85) = 0.1097 in.

Course # 4
Material: A-283 Gr C; Width = 5 ft.
Corrosion Allow. = 0.0625 in.
Joint Efficiency = 0.85

API-650 ONE FOOT METHOD

Sd = 20,000 PSI (allowable design stress per API-650 Table 5-2b)
St = 22,500 PSI (allowable test stress)

DESIGN CONDITION
G = 0.85 (per API-650)

< Design Condition G = 0.85 >

H' = Effective liquid head at design pressure
   = H + 2.31*P(psi)/G

= 17 + 2.31*0.1/0.85 = 17.27ft

t-Calc = 2.6*OD*(H' - 1)*G/(Sd*E) + CA (per API-650 5.6.3.2)
= 2.6*38*(17.27 - 1)*0.85/(20,000*0.85) + 0.0625
= 0.1429 in.

hMax_4 = E*Sd*(t_4 - CA_4)/(2.6*OD*G) + 1
= 0.85*20,000*(0.1875 - 0.0625) / (2.6 * 38 * 0.85) + 1
= 26.3036 ft.

Pmax_4 = (hMax_4 - H) * 0.433 * G
= (26.3036 - 17) * 0.433 * 0.85
= 3.4242 PSI

PG 16::> Pmax_int_shell = Min(Pmax_int_shell, Pmax_4)
= Min(0, 3.4242)

Pmax_int_shell = 0 PSI

HYDROSTATIC TEST CONDITION

< Design Condition G = 1 >

H' = Effective liquid head at design pressure
= H + 2.31*P(psi)/G
= 17 + 2.31*0.1/1 = 17.23ft

t.test = 2.6*38*(17.23 - 1)/(22,500*0.85) = 0.0838 in.

Course # 5
Material: A-283 Gr C; Width = 5 ft.
Corrosion Allow. = 0.0625 in.
Joint Efficiency = 0.85

API-650 ONE FOOT METHOD

Sd = 20,000 PSI (allowable design stress per API-650 Table 5-2b)
St = 22,500 PSI (allowable test stress)

DESIGN CONDITION
G = 0.85 (per API-650)

< Design Condition G = 0.85 >

H' = Effective liquid head at design pressure
= H + 2.31*P(psi)/G
= 12 + 2.31*0.1/0.85 = 12.27ft

t-Calc = 2.6*OD*(H' - 1)*G/(Sd*E) + CA (per API-650 5.6.3.2)
= 2.6*38*(12.27 - 1)*0.85/(20,000*0.85) + 0.0625
= 0.1182 in.

hMax_5 = E*Sd*(t_5 - CA_5)/(2.6*OD*G) + 1
= 0.85*20,000*(0.1875 - 0.0625) / (2.6 * 38 * 0.85) + 1
= 26.3036 ft.

Pmax_5 = (hMax_5 - H) * 0.433 * G
= (26.3036 - 12) * 0.433 * 0.85
= 5.2645 PSI

Pmax_int_shell = Min(Pmax_int_shell, Pmax_5)
= Min(0, 5.2645)

Pmax_int_shell = 0 PSI

HYDROSTATIC TEST CONDITION

< Design Condition G = 1 >

H' = Effective liquid head at design pressure
= H + 2.31*P(psi)/G
= 12 + 2.31*0.1/1 = 12.23ft

PG 17::> t.test = 2.6*38*(12.23 - 1)/(22,500*0.85) = 0.058 in.

Course # 6
Material: A-283 Gr C; Width = 5 ft.
Corrosion Allow. = 0.0625 in.
Joint Efficiency = 0.85

API-650 ONE FOOT METHOD

Sd = 20,000 PSI (allowable design stress per API-650 Table 5-2b)
St = 22,500 PSI (allowable test stress)

DESIGN CONDITION
G = 0.85 (per API-650)

< Design Condition G = 0.85 >

H' = Effective liquid head at design pressure
= H + 2.31*P(psi)/G
= 7 + 2.31*0.1/0.85 = 7.27ft

t-Calc = 2.6*OD*(H' - 1)*G/(Sd*E) + CA (per API-650 5.6.3.2)
= 2.6*38*(7.27 - 1)*0.85/(20,000*0.85) + 0.0625
= 0.0935 in.

hMax_6 = E*Sd*(t_6 - CA_6)/(2.6*OD*G) + 1
= 0.85*20,000*(0.1875 - 0.0625) / (2.6 * 38 * 0.85) + 1
= 26.3036 ft.

Pmax_6 = (hMax_6 - H) * 0.433 * G
= (26.3036 - 7) * 0.433 * 0.85
= 7.1047 PSI

Pmax_int_shell = Min(Pmax_int_shell, Pmax_6)
= Min(0, 7.1047)

Pmax_int_shell = 0 PSI

HYDROSTATIC TEST CONDITION

< Design Condition G = 1 >

H' = Effective liquid head at design pressure
= H + 2.31*P(psi)/G
= 7 + 2.31*0.1/1 = 7.23ft

t.test = 2.6*38*(7.23 - 1)/(22,500*0.85) = 0.0322 in.

Course # 7
Material: A-283 Gr C; Width = 2 ft.
Corrosion Allow. = 0.0625 in.

Joint Efficiency = 0.85

API-650 ONE FOOT METHOD

Sd = 20,000 PSI (allowable design stress per API-650 Table 5-2b)
St = 22,500 PSI (allowable test stress)

PG 18::> DESIGN CONDITION
G = 0.85 (per API-650)

< Design Condition G = 0.85 >

H' = Effective liquid head at design pressure
= H + 2.31*P(psi)/G
= 2 + 2.31*0.1/0.85 = 2.27ft

t-Calc = 2.6*OD*(H' - 1)*G/(Sd*E) + CA (per API-650 5.6.3.2)
= 2.6*38*(2.27 - 1)*0.85/(20,000*0.85) + 0.0625
= 0.0688 in.

hMax_7 = E*Sd*(t_7 - CA_7)/(2.6*OD*G) + 1
= 0.85*20,000*(0.1875 - 0.0625) / (2.6 * 38 * 0.85) + 1
= 26.3036 ft.

Pmax_7 = (hMax_7 - H) * 0.433 * G
= (26.3036 - 2) * 0.433 * 0.85
= 8.945 PSI

Pmax_int_shell = Min(Pmax_int_shell, Pmax_7)
= Min(0, 8.945)

Pmax_int_shell = 0 PSI

HYDROSTATIC TEST CONDITION

< Design Condition G = 1 >

H' = Effective liquid head at design pressure
= H + 2.31*P(psi)/G
= 2 + 2.31*0.1/1 = 2.23ft

t.test = 2.6*38*(2.23 - 1)/(22,500*0.85) = 0.0064 in.

<API-650 APPENDIX V FOR EXTERNAL PRESSURE>

W (Wind Pressure) = 31*(V/120)^2
= 31*(90/120)^2
= 17.44 lbf/ft^2

Pe (External Pressure) = 0.145 PSI, OR 4.02 In. H2O
= 20.88 lbf/ft^2
Ps (Shell Design Pressure) = MAX(Pe, W + 0.4*Pe)
= MAX(20.88, 17.44 + 0.4*20.88)
= MAX(20.88, 25.792)
= 25.79 lbf/ft^2

Wtr = Transposed Width of each Shell Course
= Width*[t_top / t_course]^2.5

Transforming Courses (1) to (7)

PG 19::> Wtr(1) = 5*[0.1875/0.1875]^2.5 = 5 ft
Wtr(2) = 5*[0.1875/0.1875]^2.5 = 5 ft
Wtr(3) = 5*[0.1875/0.1875]^2.5 = 5 ft
Wtr(4) = 5*[0.1875/0.1875]^2.5 = 5 ft
Wtr(5) = 5*[0.1875/0.1875]^2.5 = 5 ft
Wtr(6) = 5*[0.1875/0.1875]^2.5 = 5 ft
Wtr(7) = 2*[0.1875/0.1875]^2.5 = 2 ft
Hts (Height of the Transformed Shell)
= SUM{Wtr} = 32 ft

<REQUIRED TOP COMPRESSION RING (per API-650 5.1.5.9.e)
For Structural Roof and OD <= 60 ft,
Minimum Required Angle is 2 x 2 x 1/4 in.
Z = 0.244 in^3,

PG 20::>* * * SHELL STIFFENING PER API-650 APP. V.8 * * *

D (Tank OD) = 38 ft
SHELL MATERIAL (thinnest course) : A-283 Gr C
ts1 (Top Shell Thickness) = 0.1875 in.
tsn (Bottom Shell Thickness) = 0.1875 in.
tsmin (Smallest Actual Shell Thickness) = 0.1875 in.
JEr (Roof Joint Efficiency) = 0.85
JEs (Top Shell Joint Efficiency) = 0.85
Hts (Transformed Shell Height) = 32 ft
f_shell (Allowable Stress for thinnest Shell) = 20,000 psi
Fy_shell (Yield Stress for thinnest Shell) = 30,000 psi
E (Mod. of Elasticity for thinnest Shell) = 28,799,999 psi
TOP STIFFENER MATERIAL : A-36
f_stiff (Allowable Stress for Stiffener) = 23,200 psi
Fy_stiff (Yield Stress for Stiffener) = 36,000 psi
SHELL STIFFENER MATERIAL : A-36
f_stiff (Allowable Stress for Stiffener) = 23,200 psi
Fy_stiff (Yield Stress for Stiffener) = 36,000 psi
BOTTOM STIFFENER MATERIAL :
f_stiff (Allowable Stress for Stiffener) = 0 psi
Fy_stiff (Yield Stress for Stiffener) = 0 psi
BOTTOM PLATE MATERIAL : A-285 Gr C
f_btm (Allowable Stress for Bottom Floor) = 20,000 psi
Fy_shell (Yield Stress for Bottom Floor) = 30,000 psi
JEn (Bottom Shell Joint Efficiency) = 0.85
JEb (Bottom Joint Efficiency) = 0.85
Bottom Floor OD = 38.3333 ft

<V.8.1 UNSTIFFENED SHELLS>

Pe (External Pressure) = 20.88 lbf/ft^2
Ps (Shell Design Pressure) = 25.79 lbf/ft^2

V.8.1.1 Criteria (Elastic Failure when EFC >= 0.19,
otherwise must use ASME Section VIII)
EFC = (D/tsmin)^0.75*[(Hts/D)*(Fy/E)^0.5]
= (38/0.1875)^0.75*[(32/38)*(30,000/28,799,999)^0.5]
= 1.4599
Since EFC >= 0.19, using App. V method.

Condition 1: Wind plus specified external (vacuum) pressure
Since Pe > 15, PSI1 = MIN(Pe + 10,2.5) = 2.5

<V.8.1.2 Max External Pressure>
PS_Max = 0.6*E/[PSI1*(Hts/D)*(D/tsmin)^2.5]
= 0.6*28,799,999/[2.5*(32/38)*(38/0.1875)^2.5]
= 14.0372 lbf/ft^2

= 0.0975 psi

PV_max1 = Min(PS_Max, [PS_Max - W/144]/0.4)
= Min(0.0975, -0.0591)
= -0.0591 psi

Condition 2: Specified external (vacuum) pressure only
PSI2 = 3

PG 21::> <V.8.1.2 Max External Pressure>
PV_Max2 = 0.6*E/[PSI2*(Hts/D)*(D/tsmin)^2.5]
= 0.6*28,799,999/[3*(32/38)*(38/0.1875)^2.5]
= 11.6977 lbf/ft^2
= 0.0812 psi

PV_Max = Min(PV_Max1,PV_Max2)
= Min(-0.0591,0.0812)
= -0.0591 psi

Since PSI1*Ps >= 3*Pe, PSI = PSI1 & Ps = Ps

<V.8.1.3 Min thickness due to Design Pressure>
t_min_ext = 1.23*[(PSI*Hts*Ps)^0.4]*(D^0.6)/(E^0.4)
= 1.23*[(2.5*32*25.79)^0.4]*(38^0.6)/(28,799,999^0.4)
= 0.2398 in.

* * Warning * *tsmin = 0.1875 < t_min_ext, so tank is inadequate without « stiffeners.

<V.8.2 CIRCUMFERENTIALLY STIFFENED SHELLS>

<V.8.2.1.2 Maximum Unstiffened Shell Height>
Hs = 0.6*(tsmin^2.5)*(E)/[(D^1.5)*Ps*PSI]
= 0.6*(0.1875^2.5)*(28,799,999)/[(38^1.5)*25.79*2.5]
= 17.42 ft.

<V.8.2.1.3 Number of Stiffeners Required>
Ns = Hts/Hs - 1 (Rounded Up)
= 32/17.42 - 1
= 0.837, Rounded Up => 1
Actual Number of Stiffeners = 1

<V.8.2.1.4 Maximum Stiffener Spacing on transposed shell>

Lx = Hts/(Ns + 1)
= 32/(1 + 1)
= 16 ft

Evenly spaced uniform stiffeners,
Act. Spacing Ls = Hts/(N + 1)
= 32/(1 + 1)
= 16 ft

t_min_ext_stiff = 1.23*[(PSI*Ls*Ps)^0.4]*(D^0.6)/(E^0.4)
= 1.23*[(2.5*16*25.79)^0.4]*(38^0.6)/(28,799,999^0.4)
= 0.1817 in.

PsMax = {[tsmin*(E^0.4)/[(D^0.6)*1.23]]^2.5}/(PSI*Ls)/144
= {[0.1875*(28,799,999^0.4)/[(38^0.6)*1.23]]^2.5}/(2.5*16)/144
= 0.194 PSI

PV_max = Min(PsMax, [PsMax - W/144]/0.4)

= MIN(0.194, [0.194 - 17.44/144]/0.4)
= 0.1822 PSI

<V.8.2.2 Intermediate Stiffener Ring Design>

PG 22::> <V.8.2.2.1 Number of Waves>

N^2 = SQRT[5.33*D^3/(tsmin*Hts^2)]
= SQRT[5.33*38^3/(0.1875*32^2)]
= 39.03
N = 6.25

<V.8.2.2.3 Radial Load>

For each stiffener, Q is calculated using Ls for each.
Q_1 = Ps * Ls_1/12
= 25.79 * 16/12
= 34.39 lbf/ft

<V.8.2.2.4 Contributing Shell at Stiffener>

w_shell_1 = 2*1.47*(D*ts_4)^0.5
= 2*1.47*(38*0.1875)^0.5
= 7.8477 in.

<V.8.2.2.5 Required Moment of Inertia>

I_reqd_1 = 648*Q*D^3/[E*(N^2-1)]
= 648*34.39*38^3/[28,799,999*(6.25^2-1)]
= 1.1155 in^4

I_actual_1 = 1.5728 in^4
using L70x70x7, t = 0.1875 in., & W = 7.8477 in.

<V.8.2.2.6.1 Area Required>

For each stiffener, A_reqd is calculated using Q.

define fc = MAX(0.4Fy,15,000)
= MAX(0.4*30,000,15,000)
= 15,000 psi

A_reqd_1 = 6*Q_1*D/fc
= 6*34.39*38/15,000
= 0.523 in^2

<V.8.2.2.6.2 Area Required by Stiffener>

For each stiffener, A_stiff is calculated using shell t.

A_stiff_1 = A_reqd_1 - 26.84*ts_4*(D*ts_4)^0.5
= 0.523 - 26.84*0.1875*(38*0.1875)^0.5
= -12.91 in^2

Since A_stiff_1 <=0, No Stiffener Required

A_stiff_actual_1 = 1.457 in^2
using L70x70x7.

PG 23::>< SHELL COURSE SUMMARY >

STIFFENER ELEVATIONS ON SHELL

Stiffener #1: L70x70x7, Elev. = 16 ft.

SHELL COURSE #1 SUMMARY

Pmax_int_shell = 0 since hMax_1 < H, and hMax_2 < H

t-Calc = MAX(t-Calc_650, t_min_ext, t.seismic)
= MAX(0.217, 0.1817, 0)
= 0.217 in.

t-650min = 0.236 in. (per API-650 Section 5.6.1.1, NOTE 4)

t.required = MAX(t.design, t.test, t.min650) = 0.236 in.
t.actual = 0.1875 in.

Weight = Density*PI*[(12*OD) - t]*12*Width*t
= 0.2833*PI*[(12*38)-0.1875]*12*5*0.1875
= 4,564 lbf (New)
= 3,043 lbf (Corroded)

SHELL COURSE #2 SUMMARY
---

t-Calc = MAX(t-Calc_650, t_min_ext, t.seismic)
= MAX(0.1923, 0.1817, 0)
= 0.1923 in.

t-650min = 0.1875 in. (per API-650 Section 5.6.1.1, NOTE 4)

t.required = MAX(t.design, t.test, t.min650) = 0.1923 in.
t.actual = 0.1875 in.

Weight = Density*PI*[(12*OD) - t]*12*Width*t
= 0.2833*PI*[(12*38)-0.1875]*12*5*0.1875
= 4,564 lbf (New)
= 3,043 lbf (Corroded)

SHELL COURSE #3 SUMMARY
---

t_min_ext governs. See the STIFFENING RINGS Calculations.

t-Calc = MAX(t-Calc_650, t_min_ext, t.seismic)
= MAX(0.1676, 0.1817, 0)
= 0.1817 in.

t-650min = 0.1875 in. (per API-650 Section 5.6.1.1, NOTE 4)

PG 24::> t.required = MAX(t.design, t.test, t.min650) = 0.1875 in.
t.actual = 0.1875 in.

Weight = Density*PI*[(12*OD) - t]*12*Width*t
= 0.2833*PI*[(12*38)-0.1875]*12*5*0.1875
= 4,564 lbf (New)
= 3,043 lbf (Corroded)

```
  SHELL COURSE #4 SUMMARY
-----------------------------------------

   t_min_ext governs.  See the STIFFENING RINGS Calculations.

   t-Calc = MAX(t-Calc_650, t_min_ext, t.seismic)
          = MAX(0.1429, 0.1817, 0)
          = 0.1817 in.

   t-650min = 0.1875 in. (per API-650 Section 5.6.1.1, NOTE 4)


 t.required = MAX(t.design, t.test, t.min650) = 0.1875 in.
 t.actual = 0.1875 in.

 Weight = Density*PI*[(12*OD) - t]*12*Width*t
        = 0.2833*PI*[(12*38)-0.1875]*12*5*0.1875
        = 4,564 lbf    (New)
        = 3,043 lbf    (Corroded)


  SHELL COURSE #5 SUMMARY
-----------------------------------------

   t_min_ext governs.  See the STIFFENING RINGS Calculations.

   t-Calc = MAX(t-Calc_650, t_min_ext, t.seismic)
          = MAX(0.1182, 0.1817, 0)
          = 0.1817 in.

   t-650min = 0.1875 in. (per API-650 Section 5.6.1.1, NOTE 4)


 t.required = MAX(t.design, t.test, t.min650) = 0.1875 in.
 t.actual = 0.1875 in.

 Weight = Density*PI*[(12*OD) - t]*12*Width*t
        = 0.2833*PI*[(12*38)-0.1875]*12*5*0.1875
        = 4,564 lbf    (New)
        = 3,043 lbf    (Corroded)


  SHELL COURSE #6 SUMMARY
-----------------------------------------

   t_min_ext governs.  See the STIFFENING RINGS Calculations.

   t-Calc = MAX(t-Calc_650, t_min_ext, t.seismic)
          = MAX(0.0935, 0.1817, 0)
          = 0.1817 in.


PG 25::>   t-650min = 0.1875 in. (per API-650 Section 5.6.1.1, NOTE 4)


 t.required = MAX(t.design, t.test, t.min650) = 0.1875 in.
 t.actual = 0.1875 in.

 Weight = Density*PI*[(12*OD) - t]*12*Width*t
        = 0.2833*PI*[(12*38)-0.1875]*12*5*0.1875
        = 4,564 lbf    (New)
        = 3,043 lbf    (Corroded)
```

SHELL COURSE #7 SUMMARY
---

t_min_ext governs. See the STIFFENING RINGS Calculations.

t-Calc = MAX(t-Calc_650, t_min_ext, t.seismic)
= MAX(0.0688, 0.1817, 0)
= 0.1817 in.

t-650min = 0.1875 in. (per API-650 Section 5.6.1.1, NOTE 4)

t.required = MAX(t.design, t.test, t.min650) = 0.1875 in.
t.actual = 0.1875 in.

Weight = Density*PI*[(12*OD) - t]*12*Width*t
= 0.2833*PI*[(12*38)-0.1875]*12*2*0.1875
= 1,826 lbf (New)
= 1,217 lbf (Corroded)

PG 26::>FLAT BOTTOM: ANNULAR PLATE DESIGN

Bottom Plate Material : A-285 Gr C
Annular Bottom Plate Material : A-36

<Weight of Bottom Plate>

Bottom_Area = PI/4*(OD - 2*t_course_1 - 2*AnnRing_Width)^2
= PI/4*(456 - 2*0.1875 - 2*24)^2
= 130,500 in^2

Annular_Area = PI/4*(Bottom_OD)^2 - Bottom_Area
= PI/4*(459.9999)^2 - 130,500
= 35,690 in^2

Weight = Btm_Density * t.actual * Bottom_Area + Ann_Density * t-AnnRing * « Annular_Area)
= 0.2833 * 0.354*130,500 + 0.2833 * 0.354*35,690
= 16,667 lbf (New)
= 12,304 lbf (Corroded)

< API-650 >

Calculation of Hydrostatic Test Stress & Product Design Stress
(per API-650 Section 5.5.1)

t_1 : Bottom (1st) Shell Course thickness.

H'= Max. Liq. Level + P(psi)/(0.433)
= 32 + (0.1)/(0.433) = 32.231 ft

St = Hydrostatic Test Stress in Bottom (1st) Shell Course
= (2.6)(OD)(H' - 1)/t_1
= (2.6)(38)(32.231 - 1)/(0.1875)
= 16,457 PSI

Sd = Product Design Stress in Bottom (1st) Shell Course
= (2.6)(OD)(H' - 1)(G)/(t_1 - ca_1)
= (2.6)(38)(32.231 - 1)(0.85)/(0.125)

= 20,982 PSI

<Non-Annular Bottom Plates>

t_min = 0.236 + CA = 0.236 + 0.118 = 0.354 in. (per Section 5.4.1)

t-Calc = t_min = 0.354 in.

t-Actual = 0.354 in.

<Annular Bottom Plates> (per API-650 5.5.3 TABLE 5-1b),

t_Min_Annular_Ring = 0.236 + 0
= 0.236 in.

t_Annular_Ring = Actual Annular Ring Thickness
= 0.354 in.

PG 27::> W_Annular_Ring = Actual Annular Ring Width
= 24 in.

<Annular Bottom Plates> (per API-650 Section 5.5.2),

W_int = Minimum Annular Ring Width
(from Shell ID to Any Lap-Welded Joint)
(t_Min_Annular_Ring exclusive of corrosion)
= 390*t_Min_Annular_Ring/SQRT(H*G)
= 390(0.236)/SQRT(32.231*0.85)
= 17.58 in.

W_int = 24 in.

Wtr = Transposed Width of each Shell Course
= Width*[t_top / t_course]^2.5

Transforming Courses (1) to (7)

Wtr(1) = 5*[0.1875/0.1875]^2.5 = 5 ft
Wtr(2) = 5*[0.1875/0.1875]^2.5 = 5 ft
Wtr(3) = 5*[0.1875/0.1875]^2.5 = 5 ft
Wtr(4) = 5*[0.1875/0.1875]^2.5 = 5 ft
Wtr(5) = 5*[0.1875/0.1875]^2.5 = 5 ft
Wtr(6) = 5*[0.1875/0.1875]^2.5 = 5 ft
Wtr(7) = 2*[0.1875/0.1875]^2.5 = 2 ft
Hts (Height of the Transformed Shell)
= SUM{Wtr} = 32 ft

<API-650 APPENDIX V FOR EXTERNAL PRESSURE>

W (Wind Pressure) = 31*(V/120)^2
= 31*(90/120)^2
= 17.44 lbf/ft^2

Pe (External Pressure) = 0.145 PSI, OR 4.02 In. H2O
= 20.88 lbf/ft^2
Ps (Shell Design Pressure) = MAX(Pe, W + 0.4*Pe)
= MAX(20.88, 17.44 + 0.4*20.88)
= MAX(20.88, 25.792)
= 25.79 lbf/ft^2

PG 28::>* * * BOTTOM END STIFFENING CALCULATIONS PER V.8 * * *

Using API-650 App. V for flat bottom tank stiffening.

<V.8.2.3 Contributing Shell at Stiffener>
w_shell = 1.47*(D*tsn)^0.5
= 1.47*(38*0.1875)^0.5
= 3.9238 in.

<V.8.2.3.1 Radial Load, VI>
VI = Ps * H/48
= 25.79 * 32/48
= 17.1933 lbf/ft

<V.8.2.2.1 Number of Waves>
N^2 = SQRT[5.33*D^3/(tsmin*Hts^2)]
= SQRT[5.33*38^3/(0.1875*32^2)]
= 39.03
N = 6.25

<V.8.2.3.2 Required Moment of Inertia>

w_btm (Width of bottom available for I)
= 16*tb (cannot exceed W_annring)
= 5.664in.

I_reqd = 648*VI*D^3/[E*(N^2-1)]
= 648*17.1933*38^3/[28,799,999*(6.25^2-1)]
= 0.558 in^4

I_actual = 5.6559 in^4
using NONE, tsn = 0.1875 in., & W_shell = 3.9238 in.

<V.8.2.3.3.1 Area Required>

define f = Min(Fy_bottom, Fy_shell, Fy_stiff)
= Min(20,000, 20,000, N.A.)
= 20,000 psi

A_reqd = 6*VI*D/f
= 6*17.1933*38/20,000
= 0.196 in^4

<V.8.2.3.3.2 Area required by stiffener>

A_stiff_reqd = A_reqd - JEb*tb*w_btm - JEn*tsn*w_shell
= 0.196 - 0.85*0.354*5.664 - 0.85*0.1875*3.9238
= -2.13 in^2

Since A_stiff_reqd <=0, No Bottom Stiffener Required

A_stiff = 0 in^2
using NONE

A_actual = A_stiff + JEb*tb*w_btm + JEn*tsn*w_shell
= 0 + 0.85*0.354*5.664 + 0.85*0.1875*3.9238
= 2.33 in^2

PG 29::>< FLAT BOTTOM: ANNULAR SUMMARY >

Bottom Plate Material : A-285 Gr C
t.required = 0.354 in.
t.actual = 0.354 in.

Annular Bottom Plate Material : A-36
Minimum Annular Ring Thickness = 0.236 in.
t_Annular_Ring = 0.354 in.
Minimum Annular Ring Width = 24 in.
W_Annular_Ring = 24 in.

PG 30::>NET UPLIFT DUE TO INTERNAL PRESSURE
(See roof report for calculations)
Net_Uplift = -39,995 lbf
Anchorage NOT required for internal pressure.

WIND MOMENT (Per API-650 SECTION 5.11)

vs = Wind Velocity = 90 mph
vf = Velocity Factor = (vs/120)^2 = (90/120)^2 = 0.5625

Wind_Uplift = Iw * 30 * vf
= 1 * 30 * 0.5625
= 16.875 lbf/ft^2

API-650 5.2.1.k Uplift Check
P_F41 = WCtoPSI(0.962*Fy*A*TAN(Theta)/D^2 + 8*t_h)
P_F41 = WCtoPSI(0.962*30,000*9.39*0.0625/38^2 + 8*0.6896)
= 0.6224 PSI
Limit Wind_Uplift/144+P to 1.6*P_F41
Wind_Uplift/144 + P = 0.2172 PSI
1.6*P_F41 = 0.9958 PSI

Wind_Uplift/144 + P = MIN(Wind_Uplift/144 + P, 1.6*P_F41)
Wind_Uplift/144 = MIN(Wind_Uplift/144, 1.6*P_F41 - P)
Wind_Uplift = MIN(Wind_Uplift, (1.6*P_F41 - P) * 144)
= MIN(16.875,129.001)
= 16.875 lbf/ft^2

Ap_Vert = Vertical Projected Area of Roof
= pt*OD^2/48
= 0.75*38^2/48
= 22.563 ft^2

Horizontal Projected Area of Roof (Per API-650 5.2.1.f)

Xw = Moment Arm of UPLIFT wind force on roof
= 0.5*OD
= 0.5*38
= 19 ft
Ap = Projected Area of roof for wind moment
= PI*R^2
= PI*19^2
= 1,134 ft^2

M_roof (Moment Due to Wind Force on Roof)
= (Wind_Uplift)(Ap)(Xw)
= (16.875)(1,134)(19) = 363,626 ft-lbf

Xs (Moment Arm of Wind Force on Shell)
= H/2 = (32)/2 = 16 ft

As (Projected Area of Shell)
= H*(OD + t_ins / 6)
= (32)(38 + 2/6) = 1,227 ft^2

M_shell (Moment Due to Wind Force on Shell)
= (Iw)(vf)(18)(As)(Xs)
= (1)(0.5625)(18)(1,227)(16) = 198,720 ft-lbf

PG 31::> Mw (Wind moment)
= M_roof + M_shell = 363,626 + 198,720
= 562,346 ft-lbf

W = Net weight (PER API-650 5.11.3)
(Force due to corroded weight of shell and
shell-supported roof plates less
40% of F.1.2 Uplift force.)

= W_shell + W_roof - 0.4*P*(PI/4)(144)(OD^2)
= 19,475 + 31,865 - 0.1*(PI/4)(144)(38^2)
= 44,807 lbf

RESISTANCE TO OVERTURNING (per API-650 5.11.2)

An unanchored Tank must meet these two criteria:
1) 0.6*Mw + MPi < MDL/1.5
2) Mw + 0.4MPi < (MDL + MF)/2

Mw = Destabilizing Wind Moment = 562,346 ft-lbf

MPi = Destabilizing Moment about the Shell-to-Bottom Joint from Design « Pressure.
= P*(PI*OD^2/4)*(144)*(OD/2)
= 0.1*(3.1416*38^2/4)*(144)*(19)
= 310,294 ft-lbf

MDL = Stabilizing Moment about the Shell-to-Bottom Joint from the Shell and « Roof weight supported by the Shell.
= (W_shell + W_roof)*OD/2
= (19,475 + 31,865)*19
= 975,460 ft-lbf

tb = Annular Bottom Ring thickness less C.A. = 0.354 in.

Lb = Minimum bottom annular ring width

Lb = greater of 18 in. or 0.365*tb*SQRT(Sy_btm/H_liq)
= 18 in.

wl = Circumferential loading of contents along Shell-To-Bottom Joint.
= 4.67*tb*SQRT(Sy_btm*H_liq)
= 4.67*0.354*SQRT(30,000*32)
= 1,620 lbf/ft

wl = 0.9 * H_liq * OD (lesser value than above)
= 0.9*32*38
= 1,094 lbf/ft

MF = Stabilizing Moment due to Bottom Plate and Liquid Weight.
= (OD/2)*wl*PI*OD

= (19)(1,094)(3.1416)(38)
= 2,482,351 ft-lbf

Criteria 1
0.6*(562,346) + 310,294 < 975,460/1.5
Since 647,702 < 650,307, Tank is stable.

PG 32::> Criteria 2
562,346 + 0.4 * 310,294 < (975,460 + 2,482,351)/2
Since 686,464 < 1,728,906, Tank is stable.

RESISTANCE TO SLIDING (per API-650 5.11.4)

F_wind = vF * 18 * As
= 0.5625 * 18 * 1,227
= 12,420 lbf

F_friction = Maximum of 40% of Weight of Tank
= 0.4 * (W_Roof_Corroded + W_Shell_Corroded +
W_Btm_Corroded + RoofStruct + W_min_Liquid)
= 0.4 * (31,865 + 19,475 + 12,304 + 4,986 + 0)
= 27,452 lbf

No anchorage needed to resist sliding since

F_friction > F_wind

<Anchorage Requirement>
Anchorage NOT required since Criteria 1, Criteria 2, and Sliding
ARE acceptable.

PG 33::>SEISMIC MOMENT (API-650 APPENDIX E & API-620 APPENDIX L)

Ms (Seismic Moment)
Ms = Z*I*(C1*Ws*Xs + C1*Wr*Ht + C1*W1*X1 + C2*W2*X2)

Z = 0.075 Zone coefficient for zone 1 (from Table E-2)
I = 1 Importance Factor
S = 1.5 Site amplification factor (from Table E-3)

C1 = 0.6 = Lateral earthquake force coefficient

k = 0.59 (factor for D/H = 1.1875 from figure E-4)

T = Natural Period of First Sloshing Mode
= k*SQRT(OD) = 0.59*SQRT(38) = 3.637

C2 = Lateral Earthquake Force Coefficient
= 0.75(S)/T = .75(1.5)/(3.637) = 0.3093

From Figures E-2 & E-3
X1_H = X1/H chart factor
X2_H = X2/H chart factor
W1_Wt = W1/Wt chart factor
W2_Wt = W2/Wt chart factor
Wt = Weight of tank contents @ Max. Liquid Level

X1 = (X1_H)*H = (0.3884)*32 = 12.4285
X2 = (X2_H)*H = (0.6918)*32 = 22.1373
W1 = (W1_Wt)*Wt = (0.7668)*1,920,822 = 1,472,848
W2 = (W2_Wt)*Wt = (0.2833)*1,920,822 = 544,166

Ws = W_shell + W_Insulation (New Condition)
= 29,210 + 5,094 = 34,304
Wr = W_roof + Snow Load + W_Insulation (New Condition)
= 33,714 + 0 + 1,515 = 35,229

C1*Ws*Xs = 0.6*(34,304)(16) = 329,314
C1*Wr*Ht = 0.6*(35,229)(32) = 676,397
C1*W1*X1 = 0.6*(1,472,848)(12.4285) = 10,983,202
C2*W2*X2 = (0.3093)(544,166)(22.1373) = 3,726,191

Ms = Z*I*(C1*Ws*Xs + C1*Wr*Ht + C1*W1*X1 + C2*W2*X2)
= (0.075)(1)(329,314 + 676,397 + 10,983,202 + 3,726,191)
= 1,178,633 ft-lbf

W_shell = Weight of Shell (New Condition)
W_roof2 = Weight of Roof Plates Supported By Shell (New)

wt = (W_shell + W_roof2)/(PI*OD) (New Condition)
= (34,304 + 33,714)/(PI*38)
= 570. lbf/ft

RESISTANCE TO OVERTURNING (per Section E.4.1, E.4.2, assuming no anchors)

wl = 7.9*(tb1)*SQRT(Sy*G*H)
= 7.9*(0.236)*SQRT(36,000*0.85*32)
= 1,845 lbf/ft

where tb1 = t - CA = 0.236 in. (for Bottom Plate)

PG 34::> 1.25*G*H*OD = 1.25(0.85)(32)(38)
= 1,292 lbf/ft

since wl > 1.25*G*H*OD, wl = 1.25G*H*OD
wl = 1,292 lbf/ft

UNANCHORED TANKS (Section E.5.1)

Ms/[OD^2(wt+wl)] = 1,178,633/[(38^2)(570. + 1,292)] = 0.4384

b = wt + 1.273(Ms)/OD^2 = max longitudinal compressive force
= 570. + 1.273(1,178,633)/(38)^2 = 1,609 lbf/ft

MAXIMUM ALLOWABLE SHELL COMPRESSION (Section E.5.3)

b/(12t) = Max Longitudinal Compressive Stress
= 1,609/(12*(0.1875 - 0.0625)) = 1,073 PSI

G*H*OD^2/t^2 = (0.85)(32)(38^2)/(0.1875 - 0.0625)^2 = 2,513,715

Fa = 10^6*t/OD = (10^6)(0.1875 - 0.0625)/38 = 3,289 PSI

t = 0.1875 - 0.0625 = 0.125 in. (OK since b/(12t) <= Fa)

ANCHORED TANKS (Section E.5.2)

b = wt + 1.273(Ms)/OD^2 = Max Longitudinal Compressive Force
= 570. + 1.273(1,178,633)/(38)^2 = 1,609 lbf/ft

MAXIMUM ALLOWABLE SHELL COMPRESSION (Section E.5.3)

b/(12t) = Max Longitudinal Compressive Stress

= 1,609/(12*(0.1875 - 0.0625)) = 1,073 PSI

G*H*OD^2/t^2 = (0.85)(32)(38^2)/(0.1875 - 0.0625)^2 = 2,513,715

Fa = 10^6*t/OD = (10^6)(0.1875 - 0.0625)/38 = 3,289 PSI

t = 0.1875 - 0.0625 = 0.125 in. (OK since b/(12t) <= Fa)

ANCHORAGE OF TANKS (Section E.6.1)

N = 6 Number of Anchors
D = 38.333 ft Diameter of Anchor Circle

Net_Uplift = Net uplift due to internal pressure

MAR = minimum anchorage resistance due to seismic moment
= 1.273(Ms)/OD^2 + Net_Uplift/Circumference
= 1.273(1,178,633)/38^2 + -39,995/(PI*38)
= 704 lbf/ft circumference

btseis = anchor tension req'd to resist seismic moment
= MAR*D*PI/(N)
= (704)(38.333)(PI)/(6) = 14,130 lbf

PG 35::>ANCHOR BOLT DESIGN

Bolt Material : A-325
Sy = 36,000 PSI

< Uplift Load Cases, per API-650 Table 5-21b >

D (tank OD) = 38 ft
P (design pressure) = 2.77 INCHES H2O
Pt (test pressure per F.4.4) = P = 2.77 INCHES H2O
Pf (failure pressure per F.6) = N.A. (see Uplift Case 3 below)
t_h (roof plate thickness) = 0.7296 in.
Mw (Wind Moment) = 562,346 ft-lbf
Mrw (Seismic Ringwall Moment) = 1,178,633 ft-lbf
W1 (Dead Load of Shell minus C.A. and Any
Dead Load minus C.A. other than Roof
Plate Acting on Shell)

W2 (Dead Load of Shell minus C.A. and Any
Dead Load minus C.A. including Roof
Plate minus C.A. Acting on Shell)

W3 (Dead Load of New Shell and Any
Dead Load other than Roof
Plate Acting on Shell)

For Tank with Structural Supported Roof,
W1 = Corroded Shell + Shell Insulation
= 19,475 + 5,094
= 24,569 lbf
W2 = Corroded Shell + Shell Insulation + Corroded Roof Plates
Supported by Shell + Roof Dead Load Supported by Shell
= 19,475 + 5,094
+ 31,865 * [1 + 163,631*1.3333/(144 * 31,865)]
= 57,949 lbf
W3 = New Shell + Shell Insulation
= 29,210 + 5,094

= 34,304 lbf

Uplift Cases 1 to 3 are N.A.

Uplift Case 4: Wind Load Only
PWR = Wind_Uplift/5.208
= 16.875/5.208
= 3.2402 IN. H2O
PWS = vF * 18
= 0.5625 * 18
= 10.125 lbf/ft^2
MWH = PWS*(D+t_ins/6)*H^2/2
= 10.125*(38+2/6)*32^2/2
= 198,720 ft-lbf
U = PWR * D^2 * 4.08 + [4 * MWH/D] - W2
= 3.2402*38^2*4.08+[4*198,720/38]-57,949
= -17,941 lbf
bt = U / N = -2,990 lbf

Sd = 0.8 * 36,000 = 28,800 PSI
A_s_r = Bolt Root Area Req'd
A_s_r = N.A., since Load per Bolt is zero.

PG 36::> Uplift Case 5: Seismic Load Only
U = [4 * Mrw / D] - W2*(1-0.4*Av)
U = [4 * 1,178,633 / 38] - 57,949*(1-0.4*0)
= 66,118 lbf
bt = U / N = 11,020 lbf

Sd = 0.8 * 36,000 = 28,800 PSI
A_s_r = Bolt Root Area Req'd
A_s_r = bt/Sd
= 11,020/28,800 = 0.383 in^2

Uplift Cases 6 and 7 are N.A.

Uplift Case 8: Frangibility Pressure
Not applicable since if there is a knuckle on tank roof,
or tank roof is not frangible.
Pf (failure pressure per F.6) = N.A.

PG 37::>CAPACITIES and WEIGHTS

Maximum Capacity (to upper TL)	:	271,034 gal
Design Capacity (to Max Liquid Level)	:	271,034 gal
Minimum Capacity (to Min Liquid Level)	:	0 gal
NetWorking Capacity (Design - Min.)	:	271,034 gal

	New Condition	Corroded
Shell	29,210 lbf	19,475 lbf
Roof		
Plates	33,714 lbf	31,865 lbf
Rafters	4,389 lbf	4,389 lbf
Girders	0 lbf	0 lbf
Columns	597 lbf	597 lbf
Bottom	16,667 lbf	12,304 lbf

Stiffeners	1,040 lbf	1,040 lbf
Nozzle Wgt	0 lbf	0 lbf
Misc Roof Wgt	0 lbf	0 lbf
Misc Shell Wgt	0 lbf	0 lbf
Insulation	6,609 lbf	6,609 lbf
Total	92,226 lbf	76,279 lbf

Weight of Tank, Empty	:	92,226 lbf
Weight of Tank, Full of Product (SG=0.85)	:	2,014,830 lbf
Weight of Tank, Full of Water	:	2,354,113 lbf
Net Working Weight, Full of Product	:	2,014,830 lbf
Net Working Weight, Full of Water	:	2,354,113 lbf
Foundation Area Req'd	:	1,134 ft^2
Foundation Loading, Empty	:	81.33 lbf/ft^2
Foundation Loading, Full of Product (SG=0.85)	:	1,777 lbf/ft^2
Foundation Loading, Full of Water	:	2,076 lbf/ft^2

SURFACE AREAS
Roof 1,136 ft^2
Shell 3,820 ft^2
Bottom 1,134 ft^2

Wind Moment 562,346 ft-lbf
Seismic Moment 1,178,633 ft-lbf

MISCELLANEOUS ATTACHED ROOF ITEMS

MISCELLANEOUS ATTACHED SHELL ITEMS

PG 38::>MAWP & MAWV SUMMARY FOR OGDCL KUNNAR TANK

MAXIMUM CALCULATED INTERNAL PRESSURE

MAWP = 2.5 PSI or 69.28 IN. H2O (per API-650 App. F.1.3 & F.7)

MAWP = Maximum Calculated Internal Pressure (due to shell)
= 0 PSI or 0 IN. H2O

MAWP = Maximum Calculated Internal Pressure (due to roof)
= 0.6224 PSI or 17.25 IN. H2O

TANK MAWP = 0 PSI or 0 IN. H2O

MAXIMUM CALCULATED EXTERNAL PRESSURE

MAWV = -1 PSI or -27.71 IN. H2O (per API-650 V.1)

MAWV = Maximum Calculated External Pressure (due to shell)
= -0.1822 PSI or -5.05 IN. H2O

MAWV = Maximum Calculated External Pressure (due to roof)
= -0.1478 PSI or -4.1 IN. H2O

MAWV = N.A. (not calculated due to columns)

TANK MAWV = -0.1478 PSI or -4.1 IN. H2O

Petrochemical Engineering Consultants

APPENDIX - B
(CONCRETE CORE TESTING MANUAL)

Designation: C 42/C 42M – 04

American Association State
Highway and Transportation Officials Standard
AASHTO No.: T24

Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete[1]

This standard is issued under the fixed designation C 42/C 42M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This test method covers obtaining, preparing, and testing (*1*) cores drilled from concrete for length or compressive strength or splitting tensile strength determinations and (*2*) beams sawed from concrete for flexural strength determinations.

1.2 The values stated in either inch-pound units or SI units shall be regarded separately as standard. SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 The text of this standard references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.4 *This standard does not purport to address the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 39/C 39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C 78 Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)

C 174/C 174M Test Method for Measuring Length of Drilled Concrete Cores

C 496 Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens

C 617 Practice for Capping Cylindrical Concrete Specimens

C 642 Test Method for Density, Absorption, and Voids in Hardened Concrete

C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

C 823 Practice for Examination and Sampling of Hardened Concrete in Constructions

C 1231/C 1231M Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders

2.2 *ACI Standards:*

318 Building Code Requirements for Structural Concrete[3]

3. Significance and Use

3.1 This test method provides standardized procedures for obtaining and testing specimens to determine the compressive, splitting tensile, and flexural strength of in-place concrete.

3.2 Generally, test specimens are obtained when doubt exists about the in-place concrete quality due either to low strength test results during construction or signs of distress in the structure. Another use of this method is to provide strength information on older structures.

3.3 Concrete strength is affected by the location of the concrete in a structural element, with the concrete at the bottom tending to be stronger than the concrete at the top. Core strength is also affected by core orientation relative to the horizontal plane of the concrete as placed, with strength tending to be lower when measured parallel to the horizontal plane.[4] These factors shall be considered in planning the locations for obtaining concrete samples and in comparing strength test results.

3.4 The strength of concrete measured by tests of cores and beams is affected by the amount and distribution of moisture in the specimen at the time of test. There is no standard procedure to condition a specimen that will ensure that, at the time of test,

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.61 on Testing for Strength.

Current edition approved July 1, 2004. Published July 2004. Originally approved in 1921. Last previous edition approved in 2003 as C 42/C 42M – 03.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333.

[4] Neville, A., "Core Tests: Easy to Perform, Not Easy to Interpret," *Concrete International*, Vol. 23, No. 11, November 2001, pp. 59-68.

***A Summary of Changes section appears at the end of this standard.**

it will be in the identical moisture condition as concrete in the structure. The moisture conditioning procedures in this test method are intended to provide reproducible moisture conditions that minimize within-laboratory and between-laboratory variations and to reduce the effects of moisture introduced during specimen preparation.

3.5 There is no universal relationship between the compressive strength of a core and the corresponding compressive strength of standard-cured molded cylinders. The relationship is affected by many factors such as the strength level of the concrete, the in-place temperature and moisture history, and the strength gain characteristics of the concrete. Historically, it has been assumed that core strengths are generally 85 % of the corresponding standard-cured cylinder strengths, but this is not applicable to all situations. The acceptance criteria for core strength are to be established by the specifier of the tests. ACI 318 provides core strength acceptance criteria for new construction.

4. Apparatus

4.1 *Core Drill*, for obtaining cylindrical core specimens with diamond impregnated bits attached to a core barrel.

4.2 *Saw*, for cutting beam specimens to size for flexural strength tests and to trim ends of cores. The saw shall have a diamond or silicon-carbide cutting edge and shall be capable of cutting specimens that conform to the prescribed dimensions, without excessive heating or shock.

5. Sampling

5.1 *General*:

5.1.1 Samples of hardened concrete for use in the preparation of strength test specimens shall not be taken until the concrete is strong enough to permit sample removal without disturbing the bond between the mortar and the coarse aggregate (see Note 1 and Note 2). When preparing strength test specimens from samples of hardened concrete, samples that have been damaged during removal shall not be used unless the damaged portion(s) are removed and the resulting test specimen is of suitable length (see 7.2). Samples of defective or damaged concrete that cannot be tested shall be reported along with the reason that prohibits use of the sample for preparing strength test specimens.

NOTE 1—Practice C 823 provides guidance on the development of a sampling plan for concrete in constructions.

NOTE 2—It is not possible to specify a minimum age when concrete is strong enough to withstand damage during removal, because the strength at any age depends on the curing history and strength grade of the concrete. If time permits, the concrete should not be removed before it is 14 days old. If this is not practical, removal of concrete can proceed if the cut surfaces do not display erosion of the mortar and the exposed coarse aggregate particles are embedded firmly in the mortar. In-place test methods may be used to estimate the level of strength development prior to attempting removal of concrete samples.

5.1.2 Specimens containing embedded reinforcement shall not be used for determining compressive, splitting tensile, or flexural strength.

5.2 *Core Drilling*—A core specimen shall be drilled perpendicular to the surface and not near formed joints or obvious edges of a unit of deposit. Record and report the approximate angle between the longitudinal axis of the drilled core and the horizontal plane of the concrete as placed. A specimen drilled perpendicular to a vertical surface, or perpendicular to a surface with a batter, shall be taken from near the middle of a unit of deposit when possible.

5.3 *Slab Removal*—Remove a slab sufficiently large to secure the desired test specimens without the inclusion of any concrete that has been cracked, spalled, undercut, or otherwise damaged.

DRILLED CORES

6. Measuring the Length of Drilled Cores

6.1 Cores for determining the thickness of pavements, slabs, walls or other structural elements shall have a diameter of at least 3.75 in. [95 mm] when the lengths of such cores are stipulated to be measured in accordance with Test Method C 174/C 174M.

6.2 For cores that are not intended for determining structural dimensions, measure the longest and shortest lengths on the cut surface along lines parallel to the core axis. Record the average length to the nearest ¼ in. [5 mm].

7. Cores for Compressive Strength

7.1 *Diameter*—The diameter of core specimens for the determination of compressive strength in load bearing structural members shall be at least 3.70 in. [94 mm]. For non-load bearing structural members or when it is impossible to obtain cores with length-diameter ratio (L/D) greater than or equal to 1, core diameters less than 3.70 in. [94 mm] are not prohibited (see Note 3). For concrete with nominal maximum aggregate size greater than or equal to 1½ in. [37.5 mm], the core diameters shall be as directed by the specifier of the tests (see Note 4).

NOTE 3—The compressive strengths of nominal 2-in. [50-mm] diameter cores are known to be somewhat lower and more variable than those of nominal 4-in. [100-mm] diameter cores. In addition, smaller diameter cores appear to be more sensitive to the effect of the length-diameter ratio.[5]

NOTE 4—The preferred minimum core diameter is three times the nominal maximum size of the coarse aggregate, but it should be at least two times the nominal maximum size of the coarse aggregate.

7.2 *Length*—The preferred length of the capped or ground specimen is between 1.9 and 2.1 times the diameter. If the ratio of the length to the diameter (L/D) of the core exceeds 2.1, reduce the length of the core so that the ratio of the capped or ground specimen is between 1.9 and 2.1. Core specimens with length-diameter ratios equal to or less than 1.75 require corrections to the measured compressive strength (see 7.9.1). A strength correction factor is not required for L/D greater than 1.75. A core having a maximum length of less than 95 % of its diameter before capping or a length less than its diameter after capping or end grinding shall not be tested.

7.3 *Moisture Conditioning*—Test cores after moisture conditioning as specified in this test method or as directed by the

[5] Bartlett, F.M. and MacGregor, J.G., "Effect of Core Diameter on Concrete Core Strengths," *ACI Materials Journal*, Vol. 91, No. 5, September-October 1994, pp. 460-470.

specifier of the tests. The moisture conditioning procedures specified in this test method are intended to preserve the moisture of the drilled core and to provide a reproducible moisture condition that minimizes the effects of moisture gradients introduced by wetting during drilling and specimen preparation.

7.3.1 After cores have been drilled, wipe off surface drill water and allow remaining surface moisture to evaporate. When surfaces appear dry, but not later than 1 h after drilling, place cores in separate plastic bags or nonabsorbent containers and seal to prevent moisture loss. Maintain cores at ambient temperature, and protect cores from exposure to direct sunlight. Transport the cores to the testing laboratory as soon as possible. Keep cores in the sealed plastic bags or nonabsorbent containers at all times except during end preparation and for a maximum time of 2 h to permit capping before testing.

7.3.2 If water is used during sawing or grinding of core ends, complete these operations as soon as possible, but no later than 2 days after drilling of cores unless stipulated otherwise by the specifier of tests. After completing end preparation, wipe off surface moisture, allow the surfaces to dry, and place the cores in sealed plastic bags or nonabsorbent containers. Minimize the duration of exposure to water during end preparation.

7.3.3 Allow the cores to remain in the sealed plastic bags or nonabsorbent containers for at least 5 days after last being wetted and before testing, unless stipulated otherwise by the specifier of tests.

NOTE 5—The waiting period of at least 5 days is intended to reduce moisture gradients introduced when the core is drilled or wetted during sawing or grinding.

7.3.4 When direction is given to test cores in a moisture condition other than achieved by conditioning according to 7.3.1, 7.3.2, and 7.3.3, report the alternative procedure.

7.4 *Sawing of Ends*—The ends of core specimens to be tested in compression shall be flat, and perpendicular to the longitudinal axis in accordance with Test Method C 39/C 39M. If necessary, saw the ends of cores that will be capped so that prior to capping, the following requirements are met:

7.4.1 Projections, if any, shall not extend more than 0.2 in. [5 mm] above the end surfaces.

7.4.2 The end surfaces shall not depart from perpendicularity to the longitudinal axis by a slope of more than 1:8*d* or [1:0.3*d*] where *d* is the average core diameter in inches [or mm].

7.5 *Density*—When required by the specifier of the tests, determine the density by weighing the core before capping and dividing the mass by the volume of the core calculated from the average diameter and length. Alternatively, determine the density from the mass in air and submerged mass in accordance with Test Method C 642. After submerged weighing, dry cores in accordance with 7.3.2 and store in sealed plastic bags or nonabsorbent containers for at least 5 days before testing.

7.6 *Capping*—If the ends of the cores do not conform to the perpendicularity and planeness requirements of Test Method C 39/C 39M, they shall be sawed or ground to meet those requirements or capped in accordance with Practice C 617. If cores are capped in accordance with Practice C 617, the capping device shall accommodate actual core diameters and produce caps that are concentric with the core ends. Measure core lengths to the nearest 0.1 in. [2 mm] before capping. Unbonded caps in accordance with Practice C 1231/C 1231M are not permitted.

7.7 *Measurement*—Before testing, measure the length of the capped or ground specimen to the nearest 0.1 in. [2 mm] and use this length to compute the length-diameter (L/D) ratio. Determine the average diameter by averaging two measurements taken at right angles to each other at the mid-height of the specimen. Measure core diameters to the nearest 0.01 in. [0.2 mm] when the difference in core diameters does not exceed 2 % of their average, otherwise measure to the nearest 0.1 in. [2 mm]. Do not test cores if the difference between the largest and smallest diameter exceeds 5 % of their average.

7.8 *Testing*—Test the specimens in accordance with Test Method C 39/C 39M. Test the specimens within 7 days after coring, unless specified otherwise.

7.9 *Calculation*—Calculate the compressive strength of each specimen using the computed cross-sectional area based on the average diameter of the specimen.

7.9.1 If the ratio of length to diameter (L/D) of the specimen is 1.75 or less, correct the result obtained in 7.9 by multiplying by the appropriate correction factor shown in the following table (see Note 6):

Ratio of Length to Diameter (L/D)	Strength Correction Factor
1.75	0.98
1.50	0.96
1.25	0.93
1.00	0.87

Use interpolation to determine correction factors for L/D values not given in the table.

NOTE 6—Correction factors depend on various conditions such as moisture condition, strength level, and elastic modulus. Average values for corrections due to length-diameter ratio are given in the table. These correction factors apply to low-density concrete having a density between 100 and 120 lb/ft^3 [1600 and 1920 kg/m^3] and to normal density concrete. They are applicable to both dry and wet concrete for strengths between 2000 psi and 6000 psi [14 MPa to 42 MPa]. For strengths above 10 000 psi [70 MPa], test data on cores show that the correction factors may be larger than the values listed above.[6]

7.10 *Report*—Report the results as required by Test Method C 39/C 39M with the addition of the following information:

7.10.1 Length of core as drilled to the nearest ¼ in. [5 mm],

7.10.2 Length of test specimen before and after capping or end grinding to the nearest 0.1 in. [2 mm], and average diameter of core to the nearest 0.01 in. [0.2 mm] or 0.1 in. [2 mm],

7.10.3 Compressive strength to the nearest 10 psi [0.1 MPa] when the diameter is measured to the nearest 0.01 in. [0.2 mm] and to the nearest 50 psi [0.5 MPa] when the diameter is measured to the nearest 0.1 in. [2 mm], after correction for length-diameter ratio when required,

[6] Bartlett, F.M. and MacGregor, J.G, "Effect of Core Length-to-Diameter Ratio on Concrete Core Strengths," *ACI Materials Journal*, Vol. 91, No. 4, July-August 1994, pp. 339-348.

7.10.4 Direction of application of the load on the specimen with respect to the horizontal plane of the concrete as placed,

7.10.5 The moisture conditioning history:

7.10.5.1 The date and time core was obtained and first placed in sealed bag or nonabsorbent container,

7.10.5.2 If water was used during end preparation, the date and time end preparation was completed and core placed in sealed bag or nonabsorbent container,

7.10.6 The date and time when tested,

7.10.7 Nominal maximum size of concrete aggregate.

7.10.8 If determined, the density,

7.10.9 If applicable, description of defects in cores that could not be tested, and

7.10.10 If any deviation from this test method was required, describe the deviation and explain why it was necessary.

7.11 *Precision:*[7]

7.11.1 The single-operator coefficient of variation on cores has been found to be 3.2 %[8] for a range of compressive strength between 4500 psi [32.0 MPa] and 7000 psi [48.3 MPa]. Therefore, results of two properly conducted tests of single cores by the same operator on the same sample of material should not differ from each other by more than 9 %[8] of their average.

7.11.2 The multi-laboratory coefficient of variation on cores has been found to be 4.7 %[8] for a range of compressive strength between 4500 psi [32.0 MPa] and 7000 psi [48.3 MPa]. Therefore, results of two properly conducted tests on cores sampled from the same hardened concrete (where a single test is defined as the average of two observations (cores), each made on separate adjacent drilled 4 in. [100 mm] diameter cores), and tested by two different laboratories should not differ from each other by more than 13 %[8] of their average.

7.12 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in this test method, no statement on bias is being made.

8. Cores for Splitting Tensile Strength

8.1 *Test Specimens*—The specimens shall conform to the dimensional requirements in 7.1, 7.2, 7.4.1, and 7.4.2. Ends are not to be capped.

8.2 *Moisture Conditioning*—Condition the specimens as described in 7.3, or as directed by the specifier of tests.

8.3 *Bearing Surfaces*—The line of contact between the specimen and each bearing strip shall be straight and free of any projections or depressions higher or deeper than 0.01 in. [0.2 mm]. When the line of contact is not straight or contains projections or depressions having heights or depths greater than 0.01 in., grind or cap the specimen so as to produce bearing lines meeting these requirements. Do not test specimens with projections or depressions greater than 0.1 in. [2.0 mm]. When capping is employed, the caps shall be as thin as practicable and shall be formed of high-strength gypsum plaster.

NOTE 7—Fig. 1 illustrates a device suitable for applying caps to the bearing surfaces of core specimens.

8.4 *Testing*—Test the specimens in accordance with Test Method C 496.

8.5 *Calculation and Report*—Calculate the splitting tensile strength and report the results as required in Test Method C 496. When grinding or capping of the bearing surfaces is required, measure the diameter between the finished surfaces. Indicate that the specimen was a core and provide the moisture conditioning history as in 7.10.5.

8.6 *Precision:*[9]

8.6.1 The within laboratory single operator coefficient of variation for splitting tensile strength between 520 psi [3.6 MPa] and 590 psi [4.1 MPa] of cores has been found to be

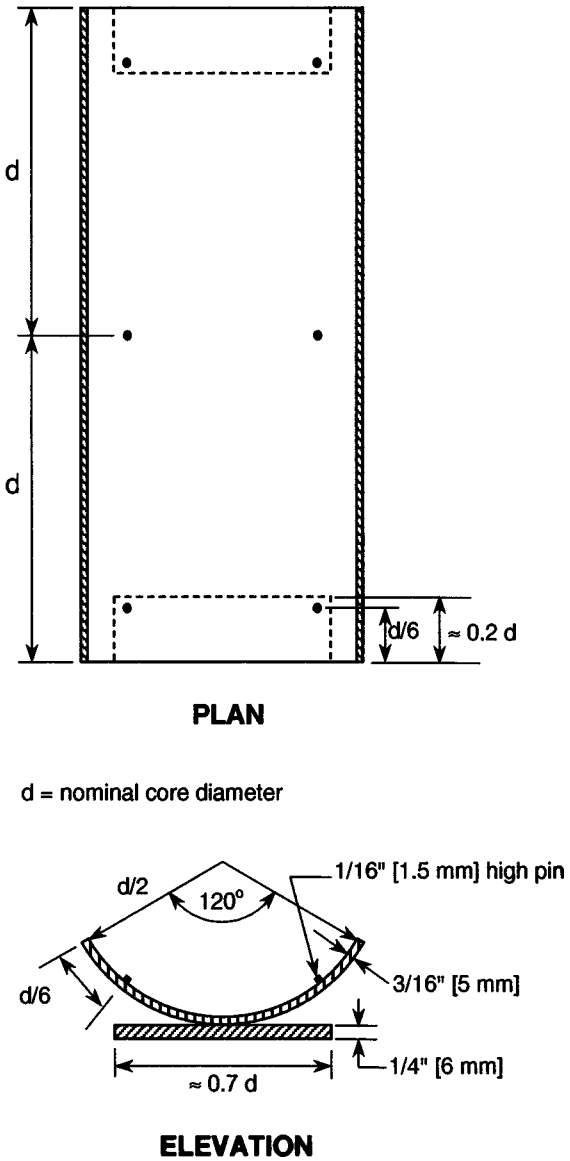

FIG. 1 Suitable Capping Device for Splitting Tensile Strength Test

[7] Bollin, G. E., "Development of Precision and Bias Statements for Testing Drilled Cores in Accordance with ASTM C 42," *ASTM Journal of Cement, Concrete, and Aggregates*, Vol 15, No. 1, 1993.

[8] These numbers represent, respectively, the (1s %) and (d2s %) limits as described in Practice C 670.

[9] Steele, G.W., "Portland Cement Concrete Core Proficiency Sample Program," Strategic Highway Research Program, SHRP-P-636, National Research Council, Washington, D.C., 1993.

5.3 %.[8] Therefore, results of two properly conducted tests by the same operator in the same laboratory on the same sample of material should not differ by more than 14.9 %[8] of their average.

8.6.2 The multi-laboratory coefficient of variation for splitting tensile strength between 520 psi [3.6 MPa] and 590 psi [4.1 MPa] of cores has been found to be 15.0 %.[8] Therefore, results of two properly conducted tests on the same sample of material of hardened concrete and tested by two different laboratories should not differ from each other by more than 42.3 %[8] of their average.

8.7 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in this test method, no statement on bias is being made.

BEAMS FOR FLEXURAL TESTING

9. Flexural Strength

9.1 *Test Specimens*—Unless otherwise specified, a beam specimen for the determination of flexural strength shall have a nominal cross section of 6 by 6 in. [150 by 150 mm] (Note 8). The specimen shall be at least 21 in. [530 mm] in length, but when two tests for flexural strength are to be made in one beam specimen, it shall be at least 33 in. [840 mm] in length. Perform the sawing operation so that the concrete will not be weakened by shock or by heating. The sawed surfaces shall be smooth, plane, parallel, and free from steps, ridges, and grooves. Take care in handling sawed beam specimens to avoid chipping or cracking.

NOTE 8—In many cases, particularly with prisms cut from pavement slabs, the width will be governed by the size of the coarse aggregate and the depth by the thickness of the slab.

9.2 *Moisture Conditioning*—Protect the surfaces of sawed specimens from evaporation by covering them with wet burlap and plastic sheeting during transportation and storage. Test the specimens within 7 days of sawing. Submerge the test specimens in lime-saturated water at 73.5 ± 3.5°F [23.0 ± 2.0°C] for at least 40 h immediately prior to the flexure test. Test the specimens promptly after removal from water storage. During the period between removal from water storage and testing, keep the specimens moist by covering with a wet blanket of burlap or other suitable absorbent fabric.

9.2.1 When the specifier of tests so directs, beams shall be tested in a moisture condition other than that achieved by conditioning in accordance with 9.2.

NOTE 9—Relatively small amounts of drying of the surface of flexural specimens induce tensile stresses in the extreme fibers that will markedly reduce the indicated flexural strength.

9.3 *Testing*—Test the specimens in accordance with the applicable provisions of Test Method C 78.

NOTE 10—Sawing may greatly reduce the indicated flexural strength; beams shall, therefore, be tested with a molded surface in tension whenever possible. The location of the tension face with respect to the position of the concrete as placed and the position of the sawed surfaces should be reported.

9.4 *Report*—Report the results in accordance with the applicable provisions of Test Method C 78 and the requirements of this test method, including the moisture condition at the time of testing. Identify orientation of the specimen's finished, sawed, and tension faces with respect to their positions in the test apparatus.

10. Precision and Bias

10.1 *Precision*—Data are not available for preparing a statement on the precision of flexural strength measured on sawed beams.

NOTE 11—Users of this method who have replicate test data that may be appropriate for a statement on repeatability are encouraged to contact the chairman of the subcommittee.

10.2 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in this test method, no statement on bias is being made.

11. Keywords

11.1 compressive strength; concrete coring; concrete sawing; concrete strength; flexural strength; splitting tensile strength

SUMMARY OF CHANGES

Committee C09 has identified the location of selected changes to this test method since the last issue (C 42/C 42M – 03) that may impact its use (Approved July 1, 2004).

(1) The wording in 7.4 was clarified and the requirements in 7.4.2 were revised.