OIL & GAS DEVELOPMENT COMPANY LIMITED
PROCUREMENT DEPARTMENT, ISLAMABAD
FOREIGN SECTION B

(To be completed, filled in, signed and stamped by the principal)

ANNEXURE 'A'

Material FITTINGS FOR FIRE HYDRANT SYSTEM

Tender Enquiry No PROC–FB/CB/PE&FD–5188/2021

Due Date

Evaluation Criteria GROUP WISE

SCHEDULE OF REQUIREMENT

Sr No	Description	Unit	Quantity	Unit Price (FOB)	Total Price (FOB)	Unit Price C & F BY SEA	Total Price C & F BY SEA	Deviated From Tender Spec. If Any
Group A								
1	ELBOW 8", LR, 90 DEG, SCH 40, A–234, WPB, BW, B16.9	Number	13					
2	ELBOW 6", LR, 90 DEG,,SCH 40, A–234, WPB, BW, NACE COMPLIANCE, B16.9	Number	140					
3	ELBOW 4", LR, 90 DEG, SCH 40, A–234, WPB, BW, B16.9	Number	10					
4	ELBOW 3", LR, 90 DEG, SCH STD, A–234, WPB, BW, B16.9	Number	60					
5	ELBOW 6", LR, 45 DEG, SCH STD, A–234, WPB, BW	Number	70					
6	ELBOW 3", 45 DEG, SCH STD, A–234, WPB, BW, B16.9	Number	30					
7	TEE 8", CS, EQUAL, SCH 40, A–234, GR. WPB, BW	Number	4					
8	TEE EQUAL 3", CS, SCH 40, A–234,GR. WPB, BW, B16.9	Number	12					
9	TEE REDUCING 6" X 3", CS, SCH 40, A–234, GR. WPB, BW	Number	11					
10	TEE REDUCING 4" X 3", CS, SCH 40, A–234, GR. WPB, BW, B16.9	Number	5					
11	TEE 6", CS. EQUAL,SCH 40,A–234,GR. WPB,BW	Number	50					
12	ELBOW 2", 90 DEG, SCH 80, A–234, WPB, BW, B16.9	Number	40					
13	REDUCER CONCENTRIC,CS 8" X 6", SCH 40, A–234, GR. WPB, NACE MR 0175,	Number	4					
14	REDUCER CONCENTRIC CS 6" X 4", SCH 40, A–234, GR. WPB, BW, B16.9	Number	2					
15	THREADOLET 1/2" X 6", 3000 #, A–105	Number	20					
16	THREADOLET 1/2" X 3", 3000 #, A–105	Number	121					
17	FLANGE 8", CS, WN, RF,150 #, SCH 40, A–105	Number	6					
18	FLANGE 6", CS, WN, RF,150 #, SCH 40, A–105	Number	120					
19	FLANGE 4", WN, RF, 150 #, SCH 40, A–105	Number	5					
20	FLANGE 3", CS, WN, RF, 150 #, SCH 40, A–105	Number	38					
21	FLANGE 2", WN, RF, 150 #, SCH 80, A–105	Number	38					
22	FLANGE BLIND 8", RF, 150 #, A–105	Number	2					
23	FLANGE BLIND 6", RF,150 #, A–105	Number	4					
Group B								
24	VALVE GATE REGULAR BORE 6", 150 #, RF, API 600, ASME B16.10, AS PER ATTACHED DATA SHEET, DOC # CVS–01–DS–002	Number	26					
25	VALVE GLOBE 3", 150 CLASS, RF, CS A216 GR WCB BOLTED BONNET., AS PER ATTACHED DATA SHEET, DOC # CVS–01–DS–002	Number	2					
26	VALVE DELUGE 6", 150 #, RF, AS PER ATTACHED DATA SHEET, DOC # 0604258–DV–001	Number	3					
27	VALVE DELUGE 3", 150 #, RF, AS PER ATTACHED DATA SHEET, DOC # 0604258–DV–001	Number	3					

IRFAN ZOUQUE BUTT
Dy Chief (Mech-iv)
Ext: 4162

OIL & GAS DEVELOPMENT COMPANY LIMITED
PROCUREMENT DEPARTMENT, ISLAMABAD
FOREIGN SECTION B

(To be completed, filled in, signed and stamped by the principal)

ANNEXURE 'A'

Material FITTINGS FOR FIRE HYDRANT SYSTEM

Tender Enquiry No PROC–FB/CB/PE&FD–5188/2021

Due Date

Evaluation Criteria GROUP WISE

Group C

28	FIRE WATER SPRINKER 1/2", AS PER ATTACHED SPECIFICATION / DATA SHEET 0604258–PDS–002	Number	121
29	FOAM SPRINKER 1/2", AS PER ATTACHED SPECIFICATION / DATA SHEET 0604258–PDS–001	Number	20

Group D

30	PIPE CS SEAMLESS 8", SCH 40, BE, API 5L, GR. B, B36.10, TLPE, AS PER ATTACHED SPECIFICATION / DATA SHEET, DOC # 0604258–ME–100, DOC # 4925–PA–2008	Meter	204
31	PIPE 3/4", CS, SEAMLESS, SCH 80, BE, API 5L GR. B, B36.10, AS PER ATTACHED SPECIFICATION / DATA SHEET, DOC # 0604258–ME–100	Meter	12
32	PIPE 1/2", CS SEAMLESS, SCH 80, PE, API 5L GR. B, AS PER ATTACHED SPECIFICATION / DATA SHEET, DOC # 0604258–ME–100	Meter	24
33	PIPE 6", CS, SEAMLESS, SCH 40, PE, API 5L GR. B, TLPE, AS PER ATTACHED SPECIFICATION / DATA SHEET, DOC # 0604258–ME–100 & DOC # 4925–PA–2008	Meter	3552
34	PIPE 4", CS, SEAMLESS, WT 6.02 MM, SCH 40, BE, API 5L GR. B, B36.10, TLPE, AS PER ATTACHED SPECIFICATION / DATA SHEET, DOC # 0604258–ME–100 & DOC # 4925–PA–2008	Meter	130
35	PIPE 3", CS, SEAMLESS, SCH 40, BE, API 5L GR. B, TLPE, , AS PER ATTACHED SPECIFICATION / DATA SHEET, DOC # 0604258–ME–100 & DOC # 4925–PA–2008	Meter	210
36	PIPE 2", CS, SEAMLESS, SCH 80, PE, API 5L GR. B, TLPE, AS PER ATTACHED SPECIFICATION / DATA SHEET, DOC # 0604258–ME–100 & DOC # 4925–PA–2008,	Meter	12

Group E

37	PIPE CS SEAMLESS 2", SCH 40, BE, API 5L, GR. B, AS PER ATTACHED SPECIFICATION / DATA SHEET, DOC # 0604258–ME–100	Meter	60
38	PIPE CS SEAMLESS 3", WT 0.216", SCH 40, BE, API 5L, GR. B, , AS PER ATTACHED SPECIFICATION / DATA SHEET, DOC # 0604258–ME–100	Number	600
39	PIPE CS SEAMLESS 4", SCH 40, API 5L, GR. B, AS PER ATTACHED SPECIFICATION / DATA SHEET, DOC # 0604258–ME–100	Meter	48
40	PIPE CS SEAMLESS 6", SCH 40, BE, API 5L, GR. B, AS PER ATTACHED SPECIFICATION / DATA SHEET, DOC # 0604258–ME–100	Meter	150
41	PIPE CS SEAMLESS 8", SCH 40, BE, API 5L, GR. B, AS PER ATTACHED SPECIFICATION / DATA SHEET, DOC # 0604258–ME–100	Number	18

Note: SEE ATTACHMENT TO SCHEDULE OF REQUIREMENT (SOR)

Vetted

IRFAN ZOUQUE BUTT
Dy Chief (Mech-iv)
Ext: 4162

ATTACHMENT TO SCHEDULE OF REQUIREMENT

TENDER NO. PROC-FB/CB/PE&FD-5188/2021 FOR FITTINGS FOR FIRE HYDRANT SYSTEM

1) BID VALIDITY: BID MUST BE VALID FOR 180 DAYS FROM BID OPENING DATE.
2) BID BOND DETAILS: BID BOND IN US$ AS TABULATED BELOW OR EQUIVALENT PKR TO BE SUBMITTED WITH TECHNICAL BID AND VALID FOR 210 DAYS FROM TENDER OPENING DATE:

GROUP	BID BOND AMOUNT
GROUP-A	US$ 508/-
GROUP-B	US$ 245/-
GROUP-C	US$ 82/-
GROUP-D	US$ 4,054/-
GROUP-E	US$ 486/-

(3) DELIVERY PERIOD: SIX (06) MONTHS FROM L/C ESTABLISHMENT DATE.
(**4) EVALUATION CRITERIA:** "EACH GROUP WISE" ON CFR BY SEA KARACHI-PAKISTAN BASIS.
(**5) TENDER DOCUMENTS** AVAILABLE ON OGDCL'S WEBSITE UNDER TAB "MASTER SET OF FOREIGN TENDER DOCUMENT (PRESS-SINGLE STAGE TWO ENVELOP) 07-09-2021).
(6) BIDDER(S) MUST ENSURE TO PROVIDE GROUP WISE TOTAL QUOTED PRICES IN FINACIAL BID FOR EACH GROUP.

IRFAN ZOUQUE BUTT
Dy. Chief (Mech-iv)
Ext: 4162

Terms & Conditions

The bidder who intends to participate in this supply. Manufacturers and stockists both are eligible to submit their bids for the tender enquiry. Bidder should provide documentary proof with technical bid otherwise bid will be considered as technically non-responsive and will be rejected. The bidder to provide the following mandatory data for evaluation/qualification.

1. Bidder must comply SOR, data sheets & Specifications completely.
2. Bidder must submit a certificate on letter head, confirming that the material supplied is " Brand New".
3. Bidder must confirm the delivery schedule.
4. Bidder must have supplied Pipe fittings to Oil & Gas E&P (Exploration & Production) Companies or Petrochemical industry in Pakistan with at least one Purchase Order of minimum Rs. 5 Million in last 05 years from the date of bid opening. The Oil & Gas E & P Company should be a member of Pakistan Petroleum Exploration & Production Companies Association (PPEPCA). Copy of at least one Purchase Order to be provided by the bidder along with Copy of Performance certificate.
5. Bidder must confirm provision of MTCs mill (test certificate) at the time of delivery of material.
6. Bidder to fulfill attached Annexures I-VI for each group.

ANNEXURE-I

FORMAT OF CORPORATE & FINANCIAL INFORMATION

PART - I
GENERAL INFORMATION

1. Name (Full Company Name):

   - Postal Address :
   - Contact Person Name :
   - Contact Person Mobile No. :
   - Company Telephone:
   - Facsimile:
   - Valid e-mail for correspondence:
   - Website Address:

   1.1 Has the Company operated under any other name? If yes please give name, date of change and reason for change.

2. Type of Entity/Firm:
   - Corporation/Stock Company
   - Public Limited
   - Private Limited
   - Partnership
   - Proprietorship

3. Shareholders information/pattern with names and addresses of majority shareholders.

4. Place of Incorporation/Registration:

5. Year of Incorporation/Registration:
   (Please provide copies of Incorporation/Registration Certificates and Memorandum & Articles of Association)

6. Company's National Tax No.

7. Company's Core Business Areas and their annual sales revenue/earnings during last five (5) years.

8. Name & Address of Owners/Directors

9. Registration with Pakistan Engineering Council (PEC) as Contractor. Please provide copy of membership certificate issued by PEC.

PART - II
FINANCIAL STRENGTH

1. Provide details with regard to the financial standing of the applicant including copies of last three (3) years annual audited profit & loss account and balance sheet. Complete postal address, email address and contact numbers of the audited firm should be provided along with the bid. Also, please fill the financial summary as per below table;

S. No.	Description	Years		
		2018	2019	2020
1	Sales Revenue			
2	Paid Up Capital			
3	Profit Before Tax			
4	Profit After Tax			
5	Current Assets			
6	T. Asset			
7	Owner Equity			
8	Long Term Debt			
9	Current Liability			
10	Total Liabilities			

2. Bank(s) credit worthiness certificates (Latest Period) of applicant organization and available credit ceiling/limits with Account Number/Title.

3. Detail record with regard to litigation/arbitration proceedings or any other dispute related to project undertaken/being undertaken by the Bidder their Sub-Contractors and Suppliers (Specially with OGDCL it Joint Venture Partners or other public and private organizations working in the Oil & Gas sector of Pakistan) during past five (05) years.

4. Any information including brochures, references and other documentary evidence of technical qualification, capability and experience of the Applicant to execute the Project.

The undersigned on behalf of _____ hereby declare that the statements made and the information provided official herewith is complete, true and correct in every detail

_____
Signature

Official Seal of the Company

ANNEXURE - II

RELATED PROJECTS BEING EXECUTED

Sr. No.	Name, Description & Capacity of the Project	Name & Address of Client	Country & Year	Project Completion Period	Contract Value*			Detailed Description of Work, Scope & Responsibilities**	Details of Equipment Procured (Including nature/type of equipment, its value* and origin/source)	Details of Qualification of Man-power Employed	Whether the Project is on Schedule? If not, specify reasons for delay and give expediting plans
					Foreign Currency	Local Currency	Total				

(*) Please indicate name and unit of currencies.

(**) For example design engineering, procurement, manufacturing and commissioning.

ANNEXURE - III

PROJECTS EXECUTED DURING LAST SEVEN (05) YEARS TO RENOWNED AND LEADING E&P COMPANIES OF THE WORLD

Sr. No.	Name, Description & Capacity of the Project	Name & Address of Client	Country & Year	Project Completion Period		Contract Value*			Detailed Description of Work, Scope & Responsibilities**	Details of Equipment Procured (Including nature/type of equipment, its value* and origin/source)	Details of Qualification of Manpower Employed	Reason for Delay in Project Completion, if applicable
				Planned	Actual	Foreign Currency	Local Currency	Total				

(*) Please indicate name and unit of currencies.

(**)For example design engineering, procurement, manufacturing and commissioning.

ANNEXURE - IV

HSE DETAILS

1- Do you have a formal written Safety Policy? YES NO

If yes, please attach a copy(s)

Is safety policy distributed to all employees and posted at the offices? YES NO

2- Do you have a safety program manual? YES NO

If yes, please state scope

_____

_____

3- Do documented procedures exist to support the safety manual? YES NO

If no, how is your safety program implemented?

_____

_____

4- Do you operate a formal review/audit of the safety program? YES NO

How are review/audit results identified, documented and implemented?

_____

_____

5- Do you hold regular safety meetings for all employees YES NO

If yes, how frequently do you hold these meetings?

Weekly _____

Fortnightly _____

Monthly _____

Others _____ When? _____

_____

6- Do you hold regular safety inspection ? YES NO

If yes, please provide details.

_____

_____

_____

7- What Type of employee training programs is in place?

_____

_____

_____

Is training delivered to subcontractors / vendors?	YES	NO
Is training delivered to clients?	YES	NO

8- How are accidents investigated and reports circulated to management? Give a copy of any report if available.

_____

_____

_____

ANNEXURE – V

TECHNICAL SUPPORT SERVICES

Please indicate only the type(s) of work your company is involved and is capable of undertaking

1.0	TECHNICAL SUPPORT SERVICES			
1.1	Mechanical Testing		YES	NO
1.2	Stress Analysis		YES	NO
1.3	Radiography		YES	NO
1.4	Ultrasonic Survey and analysis		YES	NO
1.5	Non-Destructive-Testing		YES	NO
1.6	Corrosion Inspection		YES	NO
1.7	Noise Survey and Analysis		YES	NO
1.8	Quality Inspection		YES	NO
1.9	Safety Inspection		YES	NO
1.10	Vibration measurements and Analysis		YES	NO
1.11	HSE Inspection		YES	NO
1.12	Third Party Inspection		YES	NO
1.13	Skilled/Specialist Technical Support Services:			
		Mechanical	YES	NO
		Civil	YES	NO
		Quality	YES	NO
		Safety	YES	NO
		HSE	YES	NO
		Pipeline	YES	NO
		Others	YES	NO
1.14	Non Skilled Support Services		YES	NO
1.15	Vendor Assistance		YES	NO
	Specify Vendors			
	_____			
	_____			
	_____			
1.16	Others		YES	NO
	_____			
	_____			
	_____			
2.0	METALLIC PIPE INSTALLATION, COMMUNICATION AND MAINTENANCE		YES	NO
2.1	Fabrication / Construction		YES	NO
2.2	Welding		YES	NO
2.3	Hot Tapping		YES	NO
2.4	Heat Treatment		YES	NO
2.5	Coating		YES	NO
2.6	Wrapping		YES	NO

2.7	Hydraulic	YES	NO
2.8	Pipe Work Inspection	YES	NO
2.9	Others	YES	NO

3.0 MECHANICAL WORKSHOP FACILITIES

		YES	NO
3.1	Machining	YES	NO
3.2	Welding	YES	NO
3.3	Heat Treatment	YES	NO
3.4	Steel Fabrication	YES	NO
3.5	Blasting	YES	NO
3.6	Metal Spraying	YES	NO
3.7	Electrolyte Coating	YES	NO
3.8	Hydraulic Testing	YES	NO
3.9	Valves Refurbishment	YES	NO
3.10	Others	YES	NO

4.0 INSULATION

		YES	NO
4.1	Machining	YES	NO
4.2	Hot Insulation	YES	NO
4.3	Associate Insulation	YES	NO
4.4	Others	YES	NO

5.0 E&I WORKSHOP FACILITIES

5.1 Instrument / Erection / Installation / Calibration / Testing Equipment for following:

• Pressure	YES	NO
• Flow	YES	NO
• Level	YES	NO
• Temperature	YES	NO
• Concentration	YES	NO

5.2 Equipment for the following:

• Control Panel Installation	YES	NO
• Devices for testing, checking and Calibration of control panel items	YES	NO
• Devices for cable laying, Meggering, etc.	YES	NO

6.0 ELECTRICAL WORKSHOP FACILITY

Electrical installations, Meggering, Testing devices for:

• Motors	YES	NO
• Bus Bar	YES	NO
• Control Modules	YES	NO
• Generator Control Panel	YES	NO

	• Alternator	YES	NO
	• Gas Engines	YES	NO
	• Power Cables	YES	NO
7.0	Testing Shop Facilities as per ASME "U" Stamped	YES	NO

Note: In case any service/facility is not available in-house but the company has standing arrangement to outsource such service / facility please indicate with sufficient details.

Annexure "VI"

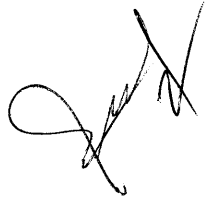
Documents submission check List

Bidder to submit following documents with bid for technical evaluation (Applicable to All Groups):

Sr. No	Description	Bidder	Manufacturer
1	Authority Letter	In favor of local agent	In favor of bidder
2	Compliance to Data Sheet & Specifications.		
3	Company Registration Certificate		
4	Quality, Health, Safety Certificates.		
5	Supply record during last 5 years as per Annex II		
6	Supply record during last 5 years as per Annex III		
7	Lab Equipment details		
8	Audited financial reports for last three years		
9	Delivery Schedule Confirmation		
10	Corporate Information (Submit Annex 1)		
11	Mill Catalogue		
12	Equipment details		
13	HSEQ Information as per Annex IV		
14	Technical Support Services information as per Annex V		

Note:

1. Bid documents should be signed and stamped by bidder and should be properly tagged and numbered.
2. Bid should be submitted in book binding form.
3. Contents of the authority letter should include the following:
    a. Tender Inquiry Number.
    b. Supply of new material as per tender specification.
    c. Signed / Stamped by manufacturer.
    d. Contact details (Name, address, telephone numbers, and email).
    e. Delivery schedule.
4. Third party inspection will be arranged by OGDCL and Bidder will provide full support.



Oil & Gas Development Company Ltd

KUNNAR LPG PLANT AND OIL FIELD

Existing Fire Fighting System Adequacy Report

0604230-PRO-RP-001

PETROCHEMICAL ENGINEERING CONSULTANTS

C-2, BLOCK NO 17, Gulshan-e-Iqbal, Karachi-
75300, Pakistan. Tel.: +92 (21) 34827780, 34961088 Fax.: +92 (21) 34961089
E-Mail : contact@pcec.com.pk web site: www.pcec.com.pk

Disclaimer

This report has been prepared on behalf of and for the exclusive use of OGDCL and is subject to an issue in accordance with the agreement between Petrochemical Engineering Consultants and OGDCL. Petrochemical Engineering Consultants accept no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party.

REV	DESCRIPTION	ORIG	REVIEW	PEC APPROVAL	DATE	CLIENT APPROVAL	DATE
0	Issued for Review	HBR	NWS	AJ	3rd Mar, 2020		

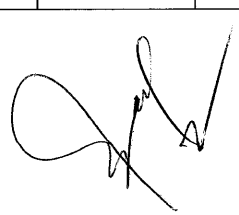
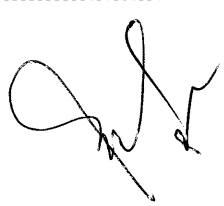
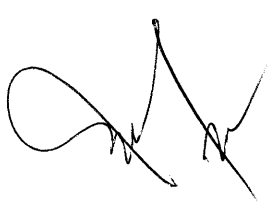


TABLE OF CONTENT



ANNEXURES



1 EXECUTIVE SUMMARY

OGDCL plans to extend its existing firewater network in Kunnar oil field to provide fire protection to storage tanks and loading gantry present in plant I area through plant II firewater system. Petrochemical Engineering Consultants (PEC) is assigned to conduct the study to check the adequacy of the system (i-e. Gap Analysis). Following are the task related to the study:

- Maximum firewater requirement for cooling of exposed surfaces of adjacent tank(s)/structure if lying within 8 kW/m^{2}have been calculated, based on Heat Radiation Modeling.
- Maximum firewater requirement for foam making purpose and for cooling of exposed surfaces for Tank top fire / Pool fire has been calculated based on Heat Radiation Modeling. Foam requirement has also been calculated as per NFPA / IP code.
- Marking of Hydrant and hydraulic analysis at the farthest hydrant with respect to different main pipe diameter.

Fire scenarios were developed by first identifying areas containing significant quantities of flammable inventories. This included products storage tanks, product pump house, and loading / unloading gantry.

For all tanks (except mounded / buried) containing Class I products, tank top fires were considered to be credible fire scenarios as per NFPA / IP Code. Fires occurring in the tank truck loading gantry, tank wagon gantry, etc. were treated as Pool fire.

Heat radiation levels of 2.5, 4.7, 8, 22 and 44 kW/m^2 were calculated at a height of 2 m from grade level for operator movement, equipment operation and hydrant placement. The maximum horizontal distances to heat radiation levels of 2.5, 4.7, 8, 22 and 32 kW/m^2 at any elevation were also determined in order to assess cooling requirements of exposed tanks.

Using site layout drawing provided by OGDCL, the heat affected tank/structure within the 8 kW/m^2 radiation level was estimated and the surface area has been

calculated as defined in IP code of the affected tank(s). The required fire water flow rate was then determined assuming an application rate of 2 LPM/m^2as per IP code/ OGRA for atmospheric aboveground Storage Tanks. The total quantity of firewater was determined assuming event duration of 2 hours.

Firewater and foam water is used for cooling and smothering of storage tanks respectively, however for gantry area only foam water is considered as firewater is not recommended for pool fire.

It is found that existing firewater tank (T-8801) has adequate capacity to deal with worst scenario that can occur at the unprotected storage area/ loading gantry present in plant I. Firewater pumps are capable to provide the required amount of firewater at the time of fire.

1.1 AREA OF COVERAGE

Area that is needed to be covered with firewater in case of fire as per IP-19 is presented in the table below

Cylindrical Tanks	Coverage Area(m^2)
Tank-03	162.8
Tank-02	114.12
Tank-01	114.12

Rectangular Tanks	Surface Area(m^2)
Tank-07-Tank-14*	473.5
Tank-15-Tank-18*	266.47

*Horizontal tanks are placed so close, considered as 1 block.

1.2 FIREWATER REQUIREMENT

Fire Scenario	Tank / Pool Fire	Affected Tank/ Structure	Firewater Flow rate For Affected Tank (USGPM)	Firewater Flow rate For Foam Solution (USGPM)	Firewater Requirement for Supplementary Hose Connection (USGPM)	Total Firewater Requirement (USGPM)	Total Firewater Capacity Required (Gallons)
Tank-01	Tank Top Fire	Tank-02, Tank-03	86.02 60.30	90.12	50	286.44	28515
Tank-02	Tank Top Fire	Tank-01	60.30	90.12	50	200.6	18192.6
Tank-03	Tank Top Fire	Tank-02	60.30	124.71	50	235.01	20095.05
Tank-07-14*	Tank Top Fire	Tank-07-14	1250.85	40.04	50	1340.89	158304.2
Tank-15-18*	Tank Top Fire	Tank-15-18	703.96	40.04	50	794	92677.4
Loading Gantry	Pool Fire	-		449.11		449.11	6736.65

* Horizontal rectangular tanks are considered as one block.

Highest demand of firewater arises in case of fire on rectangular tanks (Tank-07 to Tank-14) i-e. 1340.89 USGPM and 158304.2 gal capacity is required to ensure 2 hours of continuous firewater supply. This can be easily catered by electric motor driven firewater pump P-8801 A/B which can provide firewater with the rate of 1250 USGPM each and diesel driven pump (P-8802) can provide 2500 USGPM moreover, the firewater tank (T-8801) which has operating capacity of 20,000 bbl (840000 Gallons).

1.3 FOAM SOLUTION REQUIREMENT

Foam solution requirement is calculated as per OGRA, and presented in the table below:

Tank	Foam Solution Rate	Application Time	Foam Sol. Requirement	Foam conc. Requirement
Tank-01/02	90.12USGPM	55min	4956.6gal	148.698 gal
Tank-03	124.7USGPM	55min	6858.5gal	205.755 gal
Tank-07/08/09/10/11/12/13/14	40.04 USGPM	55 min	2202.2 gal	66.066 gal
Tank-15/16/17/18	40.04 USGPM	55 min	2202.2 gal	66.066 gal
Loading Gantry	283.29 USGPM	15 min	4249.3 gal	127.479 gal

Foam water system shall be required to meet highest demand stated in table above.

1.4 HYDRANTS

14 no. hydrants are marked on layout provided by OGDCL by ensuring that thermal radiation of no more than 8 kW/m2 reach at 2m height to ensure operator safety.

1.5 FIRE WATER MAIN

Calculated fire ring main diameter comes out to be 10-inch that also accomplish NFPA requirement of minimum fire main diameter. Hydraulics results of fire main are presented below:

Fire water pump flow rate		Velocity	Approx. Length (m)
Actual	1757.1 USGPM	7.2 ft/sec	16378.5

1.6 TOP FOAM POURER

Minimum number of foam pourer required as NFPA is presented below:

Tank	No. of Foam Pourer Required
Tank-01/02	1 (Each)
Tank-03	1
Tank-07/08/09/10/11/12/13/14	1 (Each)
Tank-15/16/17/18	1 (Each)

1.7 FIRE/ FOAM WATER SPRINKLERS

Fire water sprinklers are proposed for cooling purpose of storage tanks in the event of fire at adjacent tank. However foam water sprinklers are proposed for condensate loading gantry.

Tank	No. of Sprinklers	Sprinkler Service
Tank-01/02	19 (Each)	Fire water
Tank-03	24	Fire water
Loading Gantry	40	Foam Water

2 INTRODUCTION

The intention of the study is to assess the fire protection requirements for the Kunnar plant I storage area in line with international Codes / Standards. For this purpose OGDCL has engaged Petrochemical Engineering Consultants (PEC) to carry out fire safety and consequence study and to recommend modifications and additional requirements accordingly.

This report is based on the work carried out for adequacy check as per Scope of Work. This stage includes calculation of firewater requirement based on credible scenarios developed through heat radiation intensity models.

2.1 REFERENCE CODES AND STANDARDS

Following National Fire Protection Association (NFPA) standards used in the study:

NFPA-11	Standard for Low Expansion Foam
NFPA-24	Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA-30	Flammable and Combustible Liquids Code

Following standards from American Petroleum Institute (API) are used:

API-521	Guide for Pressure-Relieving and De-pressuring Systems
API-2001	Fire Protection in Refineries
API-RP 2030	Application of Fixed Water Spray Systems for Fire Protection in the Petroleum and Petrochemical Industries
API-2021	Fighting Fires In and Around Flammable and Combustible Liquid Atmospheric Petroleum Storage Tanks

Following standard from Institute of Petroleum Model Code (IPMS) is used:

IP Part-19	Fire Precautions at Petroleum Refineries and Bulk Storage Installations

Following Shell DEP specification used in the study:

DEP 80471030 Assessment Of The Fire Safety Of Onshore Installations

2.2 OVERVIEW OF METHODOLOGY

A fire study analysis was conducted for Kunnar Oil Field, credible fire scenarios were identified based on the storage and transfer of flammable and combustible materials at field. Following this, each fire scenario was assessed to determine heat radiation contours for selected heat radiation levels. The results were analyzed to identify other tanks requiring fire protection. Finally, the quantity of firewater required to protect the affected Tanks/Vessel/Structure was calculated.

2.3 FIRE SCENARIO DEVELOPMENT

2.3.1 METHODOLOGY

Fire scenarios were developed by first identifying areas containing significant quantities of flammable inventories. This included vertical storage tanks, horizontal storage tanks and loading/unloading gantry. A summary of flammable inventories is provided in table below.

Inventory	Product Class	Fluid Used in Modeling	Diameter (m)	Length/ Height (m)	Tank Type
Tank-01	I	Crude oil	10.293	10	Vertical
Tank-02	I	Crude oil	10.293	10	Vertical
Tank-03	I	Crude oil	13.471	10	Vertical
Tank-07-18	I	Crude oil	9.712 (Hydraulic Diameter)*	3.233	Horizontal
Loading Gantry	I	Crude oil	31.5 (Pool Dia)	-	-

* Horizontal Rectangular tanks with dimensions of (L=12.192m, W=2.438m, H=2.438).

3 FIRE TYPES

Following fire types are taken as credible scenarios for the process equipments and storage area.

3.1 POOL FIRES

Pool fires, being either tank or bund fires, occurring in case of release from gasket failure consist of large volumes of flammable material at atmospheric pressure burning in an open space. The flammable material will be consumed at the burning rate depending on factors including the prevailing winds. During combustion, heat will be released in the form of thermal radiation. Temperatures close to the flame centre will be high but will reduce rapidly to tolerable temperatures over a relatively short distance.

Any plant building or persons close to the fire or within the intolerable zone will experience burn damage with severity depending on the distance from the fire and the time exposed to the heat of the fire. In the event of a pool fire the flames will tilt according to the wind speed and direction. The flame length and tilt angle affect the distance of thermal radiation generated.

For this scenario, the pool size is calculated by determining the surface area, then calculating an equivalent pool diameter assuming a circular pool. The equivalent pool diameter is calculated using the following equation:

Equivalent Pool Diameter = (4 x Surface area of pool ÷ Perimeter)

3.2 TANK TOP FIRES

Tank top fire is regarded as credible scenarios for above ground storage tanks

- For all tanks containing Class I and Class II products, tank top fire is considered to be credible fire scenarios.
- Tank top fires for Class III tank is only considered in the case of escalation from Class I and Class II tanks.

For fire of Class-I, Horizontal distances to heat radiation levels of 2.5, 4.7, 8.0, 22 and 44 kW/m^2 were calculated at a height of 2 m from grade level for operator movement and equipment operation. The maximum horizontal distances to heat radiation levels of 2.5, 4.7, 8, 22 and 44 kW/m^2 at any elevation were also determined in order to assess cooling requirements of exposed structure/tanks.

The heat radiation levels at the site boundary were estimated from the heat radiation levels already calculated and applying the distance between the tank/gantry and the nearest site boundary.

4 THERMAL RADIATIONS

The following table indicates the exposure time necessary to reach the pain threshold relative to the indicated radiation intensity, as per API RP 521. Burns follow the pain threshold fairly quickly and the allowable radiation level is a function of length of exposure, human reaction time and mobility should be considered.

Exposure times to reach pain threshold as per API 521 is given tabulated below:

Radiation level [kW/m^2]	Exposure time to pain threshold [seconds]
1.74	60
2.33	40
2.9	30
4.73	16
6.94	9
9.46	6
11.67	4
19.87	2

Maximum recommended thermal radiation exposure limits as per IP 19 are indicated in the following

Max. Radiation Flux Level (kW/m^2)	Equipment or Location /Conditions
1 – 1.5	Sun Burn
5 – 6	Personnel injured (burns) if they are wearing normal clothing and do not escape quickly.
8 – 12	Fire escalation if long exposure and no protection
32 – 37.5	Fire escalation if no protection (consider flame impingement)
up to 350	In flame. Steel structures can fail within several minutes if unprotected or not cooled

Based on the above permissible radiation values, human response time etc, the maximum radiation level for people exposure should be limited to $2.5kW/m^2$ and hence all fire-fighting equipment should be located outside these areas. $4.7kW/m^2$ radiation levels may be considered for fire fighters with protective clothing for extended periods.

4.1 SINGLE FIRE CONCEPT

The firewater and foam requirements are calculated based on the postulate that only single major fire will occur at any one time.

4.2 SOFTWARE TOOLS

Each credible fire scenarios (tank Top fires & Pool fires) have been modeled in Shell FRED software version 4.0.

Hydraulics analysis of fire water network is carried out using PIPENET 1.6.

4.3 RESULTS

The results of the heat radiation modeling are summarized in table below:

Wind speed (m/s)	Tank no.	Horizontal Distances (m) to Each Radiation Level at Elevation of 2 m from Grade					Maximum Horizontal Distances (m) to Each Radiation Level at Any Elevation (>2m)				
		2.5 kW/m^2	4.7 kW/m^2	8 kW/m^2	22 kW/m^2	44 kW/m^2	2.5 kW/m^2	4.7 kW/m^2	8 kW/m^2	22 kW/m^2	44 kW/m^2
10.9	Tank-01/02	43.36	35.59	28.62	-	-	43.62	37.35	33.6	29.44	28.28
10.9	Tank-03	47.50	39.02	31.34	-	-	47.79	41.04	36.99	32.57	-
10.9	Tank-07 to Tank-18	41.45	36.08	32.31	24.47	-	42.17	36.11	32.44	28.36	27.37
10.9	Loading Gantry*	79.66	67.19	55.69	-	-	79.83	69.62	63.83	-	-

* Radiation contours for loading gantry is shown or 0m elevation instead of 2m elevation as this is pool fire scenario.

4.4 IDENTIFICATION OF AFFECTED AREAS

4.4.1 METHODOLOGY

For each fire scenario, the maximum horizontal distance to a heat radiation level of 8 kW/m2 for Class I products as per DEP / IP Code are calculated in the previous section was used to identify other tank / structure that require fire protection. A heat radiation level of 8 kW/m2 for Class I products as per DEP / IP Code are used in this assessment.

Fire Scenario	Tank / Pool Fire	Affected Tank/ Structure
Tank-01	Tank Top Fire	Tank-02, Tank-03
Tank-02	Tank Top Fire	Tank-01
Tank-03	Tank Top Fire	Tank-02
Tank-07-14	Tank Top Fire	Tank-07-14

Tank-15-18	Tank Top Fire	Tank-15-18
Loading Gantry	Pool Fire	-

5 CALCULATION OF FIRE WATER REQUIREMENTS

5.1.1 METHODOLOGY

For each fire scenario, the amount of fire water required to protect tanks/structure within the 8 kW/m2 heat radiation level was calculated. Using site layout drawings, the probability of a tank within the 8 kW/m2 radiation level was estimated and the surface area of the adjacent tank is calculated as IP part 19. The required fire water flow rate was then determined using an application rate of 2 LPM/m2. Un-insulated equipments that can be enveloped in flame require firewater application rate of 10 LPM/m2. The total quantity of fire water was determined assuming event duration of 2 hours.

According to IP Code 19,

> *"The need for cooling a fire-affected tank shell above the product level has been much debated. There is no known incidence of tank shell failure leading to product release under full surface fire conditions where cooling water was not applied to the shell. However, there have been some cases where it is thought that uneven application of water to the tank shell has caused distortion in some areas and consequent loss of product.*
>
> *Tank shell are intended to fold inward under full surface fire conditions instead of folding outward with potential loss of burning product. Another factor is that cooling the involved tank shell with uneven or erratic water streams will lead to hot and cool zones on the shell surface area which may lead to distortion and possible product spill or overflow. Therefore, cooling water should not be applied to the tank on fire."*

5.2 RESULTS

The results for the calculation of fire water requirements as per DEP 80.47.10.30, IP Code, NFPA, OGRA are presented in table below:

Fire Scenario	Tank / Pool Fire	Affected Tank/ Structure	Firewater Flow rate For Affected Tank (USGPM)	Firewater Flow rate For Foam Solution (USGPM)	Firewater Requirement for Supplementary Hose Connection (USGPM)	Total Firewater Requirement (USGPM)	Total Firewater Capacity Required (Gallons)
Tank-01	Tank Top Fire	Tank-02, Tank-03	86.02 60.30	90.12	50	286.44	28515
Tank-02	Tank Top Fire	Tank-01	60.30	90.12	50	200.6	18192.6
Tank-03	Tank Top Fire	Tank-02	60.30	124.71	50	235.01	20095.05
Tank-07-14*	Tank Top Fire	Tank-07-14	1250.85	40.04	50	1340.89	158304.2
Tank-15-18*	Tank Top Fire	Tank-15-18	703.96	40.04	50	794	92677.4
Loading Gantry	Pool Fire	-		449.11		449.11	6736.65

* Horizontal rectangular tanks are considered as one block.

6 CALCULATION OF FOAM REQUIREMENTS

6.1 STANDARDS, CODES & LOCAL LEGISLATION

The following standards/codes have been used for the calculation of foam solution/foam requirement:

i. DEP: 80.47.10.30

ii. NFPA 11 - *Standard for Low Expansion Foam*

iii. Fire Precaution at Petroleum Refineries and Bulk Storage Installations - *Part 19 of the Institute of Petroleum Model Code of Safe Practice in the Petroleum Industry.*

6.2 METHODOLOGY

As per DEP / IP Code foam protection is required for Class I and II tanks and similarly for Pool areas containing Class I and II products.

As per NFPA 11, foam protection of 15 minutes has been considered for spill fire (pool fire) in loading / decantation gantry, pump house, etc, 55 minutes has been considered for tank top fire of Class I and 30 minutes for tank top fire of Class II products.

6.3 RESULTS

Summary of calculations for application of foam on tank top fire and pool fire is shown in Table below.

Tank/Pool	Product	Foam Solution Application Rate (LPM/m^2)	Foam Application Time (min)	Total Foam Requirement For Foam Solution (LPM)	Foam Conc. Required (@ 3% Foam) (Liters)
Tank-01	Crude oil	4.1	55	341.16	562.9
Tank-02	Crude oil	4.1	55	341.16	562.9
Tank-03	Crude oil	4.1	55	472.08	778.9
Tank-07 - Tank-14	Crude oil	4.1	55	151.57	250.1
Tank-15-18	Crude oil	4.1	55	151.57	250.1
Loading Gantry	Crude oil	6.5	15	1700.09	765.04

7 FIRE WATER HYDRAULICS

Hydraulic analysis of fire main line has been done by using 8", 10", 12" and 14" line size of schedule 40 in order to estimate the pressure at farthest hydrant that should be no less than 100 psig as per NFPA.

7.1 SPECIFICATION OF EXISTING FIREFIGHTING SYSTEM

Firewater Tank (T-8801)	
Working Capacity, bbl	20000
Internal Diameter, m	18.5
Height, m	15
Firewater Pump (P-8801 A/B)	
Rated Flow rate, USGPM	1250
Differential Pressure, psig	145
Motor Power, hp	200
Driver type	Electric Motor
Firewater Pump (P-8802)	
Rated Flow rate, USGPM	2500
Differential Pressure, psig	145
Motor Power, hp	360
Driver type	Diesel Engine
Firewater Jockey Pump (P-8803 A/B)	
Rated Flow rate, USGPM	250
Differential Pressure, psig	145
Motor Power, hp	30
Driver type	Electric Motor

7.2 RESULTS

Following are the results of Fire main hydraulics:

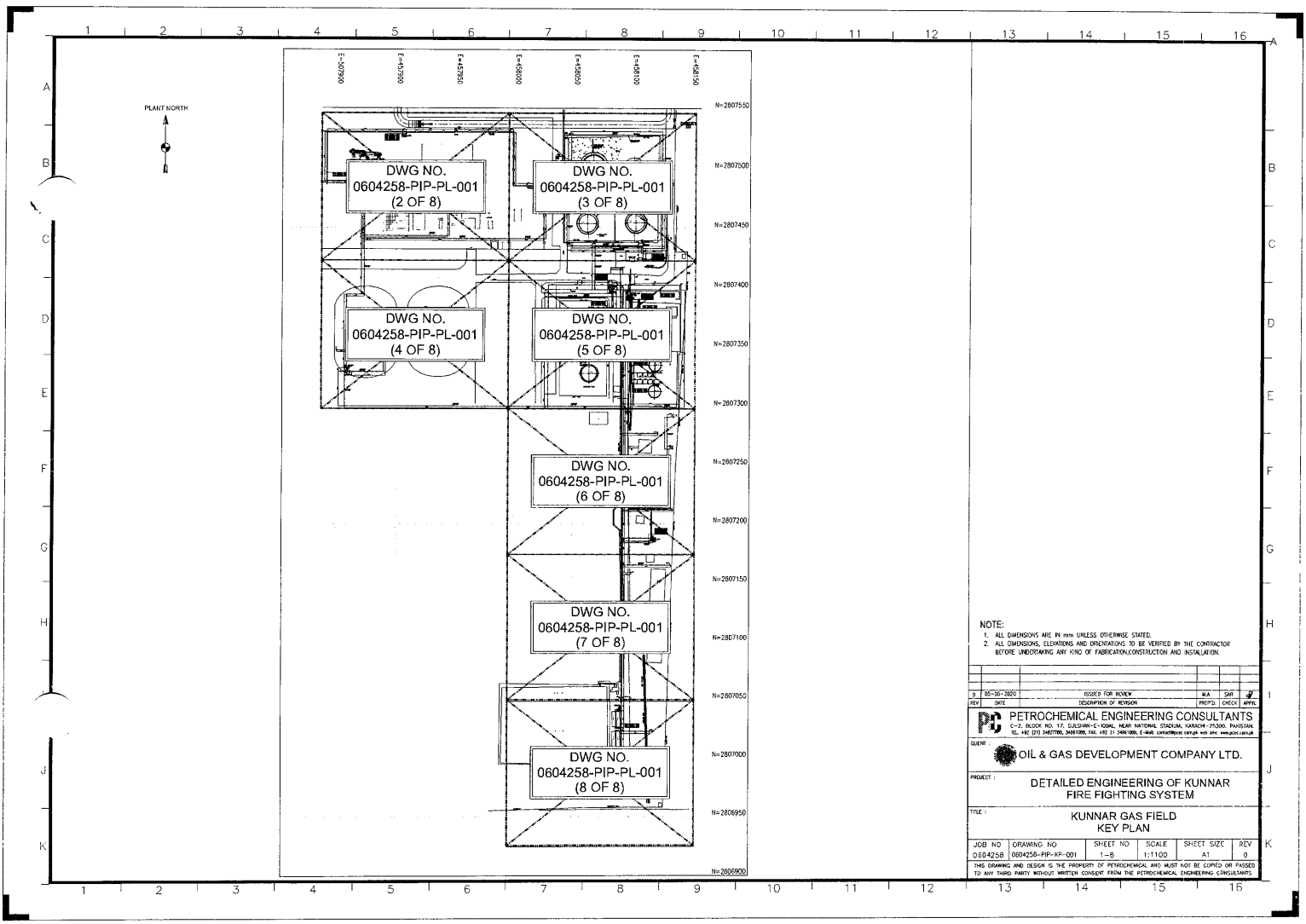
Pipeline	Diameter	Length (m)	Flow rate (USGPM)	Pressure Drop (psi)	Inlet Pressure (psig)	Outlet Pressure (psig)	Pressure Drop (psi/100ft)	Velocity (ft/sec)
Existing Fire main	12"- 40sch	1909.6	1320.7	11.76	141.3	129.37	0.0156	3.8
			1757.1	20.28	137.6	117.32	0.0270	5
			1985	25.63	135.61	109.98	0.0341	5.7
			2064.1	27.63	134.89	107.26	0.0367	5.9
New Fire main	8"- 40sch	645.8	1320.7	29.37	129.37	100	0.1155	8.5
	10"- 40sch		1757.1	17.32	117.32	100	0.0681	7.2
	12"- 40sch		1985	9.98	109.98	100	0.0392	5.7
	14"- 40sch		2064.1	7.26	107.26	100	0.0286	4.9

Above results show that 10" schedule 40 is adequate to meet maximum required firewater flow rate i-e. 1340.9 USGPM at 100 psig, in case of fire on rectangular horizontal tanks.

8 CONCLUSION:

Following are the outcome of existing firefighting system adequacy study:

- Highest demand of firewater arises in case of fire on rectangular tanks (Tank-07 to Tank-14) i-e. 1340.89 USGPM and 158304.2 gal capacity is required to ensure 2 hours of continuous firewater supply. This can be easily catered by electric motor driven firewater pump P-8801 A/B which can provide firewater with the rate of 1250 USGPM each and diesel driven pump (P-8802) can provide 2500 USGPM moreover, the firewater tank (T-8801) which has operating capacity of 20,000 bbl (840000 Gallons).
- Diesel driven Pump (P-8802) can provide1757 USGPM of firewater via 10" schedule-40 fire main pipe by keeping 100 psig at the farthest hydrant.
- 14 no. hydrants are marked on layout provided by OGDCL by ensuring that thermal radiation of no more than 8 kW/m2 reach at 2m height to ensure operator safety.



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CLIENT: OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT: DETAILED ENGINEERING OF KUNNAR FIRE FIGHTING SYSTEM

TITLE: KUNNAR GAS FIELD
KEY PLAN

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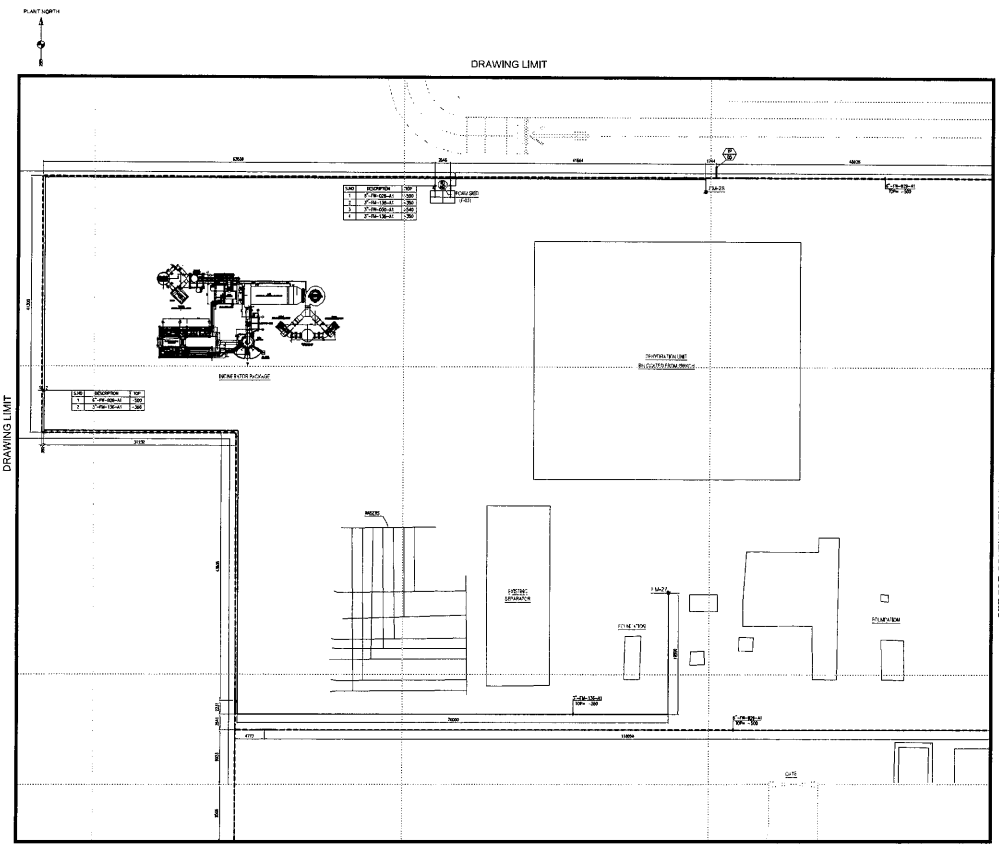

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CLIENT: OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT : DETAILED ENGINEERING OF KUNNAR FIRE FIGHTING SYSTEM

TITLE : KUNNAR GAS FIELD PIPING LAYOUT

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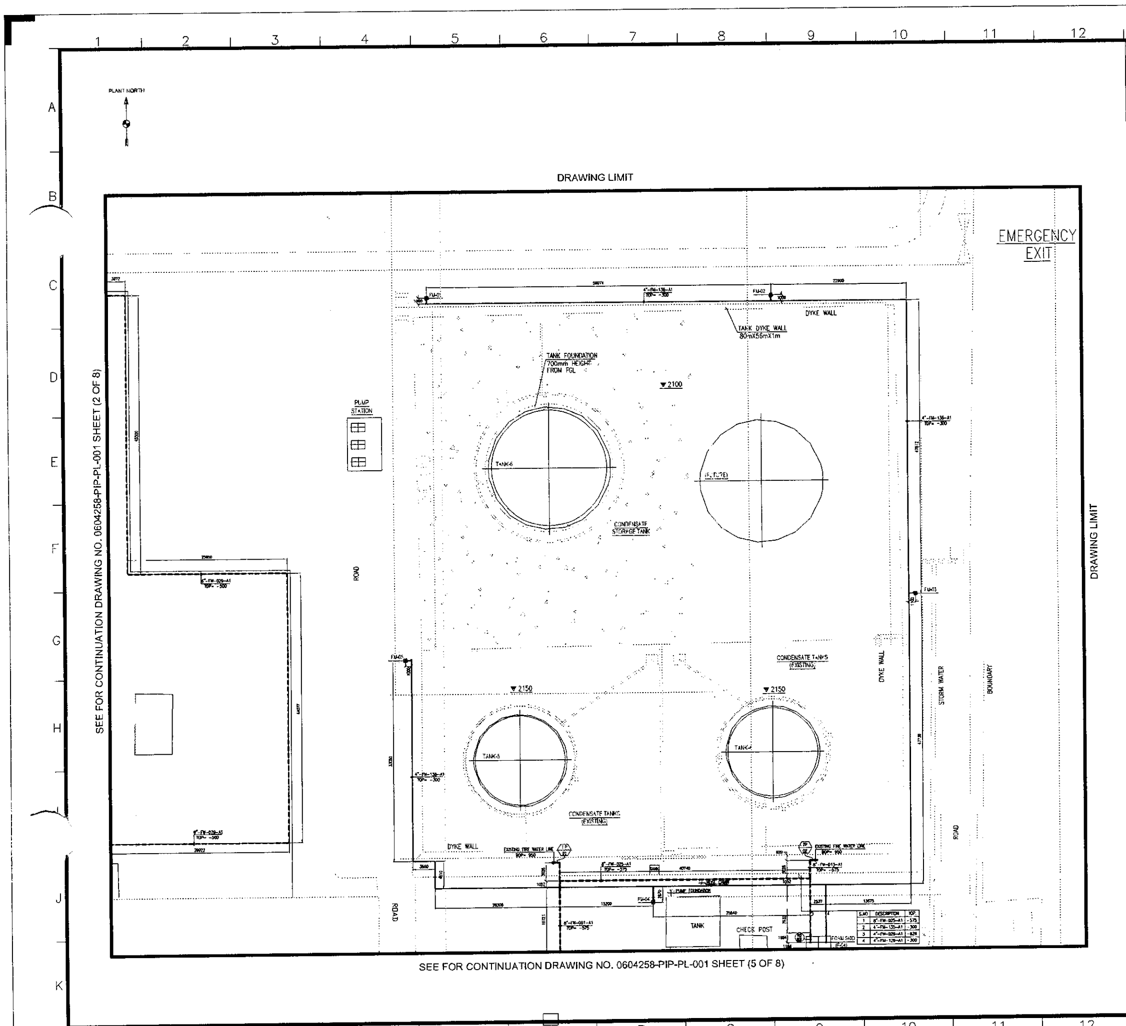

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CLIENT
OIL & GAS DEVELOPMENT COMPANY LTD.

PROJECT :
DETAILED ENGINEERING OF KUNNAR FIRE FIGHTING SYSTEM

TITLE :
KUNNAR GAS FIELD
PIPING LAYOUT

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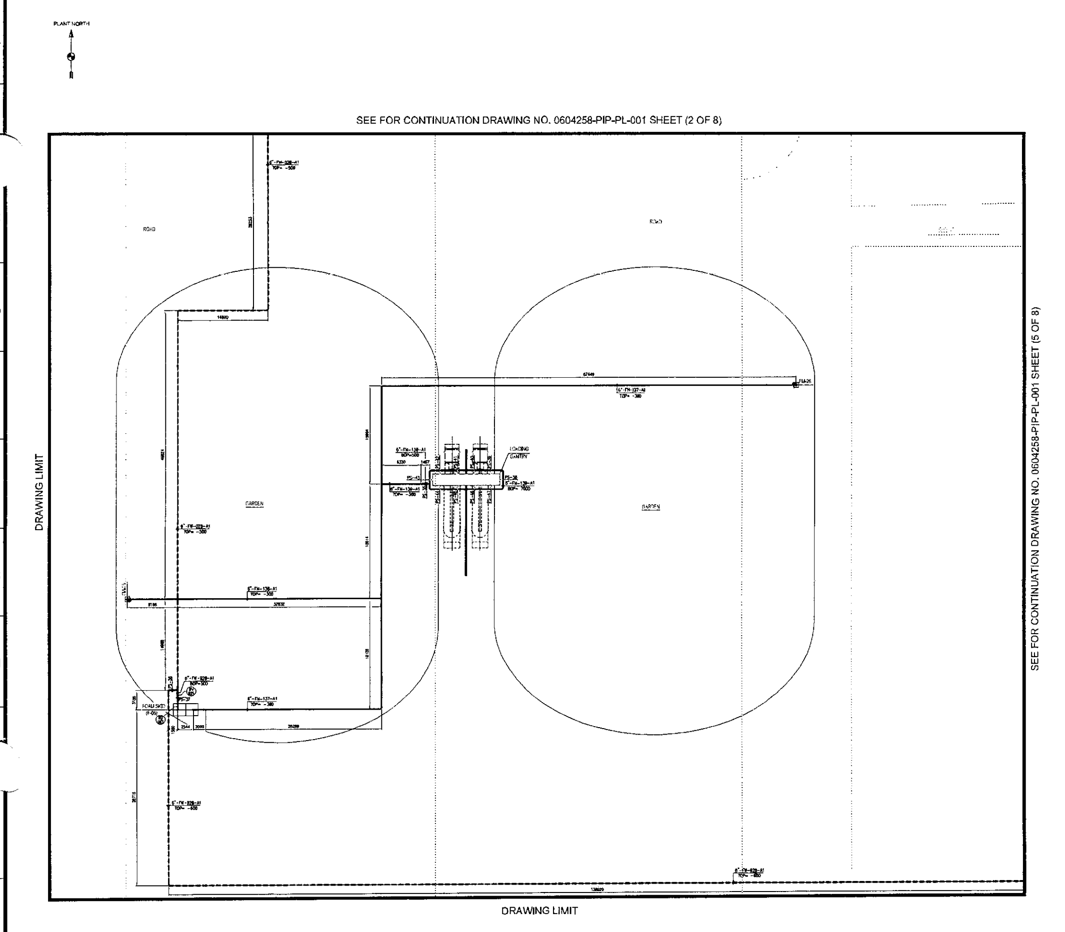

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TITLE: KUNNAR GAS FIELD PIPING LAYOUT

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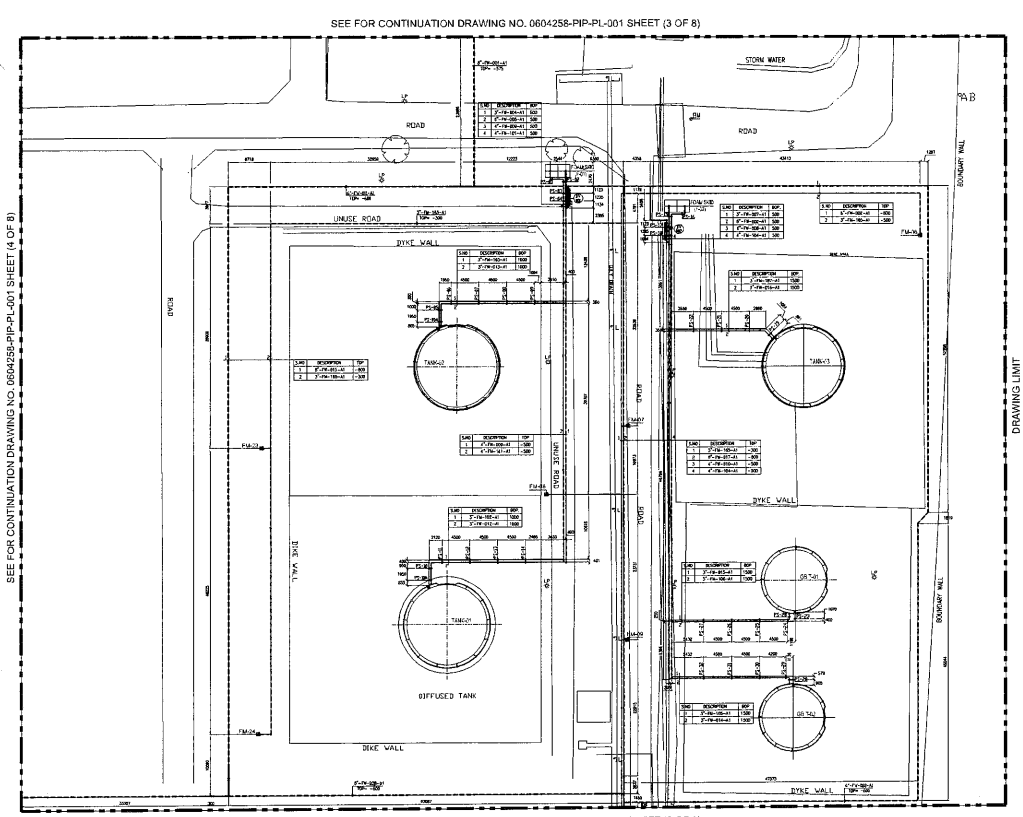

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PIPING LAYOUT

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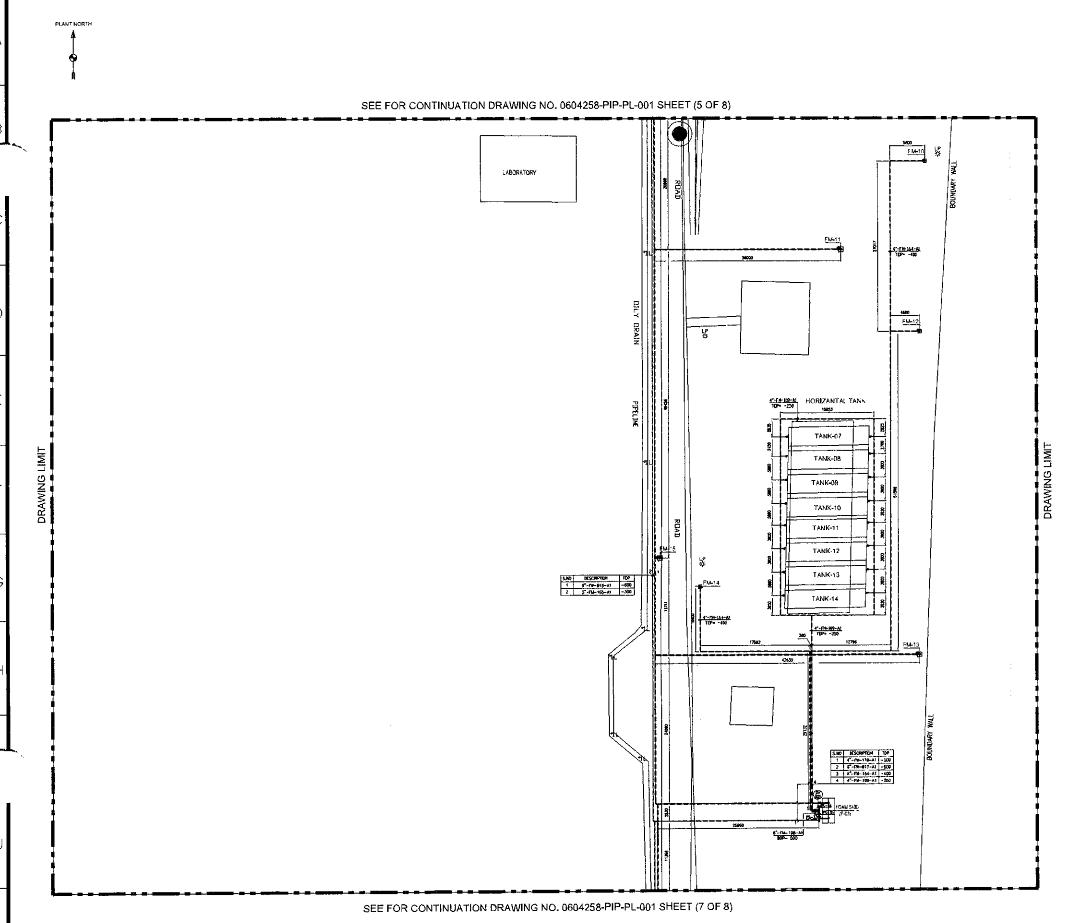

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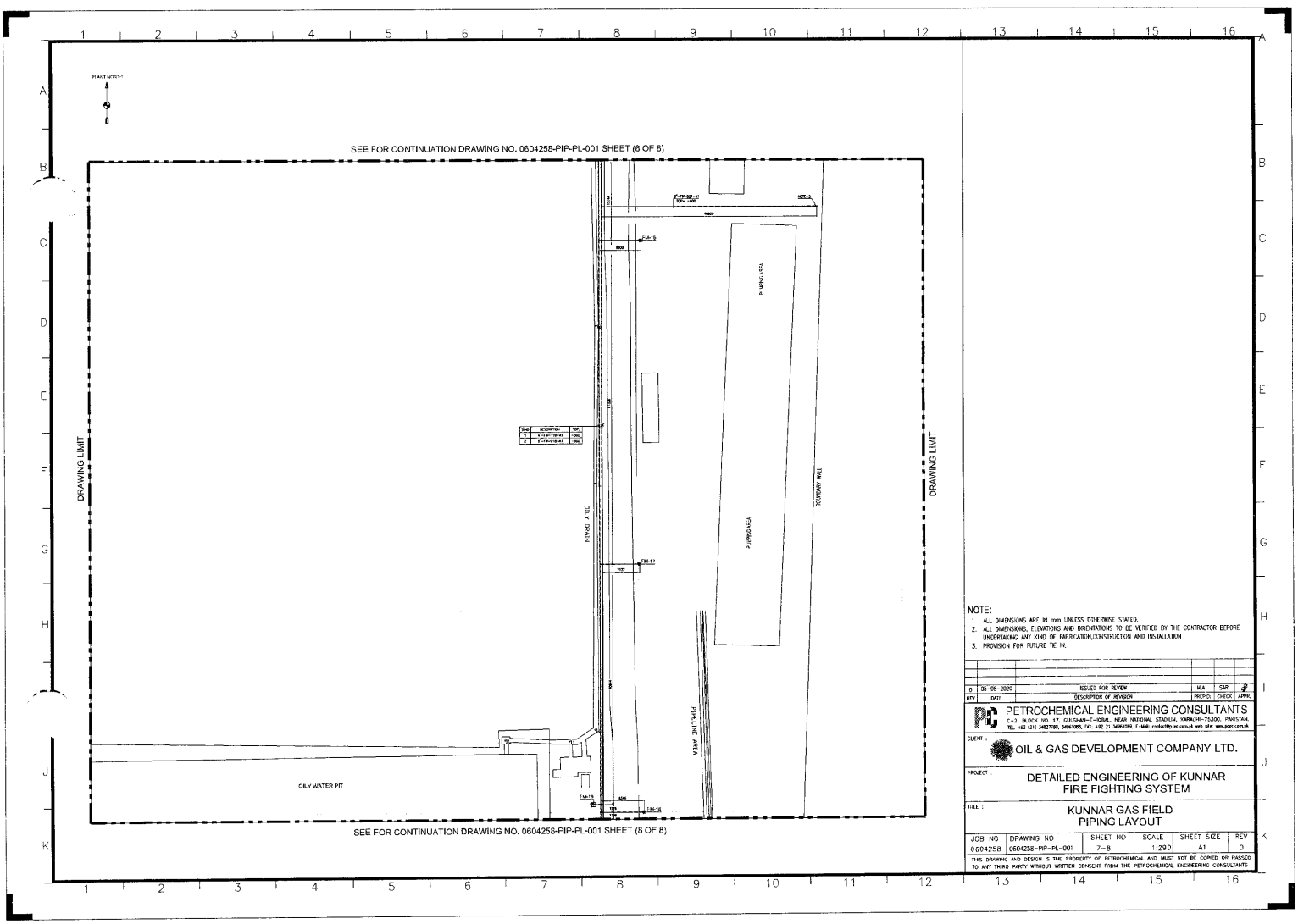

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PROJECT : DETAILED ENGINEERING OF KUNNAR FIRE FIGHTING SYSTEM

TITLE : KUNNAR GAS FIELD
PIPING LAYOUT

JOB NO	DRAWING NO	SHEET NO	SCALE	SHEET SIZE	REV
0604258	0604258-PIP-PL-001	7-8	1:290	A1	0

- Foam water and firewater are proposed for smothering and cooling purpose respectively.
- Single foam pourer is proposed for each tank however foam water sprinklers are proposed for condensate loading area.
- Firewater sprinklers are proposed for Tank-1/2/3, however for rectangular horizontal tanks firewater sprinklers are not recommended as it is a temporary setup. To deal with fire scenario on rectangular tanks, fire water hydrants shall be utilized for cooling.

OIL & GAS DEVELOPMENT COMPANY LIMITED

VALVE SPECIFICATION
FOR BALL VALVES

DOC. NO. : CVS-01-DS-002	DATE : - 10-06-2020	REV. : 1	PREP. BY	S.US

VALVE	SIZE	RATING (lb)	ENDS	CONSTRUCTTION		OPERATOR	DESIGN & TEST	VALVE STANDARD	MATERIAL		
				BODY	TRIM				BODY	TRIM	SEAL
VB-100	≤ 1 1/2"	800	SW	BOLTED BODY	REPLACEABLE BALL & SEATS, FULL PORT, FLOATING BALL	LEVER	ASME B 16.34	B.S. 5351	CARBON STEEL: FORGED ASTM A-105 NORMALIZED	TYPE 316 STAINLESS STEEL	PTFE

OIL & GAS DEVELOPMENT COMPANY LIMITED

VALVE SPECIFICATION FOR GLOBE VALVES

DOC. NO. : CVS-01-DS-002	DATE : - 10-06-2020	REV. : 1	PREP. BY S.US

VALVE	SIZE	RATING (lb)	ENDS	CONSTRUCTTION		OPERATOR	DESIGN & TEST	VALVE STANDARD	MATERIAL	
				BODY	TRIM				BODY	TRIM
VGL-100	≤ 1 1/2"	800	SW	BOLTED BONNET & GLAND O.S.&Y.	PLUG TYPE DISC RENEWABLE SEATS	HANDWHEEL	ASME B 16.34	B.S. 5352	CARBON STEEL: FORGED ASTM A-105 NORMALIZED	DISC . STEM AND SEAT RINGS 316 S.S HARD FACED SEATS
VGL-101	2" to 8"	150	RF (ASME B16.5)	BOLTED BONNET & GLAND O.S.&Y.	PLUG TYPE DISC RENEWABLE SEATS	HANDWHEEL	ASME B 16.34	B.S. 1873	CARBON STEEL: CAST ASTM A-216 GR. WCB	13% CHROME (A182 GR. F6) HARD FACED SEATS

OIL & GAS DEVELOPMENT COMPANY LIMITED

VALVE SPECIFICATION
FOR GATE VALVES

DOC. NO. : CVS-01-DS-002	DATE : - 10-06-2020	REV. : 1	PREP. BY	S.US

VALVE	SIZE	RATING (lb)	ENDS	CONSTRUCTTION		OPERATOR	DESIGN & TEST	VALVE STANDARD	MATERIAL	
				BODY	TRIM				BODY	TRIM
VG-100	≤ 1 1/2"	800	SW	BOLTED BONNET & GLAND O.S.&Y.	SOLID WEDGE RENEWABLE SEATS	HANDWHEEL	ASME B 16.34	B.S. 5352	CARBON STEEL: FORGED ASTM A-105 NORMALIZED	DISC . STEM AND SEAT RINGS 316 S.S HARD FACED SEATS
VG-101	2" to 8"	150	RF (ASME B16.5)	BOLTED BONNET & GLAND O.S.&Y.	FLEXIBLE WEDGE RENEWABLE SEATS	HANDWHEEL	ASME B 16.35	API 600	CARBON STEEL: CAST ASTM A-216 GR. WCB	13% CHROME (A182 GR. F6) HARD FACED SEATS

	DETAILED ENGINEERING OF KUNNAR FIRE FIGHTING SYSTEM			
	DOCUMENT TITLE	**DATASHEET FOR SPRINKLER HEAD (FOR VERTICAL TANKS)**		
CLIENT	**DOCUMENT NUMBER**	0604258-PDS-002	Rev-0	**PETROCHEMICAL ENGINEERING CONSULTANT**

Manufacturer	-
Model No.	-
Code & Standards	- NFPA-13

OPERATING CONDITIONS

Temperature	Min : (3) ℃	Normal : (amb) ℃ Max : (50)℃
Pressure	Operating : (6-8) barg	Design : (10) barg
Liquid	- Fire Water	
Installation	- Outdoor	

DESIGN FEATURES

1. TYPE AND ANGLE	(1)	Style	: Pendent (NOTE-1) perpendicular to tank shell
2. SIZE	(1)	Length	: VTS
	(2)	Orifice dia.	: VTS
3. MATERIAL	(1)	Frame	: Brass or Bronze
4. CONNECTION	1/2" NPT male		
5. FLOW RATE	4 USGPM/Sprinkler at 7 barg		
6 FUSING POINT	VTS		
7. FINISH	(1)	Painting	: N.A (2) Color : Natural Surface
8. ACCESSORIES	Wrench for heat detector installation at field		: 1 ea
9. TEST/INSPECTION	Visual		
10. WEIGHTS	(*) kg		
11. QUANTITY	121 Sprinklers		

ITEMS WITH ASTRISK MARK(*) TO BE FILLED IN BY VENDOR

NOTE:

1) Vendor to Confirm the type of sprinklers

REV	DATE	PRP'D	CHK'D	APP'D	DESCRIPTION
0	15/05/2020	SMR	SHR	AJ	Issued For Review

	DETAILED ENGINEERING OF KUNNAR FIRE FIGHTING SYSTEM			
	DOCUMENT TITLE	DATASHEET FOR SPRINKLER HEAD(FOR LOADING GANTRY)		
CLIENT	DOCUMENT NUMBER	0604258-PDS-001	Rev-0	PETROCHEMICAL ENGINEERING CONSULTANT

Manufacturer	-
Model No.	-
Code & Standards	- NFPA-13

OPERATING CONDITIONS

Temperature	Min : (3) ℃ Normal : (amb) ℃ Max : (50)℃
Pressure	Operating : (5.5~7.5) barg Design : (10) barg
Liquid	- Foam Water
Installation	- Outdoor

DESIGN FEATURES

1. TYPE AND ANGLE	(1) Style : Pendent (NOTE-1)
2. SIZE	(1) Length : VTS
	(2) Orifice dia. : VTS
3. MATERIAL	(1) Frame : Brass or Bronze
4. CONNECTION	1/2" NPT male
5. FLOW RATE	22.5 USGPM/Sprinkler at 6 barg
6 FUSING POINT	VTS
7. FINISH	(1) Painting : N.A (2) Color : Natural Surface
8. ACCESSORIES	Wrench for heat detector installation at field : 1 ea
9. TEST/INSPECTION	Visual
10. WEIGHTS	(*) kg
11. QUANTITY	20 Sprinklers

ITEMS WITH ASTRISK MARK(*) TO BE FILLED IN BY VENDOR

NOTE:

1) Vendor to Confirm the type of sprinklers

REV	DATE	PRP'D	CHK'D	APP'D	DESCRIPTION
0	14/05/2020	SMR	SHR	AJ	Issued For Review

	DETAILED ENGINEERING OF KUNNAR FIRE FIGHTING SYSTEM		
	DOCUMENT TITLE	DATASHEET FOR DELUGE VALVE	
CLIENT	DOCUMENT NUMBER	0604258-DV-001	Rev-0

PETROCHEMICAL ENGINEERING CONSULTANT

Item No. : **DV-001/002/003/004/005/006**
Quantity : **6**
Service : **Fire Water System**
Location : **Outdoor**

Manufacturer	-
Model No.	-
Code & Standards	- NFPA-13

OPERATING CONDITIONS

Temperature	Min : (3) ℃ Normal : (amb) ℃ Max : (50)℃
Pressure	Operating : (6-8) barg Design : (10) barg
Liquid	- Fire Water
Installation	- Outdoor

DESIGN FEATURES

1. TYPE	- (1) Valve : Horizontal Type (2) Installation : Horizontal
2. SIZE	- Valve : 6" - 1 set *
3. CONNECTION	- ANSI Class 150 Raised Face Flanged for Deluge Valve - ANSI Class 150 Rased Face Flanged for Trim Piping End to connect piping
4. MATERIAL	- (1) Body : Cast Iron, Epoxy Lined (2) Disc : * (3) Stem : * (4) Seat : *
5. OPERATION	- (1) Operating : Electric solenoid valve and manual release device (2) Release : Pneumatic detector (3) Alarm : Pressure Switch and Water Motor Gong (4) Valve : Actuating, release and test valves (5) Trim : Factory trimmed and leak tested by hydro-leak test.
6. ACCESSORIES	- (1) Solenoid valve with terminal box : Explosion proof, 2-way normally closed de-energized, 120VAC Flying lead type is not acceptable, Low power consumption type/ASCO make only (2) Pressure switch : Explosion proof, Dual SPDT, 1/2" NPT (3) Pressure relief valve : Liquid service, C.S body, set at 15 barg (4) Water motor gong : 3/4" NPT male x 1" NPT female, 3 sets (5) Piping : Trim piping and fittings in galvanized. (6) Others : Equipment tag, Drip check valve, drain cup, valves - see next page
7. FINISH	- (1) Paint : * (2) Color : *
8. REMARKS	- Each valve shall be supplied with complete trim kit to enable valve to be set with hydraulic detector circuit.
9. TEST/INSPECTION	- Visual and mfr certificate of hydraulic test - body 20.6 barg seat 13.7 barg
10. WEIGHTS	- (*) kg

ITEMS WITH ASTRISK MARK(*) TO BE FILLED IN BY VENDOR

REV	DATE	PRP'D	CHK'D	APP'D	DESCRIPTION
0	15/05/2020	SMR	SHR	AJ	Issued For Review

OIL AND GAS DEVELOPMENT COMPANY LIMIED

DETAILED ENGINEERING OF KUNNAR FIRE FIGHTING SYSTEM

Specification For Seamless Pipe

CONSULTANTS

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Document Revision History

Rev #	Document Status	Prep. By	Chk By.	App. By	Date	Client Approval	Date
00	Interdisciplinary Check	IM	SAR	AJ	15-09-21		
01	Final Issue	IM	SAR	AJ	16-09-21		

TABLE OF CONTENTS

1.0 GENERAL

1.1 Introduction

Oil & Gas Development Company Limited (OGDCL) intends to Installation of Firefighting system at Kunnar plant.

1.2 Purpose

This specification supplements the requirements for the manufacture of seamless line pipe in accordance with API Specification 5L. The seamless line pipes manufactured to this specification shall conform to the product specification level (PSL 1) and to the grade of API 5L line pipe specified in the Purchase Order, single random length (Minimum 6 mtrs length) Bevel Ends with metallic reusable end protectors and to the additional provisions of this specification.

The pipe manufactured to this specification shall be seamless.

Pipe supplied to this specification shall meet or exceed all the requirements of API Specification 5L and the additional provisions of this specification.

This specification supplements the codes listed in Section 2.0 of this specification.

1.3 Definitions

For the purpose of this specification, the following definitions shall apply:

OWNER	OIL & GAS DEVELOPMENT COMPANY LIMITED
CONCESSION REQUEST	A deviation requested by the SUBCONTRACTOR, CONTRACTOR or MANUFACTURER, usually after receiving the contract package or purchase order. Often, it refers to an authorization to use, repair, recondition, reclaim, or release materials, components, or equipment already in progress or completely manufactured but which does not comply with project requirements. A CONCESSION REQUEST is subject to OWNER approval.
ENGINEER	Party which carries out all or part of the design, engineering of the PROJECT.
CONTRACTOR	Party which carries out all or part of the procurement, construction, commissioning or management of the PROJECT. CONTRACTOR includes his approved MANUFACTURERS, SUPPLIERS, VENDORS and SUBCONTRACTORS

MANUFACTURER/ SUPPLIER/VENDOR	Party/ies, which manufactures and/or supplies material, equipment and services to perform the duties as specified by CONTRACTOR in the scope of supply
SHALL	Indicates a mandatory requirement.
SHOULD	Indicates a strong recommendation to comply with the requirements of this document.
SUBCONTRACTOR/ SUBVENDOR	The party(s) which carry(s) out all or part of the Construction, installation and testing of the system(s) as specified by the CONTRACTOR
SOUR ENVIRONMENT, SOUR SERVICE	Sour Environment or Sour Service is the term traditionally used for environments containing water and H2S in exploration and production services in oil and gas industry. In these services, sour environments are defined as "exposure to oil field environments that contain H2S and can cause cracking of materials by the mechanisms addressed by NACE MR 01 75 /ISO 15156". By extension, the term applies to all the fluids, the condition of which falls into Regions 2 and 3 of the EFC Publ. No. 16 monograph

2.0 CODES AND STANDARDS

The latest edition, unless specified otherwise, of the following codes and standards shall establish the minimum standards for the work. MANUFACTURER may use alternate standards that meet or exceed those listed if approved by OWNER.

American Society of Mechanical Engineers (ASME)

ASME Section V	Nondestructive Examination
ASME B31.8	Gas Transmission and Distribution Piping Systems

American Society for Testing and Materials (ASTM)

ASTM A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM E23	Notched Bar Impact Testing of Metallic Materials
ASTM E92	Standard Test Method for Vickers Hardness of Metallic

Materials

ASTM E112	Standard Method for Determining Average Grain Size
ASTM E1268	Standard Practice for Assessing the Degree of Banding or Orientation of Microstructures
ASTM G39	Standard practice for bent beam test specimen for stress Corrosion test

American Petroleum Institute (API)

API 5L:	Specification for Line Pipe
API 1104	Welding of Pipelines & Related Facilities
API RP 5L1	Recommended Practice for Railroad Transportation of Line Pipe
API RP 5L3	Recommended Practice for Conducting Drop - Weight Tear Test on Line Pipe
API RP 5LW	Recommended Practice for Transportation of Line Pipe on Barges and Marine Vessels

American Society of Nondestructive Testing (ASNT)

ASNT RP SNT-TC-IA	Personnel Qualification and Certification in Nondestructive Testing

European Federation of Corrosion (EFC)

Publ. No. 16	Guidelines on Material Requirements for Carbon & low alloy steels for H2S containing Environment in Oil and Gas Production

European Committee for Standardization (EN)

EN 1011	Welding - Recommendations for Welding of Metallic Materials
EN 10204	Metallic Products - Types of Inspection Documents

Health & Safety Executive (HSE)

OTI 95 635	A Test Method to Determine the Susceptibility to Cracking of Line pipe Steels in Sour Service

International Organization for Standardization (ISO)

ISO 9001:2000	Quality Management System – Requirements
ISO 9004:2000	Quality Management Systems - Guidelines for Performance Improvements
ISO 9712	Nondestructive testing qualification and certification of personnel
ISO 1027	Radiographic imaging quality indicators for non-destructive testing principles and identification

National Association of Corrosion Engineers (NACE)

NACE MR 0175/ ISO15156	Materials for use in H2S - containing Environments in oil and gas production
NACE TM 0177	Standard Test Method, Laboratory Testing of Metals for Resistance to Specific Forms of Environmental Cracking in H2S Environments
NACE TM 0284	Standard Test Method, Evaluation of Pipeline and Pressure Vessel Steels for Resistance to Hydrogen Induced Cracking

3.0 REFERENCE DOCUMENTS

Not applicable

4.0 DOCUMENT PRECEDENCE

The MANUFACTURER shall notify the CONTRACTOR/OWNER of any conflict between this specification, the related data sheets, the Codes and Standards and any other specifications noted herein. Resolution and/or interpretation precedence shall be obtained from the OWNER in writing before proceeding with the design or manufacture.

In case of conflict, the order of precedence shall be:

- National and/or Local Regulations;
- Equipment Data Sheets (s);
- Equipment Narrative Specification;

- OWNER Specifications (PTS) and Standards;
- Project Specifications and Standards;
- Industry Codes and Standards.

5.0 SPECIFICATION DEVIATION/CONCESSION CONTROL

Any technical deviations to the Specifications and its attachments including, but not limited to, the Data Sheets and Narrative Specifications shall be obtained by the MANUFACTURER only through CONCESSION REQUEST format. CONCESSION REQUESTS require CONTRACTOR/OWNER's review/approval prior to implementation of the proposed changes. Technical changes implemented prior to OWNER approval are subject to rejection.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Unless otherwise agreed with OWNER, the VENDOR's Quality System shall fully satisfy all the elements of ISO 9001:2000, 'Quality Management Systems – Requirements' and ISO 9004:2000, 'Quality Management Systems - Guidelines for Performance Improvements'.

To ensure that all work is being performed consistently and accurately and to the requirements of the PROJECT Specifications, the VENDOR shall have in effect at all times, a QA programme, which clearly establishes the authority and responsibilities of those responsible for the quality system. Persons performing quality functions shall have sufficient and well-defined authority to enforce quality requirements that they initiate or identify and to recommend and provide solutions for quality problems and thereafter verify the effectiveness of the corrective action.

Quality Systems and Quality Control requirements shall be identified and included in the CONTRACTOR/OWNER's Purchase documentation. Based on these requirements the VENDOR will develop a QA/QC programme which shall be submitted to the CONTRACTOR/COMAPNY for review and concurrence. The VENDOR's QA/QC programme shall extend to SUBCONTRACTOR(s) and/or SUBSUPPLIER(s).

CONTRACTOR/OWNER reserves the right to inspect materials and workmanship standards at all stages of manufacture and to witness any or all test. The VENDOR shall supply to the CONTRACTOR/OWNER, a copy of the relevant 'Manufacturing, Inspection & Test Plan (ITP)' for review and approval. CONTRACTOR/OWNER reserves the right for a pre-production meeting to discuss and approve the ITP. This document shall be in full accordance with the 'VENDOR Document Requirement Schedule'.

7.0 PROCESS OF MANUFACTURE

7.1 General

7.1.1 The Pipe shall confórm to the Grades of API 5L line pipe as specified in the Purchase Order, and as modified by these supplemental requirements.

7.1.2 All Pipes shall be furnished in the "non-expanded" condition.

7.1.3 Pipe MANUFACTURER shall be an API certified mill.

7.1.4 All steel used to fabricate pipe shall be manufactured from basic oxygen steel or electric furnace steel. All steel shall be fully killed All steel shall be fully killed and fine grained with a grain size of ASTM No 7 or finer as per ASTM E 112. For quenched and tempered pipe this grain size requirement shall not apply.

7.1.5 For line pipes to be used in sour application, steel shall also be calcium treated and vacuum degassed or argon treated.

7.1.6 Pipe MANUFACTURER shall submit for CONTRACTOR/OWNER approval its methods for preventing center line segregation and associated stereological procedures for assessing the degree of banding or orientation of microstructures as described in ASTM E1268.

7.1.7 The pipe shall be furnished in the hot formed, normalized, normalized and tempered or quenched and tempered condition. If hot formed pipe is furnished, the finishing temperature shall be greater than 780°C. Pipe which is finished at a temperature lower than 780°C shall be subjected to a further normalizing heat treatment, with a holding time not less than 30 minutes.

7.1.8 For pipe grade API 5L X60 and above, pipes shall be delivered in quenched and tempered condition.

7.1.9 Cold sizing and straightening of pipes are allowed only if the total strain does not exceed 3.0 percent.

7.1.10 Prior to initiation of pipe production, the CONTRACTOR/OWNER shall be allowed to visit the production facilities for the purpose of witnessing all procedures to be used in the manufacture, testing, inspection, identification, and storage of pipe throughout all stages of manufacturing process.

7.1.11 Pipe production shall not commence without written approval of the CONTRACTOR/OWNER and until a pre-production quality control meeting has been completed by the CONTRACTOR/OWNER's representative and the MANUFACTURER's production and quality assurance personnel.

7.1.12 Pipe ends shall be beveled in accordance with API 5L unless otherwise specified by the

OWNER.

7.1.13 Minimum length of pipe shall not be less than 11.0m and greater than 12.0m

7.2 Supporting Information

A manufacturing procedure specification (MPS) shall be submitted by the pipe mill along with the list of documents given below at least four weeks prior to the pre-manufacturing meeting (PMM) which shall be attended by the CONTRACTOR/OWNER. In addition to the manufacturing procedure specifications, an Inspection and Testing Plan (ITP) for steel making and pipe production shall be submitted to the CONTRACTOR/OWNER for review and approval. The ITP for steel making and pipe production shall list all the key activities in a sequential manner and shall specify the personnel responsible, reference document, acceptance criteria, test report and inspection involvement of the MANUFACTURER for each activity. ITP shall be submitted for CONTRACTOR/OWNER review / approval and to include inspection involvement of CONTRACTOR/OWNER and its third party inspection agency. CONTRACTOR/OWNER Third Party Inspection involvement where applicable will be advised by the CONTRACTOR/OWNER following a review of the ITP:

- Name of billet manufacturer and Mill;
- Steel making process, and related methods for preventing center line segregation;
- Aim chemical composition, minimum and maximum working limits (ladle and check) of chemical composition of base steel;
- As-delivery condition of pipe base steel (heat treatment), typical metallurgical microstructure;
- Name of pipe manufacturing Mill;
- Pipe manufacturing procedure including inspection procedures;
- Quality Plan including QC Organization;
- Procedures for pipe heat treatment, DWTT, hardness tests, HIC tests, SSC tests, full ring CAPCIS tests, non-destructive tests and hydrostatic test;
- SSC test specification;
- HIC test specification;
- Induction bending test specification (when applicable);
- Storage procedure for pipes;

- Histograms of past performance relating to the present supply showing SCC and HIC results, chemical and mechanical properties to demonstrate its capability to produce pipes according to this specification;
- At MANUFACTURER's option, any other technical information related to the proposed pipe supply;
- Description of the proposed bevel protectors (if any);
- List of references in seamless pipe for sour service application;
- The MANUFACTURER's proposed deviations from present specifications. Where no deviations are stated in the bid, the potential MANUFACTURER shall be considered as fully accepting the requirements of present specification.

7.3 Material Traceability

7.3.1 Each individual billet and pipe joint shall be marked in a manner to provide identification of each billet and pipe joint to an individual heat, throughout production, testing, storage, shipment and in the field.

7.3.2 Pipe traceability may be by heat number up to heat treatment, and then by pipe number up to the end of production.

7.3.3 Pipe identification procedures to be used shall provide a means of continuous accountability of each pipe joint manufactured from each heat, to include all joints cropped, or recycled after repair. A written identification procedure shall be provided to the CONTRACTOR/OWNER for review and written acceptance. Non-conformance shall, at the CONTRACTOR/OWNER's prerogative, require re-identification of each pipe joint from the heat involved, or rejection of all material manufactured from that heat.

7.3.4 Other grades of API 5L pipe shall not be substituted for the grade of pipe specified on the purchase order without the approval of the OWNER in writing.

7.4 Testing Requirements

The tests are divided into two categories:

- First day production tests;
- Production testing.

First day production tests and production testing frequencies shall be

conducted in accordance with Appendix-C of this Specification on following basis:

7.4.1 First Day Production Tests

The pipe manufacturing procedures shall be qualified during the first day of production on the first three finished pipes for destructive testing and on all pipes for nondestructive testing, produced from the same diameter, same thickness, same pipe making process. If more than one heat is used in the first production pipes, at least two heats shall be represented by the test pipes.

The pipe manufacturing procedure shall include following destructive and nondestructive testing:

- Chemical analysis as per Section 8.0;
- Tensile testing as per Section 9.1;
- Charpy testing and Charpy transition curve as per Section 9.2;
- Micrographic examination and hardness (HV10) testing as per Section 9.3;
- Drop weight test and drop weight transition curve as per Section 9.4;
- HIC testing as per Section 9.5;
- SSC testing as per Section 9.6;
- Full ring CAPCIS test as per Section 9.7;
- Hydrostatic test as per Section 10;
- Non-destructive testing as per Section 11;
- Dimensional control as per Section 12;

For pipe grades API 5L X60 and higher, SSC and full ring CAPCIS tests shall be performed as part of first day production tests in accordance with the requirements of the specification. The tests shall only be required for the heaviest wall thickness of each common pipe diameter and material grade/ pipe making process combination for each mill. The MANUFACTURER shall guarantee that all remaining pipes would also pass these tests.

If any of the first day production tests fail, production shall be halted and all pipes produced shall be identified and rejected. The reason for the failure shall be identified to the satisfaction of the CONTRACTOR/OWNER. The manufacturing procedure shall be

amended. A new set of tests shall be conducted on the first day's production to the new procedure.

7.4.2 Production Testing

The destructive and non-destructive testing shall include all testing laid down in Sections 9, 10, 11, 12 & 13 of this specification except SSC and full ring CAPCIS tests, which shall be performed during first day production tests only.

8.0 CHEMICAL PROPERTIES

8.1 General

The MANUFACTURER shall provide to the CONTRACTOR/OWNER a report giving the heat analysis of each heat of steel used in the manufacture of pipe furnished on the purchase order.

The MANUFACTURER shall provide a certified product analysis of the finished pipe to the CONTRACTOR/OWNER. The product analysis shall include all elements listed in Section 8.2, and as required by API Specification 5L including any other intentionally added elements.

The product analysis shall be conducted on two pipes per heat. Non-conformance to the chemical requirements and/or CE or Pcm shall be cause for rejection of all nonconforming material.

Recheck analysis requirements and acceptance criteria shall conform to API 5L, except that in the event a re-check analysis fails to meet the criteria and the MANUFACTURER elects to test the remaining lengths individually, the analysis shall be made for all elements listed in Section 8.2.

8.2 Chemical Composition

8.2.1 The pipe material shall conform to the chemical requirements of API 5L except as modified by the following:

Elements	Heat Analysis Max. Weight %	Product Analysis Max. Weight %
C	0.15	0.16
Mn	1.40	1.40
Si	0.35	0.40
S	0.003	0.003
P	0.015	0.015
Ca	0.006	0.006
Nb	0.050	0.050
V	0.08	0.08
Ti	0.03	0.03
Al	0.06	0.06
Cu	0.25	0.30
Ni	0.30	0.35
Mo	0.15	0.15
Cr	0.2	0.2
N	0.01	0.01

Notes:

(1) The sum of Cu + Cr + Mo + Ni shall not exceed 0.6 percent.
(2) The total Al:N ratio shall not be less than 2:1.

(3) The maximum and minimum Ca:S ratios shall be submitted to the CONTRACTOR/OWNER for review at the bid stage. Ca/S ratio shall be ≥ 1.

(4) The maximum percentages of residual elements shall be as follows:

Sn = 0.018 Bi = 0.005 As = 0.018

Sb = 0.010 Pb = 0.005 B = 0.0005

Residual elements shall be checked in product analysis.

(5) Oxygen analysis shall be required for information for checking effectiveness of de-oxidation practice.

8.2.2 The carbon equivalent (CE) or Pcm based on product analysis and calculated by the following formulas shall not exceed the following percentages:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} \pounds\ 0.41$$

$$P_{CM} = C + \frac{Si}{30} + \frac{Mn + Cu + Cr}{20} + \frac{Ni}{60} + \frac{Mo}{15} + \frac{V}{10} + 5B \pounds\ 0.22$$

8.3 Grain Size Determination

The ferrite grain size shall be determined on one pipe per heat. The specimen shall be prepared and etched for metallographic examination at 100X magnification. The grain size shall be ASTM No. 7 or finer as per ASTM E112. Grain size shall be reported on the mill test certificate. Photomicrographs (100X) shall be provided for each grain size test. Ferrite grain size requirement shall not apply to quenched and tempered pipe.

9.0 MECHANICAL PROPERTIES

Prior to final acceptance of the pipe the MANUFACTURER shall provide the CONTRACTOR/OWNER representative a certified report of all mechanical properties.

Nonconformance to any of the required mechanical properties, e.g., tensile properties, Charpy impact requirements, hardness, etc., shall be cause for rejection.

9.1 Tensile Properties

9.1.1 The tensile tests and properties shall conform to the requirements of API 5L for the grade of pipe specified on the purchase order.

The actual yield strength of the pipe shall not exceed the minimum specified yield strength as required for the API 5L grade specified, by more than 20,000 psi (137.9 MPa).

The ratio of yield strength to tensile strength shall not exceed 0.90.

The minimum required elongation shall be determined in accordance with the formula given in the footnote of Table-3A & 3B of API 5L, but shall not be less than 20 percent.

9.1.2 The tensile, yield and elongation properties shall be determined from two pipes per heat.

For heats less than 100 tons, tests on only one pipe shall be required.

9.1.3 Tensile properties shall be determined from specimens removed from pipe which has been subjected to all mechanical and heat treatment operations. Where stress relieving (PWHT) of pipe will be performed, e.g. for field welding, additional tensile testing of the pipe shall be performed on stress relieved specimens.

PWHT shall be considered for wall thickness more than 1.25" in US customary units and on 31.8 mm in SI units.

9.1.4 Tensile test specimen shall wherever possible be of full material thickness.

Tensile test specimen orientation shall be as shown in Figure-3 of API 5L. For pipe NPS 8 and over, tensile test specimens shall also be taken in transverse direction (considering not cold expanded) in addition to the mandatory longitudinal direction specimen. Results of transverse tensile test shall be for information purpose only, except that minimum specified yield strength shall be complied with. The testing procedure shall be in accordance with ASTM A370.

9.2 Charpy V-Notch Impact Tests

9.2.1 Charpy V-notch impact testing shall be performed in accordance with the requirements of API 5L Appendix-F, SR5 (including SR5A for shear area).

9.2.2 Charpy test specimens shall be full-size (10mm x 10mm) transverse specimens whenever possible. If pipe size (geometry) does not permit extraction of a full size specimen, the largest obtainable sub-size specimen shall be used. Sub-size specimens shall be in accordance with API 5L SR5 and Appendix-A of this Specification. When one-half size transverse specimens are not obtainable due to pipe size, longitudinal specimens may be substituted with the approval of the OWNER.

9.2.3 The Charpy V-notch energy requirements shall be in accordance with Appendix-A of this Specification.

9.2.4 For pipe sizes 16" and above, the average shear value of the fracture appearance of the three specimens shall not be less then 85%.

For pipe size below 16", the average shear value of the fracture appearance of the three specimens shall not be less than 60% as per API 5L SR5A.2.

9.2.5 The percent shear area shall be reported for all Charpy test specimens. The percent shear for each specimen shall not be less than 50 percent.

9.2.6 Charpy test temperature for all specimen shall be 0°C or the minimum design temperature, which ever is the lower. For thickness above 16mm, the test temperature shall be (T-10°C) where T is the minimum design Temperature.

9.2.7 Charpy testing frequency shall comply with API 5L requirements (para 9.3.5.2) and the following.

Charpy impact tests shall be performed on one (1) pipe length per one hundred (100) pipes or less from each pipe lot.

9.2.8 A full transition curve shall be established as part for the first day production and subsequently for one pipe per ten heat as shown in Appendix C.

9.2.9 If stress relieving (PWHT) is required for field welds, additional charpy testing is required in the simulated PWHT condition as part of first day production test. PWHT shall be considered for wall thickness more than 1.25".

9.3 Micrographic and Hardness Tests

9.3.1 The pipe shall be checked by removing three cross section specimens from one pipe. The three specimens shall be extracted from the pipe at locations 120 degrees apart. The specimens shall be polished and etched and examined and checked for microstructure.

9.3.2 A hardness survey shall be made on one of the above specimens. Three hardness traverses shall be made on the specimen: one traverse 2 mm from the outer edge; one traverse across the center and; one traverse 2 mm from the inner edge. A minimum of 12 readings shall be taken at 5 mm intervals.

9.3.3 Vickers hardness tests shall be conducted with a 10 kg load and the hardness should not exceed 248 HV10.

9.3.4 The hardness tests shall be conducted on one (1) pipe per 100 pipes or from each pipe lot, whichever is less. Results of the hardness tests shall be furnished to the CONTRACTOR/ OWNER representative.

9.4 Drop Weight tear Test

9.4.1 Drop Weight Tear Tests (DWTT) shall be performed on pipe equal to or greater than 16 in (406 mm) diameter in accordance with API 5L Appendix-F, SR6, for pipeline in gas service. Two transverse specimens shall be taken from one length of pipe from each heat supplied on the order.

9.4.2 DWTT shall be conducted at the minimum design temperature for wall thickness 25.4 mm and below. For pipe wall thickness above 25.4mm, test specimen and test temperature shall be as per Section 5.3 of API RP 5L3.

9.4.3 All specimens shall exhibit a minimum of 75 percent shear on the fracture surface.

9.4.4 Full transition curves shall be established and furnished for one heat out of ten, with a minimum of one full transition curve.

9.5 Hydrogen Induced Cracking Tests (HIC)

9.5.1 Line pipes shall be HIC tested. Hydrogen Induced Cracking (HIC) sensitivity test requirements and procedures shall be in accordance with Appendix-B of this specification.

9.6 Sulfide Stress Cracking Tests (SSC)

9.6.1 For line pipes of grade API 5L Gr. X60 and higher in sour service application, Sulphide Stress Cracking (SSC) tests (four point bend tests as per ASTM G39) shall be conducted according to method B of NACE Standard TM 0177 using test solution A. For acceptance, no cracking shall be observed in 720 hours with a constant load equivalent to 90% of the actual yield strength of the pipe. Specimen shall be located as near to the pipe inside surface as possible. The SSC test shall be a part of the first day production testing. A detailed procedure shall be submitted for approval to CONTRACTOR/OWNER.

9.7 Full Ring CAPCIS Tests

9.7.1 Full ring CAPCIS tests shall be applicable for API 5L Gr. X60 and above grades. A full ring CAPCIS test shall be conducted on a pipe section including girth weld in accordance with OTI 95 635. The test solution shall be the NACE TM 0177 solution-A. The test stress level shall be equivalent to the design test level or 72% of SMYS whichever is higher. For acceptance no cracks shall be observed for 720 hours.

10.0 HYDROSTATIC TEST

Hydrostatic testing of the pipe shall be in accordance with API 5L and the following.

Each length of pipe shall withstand, without leakage a hydrostatic test to a test pressure such that the hoop stress, calculated on the basis of minimum specified wall thickness and including stresses from end loading, is at least 95 percent of the specified minimum yield strength. If applied, the end load compensation factor as determined by the formula given in API 5L, Appendix K shall be used.
The test pressure for all sizes of pipe shall be held for not less than ten (10) seconds.

Hydrostatic test records will be checked by the CONTRACTOR/OWNER representative at his option.

11.0 NON DESTRUCTIVE INSPECTION

11.1 Body

11.1.1 All NDT examinations shall be performed by personnel qualified by a third party in accordance with ASNT Recommended Practice SNT-TC-1A, Level II. Personnel interpreting results of any non-destructive testing shall be qualified by a third party to

SNT-TC-1A Levels II or III. For UT at least one level III qualified inspector shall be available (on call) for overall supervision. Copies of operators' qualification certificates shall be submitted for CONTRACTOR/OWNER approval prior to production commencing. Original certificates shall be kept at the MANUFACTURER's premises and shall be made available for inspection by the CONTRACTOR/OWNER's representative.

11.1.2 The pipe shall be examined full length by ultrasonic testing prior to or after hydrostatic testing in accordance with API 5L and the following requirements.

11.1.3 A description of the ultrasonic testing (UT) equipment and the procedure to be used shall be submitted to the CONTRACTOR/OWNER for review and approval prior to production of the pipe. Requirements for ultrasonic inspection equipment and testing shall be in accordance with API 5L. The UT equipment shall be capable of detecting surface defects and transverse, longitudinal and inclined embedded defects.

11.1.4 Prior to pipe production, the CONTRACTOR/OWNER shall have the option to witness the calibration of ultrasonic testing procedures and inspect the equipment to be used by the MANUFACTURER.

The equipment shall include a monitoring audible signal which activates on defects and a visual recording system (for permanent record) to indicate reflections, which exceed that of the calibration standard.

A transducer with a frequency of 2 MHz or higher shall be used.

The ultrasonic test equipment shall be calibrated at least twice per shift.

11.1.5 The reference standard shall contain notches for calibration of the ultrasonic testing equipment in accordance with API 5L and the following. Notches shall be located on both the OD and ID surfaces of each calibration standard.

- Depth: 10 percent maximum of specified pipe wall thickness.

Acceptance criteria shall be in accordance with API 5L except that the maximum depth of discontinuities shall not exceed 10 percent of the specified wall thickness.

11.1.6 All sensitivity adjustments shall be carried out dynamically. The CONTRACTOR/OWNER Representative shall have the option to witness the dynamic calibration of the ultrasonic testing system.

11.2 Lamination Check

11.2.1 If the UT equipment used for full body testing also checks for pipe body laminations this inspection shall be acceptable as a pipe body lamination check. If the full body UT equipment is not capable of checking for laminations, then the pipe shall also be checked for laminations using ultrasonic testing with a helical pattern which covers at least 25 percent of the pipe surface.

11.2.2 For lamination inspection, one or more discontinuities in any area of the pipe that exceed an area covered by a 25 mm diameter circle shall be unacceptable.

11.3 Pipe Ends

11.3.1 After bevelling, the complete circumference of the pipe ends shall be ultrasonically tested from the inside for laminations. This inspection shall cover a width which includes the entire bevel. Alternately, the pipe ends may be tested from the outside prior to bevelling, and in such cases, a band at least 25 mm wide, which shall include the eventual bevelled area, shall be tested.

11.3.2 If UT has not been performed from the outside before cutting and if UT from the inside is not feasible because of dimensional limitations, then MT shall be applied to the bevel face. Laminations are not acceptable in this area.

11.3.3 A detailed procedure for ultrasonic and magnetic particle inspection of pipe ends shall be submitted to the CONTRACTOR/OWNER for review and approval prior to start of pipe production.

11.4 Residual Magnetism

11.4.1 Any detrimental magnetic fields resulting from magnetic particle (wet or dry) inspection, electro-magnetic inspection, or other magnetic equipment shall be checked and removed if it exceeds the following requirements. The pipe shall be checked subsequent to any inspection that uses a magnetic field and/or handling with any electromagnetic equipment and prior to shipment from the mill.

11.4.2 The pipe ends shall be checked for residual magnetism as follows:

- Measurements shall be made on the root face using a Hall-effect gaussmeter or other type of instrument approved by the CONTRACTOR/OWNER. However, in the case of dispute measurements, the Hall-effect gaussmeter shall govern. The gaussmeter shall be operated in accordance with written instructions demonstrated to produce accurate results. The accuracy shall be verified at least once each day that the gaussmeter is used;

- Measurements shall be made on each end of at least 10 percent of the pipes per working shift. As a minimum, one pipe shall be taken from the beginning of the shift, one from near the middle, and one from the end of the shift;

- If the pipe production line is equipped with in-line de-magnetising equipment, after the first working shift the measurement frequency can be reduced to cover 3 (three) pipes per shift;

- At minimum, four readings shall be taken approximately 90 degrees apart around the circumference of each end of the pipe. No reading shall exceed 20 gauss when measured with a Hall-effect gaussmeter, or equivalent values, with other types of

instruments;

- Any pipe that does not meet the above requirements shall be considered defective;
- In addition, all pipe produced between the defective pipe and the last acceptable pipe shall be measured. Alternately, if the pipe production sequence is documented, pipe may be measured in reverse sequence beginning with the pipe produced prior to the defective pipe until at least three (3) consecutive pipes meet the requirements. Pipe produced prior to the three consecutive acceptable pipes need not be measured. Pipe produced after the defect shall also be measured until at least three (3) consecutive pipes meet the acceptance requirements;
- All defective pipe shall be degaussed full length and re-measured or permanently rejected.

12.0 DIMENSIONS, WEIGHTS AND LENGTHS

Dimensions weights and lengths of the pipe shall comply with API 5L and the following requirements. All dimensional tolerances specified herein and in API Specification 5L shall apply irrespective of the pressure used in the hydrostatic test.

12.1 Diameter

12.1.1 Pipe body

The outside diameter of the pipe body, as determined by taping the circumference, shall not deviate by more than ±3 mm from the outside diameter given in the bill of materials.

12.1.2 Pipe ends

For a length of 100 mm from each pipe end, the average internal diameter shall not deviate from the nominal internal diameter by more than ±2 mm. The nominal internal diameter is defined as the outside diameter OD minus twice the nominal wall thickness.

The internal diameter shall be measured using an internal gauge or a measuring tape inside the pipe. The method and equipment used shall be approved by CONTRACTOR/OWNER. For pipe size 8 NPS and below, the internal diameter may be calculated by measuring the outside diameter with a circumference tape and subtracting twice the actual wall thickness from this value.

12.2 Out of Roundness

The ends of each pipe shall be tested for out of roundness using an internal ring gauge of

diameter 5.0 mm less than the nominal internal diameter of the pipe. The gauge shall pass freely into each end of the pipe when held normal to the pipe axis.

12.3 Length

The pipe shall be supplied to the following length requirements unless otherwise specified on the Purchase Order.

- Pipes shall be between 11.0 m (minimum) and 12.0 m (maximum) in length.

12.4 Pipe Ends

Pipe ends shall be beveled in accordance with API 5L unless otherwise specified by the CONTRACTOR.

12.5 Jointers

No jointers shall be furnished on the order.

12.6 Wall Thickness

12.6.1 Requirements for measurement of pipe wall thickness as required by API 5L shall be modified as follows:

Ultrasonic thickness testing of the pipe body and ends shall be performed by scanning along a helical or straight pattern in such a way that at least 10 percent of the pipe surface is covered. For un-inspected areas at ends, one of the following options shall be applied:

- Manual UT at four locations around the circumference with 100 mm pitch each;
- Manual wall thickness gauge along the full circumference.

The ultrasonic testing equipment shall be calibrated using a standard thickness specimen.

12.6.2 The wall thickness shall not exceed +15 percent/-10 percent of the specified wall thickness. Any pipe having a wall thickness which does not conform to the minimum specified wall thickness shall be rejected.

13.0 WORKMANSHIP, VISUAL INSPECTION AND REPAIR OF DEFECTS

13.1 General

13.1.1 All first day production tests will be witnessed by the CONTRACTOR/OWNER

Representative. In addition, all pipe will be subject to inspection by the CONTRACTOR/OWNER's representative. Sufficient notice (at least 14 days) shall be given, to the CONTRACTOR/OWNER by the MANUFACTURER of the time when production is to begin.

13.1.2 The CONTRACTOR/OWNER's representative shall have free entry at all times to all parts of the manufacturing works, which concern the manufacture, testing, inspection, quality control, storage and shipping of the pipe ordered, including the steel mill and the pipe mill.

13.1.3 The pipe mill and steel mill shall make available to the CONTRACTOR/OWNER's representative without charge, all reasonable facilities to inspect, measure, and check the pipe in all stages of production including, ultrasonic equipment for wall thickness measurements after grinding repairs.

13.1.4 The CONTRACTOR/OWNER's representative shall have the option to examine all materials rejected for any reason. If any test specimen fails to meet the requirements for any reason, the cause shall be brought to the attention of the CONTRACTOR/OWNER's representative, and all affected materials shall be retained until examined by the CONTRACTOR/OWNER's representative.

13.2 Surface Conditions

13.2.1 The MANUFACTURER shall take all reasonable precautions to insure that the pipe surface is free from imperfections, which might interfere with the efficient application of an external coating. In addition, the metal surfaces shall be sufficiently clean and smooth so as to permit non-destructive examination. All loose scale shall be removed, and pitting or rough surfaces removed by grinding. Pipe shall have a workmanlike finish, and the MANUFACTURER shall remove by grinding, mechanical marks and abrasions, such as cable marks, dings, roll marks, scores, etc., and also imperfections such as scabs, seams laps, tears and slivers even though they may be shallow enough to be within wall thickness tolerances.

13.2.2 he pipe shall contain no dents which affect the curvature of the pipe at the pipe ends. Pounding out or jacking out dents shall be prohibited.

13.2.3 All cold formed dents with a sharp bottom gouge deeper than one mm shall be considered defects which require repair or rejection. All sharp gouges shall be removed by grinding to a smooth contour. Any pipe having wall thickness which does not conform to the minimum specified wall thickness after grinding, shall be rejected. Repair shall only be permitted with the approval of the OWNER's representative.

13.3 Repair of Injurious Defects

13.3.1 Minor surface defects may be removed by grinding providing the remaining wall thickness beneath the ground area is not less than the minimum specified wall thickness. Grinding repairs shall be blended to a smooth transition on the pipe contour.

13.3.2 When grinding repairs are made because of imperfections being found by NDT, the section of the pipe containing such repairs shall be subjected to additional NDT using the same NDT techniques, and magnetic particle testing after the grinding operation. Surface defects injurious to coating application shall be removed by grinding, to a smooth contour.

13.3.3 Repairs by welding shall not be permitted.

14.0 MARKING, COATING AND BEVEL PROTECTION

14.1 Marking and Coating

14.1.1 Pipe shall be furnished bare and free of all mill coating.

14.1.2 Each pipe shall be cold die stamped with its unique pipe number on the weld bevel at each end. No other die stamping shall be permitted.

14.1.3 The pipe shall be paint stenciled at both ends, in accordance with API 5L on the outside surface of the pipe within 200 mm of the ends. Pipe markings shall show grade, weight per foot and wall thickness. Sizes, weights, lengths, and pressures shall be given in Metric units. Pipe diameter, wall thickness, length, and grade shall be marked on both inside and outside surfaces.

Full marking on one end with pipe number stencilled on the inside surface at the other end is acceptable, provided that the relevant marking is transferred on the pipe after coating at the site and off-cut materials preserved for future use.

Pipe shall be paint stenciled at one location, showing OWNER name, PROJECT name, purchaser order number and MANUFACTURER's name.

14.1.4 The pipe marking shall include the unique pipe number, lot number, heat number, and whatever other designation is required so that complete traceability is maintained, and each length of pipe can be specifically linked to all applicable chemical, mechanical, and other required tests and to each step of the manufacturing, testing and inspection operations.

14.2 Bevel Protectors

14.2.1 Bevel Protector / end caps shall be installed on all pipe ends. End caps shall be hookable type which shall allow the use of end hooks without the need for their removal during pipe handling. The bevel protector shall be the re-usable type. The details of the bevel protector/end caps shall be furnished to CONTRACTOR/OWNER for approval prior to start of the production.

14.2.2 Bevel protectors shall be of steel end type.

15.0 RECORDS, TEST REPORTS AND ADDITIONAL INFORMATION

15.1 Records and Test Reports

15.1.1 Unless otherwise specified, material certificates shall be of type 3.2 as per European Standard EN 10204.

15.1.2 The following records and test reports shall be furnished by the MANUFACTURER to the CONTRACTOR/OWNER at no cost to the CONTRACTOR/OWNER.

- Heat treatment records when any pipe is subject to heat treatment;
- Certified chemical analysis and mechanical properties tests;
- A report giving the results of the grain size evaluation (Section 8.3);
- Charpy V-notch impact tests, DWTT and hardness tests results;
- Non-destructive examination (NDT) reports;
- SSC test and full ring CAPCIS tests reports;
- Hydrogen induced cracking sensitivity test results and photographs.

15.1.3 In addition to the above listed records/test reports, the following document shall be submitted in electronic format (CD-ROM) in addition to hard copies as part of the final documentation for CONTRACTOR/OWNER records.

- Approved steel and pipe manufacturing procedure specification (MPS);
- Procedures for heat treatment, HIC test, four-point bend SSC test, full ring CAPCIS test and DWTT;
- Procedures for non-destructive testing of pipe (UT, MT and PT);
- List of first day production tests and production tests;
- Approved Inspection and Testing Plan (ITP);
- Mill certificates of pipes supplied;
- Reports of first day production tests;
- Traceability and pipe identification reports.

16.0 SHIPPING AND HANDLING

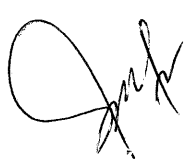
All pipes shall be handled, loaded and shipped in accordance with API RP 5L1, 'Recommended Practice for Railroad Transportation of Line Pipe and API RP 5LW', 'Recommended Practice for Transportation of Line Pipe on Barges and Marine Vessels'.

The MANUFACTURER shall submit loading instructions and diagrams for approval for all pipe shipped by truck, rail, or marine vessel; however approval of these shall not relieve the MANUFACTURER of his responsibility for any damage during shipment.

All dimensional tolerances and pipe surface conditions specified herein and in API 5L shall apply to the pipe condition as received by the CONTRACTOR/OWNER at the shipping destination.

17.0 GUARANTEE

The MANUFACTURER shall bear all costs to seek, find, and repair all leaks and /or ruptures, which occur during the field hydrostatic testing, which result from defects traceable to the manufacture of the pipe. The field test pressure will not exceed a pressure, which will cause a circumferential fiber stress greater than 100 percent of the specified minimum yield strength of the pipe. The CONTRACTOR/OWNER may elect to raise and lower the field test pressure one or more times, either as part of a planned testing routine, or as a consequence of failure in the pipeline or in the testing equipment; however, these pressure cycles shall in no way relieve the MANUFACTURER of his obligations.



APPENDIX-A

CHARPY V-NOTCH IMPACT ENERGY REQUIREMENTS

Charpy V-Notch Impact Energy Requirements (1)(2)		
Pipe Grade	Minimum Average Value (Joules)	Minimum Individual Value (Joules)
B	27	22
X42	27	22
X46	32	24
X52	36	27
X56	39	29
X60	41	31
X65	45	34
X70	48	36

Notes:

(1) Minimum absorbed energy requirements for full size (10 mm X 10 mm) transverse specimens.

(2) For other specimen sizes and orientations, the above values shall be multiplied by the following factors:

Size (mm)	Orientation	Factor
10 x 10	Longitudinal	1.5
10 x 7.5	Transverse	0.75
10 x 7.5	Longitudinal	1.125
10 x 5.0	Transverse	0.5
10 x 5.0	Longitudinal	0.75

(3) The factor J/cm^2 shall not be used.

(4) The shear area at the fracture surface of the test specimen shall be recorded. Each sample shall exhibit not less than 50% fibrous shear.

APPENDIX B
HYDROGEN INDUCED CRACKING (HIC) SENSITIVITY TESTS

B.1 Qualification of test method

Before commencement of the order, the MANUFACTURER shall provide the CONTRACTOR/OWNER with a detailed procedure for the testing, metallographic preparation and evaluation of HIC specimens. The MANUFACTURER shall qualify his test method using samples from a steel of known crack sensitivity or with results of HIC tests performed on similar material. All tests shall be witnessed by the CONTRACTOR/OWNER.

B.2 Testing Requirements

B2.1 One pipe from each of the first three heats of pipe produced shall be tested. One pipe out of every subsequent ten heats shall be tested. The pipes for testing shall be selected by the CONTRACTOR/OWNER's representative from the heats exhibiting the higher sulfur contents.

B.2.2 Three specimens shall be removed from each test pipe. The specimens shall be removed from the pipe radially and shall be located approximately 120 degrees apart. The specimens shall be prepared for testing in accordance with Section 4 of NACE TM 0284.

B.2.3 The specimens shall be tested in accordance with Section 6 of NACE TM 0284 and the following requirements:

- The test shall be performed in the NACE TM 0177 test solution, i.e. 0.5 percent acetic acid + 5 percent NaCl + H2S;
- The pH value of the solution shall be measured at the beginning and at the end of the test;
- Test conditions shall be as follows:

- Temperature: 25 ± 3°C
- H2S Concentration: (2300 - 3500 ppm) saturated condition
- Initial pH: 2.9 - 3.3
- Final pH: 3.5 - 4.0
- Test Period: 96 hours

Following exposure the specimens shall be cleaned, sectioned, polished, etched, examined and evaluated.

B.3 Test Evaluation The specimens shall be evaluated in accordance with Section 7 of NACE TM 0284 and following requirements:

B.3.1 Blistering

The tendency to blister shall be reported after visual examination. Photographs shall be taken of the two wide faces of each coupon to show any blistering. Where photography does not adequately show blisters a dimensional sketch may be substituted.

B.3.2 Hydrogen induced cracking

Specimens taken with their long axis (100 mm) parallel to the rolling direction shall be sectioned transversely at three points.

Metallographic evaluation shall comply with NACE TM0284 with the additional requirement that all faces shall be subjected to either wet magnetic particle testing or macroetching, before final metallographic polishing, in order to make an accurate assessment of whether any significant cracks are present which may have become invisible due to smearing of the metal surface during preparation.

The sections shall be mounted in epoxy resin, or an equivalent, and polished. To avoid the possible obscuring of fine cracks, the metallographic preparation shall entail polishing to a finish of 1 µm or less. Cracking shall then be estimated by micrographic examination at magnifications of 30X and 100X.

B.3.3 Evaluation

For each crack observed, the length and extent of stepwise propagation shall be measured. For each section containing cracks, one photograph shall be taken showing one of the complete transverse sections with examples of cracking.

HIC is evaluated in terms of crack length ratio (CLR), crack thickness ratio (CTR) and crack sensitivity ratio (CSR).

These values shall be reported for each section examined and as the average of three sections per specimen. The results for each specimen, i.e. the average of the three sections examined, shall be used for evaluating HIC susceptibility. In this evaluation, cracks associated with surface blistering which have no part more than 1 mm from the specimen surface shall be disregarded.

B.3.4 Acceptance criteria

The following acceptance criteria shall be met:

- CLR = 15% maximum
- CSR = 1.5% maximum
- CTR = 5% maximum

The maximum individual crack length on any section shall not exceed 5 mm.

If any specimen fails to meet the above acceptance criteria, the heat of steel represented by the test shall be rejected. In addition, the MANUFACTURER may elect to make re-tests on two additional test pipes, selected by the CONTRACTOR/OWNER's representative, which represent two other heats from the 10 heat lot. If both of the re-tests meet the above acceptance criteria, the 10 heat lot shall be accepted, except for the heat which failed the initial test. If one or both of the re-tests fail, the entire 10 heat lot shall be rejected.

B.4 Test Report

The test report shall contain the following information.

- Results of cracking evaluation indicating CLR, CTR, and CSR for each section and also averaged for 3 sections with test result (i.e., pass/fail);
- Photomicrographs of the specimens showing cracking together with photographs of adjacent material:
  - unetched; showing types of inclusions;
  - etched; showing microstructure of parent material.
- Banding index per ASTM E 1268 shall be recorded for information;
- The pH of H2S saturated solution at the start and end of the test, the H2S content and type of solution;
- Photographs of specimens showing any blisters;
- Location and dimensions of specimens;
- Mechanical properties of materials tested.

APPENDIX C

TESTING AND INSPECTION

Test/Inspection	First-day Production Tests		During Production	
	Frequency	Remarks	Frequency	Remarks
VISUAL INSPECTION				
Dimensions	All pipes		All pipes	
Pipe end squareness	All pipes		2 pipes per shift	
Straightness	All pipes		Random	
Surface defects	All pipes	External	All pipes	External
ULTRASONIC EXAMINATION				
Pipe ends	All pipes	25 mm of pipe ends	All pipes	25 mm of pipe ends
Pipe body (defects)	All pipes	100 percent of surface	All pipes	100 percent of surface
Pipe body (lamination)	All pipes	25 percent of surface	All pipes	25 percent of surface
Pipe thickness	All pipes	10 percent of surface	All pipes	10 percent of surface
MT				
Seamless pipe body	All selected pipes		All pipes	
Bevel faces	All pipes	Only if ultrasonic testing is impossible	All pipes	Only if ultrasonic testing is impossible
PHYSICAL TESTS				
Tensile test	Two selected pipes		Two pipes per heat	
Charpy V-Notch test				
Transition curve	One selected pipe		One pipe per 10 heats	
At minimum test temperature	Two selected pipes		One pipe per 100 pipes per heat	
Drop Weight Tear test				

Transition curve	Two selected pipes		One pipe per 10 heats	
At minimum test temperature	Two selected pipes		One pipe per heat	
Macro, micro plus hardness	Two selected pipes		One pipe per 100 pipes or from each pipe lot, whichever is less	
CHEMICAL COMPOSITION / CORROSION TESTS				
Heat analysis	One per heat		One per heat	
Product analysis	Two per heat		Two per heat	
Hydrogen Induced Cracking Test	One pipe from each of the First three heat (cl. C2)		One pipe per ten heats	
SSC Test	One pipe for heaviest Wall Thk of each OD			
Full Ring CAPCIS test	1 test coupon			
HYDROTEST				
Hydrotest	All pipes		All pipes	

SPECIFICATION FOR THREE LAYERS POLYETHYLENE PIPE COATING

Project: **Miscellaneous Field**

Client: **Oil & Gas Development Company Limited**

Prepared by:	**AHS**
Checked by:	**AB**
Approved by:	**SC**
Revised by:	**-**

Rev.	Description of Revision	Date	Revised Page Nos.
0	ISSUED FOR BIDDING	[redacted]	

CONTENTS

1.0 GENERAL

1.1 Scope

1.1.1 This Specification defines the supply and application of 300 – 400 microns Fusion Bonded Epoxy (FBE) Corrosion Protection Coating, 300 – 400 microns intermediate layer of copolymer adhesive and 2000 microns outer polyethylene coating to steel line pipe. The pipe shall be supplied in double random length and in accordance with Specification No. 4985-PA-2006.

1.1.2 The Supplier shall be responsible for ensuring that the materials utilized are suited for the design life of 50 years.

1.1.3 All inspection and certification shall be undertaken by a third party certification body approved by the Company. In addition to the third party certification, Company may also appoint its own inspector for the witnessing/inspection of coating application and tests.

1.2 Definitions

"Company" means "Oil and Gas Development Company Limited (OGDCL)"

"Engineering Consultant" shall mean "OGDCL"

"Supplier" means Entity with whom the Company will execute a Contract for supply of equipment/material as per this document

"Project" means "Miscellaneous Field Development"

1.3 Errors or Omissions

1.3.1 The review and comment by the Company/Engineering Consultant of any Supplier's or its manufacturer's drawings, procedures or documents shall only indicate acceptance of general requirements and shall not relieve the Supplier 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 Supplier in this Specification shall be immediately brought to the attention of the Company/Engineering Consultant.

1.4 Deviations

All deviations to this Specification, other related specifications or attachments shall be brought to the knowledge of the Company/Engineering Consultant before issuing the

procurement document. All deviations made during the procurement, design, manufacturing, testing and inspection shall be with written approval of the Company/Engineering Consultant prior to execution of the work. Such deviations shall be shown in the documentation prepared by the Supplier.

1.5 Conflicting Requirements

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

1.6 Reporting Procedure

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

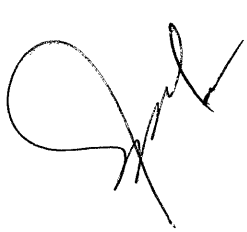
1.6.2 Daily, weekly monthly and run summaries of all major aspects of the production process shall be provided as reports to the Company/Engineering Consultant.

2.0 CODES, STANDARDS AND SPECIFICATIONS

The materials and equipment supplied and work performed under this Specification shall conform to the latest edition of the industry Codes and Standards, references recommended practices and project specification listed below:

ANSI B31.8	Liquid Petroleum Transportation Piping Systems
ISO 9000/9001/9002	Quality Systems
API Spec. 5L	Specification for Line Pipe
API RP 5L1	Recommended Practice for Railroad Transportation of Line Pipe.
API RL 5L5	Recommended Practice for Marine Transportation of Line Pipe.
ASTM E 337	Test for Relative Humidity by Wet & Dry Bulb Psychrometer.
ASTM C177	Test Method for Steady-State Thermal Transmission Properties by Means of the Guarded Hot Plate

ASTM C518	Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter
ASTM D-1621	Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D 1622	Test Method for Apparent Density of Rigid Cellular Plastics
ASTM D1623	Test Method for Tensile Properties of Rigid Cellular Plastics
ASTM D2126	Test Method for Response of Rigid Cellular Plastics to Thermal & Humid Aging
ASTM D2856	Test Method for Open Cell Content of Rigid Cellular Plastics by the Air Psychrometer.
ASTM G8	Cathodic Disbonding of Pipeline Coatings.
NACE RP-02-74	Recommended Practice, High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation.
NACE RP-01-88	Discontinuity (Holiday) Testing of Protective Coatings
SSPC-SP-1	Solvent Cleaning
SSPC-SP-10	Mechanical Cleaning
SSPC-AB-1	Mineral and slag abrasive
SSPC-PA-2	Measurement of dry coating thickness.
SSPC-VIS-1	Visual standards for abrasive blast cleaned steel
DIN 30670	Polyethylene Coating Pipe for Steel Pipes & Fittings
4985-PA-2006	Line Pipe Material
4985-DS-1801	Heat Shrinkable Sleeves for 3-Layer Polyethylene Coated Pipe Weld Joints, Pipe Bends, and Coating Damages.



3.0 QUALITY PROGRAM

A quality control program shall be submitted to the Company for review and approval prior to first production. The program shall be in accordance with ISO 9000/ 9001/9002 as the appropriate standard.

The quality program shall, minimum, include the following:

a) Raw material handling procedures

b) Surface preparation procedure

c) Raw material testing

d) Coating application procedures

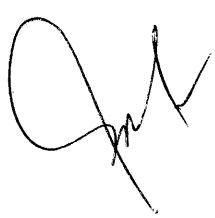
e) Inspection & testing of coating procedures

f) Inspection & testing equipment calibration

g) Coating repair procedures

h) Handling & stockpiling

i) Personnel qualification



Sr. No	Description	Compliance by 3LPE coating mill
4.0	**DESIGN REQUIREMENTS**	
4.1	The normal pipe cover is 1.0 – 2.0 meters of soil. At various crossings and at other topographical features the cover will be increased beyond 2 meters up to a maximum of 7.0 meters soil cover at the worst case river crossing.	
4.2	The FBE, intermediate layer of copolymer adhesive and outer polyethylene coating shall be capable of withstanding a maximum continuous operating temperature (i.e. design temperature) of 140°F.	
4.3	The FBE, intermediate layer of copolymer adhesive and outer polyethylene coating shall be capable of withstanding the cyclic operating temperature range between 85°F and 130°F over the design life, and minimum ambient temperatures of 30°F.	
4.4	The FBE, intermediate layer of copolymer adhesive and outer polyethylene coating thickness shall be not less than the minimum thickness shown in article 6.1, 6.2 and 6.3 of this specification.	
4.5	The FBE, intermediate layer of copolymer adhesive and outer polyethylene coating pipe shall be installed using conventional lifting and laying equipment.	
4.6	The design life of all the coatings shall be 50 years.	
4.7	Supplier shall, at the time of bidding, state and guarantee the maximum interfacial shear stresses between the FBE and outer polyethylene coating before failure can occur on the coated pipe for evaluation and acceptance by the Company.	
4.8	Coating system shall withstand the operating and construction conditions like rocky, water immersed, sandy etc. and soil conditions.	

Sr. No	Description	Compliance by Line Pipe Manufacturer
5.0	**QUALIFICATION REQUIREMENTS**	
5.1	**Coating Procedure Specification**	
5.1.1	A detailed coating procedure shall be prepared by the manufacturer for qualification and Company's/Engineering Consultant approval not later than 02 weeks prior to commencement of coating application.	
5.1.2	The Company may appoint its own inspector to witness the production of test pipes and related inspection and testing.	
5.1.3	The coating procedure shall be qualified by coating five double random lengths of line pipe in strict accordance with the coating procedure and this Specification.	

Sr. No	Description	Compliance by Line Pipe Manufacturer
5.1.4	The Supplier may choose to use first day production tests for purposes of qualification.	
5.1.5	The Supplier shall submit certified records of all aspects of the qualification procedure to the Company for approval.	
5.1.6	Any failure to meet any part of the qualification procedure shall require the Supplier to revise the procedure and repeat the qualification process.	
5.2	**General**	
	The coating procedure shall address the following points as a minimum:	
5.2.1	Before commencement of the coating works at the factory, the manufacturer shall submit a detailed procedure for Company's approval to qualify the coating application and testing / inspection procedure.	
5.2.1.1	Line pipe handling, storage and inspection at all stages of application work.	
5.2.1.2	Complete details of the coating materials together with quality control, storage of materials, Manufacturer's certification and safety sheets. Manufacturer's certification shall cover all characteristics specified in Article 6.1, 6.2 and 6.3.	
5.2.1.3	Application of FBE coating, intermediate copolymer adhesive and outer polyethylene coating including details of thickness, density, thermal conductivity, compressive and shear strengths, bonding strengths and details of application equipment. Coating mill to provide all this information.	
5.2.1.4	Rise and gel times, core temperature, and methods for the FBE as appropriate.	
	Inspection & testing including instrument and equipment types, frequency and acceptance criteria.	
	Details of instrument and equipment calibration methods including relevant standards and examples of calibration certificates.	
	Complete details of inventory of laboratory and testing equipment.	
	Coating repair procedures and acceptance criteria for repair and rejection.	
	First Day Production Tests	
	Shop testing.	

Sr. No	Description			Compliance by 3LPE Coating Mill
6.0	**MATERIALS**			
	The coating material shall meet the following characteristics:			
6.1	**Fusion Bonded Epoxy (FBE)**			
	Property	**Standard**	**Value**	
6.1.1	Coating Thickness (Nominal)		300~400 microns	
6.1.2	Powder Density		1450 kg/m³	
6.1.3	Elongation	ASTM 2370	6%	
6.1.4	Hardness (1/8" Ball, 100 kg load)		48 - 50 Rockwell	
6.1.5	Water Absorption at 65°C	ASTM D570	3% weight basis	
6.1.6	Impact Resistance	ASTM G-14 – 72	1.5J @ 25°C	
6.1.7	Abrasion Resistance	ASTM D-1044	0.198 grams weight loss/ 1000 gm wt; 5000 cycles	
6.1.8	Shear Adhesion	ASTM D-1002	185 kg/cm²	
6.1.9	Tensile Strength	ASTM D-2370	40 MPa @ 45°c	
6.1.10	Dielectric Strength	ASTM E-149	48±8 Volts/micron	
6.2	**Intermediate Co-polymer Adhesive Layer**			
	Property	**Standard**	**Value**	
6.2.1	Coating Thickness		300-400 microns	
6.2.2	Melt Index	ASTM D 1238 19°C/2.16 kg	1.0 - 2.0 g/10 min.	
6.2.3	Density	ASTM D 1505	0.92 - 0.93 g/cm³	
6.2.4	Vicat Softening Point	ASTM D 1525	90°C (min.)	
6.2.5	Melting Point	DSC	110°C (min.)	
6.2.6	Ultimate Tensile Strength	ASTM D 638 @ 50 mm/min.	13 MPa (min.)	
6.2.7	Elongation (Ultimate)	ASTM D 638	600% (min.)	
6.3	**Outer Polyethylene Coating**			
	Property	**Standard**	**Value**	
6.3.1	Coating Thickness		2000 microns	
6.3.2	Density	ASTM D 1505	950 kg/m³	
6.3.3	Melt Index	ASTM D 1238	0.25 - 0.45	
6.3.4	Tensile Stress @ 50 mm/min.)	ASTM D 638	18 MPa	
6.3.5	Elongation	ASTM D 638	600% min.	
6.3.6	Vicat Softening Point	ASTM D 1525	120°C	
6.3.7	Melting Point	DSC	120 (min.)	
6.3.8	Oxidative Induction Time in Oxygen @220°C, Alum Pan	ASTM D 3895	15 minutes (min.)	
6.3.9	Hardness (Shore D)	ASTM D 2240	60 (min.)	
6.3.10	Stress Cracking Resistance	ASTM 1693 Condition B (F50)	300 Hours	

Sr. No	Description			Compliance by 3LPE Coating Mill
6.3.11	Moisture Absorbency	ASTM D1693	0.01% max.	
6.3.12	Carbon Black Content	ASTM D 1603	1.8 - 2.2 %	
6.3.13	Dielectric Breakdown Voltage		30kV (min.)	
6.3.14	Creep number		0.8 to 1.7 g/10mm	
6.3.15	Temperature resistance		-2°C to +60°C	
6.3.16	Low Temperature brittleness		Less than – 50°C	
6.3.17	Electrical Insulation resistance		Over 10^8 ohm m^2	
6.3.18	Carbon Black Particle		Less than 25 micron.	

Sr. No	Description	Compliance by 3LPE coating mill
7.0	**COATING APPLICATION**	
7.1	**Surface Preparation**	
7.1.1	Pipes shall be inspected from a corrosion standpoint in accordance with SSPC-VIS 1. Pipes in conditions A and B only shall be accepted and any pipe in condition C or D shall be rejected.	
7.1.2	The external surface of the pipe shall be cleaned of all oil, grease, moisture, or other hydrocarbon contaminants, and other atmospheric condition and paint by the Supplier prior to abrasive cleaning. A solvent shall be used in accordance with SSPC-SP-1	
7.1.3	A salt meter approved by the Company/Engineering Consultant shall be used to carry out salt tests before washing and after blast cleaning (after first blast if two blast system is used). One test shall be carried out at each end and one at the center of the pipe. The frequency of the salt tests shall be agreed between the Supplier and the COMPANY/ENGINEERING CONSULTANT.	
7.1.4	The salt test meter shall be calibrated and used in accordance with Manufacturer's recommendations and the acceptance criteria shall be 2 micrograms/cm2 or less.	
7.1.5	During sandblast cleaning process, ends of the pipes should be protected by plugs, in order to prevent entry of foreign or abrasive particle into the pipe.	
7.1.6	Each length of pipe shall be uniformly heated to at least 60°C to completely remove all moisture and to prevent any condensation of moisture on the pipe, and prior to after abrasive cleaning. The temperature of the substrate shall be a minimum of 5.5°F above the dew point during surface preparation, application and drying. The temperature, dew point, and relative humidity shall be determined with a sling Psychrometer or other approved equal following procedures in ASTM E-337. Readings shall be taken at the start of work and every four (4) hours thereafter. Preheated pipe temperatures shall not exceed 150 °F. Any abrasive entering the pipe shall be removed prior to coating	

Sr. No	Description	Compliance by 3LPE coating mill
7.1.7	The exterior pipe surface shall be abrasive cleaned to a "near white metal finish" Class SA 2.5 using steel grit or dry sand as described in SSPC-SP-10 to remove all dirt, mill scale, rust, corrosion products, oxides, paint and other foreign and deleterious matter. The compressed air for cleaning shall be free of water and oil. Adequate separators, filters, or traps shall be provided.	
7.1.8	The abrasive working mix shall be selected to produce an anchor pattern profile of not less than 0.050 mm and not greater than 0.100 mm.	
7.1.9	The abrasive will be G24 to G50 grit to provide the specified anchor pattern	
7.1.10	The blast cleaned surface shall not be contaminated with dirt, dust, metal particles, hydrocarbons, water, chlorides, surface or any other foreign matter which would be detrimental to the coating. In cases where pipes were varnished/coated for temporary protection, pipe shall be checked with magnifying glass (X30) to confirm that no residues of varnish/coating remain in the anchor pattern valleys.	
7.1.11	Prior to the coating application, the exterior surface shall be thoroughly inspected under adequate lighting. All surface imperfections such as slivers, scabs, burrs, gouges and sharp edges/defects etc. shall be completely removed by grinding. Pipes with ground areas greater than 25 mm in diameter shall be re-blasted.	
7.1.12	Pipe lengths containing a dent shall be set aside for the COMPANY/ENGINEERING CONSULTANT representative to determine its disposition. Gouges or dents shall not be ground without COMPANY/ENGINEERING CONSULTANT approval.	
7.1.13	No grinding shall be permitted which reduces the wall thickness of the pipe below the minimum permitted for a new pipe as specified in design specification.	
7.1.14	All blast cleaned pipes shall be checked for dust, freedom of oil chlorides and anchor pattern.	
7.1.15	The abrasive working mix shall be maintained clear of contaminants by a continuous and effective operation of the abrasive machine scalping and air wash separators.	
7.1.16	After cleaning and prior to coating, cleaned pipe shall be inspected by manufacturer under ample lighting conditions to ensure that all the cleaning steps have been adequately performed.	
7.1.17	The abrasive cleaned surface shall not be contaminated with dirt, dust, metal particles, oil, water, or any other foreign matter from any source, nor shall the anchor pattern be destroyed or burnished by pipe transport systems, processing equipment, tools, or follow-up cleaning with abrasive grinders.	
7.1.18	Following abrasive cleaning and prior to the coating application, all dust, grit, metal particles or other loose contaminants remaining on the surface or entering the interior of the pipe shall be blown off with clean, dry, oil-free compressed air in a manner not affecting the other cleaned pipe or pipe to be coated. When compressed air cleaning facilities are not available, vacuum cleaning or other suitable methods may be used.	

<table>
<tr><th>Sr. No</th><th>Description</th><th>Compliance by 3LPE coating mill</th></tr>
<tr><td>7.1.19</td><td>Improperly cleaned pipe shall be re-cleaned at the expense of the Supplier. The cleaned pipe shall be immediately transferred to the coating racks. The pipe surface shall not be allowed to flash rust before coating. Under no circumstances shall the total elapsed time from the start of cleaning to the application of coating exceed the following time humidity table:
<table>
<tr><th>Relative humidity (%)</th><th>Time (hours)</th></tr>
<tr><td>80</td><td>1</td></tr>
<tr><td>70</td><td>1.5</td></tr>
<tr><td>60</td><td>1.75</td></tr>
<tr><td>50</td><td>2.0</td></tr>
</table></td><td></td></tr>
<tr><td>7.1.20</td><td>No blast cleaning should be performed in relative humidity greater than 80% unless the pipe is heated 3°C above the dew point formation temperature or 25°C, whichever is higher.</td><td></td></tr>
<tr><td>7.1.21</td><td>Any raised silver, scabs, laminations or bristles of steel remaining on the newly cleaned pipe surface shall be removed using abrasive sanders. This operation shall not burnish or destroy the surface anchor pattern.</td><td></td></tr>
<tr><td>7.1.22</td><td>Any surface preparation which does not conform to these specifications (just prior to coating) shall be rejected. Grease-free chalk shall be used to mark areas, which do not meet the specified requirements.</td><td></td></tr>
<tr><td>7.1.23</td><td>It is very important that the specified surface cleanliness exists at the point of coating application. The period between cleaning and coating shall be kept to a minimum.</td><td></td></tr>
<tr><td>7.2</td><td>Fusion Bonded Epoxy (FBE)</td><td></td></tr>
<tr><td>7.2.1</td><td>The coating manufacturer's specification for the application and curing temperature and time of the specified Fusion Bonded Epoxy Powder System shall become a part of this Specification. It is the intention of this provision that the Supplier will be required to make applications of the coating materials in accordance with the coating manufacturer's recommendations, and to work with the coating manufacturer and/or the coating manufacturer's representative to eliminate any difficulties that might arise in the application of the FBE coating. The use of a liquid applied epoxy coating in lieu of the FBE is not permitted.</td><td></td></tr>
<tr><td>7.2.2</td><td>The FBE coating shall be applied by electrostatic spray to produce a uniform coating with minimum dry film thickness (DFT) of 300 microns.</td><td></td></tr>
<tr><td>7.2.3</td><td>The maximum allowable thickness on any pipe is 400 microns. Thickness in excess of 400 microns will be dis-positioned by the coating mill.</td><td></td></tr>
<tr><td>7.2.4</td><td>The pipe shall be uniformly preheated to between the minimum and maximum temperatures recommended by the powder manufacturer for optimum application conditions.</td><td></td></tr>
<tr><td>7.2.5</td><td>Temperature of each pipe shall be checked continuously by accurately calibrated indicating and recording pyrometers approved by the COMPANY/ENGINEERING CONSULTANT. When used these shall be checked for error not less than every four hours against calibrated temperature measuring instruments.</td><td></td></tr>
</table>

Sr. No	Description	Compliance by 3LPE coating mill
7.2.6	Oxidation of the steel prior to coating in the form of 'bluing' or other apparent oxide formation is not acceptable. If such oxidation should occur, the pipe shall be cooled to ambient temperature and re-cleaned.	
7.2.7	Prior to coating with fusion bonded epoxy powder, the powder application system shall be thoroughly cleaned to remove any powder other than that in use.	
7.2.8	The use of recycled powder shall not be permitted	
7.2.9	Adhesive	
7.2.9.1	The Supplier shall ensure that rollers push the adhesive into the base of welds to eliminate presence of any air entrapment or voids immediately adjacent to the longitudinal weld. The adhesive layer shall be applied before the FBE gel time has expired by using either the crosshead or lateral extrusion technique. Application of the adhesive shall not be permitted after full curing of the FBE. The Supplier shall establish to the satisfaction of COMPANY/ENGINEERING CONSULTANT that adhesive is applied within the gel time window of the FBE and at the temperature recommended by the adhesive manufacturer. The Supplier shall state the proposed time interval (minimum and maximum) between FBE and adhesive applications at the proposed pipe temperature range and extent of overlap.	
7.2.9.2	The adhesive shall be applied to a thickness of between 300 and 400 microns as approved by the COMPANY/ENGINEERING CONSULTANT.	
7.2.10	The coating close to pipe end shall be cut back for the length of 150 mm. The end of the coating shall be beveled at 30-45 degrees. Any change in the cut back must be approved by the Company.	
7.2.11	'Frothing' of the coating at the steel/coating interface shall be avoided.	
7.2.12	All compressed air used for delivery of FBE in the coating chamber shall be free from moisture, oil and other contaminants.	
7.2.13	Immediately after application of FBE layers, copolymer adhesive and HDPE will be coextruded within the gel time of the FBE as per manufacturer's requirement.	
7.3	**Polyethylene Backing**	
7.3.1	The Polyethylene shall be applied by either the cross-head or annular extrusion technique by a procedure approved by the Company/Engineering Consultant. The polyethylene shall be applied over the adhesive within the time limits established during pre-production testing. The polyethylene outer layer shall enclose FBE and intermediate copolymer adhesive and provide a waterproof barrier capable of withstanding external hydrostatic pressure to water depths of up to 20m.	
7.3.2	The polyethylene topcoat shall have a minimum thickness of 3000 (for 30" and above) microns and shall be able to withstand impact without deterioration of polyethylene coating during backfilling of the trench after installation. Manufacturer may propose a different thickness of the outer jacket to suit the application; however, it shall be subject to approval of the Company.	
7.3.3	Care shall be taken not to damage the FBE corrosion protection coating when preparing cutbacks.	

Sr. No	Description	Compliance by Line Pipe Manufacturer
8.0	**INSPECTION**	
	In addition to the tests required on the material batches. Manufacturer shall perform the tests detailed below on finished coatings to demonstrate compliance with this specification.	
8.1.1	Coating Procedure Qualification Testing	
8.1.1.1	Prior to commencing full production, two pipes shall be coated of each pipe diameter with single layer FBE and eight pipes of each pipe diameter shall be coated with full coating system in accordance with the coating procedure specifications witnessed by the Supplier for Qualification Testing. Supplier shall cut samples from each pipe, which are adequately sized to permit the required testing.	
8.1.1.2	The two FBE coated pipes shall be subjected to complete set of tests as specified in Table-1.	
8.1.1.3	Supplier shall select samples from four full-system coated pipes. These samples shall be inspected and tested as per requirements detailed in Table 1.	
8.1.1.4	Pipes selected for PQT testing shall pass all the criteria contained in Table 1 before production commences.	
8.1.2	Production Testing	
	If problems develop, or significant changes occur, i.e. in materials (FBE, Adhesive, PE batches) or in production parameters, these tests should be run on the first production.	
	Production testing shall be performed at the frequency shown in Table 2.	
	The frequency shown in Table 2 will be for normal production.	
	One sample of coated pipe shall be sent to the company for storage. This sample shall be taken from the same piece of pipe as the Cathodic Disbondment (CD) test samples and should be 1 m long and at least half the circumference of the pipe	
8.1.3	Visual Inspection	
8.1.3.1	The following external surfaces of the coated pipe shall be carefully inspected: • Adjacent to the cut back at each end of pipe. • Adjacent to longitudinal welds • Within the thickness of the coating.	
8.1.3.2	The coating shall be smooth, and shall be blemish free, with no dust or other particulate inclusions. The coating shall not show any defects such as wrinkles, engravings, deep cuts, swelling, unbonded zones, air inclusion tears, voids, etc.	
8.1.4	Coating Thickness	
8.1.4.1	The thickness of the cooled Three Layer coating system shall be checked using an approved magnetic or electromagnetic type gauge.	
8.1.4.2	Measurements shall be made on at least 12 points uniformly spaced over the length of pipe and its circumference. At least 3 points shall be on the welds.	
8.1.4.3	The minimum coating system thickness shall be 2.6 mm and maximum 3.0 mm.	
8.1.4.4	Any individual reading less than 3 mm shall be cause for the coated pipe length to be rejected. Such pipe may be held for further inspection and possible acceptance by the Supplier.	

Sr. No	Description	Compliance by 3LPE coating mill
9.0	**TESTING**	
9.1	**Holiday Detection**	
	Each pipe shall be inspected for holidays over 100% of its coated surface using high voltage DC detector. Holiday detection shall be performed on surfaces that are at ambient temperature and free from moisture or conductive surface contamination.	
	The detector shall be subject to Company/Engineering Consultant approval and a type that maintains intimate contact with the coating. The operating voltage between electrode and pipe shall be checked at least twice per working shift. The holiday test shall be performed in accordance with NACE RP-0274 standard.	
	The Supplier shall demonstrate to the Company/Engineering Consultant that setting of the detector is satisfactory for detecting pinholes. This setting will be checked once every two hours. The correct travel speed shall be determined by consistent detection of an artificial pinhole made in a good coating sample but shall not exceed 300 mm/s.	
	All holidays and other defects shall be marked for subsequent repair and re-testing. On re-testing, no holidays shall be permitted in the final coating.	
	The number of holidays for each pipe length shall be recorded. Coated pipe having holidays in excess of 1 per 2 square meters shall be stripped to bare metal and re-coated at no additional cost to the Company/Engineering Consultant.	
9.2	**Penetration Test**	
9.2.1	Penetration shall not be more than 0.2 mm for a test conducted at 25 ° C and 0.3 mm at 50 ° C for extruded coatings as per DIN 30670.	
9.2.2	The test shall be conducted on five (5) twist specimens taken from different pipes. If one of the specimens proves to be not satisfactory, ten (*10) other specimens shall be re-tested and give satisfactory results.	
9.2.3	Test Procedure • Take a test specimen of the pipe coating. • Immerse the test specimen in the water bath at the test temperature and leave it for at least 1 hour. • Place the penetrator and read the measure on the 1/100 comparator (1). • Load the inertia block onto the penetration in one go (1 kg/mm2 penetrator cross-section). • Read the comparator (2). • The difference (2-1) gives the penetration depth d in 100 mm.	
9.3	**Impact Resistance Test**	
	A sample of coated pipe shall be impact tested in accordance with the procedure specified in DIN 30670.	
	Tests shall be performed at temperature of 23+ 2°C.	
	When tested in accordance with sub clause 5.3.4 DIN 30670, the coating shall withstand 30 impacts without any electrical breakdown occurring.	
9.4	**Transverse Electric Resistivity Test**	
	The test consists of measuring at regular intervals the insulation strength of the coating of a pipe immersed in a salt solution.	
	A sleeve of the coated pipe shall be used and obturated at one end to prevent the salt solution from coming into contact with the metal wall. The sleeve is then filled	
	At regular intervals, the transverse resistivity shall be measured with the megohmmeter. The transverse resistivity of coating, Rs, is expressed by the formula: Rs = R.S. In which, R: Electric resistance and S : immersed pipe surface area in m^2	
	The transverse resistivity of coating after 100 days of immersion shall be at least 10^8 m^2.	

Sr. No	Description	Compliance by 3LPE coating mill
9.5	**Resistance to Ultraviolet**	
9.5.1	The test is carried out with a radiation apparatus equipped with a xenon lamp. The elongation at break of the sample after the tension test is compared with that of an identical non tested sample.	
9.5.2	The test specimens are exposed to the xenotest radiation for 800 hours at a temperature of 60 ° C and in relative air humidity of 65%.	
9.5.3	The percent elongation rate is measured on five (5) test samples after radiation at a tension speed of 50 mm/min. The same operation is performed on 5 non-exposed samples. The tension speed is the same.	
9.5.4	The mean elongation rate after exposure to xenotest shall be at least equal to 50% of the mean elongation rate before exposure to radiation.	
9.6	**Cathodic Disbondment Test**	
9.6.1	Cathodic disbondment testing shall be performed for 30 days in a 3% NaCl electrolyte at 23± 2°C with potential of 1.5 V in accordance with ASTM G42. The acceptance criteria shall be 5 mm maximum disbondment from the edge of the pre-drilled hole.	
9.6.2	Degree of Cure	
9.6.2.1	A thermal analysis shall be carried out using a Differential Scanning Calorimeter (DSC).	
9.6.2.2	Epoxy film samples shall be removed from the coated pipe using hammer and cold chisel. This produces furled coating flakes. Care shall be taken to remove samples of full film thickness but at the same time avoid the inclusion of steel debris and contamination with adhesive or polyethylene. The sample shall be tested for cure using DSC procedure.	
9.6.2.3	The glass transition temperature differential (Tg) shall be the test used to verify cure along with a visual examination to ensure no residual cure in the portion of the graph beyond the glass transition.	
9.6.2.4	The required cure characteristics are: $\blacktriangledown$Tg = 2°C to + 3°C ($\blacktriangledown$Tg = $\triangle$Tg final – $\blacktriangledown$Tg initial) Only a 95% minimum cured coating shall be acceptable. % Cure = ($\blacktriangledown$H - $\blacktriangledown$H residual) x 100/$\blacktriangledown$H ($\triangle$H = exothermic heat of reaction)	
9.6.2	**Flexibility Test**	
9.6.2.1	The flexibility of the coating shall be determined once on the first day of production using only FBE layer coated pipes (2 Nos.) by the following method:	
9.6.2.2	Coated samples (300 mm x 50 mm x thickness of pipe wall) taken from an FBE coated pipe joint shall be subjected to a bend test at a temperature of 0°C and 20°C to induce a 2% and 3% strain respectively in the sample.	
9.6.2.3	At each temperature the test shall be carried out in triplicate. The deflection loading rate during bend testing shall be 25± 2 mm/min.	
9.6.2.4	The mandrel sizes shall be selected according to the following formula: $D = \frac{t(1-S)}{S}$ Where : D = Mandrel diameter (mm, t = Specimen wall thickness (mm) S = 0.02 at 0°C 0.03 at 20°C	
9.6.2.5	The coating shall not exhibit any signs of cracking, disbondment or pinholes.	

Sr. No	Description	Compliance by 3LPE coating mill
9.6.3	**Hot Water Resistance Test**	
9.6.3.1	Hot water resistance test as detailed below shall be carried out on two pipes coated with only FBE layer.	
9.6.3.2	A coated sample of 200 mm x 100 mm machined from a pipe ring of the coated pipe shall be immersed in potable water at 85°C for 5 hours.	
9.6.3.3	The bare edges of the sample shall be coated with a surface tolerant epoxy or epoxy phenolic to prevent ingress of moisture beneath the coating.	
9.6.3.4	Immediately after the 5 hours exposure, the coated sample shall be removed from the water bath and allowed to cool to ambient temperature. Subsequently, the coating adhesion shall be tested by the following method:	
9.6.3.5	Using a sharp and pointed knife, two incisions of approximately 15 mm in length shall be made through to the steel surface to form an "X" with an angle of intersection of approximately 30°. Commencing at the intersection, an attempt shall be made to lift the coating from the steel substrate, using the blade of the knife.	
9.6.3.6	Resistance of the coating to peel or a cohesive failure entirely within the coating in the absence of excessive voids caused by foaming constitutes a pass. Partial or complete adhesion failure between the coating and the metal substrate constitutes a failure.	
9.6.3.7	Cohesive failure caused by voids in the coating, leaving a honeycomb structure on the steel surface, also constitutes a fail condition.	
9.6.3.8	In addition, the coating shall not show any tendency towards disbonding or blistering. A slight discoloration of the coating is acceptable.	
9.6.3.9	If holidays occur on successive pipes, the Supplier shall stop the coating line immediately to determine the cause and take corrective action.	
9.6.4	Adhesion And Peel Tests	
9.6.4.1	The adhesion strength of the FBE shall be determined in accordance with ASTM D4541. The minimum adhesion strength shall be 21 kg/cm2.	
9.6.4.2	The three layer coating system peel strength shall be determined in accordance with the methods described in DIN 30670. The test shall be performed at 20± 5°C and 50± 5°C. Tests shall be carried out on pipe body as well as on the weld.	
9.6.4.3	Minimum peel strength shall be at least 35 newtons per centimeter width of strip peeled at 20+ 5°C and 15 newtons per centimeter with at 50± 5°C in accordance with paragraphs 4.2.3 and 5.3.3, of DIN 30670.	
9.6.4.4	The failure mode shall be recorded. The failure should occur as a cohesive failure within the Three Layer System or at the adhesive/FBE interface or cohesive/FBE interface. If failure occurs at the FBE/steel interfaces, this will be considered a total failure of the system.	

TABLE - 1

SUMMARY OF INSPECTION AND TESTS TO BE CARRIED-OUT FOR PROCEDURE QUALIFICATION OF LINEPIPE COATING FOR EACH PIPE DIAMETER

Property	Acceptable Values	Number of Tests
Before Cleaning		
♦ Pipe condition	Condition A&B of ISO 8501 (part 1)	10
♦ Chlorides	2 µ g cm²	30 (3x10 pipe)
♦ Oil Contamination	No indication of oil contamination	10
After cleaning		
♦ Cleanliness	Sa 2 ½	10
♦ Profile	50 – 100 µm	10
♦ Chloride	2µ grams/cm²	30(3x10 pipe)
♦ Dust and Oil	No indications of dust or oil contamination.	
Coating Thickness		
♦ FBE coated	300µm - 400µm	24(12x2 pipes)
♦ FBE+Adhesive+PE	3000 µm	120(12x10 pipe)

Property	Acceptable Values	Number of Tests
Holidays		
♦ FBE	Smooth with no surface defects	2
♦ FBE+Adhesive+PE	Smooth with no surface defects	10
Adhesion/Peel Strength		
♦ FBE	Resistance to peel or a cohesive failure	2
♦ FBE+Adhesive+PE	35N/cm at 20± 50°C, 50N/cm at 50+2°C	10 (2x5 pipes)
Impact resistance		
♦ FBE	18J (minimum)	2
♦ FBE+Adhesive+PE	Zone A of Fig. 1 DIN 30670	5 (Random)
Penetration (indentation) testing		
♦ FBE	0.20mm at 25°C, 0.30mm at 50°C	10(2x5 pipes)
♦ FBE+Adhesive+PE	Original Value	2
Degree of Cure		
♦ FBE	-2°C≤ ΔTg ≤ +3°C	2
♦ FBE+Adhesive+PE		3 (Random)

Flexibility Bend Test		
♦ FBE	No cracking/disbondment pinholes	2
Hot water resistance		
♦ FBE	No disbanding or blistering after adhesion tests.	1 (Random)
Cathodic disbondment		
FBE	Average radius of disbondment 5 mm	2
FBE+Adhesive+PE	Average radius of disbondment 5 mm	3 (Random)
Transverse electric resistivity test	$10^8 m^2$ after 100 days of immersion.	
Resistance of Ultraviolet.	800h at 60°C in 65% relative humidity 50%	

TABLE 2

SUMMARY OF INSPECTIONS AND TESTS TO BE CARRIED-OUT FOR PRODUCTION OF COATING OF LINEPIPE SYSTEM FOR EACH PIPE DIAMETER

Property	Acceptable Values	Minimum frequency
Before Cleaning		
♦ Pipe condition	Conditions A&B of ISO 8501 (part 1)	
♦ Chlorides	2 µ g cm²	
♦ Oil	No indication of oil contamination	
After cleaning		
♦ Cleanliness	ISO-Sa 2 ½	
♦ Profile	50 – 100 µm	
♦ Chloride	<2µg /cm²	
♦ Dust	No indications of dust contamination.	
♦ Oil	No indications of oil contamination.	
FBE Application		
♦ Pipe temperature	MANUFACTURER'S required range	Continuous
Coating Thickness	300-400 microns	Each pipe
Holidays	No holidays.	Each pipe
Visual Examination.		Each pipe
♦ Thickness of coating	No surface defects	
♦ Longitudinal welds.	No air contrapment.	
♦ Cut backs	150+0/-20 mm width, bevel 30-45°	
Peel Strength		
♦ At 20°C	35 Newtons per cm width of strip peeled	1 per 100 pipe
♦ At 50°C	15 Newtons per cm width of strip peeled	1 per 100 pipe
	Zone A of Fig. 1 DIN 30670	1 per 100 pipe
Impact Resistance	MANUFACTURER'S required range	1 per 100 pipe
Penetration (indentation) Testing	< 5 mm	First pipe, last pipe and at intervals of every 350 pipes.
Cathodic Disbondment	No disbonding or blistering after adhesion tests.	First pipe, last pipe and at intervals of every 350 pipes.
Hot Water Resistance		

4.0 COATING REPAIRS

10.1 General

10.1.1 The Coating mill shall submit a repair procedure for the approval of the Company prior to the start of production.

10.1.2 The Supplier shall demonstrate that the repair is as strong as the parent material.

10.2 Repair of Bare Pipe

10.2.1 Scratches, grooves, gouges, and slivers may be removed by filing or grinding, in accordance with procedures approved by the Company.

10.2.2 The Supplier shall grind or otherwise repair damaged bevels and pipe found to have been damaged, in accordance with the pipe repair section of the Line Pipe Spec. 4985-PA-2006.

10.2.3 All ends of pipes which are damaged to such an extent that they cannot be repaired by grinding or filing shall be rebevelled by the Supplier.

10.2.4 The Supplier shall furnish a bevelling machine for repair of the pipe ends.

10.3 Repair of Polyethylene Coating

Damaged line coating shall be repaired as per the following criteria:

a. Small Damages Extending up to 1.0 cm^2

Small damages to 3LPE should be repaired using PE melt sticks; with epoxy primer if bare metal is visible.

b. Damages Extending up to 300 mm or 100 cm^2

Polyethylene repair patches precoated with hotmelt adhesive, should be used in conjunction with a hotmelt filler adhesive and epoxy primer (if bare steel visible) as per manufacturer's recommendations. Repair patches when installed should overlap the damaged area by minimum 50 mm all round. Surface shall be mechanically cleaned before the application of FBE primer.

c. Damages Extending Over 300mm or 100 cm^2

Full encirclement heatshrink sleeves with epoxy primer in accordance with specification. Surface shall be mechanically cleaned before the application of FBE primer.

The Supplier shall warrant that if the coating is found defective or not meeting the required performance the Supplier shall repair or replace the defective coating. The warranty shall be valid for 12 months from the acceptance date of pipeline facility.

5.0 IDENTIFICATION & MARKING

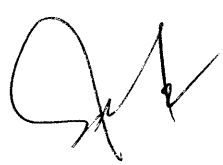
11.1 The pipe will be delivered to the Supplier marked in accordance with the Spec. 4880-PA-2006. The Supplier shall maintain the pipe identification throughout the process of cleaning and coating of the pipe.

11.2 Additional markings shall be applied 50 mm from the end of the coating and outside the pipe at each end. Letters and numerals shall be 25 mm in height.

11.3 Pipe which has undergone repair in accordance with section 10.0 shall be marked with a band painted around the entire circumference of the coated pipe and not more than 75mm from the cutback at each end. These pipe sections will be retained as spares by the Company.

11.4 All markings shall be stenciled and spray applied with paint compatible with the coating material and of a contrasting color.

11.5 Pipes of different wall thickness shall be color coded with different color bands.



6.0 STORAGE HANDLING & SHIPPING

12.1 The coated pipe shall at all times be handled in a manner to avoid damage to the coating.

12.2 The coated pipe shall be supported only by the uncoated ends until the coating has cooled to ambient temperature.

12.3 The coated pipe shall be stored in an area, which will not result in accumulation of dust or dirt either from the environment or surrounding.

12.4 The coated pipe shall be protected to avoid degradation from ultraviolet light radiation.

12.5 Any coated pipe section that shows contamination in any form whatsoever from the environment or surrounding shall be adequate grounds for stripping the entire coating and completely re-coating the pipe with 3-layer polyethylene and/or FBE as considered appropriate by Company's/Engineering consultant representative.

12.6 All pipes which have undergone repair shall be stockpiled separately from non-repaired joints or shall be color coded for ease of identification.

12.7 A padding approved by the Company shall be provided between the pipe stacked after coating during storage, transportation and shipment.

12.8 The number of rows of pipes to be stacked up shall not exceed six.

7.0 DOCUMENT SUBMITTALS

13.1 The Supplier shall submit copies of each of the following documents to the Company/Engineering Consultant as set forth below:

Document	Submittal	No of Copies
Quality Control and Application Procedures	Before PQT	2
Coating Repair Procedures	Before PQT	2
Storage, Handling and Transportation Procedures	Prior to Coating	2
Qualification Test Report	Prior to Coating	2
Certified Material Test Certificates	Prior t o Coating	2
Certified Inspection Report	Weekly	1
Tally Record of Pipe Received	Weekly	1
Tally Record of Pipe Coated/Loaded Out	Prior to Shipping	6
Coating Repairs Undertaken	Reported Daily	1

13.1 All certificates shall be in English language and with SI units of measure. Certificates shall be visibly signed by the Supplier.

13.2 The Supplier shall maintain a complete record of the pipe from the time it first enters the coating yard until the completion of load out of coated pipe. Pipe joint length and date of the coating application shall be recorded for each joint of pipe. The Supplier shall provide this information to the Company according to the schedule specified above.

8.0 TRANSPORTATION

The Supplier shall be responsible for the good condition of the coated pipes. In all cases, the Supplier shall be responsible for the repair of coated pipes until the pipeline is taken over by the Company/Engineering Consultant. On receipt of coated pipes, at Site, the Company/Engineering Consultant shall be invited for the inspection of coating. The Supplier shall arrange for the re-coating or replacement of pipes found to be excessively damaged.

9.0 WARRANTY

The Supplier shall warrant that if the coating is found defective or not meeting the required performance the Supplier shall repair or replace the defective coating. The warrantee shall be valid for 24 months from the acceptance date of the pipeline facility.

TOR FOR THIRD PARTY INSPECTION & EXPEDITING

FOR GROUP-D ONLY

1. Introduction:

Inspection of material as per purchased order. Third party presence will be 100% during the manufacturing and coating process.

2. Scope of Inspection

2.1 Inspection of Line Pipes during Manufacturing in accordance with Applicable Standards, PO & tender specifications & Expediting services in order ensure timely supply of pipe to OGDCL. Activity or test not mentioned in following scope of work but required as per tender specification will also be witnessed by third party inspector.

2.2 Documents Review for Approval.

2.2.1 Review of Manufacturing Procedure Specification

2.2.2 Review of Inspection / Testing Procedures & Plan

2.2.3 Review of Calibration Certificates of NDT & Destructive tests Equipment.

2.2.4 Review of Inspection test plan

2.2.5 Review of Raw Material & verification through MTC'S

2.2.6 Review of NDT Personnel Certifications & records

2.2.7 Review of Manufacturing schedule (In order to expedite)

2.3 Visual Inspection of billets and Witness of Associated Tests

2.3.1 Visual inspection of billets to evaluate the dimensional features

2.3.2 Visual inspection of billets to detect surface imperfections like lamination, gouges &/or pitting.

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2.3.3 Witnessing of chemical test of billets, to ensure chemical properties of raw material to be used.

2.3.4 Verification of chemical test reports as per applicable code/standard &/or client's specification (if any).

2.4 Visual/dimensional inspection during manufacturing

2.4.1 Witnessing of billet charging in furnace.

2.4.2 Visual inspection of initial shell.

2.4.3 Dimensional check of initial shell.

2.4.4 Witnessing/monitoring of pickling process like temperature/hold time.

2.4.5 Witnessing of cold draw and visual inspection for any surface defects during process.

2.4.6 Witnessing of annealing (stress relieving) to ensure proper temperature and travelling speed (hold time).

2.5 Witnessing of Hydrostatic Test of Pipe in accordance with Applicable Standard

2.5.1 Test pressure shall be designated in accordance with applicable standard

2.5.2 Test duration shall be observed (10) seconds per pipe length.

2.5.3 Ensuring no leakage during test from end seal for constant test pressure.

2.5.4 Witness of Hydrostatic test data and pipe data.

2.6 Witnessing of Non-Destructive Evaluation in Accordance with Applicable Standard

2.6.2 Witnessing of complete Length of pipe inspected by NDT (**for PSL 2 only or if mentioned in client's specification/purchase order)**.

2.6.3 All defects detected in NDT process shall be marked with spray paint.

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2.6.4 Verification of NDT test reports.

2.7 Destructive Test of Pipe.

2.7.1 Witnessing of destructive tests from finished product.

2.7.2 Verification of destructive test reports according to applicable code/standard & specification

2.8 Witnessing of Final Inspection of Pipe:

2.6.1 Final Inspection shall be conducted in order to witness the following Features of Pipe.

- Pipe Length.
- Straightness.
- Pipe end Squarness.
- Pipe Weight.
- Bevel Angle and root.
- Pipe body for any surface defects.
- Pipe bevel Protection Guard.
- Marking on pipe. (Stencilling)
- Magnetic Residuals. (test)

3. Inspection of 3 Layer Polyethylene Coating in Accordance with Applicable Standard

3.1 Documents Review:

3.1.1 Raw Material Handling Procedure

3.1.2 Surface Preparation Procedure

3.13 Raw Material Testing Procedure

3.1.4 Coating Application Procedure

3.1.5 Inspection and Testing Procedure

3.1.6 Inspection and Testing Equipment Calibration

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3.1.7 Coating Repair Procedures

3.1.8 Handling and Stockpiling Procedure

3.1.9 Personnel Qualification Record

3.1.10 MTC'S of coating raw material.

3.2 Visual Inspection of Pipe before Blast Cleaning:

3.2.1 Visual inspection of pipe external surface to ensure removal of oil grease and all other foreign substances.

3.2.2 Visual inspection of pipe to ensure drying of pipe

3.2.3 Visual inspection for quality of Epoxy Primer, Adhesive and PE from each batch.

3.2.4 Verification of visual inspection reports

3.3 Visual Inspection after Blast Cleaning:

3.3.1 Visual inspection of pipe for surface profile according to applicable standard.

3.3.2 Visual inspection of blast pipe for surface defects, such as lamination, gouge & other detrimental defects

3.3.3 Verification of post blasting data reports.

3.4 Inspection of 3 Layer Coating during Application in accordance with Applicable Standard

3.4.1 Witnessing of Pre- heating.

3.4.2 Witnessing of Chromate application.

3.4.3 Witnessing of FBE application

3.4.4 Witnessing of PE application

3.5 Final Visual Inspection of Coated Pipes:

3.5.1 Visual inspection of coated pipes to ensure that Coating is free from any wrinkles, engravings, deep cuts, swelling, unbounded zones, air inclusions tears and voids etc.

3.5.2 To ensure thickness of coating with in the specified range.

3.6 Destructive & Non- destructive Tests in accordance with Applicable Standard:

3.6.1 Holiday detection Test

3.6.2 Thickness gauging

3.6.3 Adhesion and Peel test

3.6.4 Penetration Test

3.6.5 Impact resistance test

3.6.6 Cathodic disbandment test

3.6.7 Flexibility test

3.6.8 Hot water resistance test

3.6.8 PE tensile test

3.6.9 Transverse electric resistivity test

3.6.10 Resistance to ultraviolet.

3.6.11 Verification of Destructive & non-destructive test reports.

4.0 Reporting Structure:

- Verification of Progress reports of all activities prepared by Pipe Manufacturer
- Submit a Non Conformance report to OGDCL signifying the quality concern & remedy.
- Daily Inspection Report will be sent to OGDCL by 3rd party inspector.
- Executive Summary of pipe Manufacturing.
- Detailed report at the end of complete inspection (Soft and hard copy).

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