B957-300-16-43-00001

PLANT NORTH / TRUE NORTH — 26°37'30" — PREVAILING WIND DIRECTION

BATTERY LIMIT FLARE / ETHYLENE

BATTERY LIMIT PIPELINE FLARE/CW & INSTRUMENTATION

BATTERY LIMIT ELECTRICAL

BATTERY LIMIT ELECT

MAIN PIPE RACK

REF. DWG. NO.	REFERENCE DRAWING TITLE
B957-999-81-45-00001	OVERALL PLOT PLAN
B957-300-16-43-00002	EQUIPMENT LAYOUT_ECU

NOTES :-

1. ALL DIMENSIONS ARE IN M.M. UNLESS OTHERWISE SPECIFIED.
2. ALL ELEVATIONS ARE IN M.M. AND ARE WITH REFERENCE TO HIGHEST POINT OF PAVEMENT EL. 100000 WHICH CORRESPONDS TO 405.5M ABOVE MEAN SEA LEVEL (MSL).
3. CONCRETE BLIND FLOOR SHALL BE PROVIDED BELOW AIR COOLERS.
4. PERIPHERAL DRAIN SHALL BE PROVIDED ALL AROUND OUT SIDE OF THE B/L.
5. ALL LOCAL PLATFORMS REQUIRED FOR OPERATION AND MAINTENANCE OF EQUIPMENTS/ VALVES SHALL BE PROVIDED DURING DETAIL ENGINEERING.
6. STRUCTURE & PLATFORM ARRANGEMENT FOR HEATER PIPING SHALL BE FINALIZED DURING DETAIL ENGINEERING.
7. INTERCONNECTING PLATFORMS BETWEEN TECH STRUCTURES, WALKWAY IN PIPE RACKS, AIR COOLER PLATFORMS, COLUMN PLATFORMS ETC. SHOWN IN EQUIPMENT LAYOUT ARE PRELIMINARY.
8. ALL PUMPS CENTER LINE ARE LOCATED WITH CENTER LINE OF PUMP BASE PLATE UNLESS OTHERWISE MARKED.
9. INTERMEDIATE SUPPORT MEMBERS AT PIPE RACK TIERS (1ST & 2ND) SHALL BE PROVIDED FOR SUPPORTING SMALL BORE LINES.
10. PLAN ELEVATION WHEREVER MENTIONED IN LAYOUT IS TOG UNLESS OTHERWISE SPECIFIED.
11. EXTENSION OF COLUMNS OF PIPE RACK/TECHNOLOGICAL STRUCTURE AND SUPPORTING ARRANGEMENT FOR PIPING ARE HOLD.
12. RETRACTABLE TROLLEY SHALL BE PROVIDED ALONG WITH PIPE DAVIT FOR MAINTENANCE OF FAN GEAR/BOX OF AIR COOLER AND.
13. INLINE EQUIPMENTS ARE NOT SHOWN IN EQUIPMENT LAYOUT.

HOLDS :-

1. PSA REJECT GAS/ PGH/ DCW/ OFF GAS COMPRESSORS SHED SIZES ARE UNDER HOLD.
2. ALL PLATFORM ELEVATIONS RELATED TO COLD BOX PACKAGE ARE UNDER HOLD.
3. THERMAL OXIDIZER PACKAGE SIZE IS UNDER HOLD.
4. DEAERATOR PACKAGE SIZE AND ELEVATION IS UNDER HOLD.
5. DELETED.
6. FIRE BOOSTER PUMPS ARE UNDER HOLD.
7. DELETED.
8. COMPRESSOR SHED HOOK HEIGHT AND CAPACITY.
9. LOCATION OF ETHYLENE RUN-DOWN CHILLER.
10. DELETED.
11. AS MARKED.
12. EJECTOR PACAGE & REBOILER ELEVATIONS.

LEGEND :-

BTL EL.	BOTTOM TANGENT LINE ELEVATION		BATTERY LIMIT
CL EL.	CENTRE LINE ELEVATION		CORRIDOR (FOR U/G PIPES)
EWSS	EYE WASH & SAFETY SHOWER		DROP OUT AREA
FIM	FREE ISSUED MATERIAL		GRATING PLATFORM
NTS	NOT TO SCALE		RCC FLOOR
PLTF EL.	PLATFORM ELEVATION		HARD STAND
TOC EL.	TOP OF CONCRETE ELEVATION		MONORAIL
TOG EL.	TOP OF GRATING ELEVATION		LADDER
TOS EL.	TOP OF STEEL ELEVATION		DAVIT
WP. EL.	WORKING POINT ELEVATION		REVISION/CHANGES
SS	SLIDING SADDLE		
FS	FIXED SADDLE		
CL	CENTER LINE		
EL	ELEVATION		
TS	TECHNOLOGICAL STRUCTURE		
HS	HARD STAND		
AS	ANALYZER SHELTER		
BPR	BRANCH PIPE RACK		
BPR	BRANCH PIPE RACK		
OWS	OILY WATER SEWAGE		
CRWS	CONTAMINATED DRAIN WATER SEWAGE		
U/G	UNDERGROUND		
TLE	TRANSFER LINE EXCHANGER		
S/S	SUBSTATION		
SRR	SATELLITE RACK ROOM		

प्रस्तुत आरेख एवं इसमें दिखाए गए डिज़ाइन इंजीनियर्स इंडिया लिमिटेड की संपत्ति है। ये उधार दिए गए हैं और उधारकर्ता ने यह सहमति किया है कि न तो इन्हें पुनः मुद्रित किया जाएगा, न नकल की जाएगी, न उधार दिए जाएगा, न प्रतिलिपि किए जाएगा और न ही संलिपि और किसी प्रयोग के अलावा इसका कोई अन्य प्रयोग इसमें कोई अन्य प्रयोग होगा और यह प्रयोग उधार देने वाले द्वारा उधारकर्ता को लिखित रूप में दी गई सहमति से होगा।

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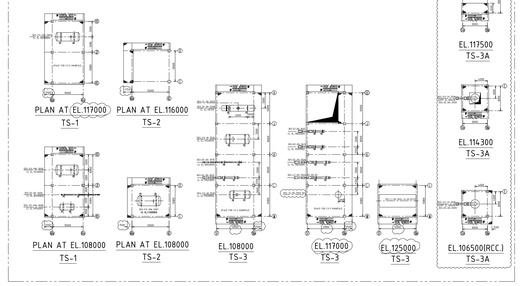
EQUIPMENT LIST

EQUIPMENT NO.	DESCRIPTION	P. & ID NO.	LOCATION
COLUMNS			
30A-CF-1101	OASIS RM. FRACTIONATOR	30A-1107	E4
30A-CF-1102	PYROLYSIS FUEL OIL STRIPPER	30A-1141	G3
30A-CF-1103	QUENCH TOWER	30A-1142	G4
30A-CF-1401	PROCESS WATER STRIPPER	30A-1152	G3
30A-CF-1402	CAUSTIC WASH WATER TOWER	30A-1153	G4
30A-CF-2201	HP DEPROPANIZER	30A-1245	H4
30A-CF-2202	LP DEPROPANIZER	30A-1253	I4
30A-CF-2301	DEMETHANIZER	30A-1254	J4
30A-CF-2302	DEETHANIZER	30A-1255	K4
30A-CF-2303	OASIS RM.ETHANE/ETHYLENE STRIPPER	30A-1256	L4
30A-CF-2501	DEBUTANIZER	30A-1257	J4/I5
30A-CF-2502	REFLUX DRUM	30A-1258	K4
30A-CF-2503	OASIS RM.ETHANE/ETHYLENE STRIPPER	30A-1259	L4
30A-CF-2504	PROPYLENE FRACTIONATOR NO. 1	30A-1260	M4
30A-CF-2505	PROPYLENE FRACTIONATOR NO. 2	30A-1261	N4
30A-CF-2506	DEPROPANIZER	30A-1262	O4
30A-CF-2507	REFLUX TOWER	30A-1263	P4
30A-CF-2508	DEBUTANIZER	30A-1264	Q4
30A-CF-2509	DEPROPANIZER	30A-1265	R4
30A-CF-2510	DEBUTANIZER	30A-1266	S4
30A-CF-2511	DEPROPANIZER	30A-1267	T4
30A-CF-2512	DEBUTANIZER	30A-1268	U4
30A-CF-2513	DEPROPANIZER	30A-1269	V4
30A-CF-2514	DEBUTANIZER	30A-1270	W4
30A-CF-2515	DEPROPANIZER	30A-1271	X4
30A-CF-2516	DEBUTANIZER	30A-1272	Y4
30A-CF-2517	DEPROPANIZER	30A-1273	Z4
30A-CF-2518	DEBUTANIZER	30A-1274	AA4
30A-CF-2519	DEPROPANIZER	30A-1275	BB4
30A-CF-2520	DEBUTANIZER	30A-1276	CC4
30A-CF-2521	DEPROPANIZER	30A-1277	DD4
30A-CF-2522	DEBUTANIZER	30A-1278	EE4
30A-CF-2523	DEPROPANIZER	30A-1279	FF4
30A-CF-2524	DEBUTANIZER	30A-1280	GG4
30A-CF-2525	DEPROPANIZER	30A-1281	HH4
30A-CF-2526	DEBUTANIZER	30A-1282	II4
30A-CF-2527	DEPROPANIZER	30A-1283	JJ4
30A-CF-2528	DEBUTANIZER	30A-1284	KK4
30A-CF-2529	DEPROPANIZER	30A-1285	LL4
30A-CF-2530	DEBUTANIZER	30A-1286	MM4
30A-CF-2531	DEPROPANIZER	30A-1287	NN4
30A-CF-2532	DEBUTANIZER	30A-1288	OO4
30A-CF-2533	DEPROPANIZER	30A-1289	PP4
30A-CF-2534	DEBUTANIZER	30A-1290	QQ4
30A-CF-2535	DEPROPANIZER	30A-1291	RR4
30A-CF-2536	DEBUTANIZER	30A-1292	SS4
30A-CF-2537	DEPROPANIZER	30A-1293	TT4
30A-CF-2538	DEBUTANIZER	30A-1294	UU4
30A-CF-2539	DEPROPANIZER	30A-1295	VV4
30A-CF-2540	DEBUTANIZER	30A-1296	WW4
30A-CF-2541	DEPROPANIZER	30A-1297	XX4
30A-CF-2542	DEBUTANIZER	30A-1298	YY4
30A-CF-2543	DEPROPANIZER	30A-1299	ZZ4
30A-CF-2544	DEBUTANIZER	30A-1300	AAA4
30A-CF-2545	DEPROPANIZER	30A-1301	BBB4
30A-CF-2546	DEBUTANIZER	30A-1302	CCC4
30A-CF-2547	DEPROPANIZER	30A-1303	DDD4
30A-CF-2548	DEBUTANIZER	30A-1304	EEE4
30A-CF-2549	DEPROPANIZER	30A-1305	FFF4
30A-CF-2550	DEBUTANIZER	30A-1306	GGG4
30A-CF-2551	DEPROPANIZER	30A-1307	HHH4
30A-CF-2552	DEBUTANIZER	30A-1308	III4
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30A-CF-2554	DEBUTANIZER	30A-1310	KKK4
30A-CF-2555	DEPROPANIZER	30A-1311	LLL4
30A-CF-2556	DEBUTANIZER	30A-1312	MMM4
30A-CF-2557	DEPROPANIZER	30A-1313	NNN4
30A-CF-2558	DEBUTANIZER	30A-1314	OOO4
30A-CF-2559	DEPROPANIZER	30A-1315	PPP4
30A-CF-2560	DEBUTANIZER	30A-1316	QQQ4
30A-CF-2561	DEPROPANIZER	30A-1317	RRR4
30A-CF-2562	DEBUTANIZER	30A-1318	SSS4
30A-CF-2563	DEPROPANIZER	30A-1319	TTT4
30A-CF-2564	DEBUTANIZER	30A-1320	UUU4
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30A-CF-2566	DEBUTANIZER	30A-1322	WWW4
30A-CF-2567	DEPROPANIZER	30A-1323	XXX4
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30A-CF-2570	DEBUTANIZER	30A-1326	AAAA4
30A-CF-2571	DEPROPANIZER	30A-1327	BBBB4
30A-CF-2572	DEBUTANIZER	30A-1328	CCCC4
30A-CF-2573	DEPROPANIZER	30A-1329	DDDD4
30A-CF-2574	DEBUTANIZER	30A-1330	EEEE4
30A-CF-2575	DEPROPANIZER	30A-1331	FFFF4
30A-CF-2576	DEBUTANIZER	30A-1332	GGGG4
30A-CF-2577	DEPROPANIZER	30A-1333	HHHH4
30A-CF-2578	DEBUTANIZER	30A-1334	IIII4
30A-CF-2579	DEPROPANIZER	30A-1335	JJJJ4
30A-CF-2580	DEBUTANIZER	30A-1336	KKKK4
30A-CF-2581	DEPROPANIZER	30A-1337	LLLL4
30A-CF-2582	DEBUTANIZER	30A-1338	MMMM4
30A-CF-2583	DEPROPANIZER	30A-1339	NNNN4
30A-CF-2584	DEBUTANIZER	30A-1340	OOOO4
30A-CF-2585	DEPROPANIZER	30A-1341	PPPP4
30A-CF-2586	DEBUTANIZER	30A-1342	QQQQ4
30A-CF-2587	DEPROPANIZER	30A-1343	RRRR4
30A-CF-2588	DEBUTANIZER	30A-1344	SSSS4
30A-CF-2589	DEPROPANIZER	30A-1345	TTTT4
30A-CF-2590	DEBUTANIZER	30A-1346	UUUU4
30A-CF-2591	DEPROPANIZER	30A-1347	VVVV4
30A-CF-2592	DEBUTANIZER	30A-1348	WWWW4
30A-CF-2593	DEPROPANIZER	30A-1349	XXXX4
30A-CF-2594	DEBUTANIZER	30A-1350	YYYY4
30A-CF-2595	DEPROPANIZER	30A-1351	ZZZZ4
30A-CF-2596	DEBUTANIZER	30A-1352	AAAAA4
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30A-CF-2602	DEBUTANIZER	30A-1358	GGGGA4
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30A-CF-2611	DEPROPANIZER	30A-1367	PPPPA4
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30A-CF-2622	DEBUTANIZER	30A-1378	AAAAAA4
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30A-CF-2624	DEBUTANIZER	30A-1380	CCCCAA4
30A-CF-2625	DEPROPANIZER	30A-1381	DDDDAA4
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30A-CF-2634	DEBUTANIZER	30A-1390	MMMMAA4
30A-CF-2635	DEPROPANIZER	30A-1391	NNNNAA4
30A-CF-2636	DEBUTANIZER	30A-1392	OOOOAA4
30A-CF-2637	DEPROPANIZER	30A-1393	PPPPAA4
30A-CF-2638	DEBUTANIZER	30A-1394	QQQQAA4
30A-CF-2639	DEPROPANIZER	30A-1395	RRRRAA4
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30A-CF-2703	DEPROPANIZER	30A-1459	DDDDAAAAA4
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30A-CF-2721	DEPROPANIZER	30A-1477	VVVVAAAAA4
30A-CF-2722	DEBUTANIZER	30A-1478	WWWWAAAAA4
30A-CF-2723	DEPROPANIZER	30A-1479	XXXXAAAAA4
30A-CF-2724	DEBUTANIZER	30A-1480	YYYYAAAAA4
30A-CF-2725	DEPROPANIZER	30A-1481	ZZZZAAAAA4
30A-CF-2726	DEBUTANIZER	30A-1482	AAAAAAAAAA4
30A-CF-2727	DEPROPANIZER	30A-1483	BBBBAAAAAA4
30A-CF-2728	DEBUTANIZER	30A-1484	CCCCAAAAAA4
30A-CF-2729	DEPROPANIZER	30A-1485	DDDDAAAAAA4
30A-CF-2730	DEBUTANIZER	30A-1486	EEEEAAAAAA4
30A-CF-2731	DEPROPANIZER	30A-1487	FFFFAAAAAA4
30A-CF-2732	DEBUTANIZER	30A-1488	GGGGAAAAAA4
30A-CF-2733	DEPROPANIZER	30A-1489	HHHHAAAAAA4
30A-CF-2734	DEBUTANIZER	30A-1490	IIIIAAAAAA4
30A-CF-2735	DEPROPANIZER	30A-1491	JJJJAAAAAA4
30A-CF-2736	DEBUTANIZER	30A-1492	KKKKAAAAAA4
30A-CF-2737	DEPROPANIZER	30A-1493	LLLLAAAAAA4
30A-CF-2738	DEBUTANIZER	30A-1494	MMMMAAAAAA4
30A-CF-2739	DEPROPANIZER	30A-1495	NNNNAAAAAA4
30A-CF-2740	DEBUTANIZER	30A-1496	OOOOAAAAAA4
30A-CF-2741	DEPROPANIZER	30A-1497	PPPPAAAAAA4
30A-CF-2742	DEBUTANIZER	30A-1498	QQQQAAAAAA4
30A-CF-2743	DEPROPANIZER	30A-1499	RRRRAAAAAA4
30A-CF-2744	DEBUTANIZER	30A-1500	SSSSAAAAAA4
30A-CF-2745	DEPROPANIZER	30A-1501	TTTTAAAAAA4
30A-CF-2746	DEBUTANIZER	30A-1502	UUUUAAAAAA4
30A-CF-2747	DEPROPANIZER	30A-1503	VVVVAAAAAA4
30A-CF-2748	DEBUTANIZER	30A-1504	WWWWAAAAAA4
30A-CF-2749	DEPROPANIZER	30A-1505	XXXXAAAAAA4
30A-CF-2750	DEBUTANIZER	30A-1506	YYYYAAAAAA4
30A-CF-2751	DEPROPANIZER	30A-1507	ZZZZAAAAAA4
30A-CF-2752	DEBUTANIZER	30A-1508	AAAAAAAAAAA4
30A-CF-2753	DEPROPANIZER	30A-1509	BBBBAAAAAAA4
30A-CF-2754	DEBUTANIZER	30A-1510	CCCCAAAAAAA4
30A-CF-2755	DEPROPANIZER	30A-1511	DDDDAAAAAAA4
30A-CF-2756	DEBUTANIZER	30A-1512	EEEEAAAAAAA4
30A-CF-2757	DEPROPANIZER	30A-1513	FFFFAAAAAAA4
30A-CF-2758	DEBUTANIZER	30A-1514	GGGGAAAAAAA4
30A-CF-2759	DEPROPANIZER	30A-1515	HHHHAAAAAAA4
30A-CF-2760	DEBUTANIZER	30A-1516	IIIIAAAAAAA4
30A-CF-2761	DEPROPANIZER	30A-1517	JJJJAAAAAAA4
30A-CF-2762	DEBUTANIZER	30A-1518	KKKKAAAAAAA4
30A-CF-2763	DEPROPANIZER	30A-1519	LLLLAAAAAAA4
30A-CF-2764	DEBUTANIZER	30A-1520	MMMMAAAAAAA4
30A-CF-2765	DEPROPANIZER	30A-1521	NNNNAAAAAAA4
30A-CF-2766	DEBUTANIZER	30A-1522	OOOOAAAAAAA4
30A-CF-2767	DEPROPANIZER	30A-1523	PPPPAAAAAAA4
30A-CF-2768	DEBUTANIZER	30A-1524	QQQQAAAAAAA4
30A-CF-2769	DEPROPANIZER	30A-1525	RRRRAAAAAAA4
30A-CF-2770	DEBUTANIZER	30A-1526	SSSSAAAAAAA4
30A-CF-2771	DEPROPANIZER	30A-1527	TTTTAAAAAAA4
30A-CF-2772	DEBUTANIZER	30A-1528	UUUUAAAAAAA4
30A-CF-2773	DEPROPANIZER	30A-1529	VVVVAAAAAAA4
30A-CF-2774	DEBUTANIZER	30A-1530	WWWWAAAAAAA4
30A-CF-2775	DEPROPANIZER	30A-1531	XXXXAAAAAAA4
30A-CF-2776	DEBUTANIZER	30A-1532	YYYYAAAAAAA4
30A-CF-2777	DEPROPANIZER	30A-1533	ZZZZAAAAAAA4
30A-CF-2778	DEBUTANIZER	30A-1534	AAAAAAAAAAAA4
30A-CF-2779	DEPROPANIZER	30A-1535	BBBBAAAAAAAA4
30A-CF-2780	DEBUTANIZER	30A-1536	CCCCAAAAAAAA4
30A-CF-2781	DEPROPANIZER	30A-1537	DDDDAAAAAAAA4
30A-CF-2782	DEBUTANIZER	30A-1538	EEEEAAAAAAAA4
30A-CF-2783	DEPROPANIZER	30A-1539	FFFFAAAAAAAA4
30A-CF-2784	DEBUTANIZER	30A-1540	GGGGAAAAAAAA4
30A-CF-2785	DEPROPANIZER	30A-1541	HHHHAAAAAAAA4
30A-CF-2786	DEBUTANIZER	30A-1542	IIIIAAAAAAAA4
30A-CF-2787	DEPROPANIZER	30A-1543	JJJJAAAAAAAA4
30A-CF-2788	DEBUTANIZER	30A-1544	KKKKAAAAAAAA4
30A-CF-2789	DEPROPANIZER	30A-1545	LLLLAAAAAAAA4
30A-CF-2790	DEBUTANIZER	30A-1546	MMMMAAAAAAAA4
30A-CF-2791	DEPROPANIZER	30A-1547	NNNNAAAAAAAA4
30A-CF-2792	DEBUTANIZER	30A-1548	OOOOAAAAAAAA4
30A-CF-2793	DEPROPANIZER	30A-1549	PPPPAAAAAAAA4
30A-CF-2794	DEBUTANIZER	30A-1550	QQQQAAAAAAAA4
30A-CF-2795	DEPROPANIZER	30A-1551	RRRRAAAAAAAA4
30A-CF-2796	DEBUTANIZER	30A-1552	SSSSAAAAAAAA4
30A-CF-2797	DEPROPANIZER	30A-1553	TTTTAAAAAAAA4
30A-CF-2798	DEBUTANIZER	30A-1554	UUUUAAAAAAAA4
30A-CF-2799	DEPROPANIZER	30A-1555	VVVVAAAAAAAA4
30A-CF-2800	DEBUTANIZER	30A-1556	WWWWAAAAAAAA4
30A-CF-2801	DEPROPANIZER	30A-1557	XXXXAAAAAAAA4
30A-CF-2802	DEBUTANIZER	30A-1558	YYYYAAAAAAAA4
30A-CF-2803	DEPROPANIZER	30A-1559	ZZZZAAAAAAAA4
30A-CF-2804	DEBUTANIZER	30A-1560	AAAAAAAAAAAAA4
30A-CF-2805	DEPROPANIZER	30A-1561	BBBBAAAAAAAAA4
30A-CF-2806	DEBUTANIZER	30A-1562	CCCCAAAAAAAAA4
30A-CF-2807	DEPROPANIZER	30A-1563	DDDDAAAAAAAAA4
30A-CF-2808	DEBUTANIZER	30A-1564	EEEEAAAAAAAAA4
30A-CF-2809	DEPROPANIZER	30A-1565	FFFFAAAAAAAAA4
30A-CF-2810	DEBUTANIZER	30A-1566	GGGGAAAAAAAAA4
30A-CF-2811	DEPROPANIZER	30A-1567	HHHHAAAAAAAAA4
30A-CF-2812	DEBUTANIZER	30A-1568	IIIIAAAAAAAAA4
30A-CF-2813	DEPROPANIZER	30A-1569	JJJJAAAAAAAAA4
30A-CF-2814	DEBUTANIZER	30A-1570	KKKKAAAAAAAAA4
30A-CF-2815	DEPROP

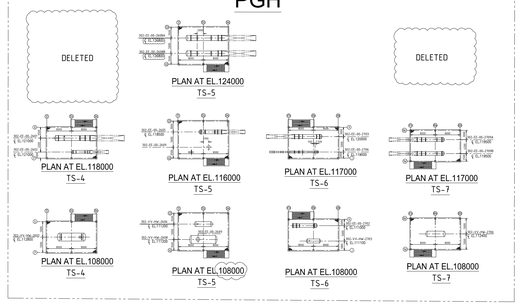
B957-300-16-43-00002

PLANT NORTH
TRUE NORTH
26°37'30"
PREVAILING WIND DIRECTION

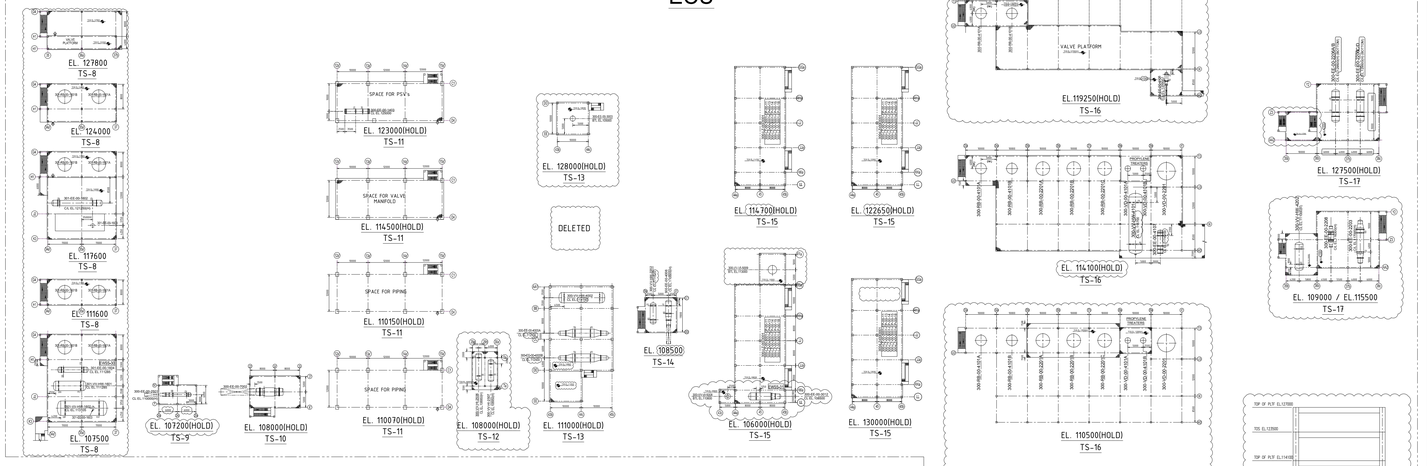
BTX

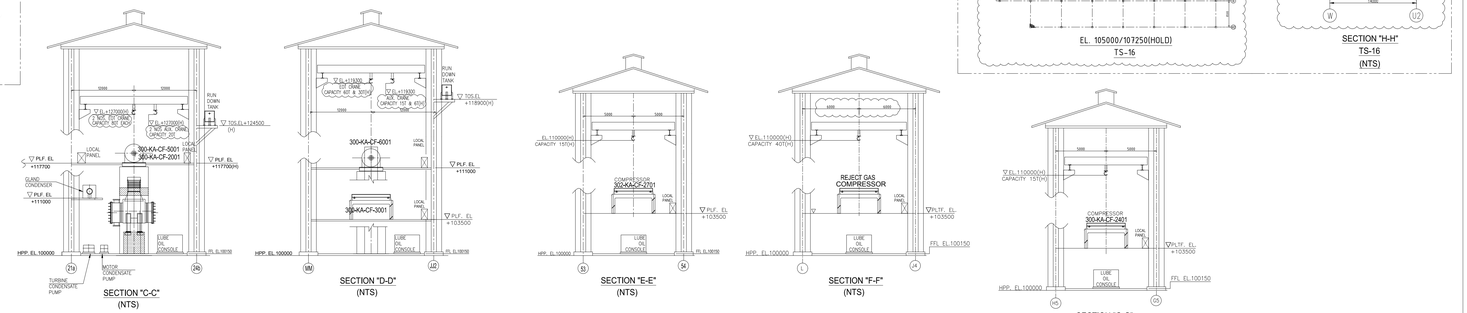


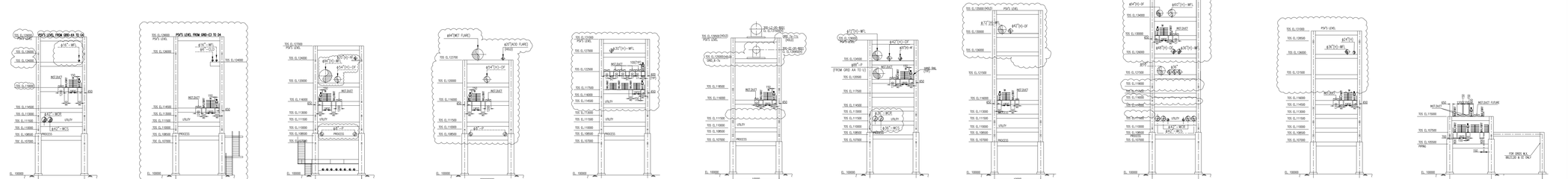
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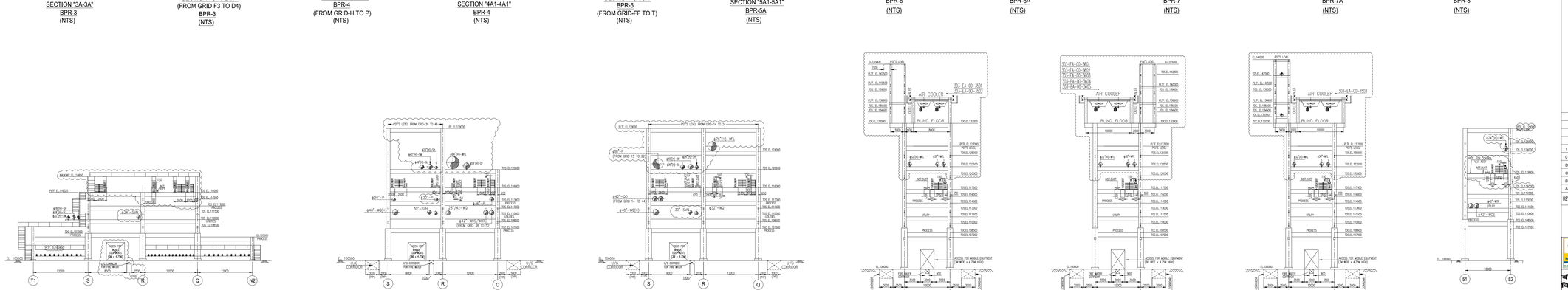


ECU









REF. DWG. NO.	REFERENCE DRAWING TITLE
B957-999-81-45-00001	OVERALL PLOT PLAN
B957-300-16-43-00001	EQUIPMENT LAYOUT_ECU

NOTES :-

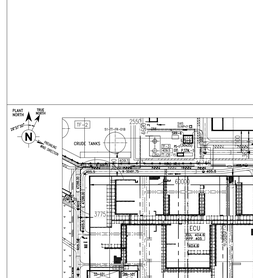
1. ALL DIMENSIONS ARE IN M.M. UNLESS OTHERWISE SPECIFIED.
2. ALL ELEVATIONS ARE IN M.M. AND ARE WITH REFERENCE TO HIGHEST POINT OF PAVEMENT EL. 100000 WHICH CORRESPONDS TO 405.0M ABOVE MEAN SEA LEVEL (MSL).
3. CONCRETE BLIND FLOOR SHALL BE PROVIDED BELOW AIR COOLERS.
4. PERIPHERAL DRAIN SHALL BE PROVIDED ALL AROUND OUT SIDE OF THE B/L.
5. ALL LOCAL PLATFORMS REQUIRED FOR OPERATION AND MAINTENANCE OF EQUIPMENTS/ VALVES SHALL BE PROVIDED DURING DETAIL ENGINEERING.
6. STRUCTURE & PLATFORM ARRANGEMENT FOR HEATER PIPING SHALL BE FINALIZED DURING DETAIL ENGINEERING.
7. INTERCONNECTING PLATFORMS BETWEEN TECH STRUCTURES, WALKWAY IN PIPE RACKS, AIR COOLER PLATFORMS, COLUMN PLATFORMS ETC. SHOWN IN EQUIPMENT LAYOUT ARE PRELIMINARY.
8. ALL PUMPS CENTER LINE ARE LOCATED WITH CENTER LINE OF PUMP BASE PLATE UNLESS OTHERWISE MARKED.
9. INTERMEDIATE SUPPORT MEMBERS AT PIPE RACK TIERS (1ST & 2ND) SHALL BE PROVIDED FOR SUPPORTING SMALL BORE LINES.
10. PLAN ELEVATION WHEREVER MENTIONED IN LAYOUT IS TOG UNLESS OTHERWISE SPECIFIED.
11. EXTENSION OF COLUMNS OF PIPE RACK/TECHNOLOGICAL STRUCTURE AND SUPPORTING ARRANGEMENT FOR PIPING ARE HOLD.
12. RETRACTABLE TROLLEY SHALL BE PROVIDED ALONG WITH PIPE DAVIT FOR MAINTENANCE OF FAN GEAR/BOX OF AIR COOLER AND.
13. INLINE EQUIPMENTS ARE NOT SHOWN IN EQUIPMENT LAYOUT.

HOLDS :-

REFER DRAWING NO. B957-300-16-43-00001

LEGEND :-

BTL EL.	- BOTTOM TANGENT LINE ELEVATION		BATTERY LIMIT
CL EL.	- CENTRE LINE ELEVATION		CORRIDOR (FOR UG PIPES)
EWSS	- EYE WASH & SAFETY SHOWER		DROP OUT AREA
FIM	- FREE ISSUED MATERIAL		GRATING PLATFORM
NTS	- NOT TO SCALE		RCC FLOOR
PLTF EL	- PLATFORM ELEVATION		HARD STAND
TOC EL	- TOP OF CONCRETE ELEVATION		MONORAIL
TOG EL	- TOP OF GRATING ELEVATION		LADDER
TOS EL	- TOP OF STEEL ELEVATION		DAVIT
WP. EL	- WORKING POINT ELEVATION		REVISION/CHANGES
SS	- SLIDING SADDLE		
FS	- FIXED SADDLE		
CL	- CENTER LINE		
EL	- ELEVATION		
TS	- TECHNOLOGICAL STRUCTURE		
HS	- HARD STAND		
AS	- ANALYZER SHELTER		
BPR	- BRANCH PIPE RACK		
BPR	- BRANCH PIPE RACK		
OWS	- OILY WATER SEWAGE		
CRWS	- CONTAMINATED DRAIN WATER SEWAGE		
U/G	- UNDERGROUND		
TLE	- TRANSFER LINE EXCHANGER		
S/S	- SUBSTATION		
SRR	- SATELLITE RACK ROOM		



PLOT SIZE-600Mx340M		
UNIT DESCRIPTION	CAPACITY	LICENSOR
ECU	1200 KTPA	LUMMUS

REV.	DATE	DESCRIPTION	BY	CHKD	APPD	PEM
1	24/10/2025	REVISED & ISSUED FOR ENGINEERING	AV/KKV	MK/SNH	AS	SV
0	28/02/2025	ISSUED FOR ENGINEERING	SSR/KKV	MK/SNH	GB	SV
D	15/02/2025	ISSUED FOR EQUIPMENT LAYOUT COMMITTEE REVIEW	SSR/KKV	MK/SNH	GB	
C	06/02/2025	REVISED & REISSUED FOR COMMENTS	SSR	MK/SNH	GB	
B	14/11/2024	REVISED & REISSUED FOR COMMENTS	SSR	MK/SNH	GB	
A	30/10/2024	ISSUED FOR COMMENTS	PK	MK/SNH	GB	

इंजीनियर्स इंडिया लिमिटेड (भारत सरकार का उपक्रम) ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

भारत पेट्रोलियम कॉर्पोरेशन लिमिटेड BHARAT PETROLEUM CORPORATION LTD.

बीना पेट्रोकेमिकल्स एवं रिफाइनरी विस्तार परियोजना (बी.पी.आर.ई.पी.) बीना, मध्य प्रदेश	BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (B.P.R.E.P.) BINA, MADHYA PRADESH
उपस्कर अभिन्यास इथिलीन क्रेकर यूनिट	EQUIPMENT LAYOUT ETHYLENE CRACKER UNIT

SCALE	JOB NO.	UNIT	DIVN.	DEPT.	DWG. NO.	REV.
1:700	B957	300	16	43	00002	1

3-1641-0500 REV.5 / 06.12.2024 A0-1189 x 841

यह ड्राइंग, डिज़ाइन एवं इसमें दिए गए विवरण इंजीनियर्स इंडिया लिमिटेड की संपत्ति है। इसे इस प्रारूप में केवल इस उद्देश्य के लिए उधार दिया जाता है कि यह उधारकर्ता को लिखित रूप में दी गई सहमति के अनुसार ही उपयोग किए जाएगा। न तो इसे दोबारा बनाया जाएगा, न प्रदर्शित किया जाएगा और न ही किसी अन्य को दिया जाएगा।
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DWG.NO.

Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 13DD		**Description :** SOLID STATE DECOUPLER		
Approved Suppliers				
1	3939	KRISTRON CONTROLS & SYSTEMS PRIVATE LIMITED	INDIA	

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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 13EA		**Description :** ANODES FOR C P SYSTEM		
Approved Suppliers				
1	4148	SHAKTIANODES PRIVATE LIMITED	INDIA	
2	4102	VIJAY CORROSION TECHNOLOGY	INDIA	
3	3899	CONTROL PLUS OIL AND GAS SOLUTIONS PVT	INDIA	
4	27584	SEAL FOR LIFE INDUSTRIES MEXICO S. DE R. L. DE C.V.	MEXICO	
5	S245	SCIENTIFIC METAL ENGINEERS (P) LTD	INDIA	
6	E100	ELECTRO PROTECTION SERVICES INDIA P LTD	INDIA	
7	C133	CATHODIC CONTROL CO PVT. LTD.	INDIA	
8	E629	EMIRATES TECHNO CASTING LLC	UNITED ARAB EMIRATES	
9	D142	DE NORA INDIA LTD-FORMLY T-168	INDIA	

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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 13KE		**Description :** TRANSFORMER-RECTIFIER UNIT FOR C.P.S.		
Approved Suppliers				
1	K182	KRISTRON SYSTEMS	INDIA	
2	27519	BIN SARI SPECIALIZED TECHNOLOGIES	UNITED ARAB EMIRATES	
3	4179	RECTIFIERS AND CONTROL ELECTRONICS TECHNOLOGIES PRIVATE LIMITED	INDIA	
4	3939	KRISTRON CONTROLS & SYSTEMS PRIVATE LIMITED	INDIA	
5	C133	CATHODIC CONTROL CO PVT. LTD.	INDIA	

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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 13KF		**Description :** CATHODIC PROTECTION POWER SUPPLY MODULE		
Approved Suppliers				
1	3939	KRISTRON CONTROLS & SYSTEMS PRIVATE LIMITED	INDIA	
2	K182	KRISTRON SYSTEMS	INDIA	

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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 13MA		**Description :** JUNCTION BOXES (FLAME PROOF)		
Approved Suppliers				
1	3681	FCG POWER INDUSTRIES PVT LTD	INDIA	
2	R175	R STAHL PVT LTD	INDIA	
3	3706	PHOENIX MECANO INDIA PVT. LTD.	INDIA	
4	F036	FLAMEPROOF EQUIPMENTS PVT.LTD	INDIA	
5	S158	SUDHIR SWITCHGEARS PVT LTD	INDIA	
6	B024	BALIGA LIGHTING EQUIPMENTS (P) LIMITED	INDIA	
7	G159	PEPPERL & FUCHS MANUFACTURING (INDIA) PRIVATE LIMITED	INDIA	
8	F024	FLEXPRO ELECTRICALS PVT LTD	INDIA	
9	4364	SAI INDUSTRIES	INDIA	
10	4245	FCG HI-TECH PRIVATE LIMITED	INDIA	
11	K173	KAYSONS TECHNO EQUIPMENTS PVT. LTD.	INDIA	

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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 13OC		**Description :** CABLES-MEDIUM VOLTAGE-POWER-XLPE		
Approved Suppliers				
1	K190A	KEC ASIAN CABLES LIMITED	INDIA	
2	4163	KLJ PARAFLEX INDIA LIMITED	INDIA	
3	4261	TORTEK INDIA PRIVATE LIMITED	INDIA	
4	4262	K C POWERTRACKS	INDIA	
5	4263	TIRUPATI PLASTOMATICS PRIVATE LIMITED	INDIA	
6	4264	SURAJ CABLES (INDIA) PRIVATE LIMITED	INDIA	
7	4265	SVARN INFRATEL PRIVATE LIMITED	INDIA	
8	D012	DELTON CABLES LIMITED	INDIA	
9	4234	LASER POWER & INFRA PRIVATE LIMITED	INDIA	
10	3669	KEI INDUSTRIES LIMITED	INDIA	
11	3814	RR KABEL LIMITED	INDIA	
12	4298	SHRIRAM TELELINK	INDIA	
13	3602	Special Cables Pvt. Ltd.	INDIA	
14	K082	KEI INDUSTRIES LIMITED	INDIA	
15	U003	UNIVERSAL CABLES LTD	INDIA	
16	T124	TORRENT ELECTRICALS LIMITED	INDIA	
17	A132	ASSOCIATED FLEXIBLES & WIRES [P] LTD	INDIA	
18	C145	CORDS CABLE INDUSTRIES LTD	INDIA	
19	S025	SRIRAM CABLES PVT LTD	INDIA	
20	3731	POLYCAB INDIA LIMITED	INDIA	
21	3732	POLYCAB INDIA LIMITED	INDIA	
22	3722	POLYCAB INDIA LIMITED	INDIA	
23	G156	GEMSCAB INDUSTRIES LTD	INDIA	
24	H060	HAVELLS INDIA LTD	INDIA	
25	R203	LKB ENGINEERING PRIVATE LIMITED	INDIA	
26	3969	SHIVPRIYA CABLES PRIVATE LIMITED	INDIA	
27	3854	CHANDRESH CABLES LIMITED	INDIA	
28	S304	SUYOG ELECTRICALS LTD	INDIA	
29	U085	APAR INDUSTRIES LTD	INDIA	
30	4137	INSUCON CABLES AND CONDUCTORS PRIVATE LIMITED	INDIA	
31	4351	UNIVERSAL CABLE MANUFACTURING COMPANY	INDIA	
32	4281	SBEE CABLES INDIA LIMITED	INDIA	
33	4104	ZENIUM CABLES LIMITED	INDIA	
34	4105	ULTRACAB (INDIA) LIMITED	INDIA	
35	3781	POLYCAB INDIA LIMITED	INDIA	
36	3783	POLYCAB INDIA LIMITED	INDIA	
37	3796	PARAMOUNT COMMUNICATIONS LTD	INDIA	
38	4055	DYNAMIC CABLES LIMITED	INDIA	
39	3765	THERMO CABLES LTD.	INDIA	
40	4001	RAVI INDUSTRIES	INDIA	

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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 13OC		**Description :** CABLES-MEDIUM VOLTAGE-POWER-XLPE		
41	4299	POLYVION CABLES PRIVATE LIMITED	INDIA	

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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 13OD		**Description :** CABLES-CONTROL (UNPAIRED)-XLPE		
Approved Suppliers				
1	K190A	KEC ASIAN CABLES LIMITED	INDIA	
2	4299	POLYVION CABLES PRIVATE LIMITED	INDIA	
3	3752	APAR INDUSTRIES LTD	INDIA	
4	4261	TORTEK INDIA PRIVATE LIMITED	INDIA	
5	4262	K C POWERTRACKS	INDIA	
6	4264	SURAJ CABLES (INDIA) PRIVATE LIMITED	INDIA	
7	4265	SVARN INFRATEL PRIVATE LIMITED	INDIA	
8	4221	BONTON CABLES (INDIA) PRIVATE LIMITED	INDIA	
9	4234	LASER POWER & INFRA PRIVATE LIMITED	INDIA	
10	3669	KEI INDUSTRIES LIMITED	INDIA	
11	4297	GOYOLENE FIBRES (INDIA) PRIVATE LIMITED	INDIA	
12	4298	SHRIRAM TELELINK	INDIA	
13	3602	Special Cables Pvt. Ltd.	INDIA	
14	3814	RR KABEL LIMITED	INDIA	
15	3724	CORDS CABLE INDUSTRIESLTD.	INDIA	
16	C145	CORDS CABLE INDUSTRIES LTD	INDIA	
17	U003	UNIVERSAL CABLES LTD	INDIA	
18	S304	SUYOG ELECTRICALS LTD	INDIA	
19	R203	LKB ENGINEERING PRIVATE LIMITED	INDIA	
20	A132	ASSOCIATED FLEXIBLES & WIRES [P] LTD	INDIA	
21	E063	ELKAY TELELINKS LTD.-	INDIA	
22	D012	DELTON CABLES LIMITED	INDIA	
23	3722	POLYCAB INDIA LIMITED	INDIA	
24	G156	GEMSCAB INDUSTRIES LTD	INDIA	
25	H060	HAVELLS INDIA LTD	INDIA	
26	S025	SRIRAM CABLES PVT LTD	INDIA	
27	T124	TORRENT ELECTRICALS LIMITED	INDIA	
28	A034	ASSOCIATED CABLES PVT LTD	INDIA	
29	E169	ECKO CABLES PVT LTD	INDIA	
30	T212	THERMO CABLES LTD (FORM. T-150)	INDIA	
31	3854	CHANDRESH CABLES LIMITED	INDIA	
32	4137	INSUCON CABLES AND CONDUCTORS PRIVATE LIMITED	INDIA	
33	4351	UNIVERSAL CABLE MANUFACTURING COMPANY	INDIA	
34	4281	SBEE CABLES INDIA LIMITED	INDIA	
35	4105	ULTRACAB (INDIA) LIMITED	INDIA	
36	3783	POLYCAB INDIA LIMITED	INDIA	
37	3784	POLYCAB INDIA LIMITED	INDIA	
38	3796	PARAMOUNT COMMUNICATIONS LTD	INDIA	
39	3765	THERMO CABLES LTD.	INDIA	
40	4001	RAVI INDUSTRIES	INDIA	

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Sr No	Supplier Code	Supplier Name	Country	Holiday Description
Item Code : 13OD		**Description :** CABLES-CONTROL (UNPAIRED)-XLPE		
41	4163	KLJ PARAFLEX INDIA LIMITED	INDIA	

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TECHNICAL CONFIRMATION LIST FOR CP SYSTEM

PROJECT : MPMC AND PMC/EPCM SERVICES FOR ETHYLENE CRACKER UNIT AND UTILITIES & OFFSITES RELATED TO BINA PETCHEM & REFINERY EXPANSION PROJECT (BPREP)

OWNER : BHARAT PETROLEUM CORPORATION LIMITED (BPCL)

PMC : ENGINEERS INDIA LIMITED (EIL)

JOB NO. : B957

A	19-03-2025	ISSUED FOR TENDER	AD	SD	RC
Rev. No	**Date**	**Purpose**	**Prepared by**	**Checked by**	**Approved by**

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TECHNICAL COMPLIANCE

SL.NO.	COMPLIANCE STATEMENT/ QUERRY	CONTRACTOR'S CONFIRMATION / ANSWER
1	Confirm contractor's compliance (without exception & deviation) with Cathodic Protection scope of work	
2	Confirm that deliverables as elaborated in scope of work shall be submitted by contractor.	
3	Confirm that the drawings for each item/equipment shall be submitted by the contractor in one lot so as to facilitate an overall systematic review.	
4	Confirm that design document, drawings and construction drawings shall be submitted and got reviewed by company/company's representative.	

Notes: -

1. The Contractor shall indicate his reply in the space provided in the Technical Questionnaire. In case space provided is not adequate, the reply may be furnished separately under suitably numbered annexure/ attachments duly referred against the comment/ query.
2. The Compliance Statements/ Queries are required to be categorically confirmed/ answered by the contractor and the completely filled in Tech questionnaire shall be submitted together with the Bid.

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JOB SPECIFICATION
FOR
CATHODIC PROTECTION SYSTEM

PROJECT	**:**	**MPMC AND PMC/EPCM SERVICES FOR ETHYLENE CRACKER UNIT AND UTILITIES & OFFSITES RELATED TO BINA PETCHEM & REFINERY EXPANSION PROJECT (BPREP)**
UNIT	**:**	**ETHYLENE CRACKER UNIT**
OWNER	**:**	**BHARAT PETROLEUM CORPORATION LIMITED (BPCL)**
PMC	**:**	**ENGINEERS INDIA LIMITED (EIL)**
JOB NO.	**:**	**B957**

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1.0 SCOPE OF WORK

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1.1 SCOPE OF WORK FOR CATHODIC PROTECTION SYSTEM (CP SYSTEM)

The work to be performed by the EIL/ OWNER approved CP contractor shall comprise of design, detailed engineering, supply, installation, testing and commissioning of Impressed Current Cathodic Protection (CP) System for soil/ sand side corrosion prevention of Underground Vessels inside pit filled with sand/soil, Tank bottom plate resting on soil/ sand pad (without application of thermal isolation barrier or fire bricks below tank bottom plate), UG piping (without having heat insulating material) as well as sacrificial type CP system for Coolers/ Condensers (as applicable) within the scope of this project. Sacrificial Anode Cathodic Protection system shall be considered on channel and floating head side of cooler/ heat exchangers containing conductive fluids/cooling water with dissimilar metallurgy in channel/floating head side.

This document is not intended to be all-inclusive and the use of the guidelines set forth here do not relieve the CONTRACTOR of his responsibility of providing adequate CP System, which shall be proved performing to the entire satisfaction of the OWNER/ EIL.

The successful EPC contractor shall furnish all necessary details with supporting documents of proposed CP contractor (List of orders executed with copies of work orders/ technical details of work executed, completion certificate of CP contractor during detail engineering stage.

The contractor needs to supply all materials, consumables in his scope of supply from EIL/ Owner approved vendor list. The items which are not listed, the same shall be considered based on proven track record (PTR) basis for application of minimum one year period and five years for critical items such as MMO wire anode (filled with factory coke breeze and connecting lead cable), Surge diverter, SSPC (solid state polarization cell) / DC Decoupler and Reference electrode with satisfactory performance record (Refer technical specification of items). The contractor shall provide all construction tools, tackles, equipment and personnel necessary for the work and prepare detailed engineering package including construction drawings before starting of the work. After commissioning of the system commissioning report along with as built drawings including soft copies in latest version of AutoCAD and operating manuals to be prepared.

The Contractor needs to keep vigilance and take all precautionary measures to prevent fire hazards during execution of job.

1.2 SCOPE OF WORK FOR CATHODIC PROTECTION SYSTEM INSTALLATION

1.2.1 Item wise works envisaged under this Contract will comprise of the following:

Preparation and submission of Detail Engineering package as per Design basis and job specifications enclosed in this document. The detail engineering package shall include, as a minimum, design calculations, Bill of quantities, layout drawings of all materials/ equipments of CP System, Connection schemes and wiring diagrams, Installation procedures, name of equipment suppliers, shop/ field testing & inspection plan for equipment, necessary technical information/ datasheets, fabrication/ construction drawings, testing and commissioning procedures and formats, Quality control/ Quality assurance documents etc. & obtain approval from OWNER/ EIL before execution of work. CONTRACTOR needs to obtain approval on all layout drawings of cathodic protection materials/ equipment at site from OWNER/ EIL before starting the installation work.

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1.2.2 Carry out Soil Resistivity test, detailed engineering, Supply all materials, equipment and perform all erection and installation work as per approved detail-engineering package. Provision of all service connection to T/R units including power cable starting from power source to PDB and PDB to TRU shall be in CONTRACTOR's scope of work.

1.2.3 Shop testing of all major contractor supplied CP equipment (T/R, Anode, Cables, Junction Boxes, and RTU etc.) and submission to EIL of Test results/ certificates for approval before delivery of equipment.

1.2.4 Field-testing of individual components of CP System as per approved detail engineering package. Final commissioning of installed system as per approved procedure and submission to EIL of results thereof.

1.2.5 Liaison with other agencies, seek and obtain all permission related and obligatory to his part of the work.

1.2.6 Preparation and submission of 1 set of soft copy and 6 sets of hard copies to client and one set each soft and hard copy to EIL for records for all as built CP System package comprising of operation and maintenance manual for equipment, as-built drawings, Material specifications and Pre-commissioning/ Commissioning results.

1.2.7 After Commissioning of the CP System, if it is found that structure to electrolyte potential achieved at some location is in the range which is below acceptable limit as per code, then a supplementary CP System need to be installed to bring the potential level at such locations within acceptable limit as mentioned vide section 2.0 for "Design Basis/ Philosophy for CP System".

1.2.8 CONTRACTOR shall give performance guarantee for CP System for applicable equipments/ UG piping as per design basis and job specifications and operation guarantee of the material and equipment supplied by him as well as guarantee against defective workmanship for installation work carried out by him.

1.3 INSTRUCTION TO BIDDERS

1.3.1 Site Particulars

It shall be the bidder's responsibility to have a thorough understanding of the reference documents, site conditions and specification included therein. The intending bidders shall be deemed to have visited the site and have studied the conditions before submitting the Bids. Non-familiarity with the site conditions will not be considered a reason either for extra claims or for not carrying out the work in strict conformity with the drawings and specifications.

1.3.2 Every item of work and supply by CONTRACTOR shall be subject to Engineer-In-Charge scrutiny, supervision and approval. Any work carried out or supplies affected without such approval shall stand automatically rejected and his claim for compensation for such unauthorized work shall be null and void.

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1.4 SPECIFIC REQUIREMENTS FOR CP SYSTEM WORKS

1.4.1 General

Clauses given under specific requirements for CP System works shall be read in conjunction with General conditions of contract and in case of any conflict, the provisions of specific requirements for CP System works will override the provision of general conditions of contract.

1.4.2 EIL/ OWNER shall have the right to inspect the following:

- Workshop & production facilities available with CONTRACTOR or its tie up agency.
- Fabrication/ testing of material/ equipment to be supplied by CONTRACTOR or its tie up agency for CP system.

1.4.3 It shall be Bidder's responsibility to arrange access for EIL/ OWNER Personnel for such visits. All costs related with travel, boarding, lodging for EIL/ OWNER personnel for such visits (if any) shall be borne by EIL/ OWNER.

1.4.4 Materials

1.4.4.1 Material Supplied By Owner

No material for CP System shall be supplied by owner.

1.4.4.2 Material Supplied by Contractor

The Contractor shall procure, supply all materials, equipment and consumables required for the work in his scope. Technical specifications of major items are given in section 3.0 for "Job specification for CP System", of this document. Supply of all balance materials, consumables not covered in section 3.0 for "Job specification for CP System", but required for completion of work as per this specification shall be entirely Contractor's responsibility. The rates quoted for the execution of the Contract shall be inclusive of all Contractor supplied material and equipment.

1.4.5 Warranty

Contractor needs to provide design guarantee for the system as per codes and standards & the protection criteria mentioned in the section Design basis/ Philosophy of this document also shall replace/ repair or reinstall free of cost any material/ equipment supplied or installed by him in case it fails to operate due to defective material or workmanship as per requirements of this specification within 12 (Twelve) months from the date of issue of completion certificate and acceptance of the CP System by Owner. Contractor shall replace at his own cost if any item found defective or missed before handing over the system to owner.

Comprehensive Annual Maintenance (AMC) for CP System for 1 year is in CP Contractor’s scope after Guarantee/ Warrantee period is over.

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1.4.6 Construction Aids, Equipment, Tools and Tackles

Contractor shall be solely responsible for making available for executing the work, all requisite construction equipment, special Aids, tools, tackles and testing equipment and appliances, all instruments including automatic Programmable current interrupters required for commissioning and interference testing of the system. Such construction equipment shall be in first class operating condition. Any discrepancies pointed out by Owner/ EIL shall be immediately got rectified, repaired or the equipment replaced all together by Contractor. Owner/ EIL shall not in any way be responsible for providing any such equipment, machinery tools and tackles etc. The Owner/ EIL reserves the right to re-arrange such deployment depending upon the progress and priority of work in various sections at no extra cost to Owner.

1.4.7 Transportation, Packing and Handling

Contractor shall be responsible for transportation of all equipment/ materials required for CP system work and unload the same at allotted area at site.

1.4.7.1 To protect all the material during period of dispatch, storage and erection against corrosion, incidental damage due to vermin, sunlight, rain, high temperature, humid atmosphere, rough handling in transit and storage in open during monsoon including delays in transit. Bidder shall be responsible for any damage to equipment/ material due to above reasons.

1.4.7.2 Bidder to refer Section 2.0 for "Design Basis/ Philosophy for CP System", Section 3.0 for "Specification for CP System material & equipment", Section 4.0 for “Mandatory Spares for Cathodic Protection System”,

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2.0 DESIGN BASIS/ PHILOSOPHY FOR CP SYSTEM

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ABBREVIATION

AJB	:	Anode Junction Box
CP	:	Cathodic Protection
CPTR	:	Cathodic Protection Transformer Rectifier
CJB	:	Cathode Junction Box
MJB	:	Monitoring junction Box
MMO	:	Mixed Metallic Oxide
PCP	:	Permanent Cathodic Protection
CMS	:	Central monitoring system
RTU	:	Remote Terminal Unit
PLC	:	Programmable logic controller
DW	:	Deep well
GL	:	Ground Level

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1.0 Codes and Standards

The entire work shall be performed as per the following codes/ standards.

NACE	: SP-0169, SP-0285, SP-0177, SP-0286
OISD	: OISD 150
DIN EN 50162 VDE 015:	Protection against corrosion by stray current from direct current (DC) systems.
BS EN 12954	: Cathodic protection of buried or immersed metallic structures
IEC/ NEC/ IS	: Relevant codes
IS/ IEC: 60079	: Electrical Apparatus for Explosive Gas Atmosphere
IS/ IEC: 60529	: Classification of Degree of Protection Provided by Enclosures

Indian electricity act and rules framed there under.

Fire insurance regulations.
Regulations laid by Chief Electrical Inspector of State.
Regulations laid by Chief Inspector of Explosives.
Regulation laid by Factory Inspector of State.

Wherever the requirements in this specification are in conflict with any of the above standards, the requirements of this specification shall be binding.

2.0 Design basis:

Impressed Current Cathodic Protection (CP) System to be provided for Carbon Steel material for soil side corrosion prevention of underground piping (without having heat insulating material), Tank bottom plate (without application of thermal isolation barrier, fire brick on tank bottom plate) resting on soil/ sand pad, underground vessels inside the pit and their connecting lines as applicable for the tender. Anodes to be considered for impressed current CP System shall be Mixed Metal Oxide (MMO) tubular and close distributed long line mixed metal oxide (MMO) wire anode piggyback connected with anode lead cable, factory pre-packed with coke breeze with factory connected tail cables as per structure design and site condition. Also, Sacrificial Anode Cathodic Protection system shall be considered on channel and floating head side of cooler/ heat exchangers containing conductive fluids/cooling water with dissimilar metallurgy in channel/floating head side. The dissimilar metallurgy shall be in the form of Bimetallic (Galvanic) coupling made of Carbon Steel and Stainless Steel or other ferrous or non-ferrous alloys (e.g. Carbon Steel Channel having SS 316 Fixed Tube Sheet etc.).

No Insulating joints shall be installed to isolate any incidental structures from CP System within the Battery limit. Hence the structures intended to be cathodically protected shall be in electrical continuity with many foreign structures within the plant complex such as RCC pavements, RCC foundations, earthing grids, other U/G structures, which are not intended to be protected. The CP current requirement therefore shall be governed by following factors:

- Surface area and coating quality of structures to be protected.
- Surface area and surface condition of nearby foreign structures including earth grid.
- Relative position of anode between foreign structure and structure intended to be protected.

To take care of such situation CP System shall be designed & installed in two stages by providing one preliminary design and another supplementary design for Impressed Current CP System as follows:

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Preliminary design:

A preliminary design shall be made as per required scheme which shall be approved by Owner/ consultant. The quantities required for T/R units, Power Distribution Boards, anode beds of various configurations, Junction boxes (AJB, CJB, MJB, etc.), Cables of various sizes, Thermit weld connections, and any other materials as required shall be calculated by CP CONTRACTOR. The locations of T/R units, Distribution Boards, anode beds of various configurations, Junction boxes (AJB, CJB, MJB, etc.), Cables of various sizes, Thermit weld connections, shall be marked by CONTRACTOR in appropriate layout drawings and shall be submitted along with Detail engineering package to OWNER/ EIL for approval. The T/R Units, PDB, and MJB shall be installed at one location under a common sun/ rain shed in non-classified area near the equipment. Based on site condition, CP contractor shall decide location/distance of the CP equipment from the site plot plan/layout. Cathodic protection Transformer Rectifier unit (CPTR Unit) shall be oil cooled, outdoor type. The power supply for the T/R Unit/ PDB shall be drawn from the identified cubical of the electrical substation nearest to the equipment.

Supplementary design:

After energising CP System as per preliminary design, the unprotected/ under protected and over protected areas shall be identified and a supplementary design is to be made to bring all structures intended to be protected within acceptable potential limits.

The following criteria shall be followed to determine the protection levels:

- Maximum allowable equipment to soil potential with respect to Cu/ $CuSO_4$ ref. Cell: –1.10V (Instant OFF) for impressed current system.
- Minimum allowable equipment to soil potential with respect to Cu/ $CuSO_4$ ref. Cell: –0.850 V (Instant OFF) or –100mV polarization shift .
- Discretion to use any of the criteria shall solely rest with Owner/ Owner's Representative.
- Interference Criteria: +50mV positive shift.
- Design life of Anode = 25 years (minimum) for impressed current CP system.

a) While deciding number of modular type 75V/75A, 50V/50A, 25V/25A , 50V/75A, 50V/25A, 25A/12 V capacity T/R units, considerations must be given to see no T/R unit is loaded more than 75% of its rated output voltage & current capacity throughout design life while feeding load to a single or group of anode beds.

b) For continuous wire anode the anode current capacity shall be considered as 30mA/m for design purpose and tubular anode 6A rated current output to be considered.

c) Identification and mitigation of interference between structures to be protected as well as between the structures to be protected and foreign structures need to be carried out by the contractor as per the requirements of the codes mentioned in this document.

d) Earthing of all T/R Units, PDB and Junction Boxes need to be done by connecting the same with plant earthing grids, wherever plant earthing grids are not available nearby, a separate earth pit approved by OWNER/ EIL may be considered by contractor.

e) To avoid cable damage in the long run, all cables are to be laid at the cable trays wherever possible; underground cable laying through PVC/ HDPE conduit should be considered only when

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no cable trays are available nearby. All CP System cables need to be laid at power cable trays, all multi core- monitoring cables may be laid in either electrical or instrumentation cable trays whichever is available.

f) The type of coating and operating temperature of each Equipment should be taken into consideration for all detail-engineering calculations.

g) Wherever specific guidelines are not furnished for cathode structure current density, a current density shall be considered for coated piping: 3.0 mA/m2 and for bare cathode/incidental structures: 25 mA/m2.

h) If operating temperature of Equipment exceeds 25 deg C, protective current density shall be corrected @ 0.5mA/m2/deg. C up to 60 deg.C.

i) Connection of drainage cables and measurement cables to the structure shall be done by Thermit welding method.

j) Sand resistivity need to be considered for the structure CP System design as minimum 200 ohm- m or as measured at site whichever is higher.

k) The structure shall have suitable paint for the soil side corrosion protection

l) Reference cell shall be supplied along with required length of lead cable connected at manufacturer's factory as far as possible.

2.1 Design Scheme for Cathodic Protection (CP) System:

Free ends of each string anode shall be terminated to AJB through loop connection on sand cushions. Outdoor type, Transformer-Rectifier unit (T/R Unit) shall be installed to energise the anode strings through anode junction boxes (AJB). Rating of T/R unit shall be 75V/75A, 50V/50A, 25V/25A, 50V/75A, 50V/25A, 25A/12 V based on design calculations. T/R Unit shall have one or two outgoing positive header cables, which shall be terminated to post/ structure mounted AJB to be installed at suitable location near the structures. T/R Unit shall have one out going negative header cable, which shall be terminated, to a cathode junction box cum test station (CJB). CJB cum test station (CJB) shall be located at suitable location near the structures for the drainage connection and potential measurement. Two drainage cables and two measurement cables from each structure shall be terminated to its CJB. Power supply for the T/R Unit shall be drawn from the nearest S/S. OWNER shall provide one 63A/ 250A, 415V, TP circuit breaker/ Switch Fuse unit at the nearest S/S. CONTRACTOR need to lay one 3-phase, 4-wire (Required cable size) power supply cable from this circuit breaker/ Switch Fuse unit outlet to one outdoor type PDB near the T/R Unit location for distribution of power to the T/R Unit. The reference cell cables and the measurement cables from each structures shall be routed through the respective cathode junction box cum test station (CJB) to a single Monitoring Junction Box (MJB), which shall be located near the T/R Units and have the provision of measurement of structure to soil potential.

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Also for monitoring of structure to soil potentials at the T/R unit, monitoring cables consisting of reference cell and measurement cables shall be laid between MJB and T/R unit for connection of at least three reference cells to T/R Unit panel. Rotary Selector shall be used at the TR Unit for measurement of potential for each reference cell. The T/R Units, PDB, MJB and RTU shall be installed at one location under a common sun/ rain shed in non-classified area near the Electrical S/S or near the process unit/ offsite area to be decided jointly at the detailed engineering stage by EIL / OWNER.

Common Computerized central monitoring of all T/R units and the permanent reference cells of CP System shall be provided with the help of microprocessor based CP System remote terminal unit (RTU) for subject unit area. The central monitoring unit shall be located at Central Electrical substation.

2.1.1 Tank Bottom Plate:

The anode strings shall be laid in the sand cushion of the tank foundation, extending straight from one end to other end or making each single loop in the same end of the tank rim. Alternatively, concentric anode ring configuration factory predesigned may be considered for diameter 60 meter and above. Following guide lines shall be considered irrespective of anode length worked out from the current density calculation for installation of String Anode for coated tank bottom plates for uniform current distribution:

- Average depth of String anode from bottom plate to be protected shall be minimum 1m.
- Spacing between consecutive anode strings shall be maximum 1.5m.
- Minimum 5 nos reference cell to be provided for each tank.

2 Nos. of anode lead cables from each string loop shall be terminated to AJB. Each alternate loops of string shall be in same direction for easy access of AJB's. However tail cables of each alternate loop of anode string shall be terminated into different AJB. Dedicated TRU with suitable rating to be considered for each tank.

In case tank is mounted on RCC pile foundation, one insulating HDPE film is to laid on the pile cap before sand filling of the cap to ensure minimum CP system current is diverted to the pile cap.

Contractor need to lay one layer of insulating HDPE film of thickness 1.2mm on the concrete surface of the RCC cap before sand filling on the pile cap. The contractor shall decide the Roll size of the HDPE film. While laying, overlap of 5mm is to be made between consecutive longitudinal HDPE strips. Also, the overlaps need to be sealed using blowlamp or plastic welding method.

During operation of the tank, the bottom plate is subject to flexure and settlement due to loading/ unloading of the contents of tank. Therefore, if required suitable shielding arrangement to be provided on string anode system to ensure that it does not touch the bottom plate.

Three HDPE perforated pipes shall be provided under the tank at 300 mm distance from tank base. All the pipes shall be installed at 1200 apart from each other. The HDPE pipe shall be covered with geotextile cloth and shall be of 75mm diameter, slotted of 50 mm (2 inch) in length 0.15 mm width, 4 kg/cm2 pressure rating, sealed at one end.

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2.1.2 U/G vessels:

RCC pit shall be provided for the U/G vessel, Anodes string employed for C.P. System of U/g vessels shall be located within the RCC pit. Specific installation requirements of String Anode shall be as follows:

- Anode strings shall be installed in the sand cushion surrounding the vessel at a distance of 500 mm from the vessel.
- Separation distance between consecutive String anode loop shall be uniform.
- Length of each longer side of the loop string anode shall be same as the length of the vessel + 0.6m.
- Minimum 4 No. of strings should be considered for each vessel

Free ends of each anode string should be connected to AJB located at each end of the vessel. Thus 2 No. of anode lead cables from each anode string shall be terminated to AJB.

2.1.3 Plant UG Piping :

Anode Beds to be employed for C.P. System of U/G piping shall be Close distributed MMO Titanium tubular anode pre-packed with coke breeze should be considered as anode for impressed current CP System except for very congested area where MMO Titanium wire anode pre-packed with coke breeze at anode manufacturer's factory shall be installed for underground piping as applicable as per site condition. The length of anode wire shall be same as length of U/G pipe for single run of pipe. In case of parallel run of pipes and higher dia pipes, the no.of continuous anode strings to be considered depending on factors such as diameter of pipes, congestion of the area etc. Each continuous anode string shall be of 300m (max.) length and shall be fed at both ends from a single T/R Unit using same or different anode junction box. Wire anode shall be laid laterally along the pipe axis at a distance 2D or 500mm from the pipe.

For monitoring the performance of the CP System, Permanent Cu/CuSO4 reference or silver / silver chloride reference (as per site condition) cells shall be installed at a distance of 300mm from the UG Piping for monitoring of CP System. Minimum 5 no. of reference cells to be installed for piping at equidistant locations for each TR Unit. Test coupons to be provided to measure the off potential in the critical / congested area. Also, soil access pots shall be provided for measurements for potentials at each test post in paved areas. Test posts shall be provided at an average spacing of 150 m distance.

2.2 Detailed Engineering Works to be performed by Contractor for CP System:

Following detailed engineering works are to be performed by contractor based on scheme given vide item no. 2.1 and design basis given vide item no. 2.0 of this document for CP System:

- List of materials/ equipments to be procured from Indian market/ foreign market.
- Item wise list of vendors with their reference lists for supply of materials/ equipment.
- Calculation and Preparation of Bill of Quantities for all CP system materials and equipment required.

Bill of quantity along with detailed calculations and preparation of specifications, installation work procedures & fabrication/ construction drawings for following items:

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- CP System power distribution board (PDB): Total quantity and connection scheme showing group of T/R units to be connected with each CP System PDB and connection details between owner's switch board and each CP System PDB.

- T/R unit: Total quantity, detailed circuit diagrams and their installation drawings.

- AJB/ CJB/ MJB: Total quantity and connection Scheme showing how group of anodes, anode beds and structure/ equipment are to be connected with each AJB/ CJB/ MJB. Also, fabrication drawing & schematic drawing for internal terminal arrangements and installation drawings for a typical AJB/ CJB/ MJB.

- Anodes: Total nos. of Anode strings and anode string to anode lead cable joint details for entire CP System and their layout arrangement drawings showing no. of anode strings in each. structure/ equipment. Construction drawings and work procedures for anode to cable jointing and also for installation of anode strings.

Design calculations showing:

- Cables: Total quantity of cables and their layout drawing for each CP Station as well as for entire CP System for +ve header cables, -ve header cables, anode lead cables, earthing cables, drainage cables, power supply cables and multi-core monitoring cables.

- Cable to structure/ equipment joint: Total quantity of joints and details of a typical joint.

T/R unit wise CP System layout drawing showing how each T/R unit is connected with group of anode strings for UG Vessel/ Tank bottom plate/ UG piping through AJB/ CJB/ MJB.

- Test points: All reference cells and anode strings should be marked in a single layout drawing.

- Overall CP System layout drawing including all test points, anodes, anode beds, AJB, CJB, MJB, cable routes on a plot plan. All CP System materials/ equipment shall be marked properly for easy identification on all appropriate drawings as well as on site.

- Preparation of testing & commissioning procedure for CP System.

- Preparation of construction drawings with soft copies before starting of installation/ procurement work, Preparation of Soft & hard copies of as built drawings after completion of CP System work, shall also be furnished.

- Quantified list of the major construction equipment, tools, tackles etc. including Diesel engine pump set for dewatering at cable/ pipe trench the BIDDER proposes to use for execution of the work.

- Details & list of vehicles proposed to be used by the CONTRACTOR during the entire construction & commissioning period for transportation of material, equipments, as well as movement of personnel within the plant area.

- Bar chart giving details how BIDDER plans to execute the work within the specified time

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schedule.

- Quality Assurance Plans/ Procedure

The CONTRACTOR shall establish document and maintain an effective Quality Assurance system as outlined in recognized codes etc. and Quality Assurance Plans included in Specifications etc. to ensure that the work is performed in a planned, systematic manner to the best quality standards and properly documented to provide confidence that materials supplied and/ or work executed and services performed by him conform to the applicable specifications and all the requirements of contract document and work executed by him shall perform satisfactorily over the entire period of its life.

The Quality Assurance Systems Plans/ Procedures of the CONTRACTOR shall generally cover the following aspects/ details, which shall be furnished by BIDDER along with, his detail- engineering package.

i) A Quality Assurance Organogram with curriculum vitae of key personnel responsible for the Quality Assurance at site.

ii) Complete details pertaining to the responsibility authority and accountability of the Quality Assurance Organization of the CONTRACTOR at site.

iii) Equipments, material, Erection, Installation, Testing and commissioning control plans for quality testing/ inspection etc.

iv) Quality Control of processes such as Thermit welding, anode to cable jointing etc.

v) Control Procedures/ Plans for calibration and safe up-keep of instruments, gauges and similar testing equipments etc.

vi) Quality audit & Maintenance/ records/ procedures etc.

vii) Other relevant details.

Quality Assurance System Plans/ Procedures of the CONTRACTOR shall be furnished in the form of a QA manual. BIDDER shall be required to provide explanation pertaining to the details furnished by him in accordance with provisions contained in this clause and any further details, as sought for by OWNER/ EIL. In addition, all the Quality Assurance Programs/ Plans as per specifications enclosed with the Contract shall be fully complied with by the Contractor.

- Precautionary measures to be taken to prevent fire hazard during Thermit welding and Pin Brazing of structure/ equipment for the purpose of cable to structure/ equipment joint as well as during installation, operation & maintenance of CP System.

- All other information as required in individual job specifications shall be furnished by CONTRACTOR in his detail-engineering package.

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3.0 SPECIFICATION FOR CP SYSTEM EQUIPMENT AND MATERIALS

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3.1 SPECIFICATION
FOR OIL COOLED TRANSFORMER/ RECTIFIER UNIT

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SPECIFICATIONS AND TESTING OF OIL COOLED TRANSFORMER RECTIFIER UNITS

The specifications and testing procedure of transformer units are given as follows:

3.1 TRANSFORMER RECTIFIER UNITS (T/R UNITS)

The transformer rectifier units shall be a standard product of a manufacturer regularly engaged in production of cathodic protection power supplies. The units shall be supplied in accordance with the following specifications and data sheets.

3.1.1 CODES AND STANDARDS

In general the T/R Unit covered by this specification shall unless otherwise specified, be in line with the requirements of any of the latest applicable standard of:

a) Indian Standards Institution (ISI)

b) International Electrotechnical commission (IEC)

c) American Standards Institution (ANSI)

d) British Standards Institution (BS)

Wherever the requirements in this specification are in conflict with any of the above standards, the requirements under this specification shall be binding.

3.1.2 TRANSFORMER

The main transformer will be the isolation type having separate primary and secondary windings. An electrostatic shield, composed of heavy copper foil, shall be placed between the two windings and grounded to the rectifier cabinet, for this purpose a visible lead should be brought out from the copper foil which shall be connected to any of the mounting stud of the transformer core. Transformer winding wire insulation, winding interlayer insulation, core to winding insulation shall be class F type. The transformer core and winding will be dipped in thermosetting varnish and baked. Transformer varnish will meet the standards for 155 degree C operation. The transformer winding shall withstand 2,000 volt (RMS at 50 hertz) applied for one minute between the windings and between each winding and the transformer core. Maximum temperature of transformer oil will not exceed 85 Deg.C and air temperature inside the upper cabinet will not exceed 85 Deg.C at full load current at ambient temperature of up to 45 deg.C. Transformer full load efficiency will not be less than 95%.The auto transformer shall be similar to main transformer except it will have single winding and tapping for manual mode of control.

3.1.3 RECTIFYING ELEMENTS

The power rectification shall be done by Silicon diodes mounted on heat sinks of sufficient size to prevent the diode case temperature from exceeding 100^{o}C at ambient temperature as per data sheet. The peak inverse voltage rating and current ratings of the diodes shall be as per data sheet. The diodes shall be connected in Bridge circuitory for full wave rectification. Each diode in the bridge circuit shall be protected by a HRC fuse.

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3.1.4 A.C. INPUT

The transformer rectifier units shall be designed to operate on 240 volts (±10%) AC single phase, 50 Hz power supply. Inrush current limiting reactor of suitable rating to be provided at input line of the main transformer to avoid possibility of abnormal tripping of MCB while closing circuit using MCB.

3.1.5 D.C OUTPUT

The transformer rectifier shall be designed to operate continuously at 100% rated output current and 100% rated output voltage at input supply voltage 240v (±10%) without exceeding specified hot spot temperature limit and without damaging any components.

3.1.6 D.C OUTPUT ADJUSTMENTS

The DC output control shall be available in any of the following modes, with the help of a selector switch.

3.1.6.1 MANUAL MODE

Output voltage at 23 equal steps up to 100% rated voltage shall be available by means of coarse and fine tap changing switches for rated input supply voltage and 100% rated output current. Tapping for output voltage control shall be taken from a separate auto transformer. The controlled output voltage of the auto transformer shall be fed to main transformer input. The output of the main transformer shall be rectified for DC load supply.

3.1.6.2 AUTO MODE

Unit shall have CONSTANT OUTPUT CURRENT/ VOLTAGE CONTROL (AVCC MODE) in AUTO MODE as per Data Sheet.

CONSTANT CURRENT AND VOLTAGE CONTROL (AVCC MODE)

It will be possible to operate the T/R unit in either Constant Voltage Mode or Constant Current Mode.

Constant Voltage control feature shall be achieved by automatically adjusting T/R unit output voltage between 0 to 100% rated voltage through close loop control using T/R unit output voltage as feedback taken from the voltage divider inside the T/R unit so that T/R unit output voltage of any value between 0 to 100% rated voltage does not vary more than ±0.5V of set value when there is a change in input supply voltage of ±10% or change in load resistance over a specified range decided by the ratio of output voltage & current rating of the T/R Unit

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3.1.7 DC OUTPUT RIPPLE

The filter circuit shall be designed in such a manner that ripple factor does not exceed 5% RMS at rated load both in Auto and manual mode.

3.1.8 INPUT OVERLOAD PROTECTION

Protection from overloads on the input will be provided by Miniature circuit breakers of suitable rating on the input side. The trip point will be unaffected by ambient temperature. The trip handles of individual poles of circuit breaker will be mechanically linked so that all lines are opened when an overload occurs. In addition to above MCB, HRC fuse of suitable rating should be connected before MCB so that AC .input current is limited to max. 10% excess rated input current as per data sheet.

3.1.9 OUTPUT OVERLOAD PROTECTION

Protection from overload on the output in auto mode for T/R unit having either constant current control or constant pipe to soil potential control will be provided by another close loop SCR control circuitry giving automatic constant current control same as mentioned vide 3.1.6.2(i) except that it will act as back up control to main auto mode control. Separate PCB shall be used for main auto mode control and the backup control. The current limit for backup control is to be set by two limit switches marked "coarse" and "fine". The limits of the two switches shall be algebraically additive and shall give equal 30 steps up to 110% rated current. One scale calibrated in Ampere shall be provided with each limit switches so that current limit can be set by operator at any desired value in 30 equal steps. In any circumstances even in case of short circuit the T/R unit output current should not exceed the current limit set by the backup control.

In addition to above electronic current limiting feature HRC fuse of suitable ratings to be used at positive and negative terminals as well as one double pole MCB of suitable rating to be connected after HRC fuse at the output to disconnect T/R unit quickly in case of over loads in the output circuit or for ease of isolating T/R Unit from the circuit when it is desired to keep the T/R Unit in standby mode.

3.1.10 VOLTAGE SURGE PROTECTION

Each silicon controlled rectifier (SCR) and Diodes shall be protected from voltage surges by means of R-C/MOV circuitry. This R-C circuitry/MOV will be rated as recommended by the manufacturer of the SCR/

Diodes so that they will conduct heavily before the peak inverse voltage ratings of the SCR/ Diodes are reached. In addition, lighting arrestors and zener Barrier type or MOV type surge Diverters shall be provided in the AC input and DC output circuit of the Transformer rectifier as per data sheet.

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3.1.11 COOLING

The transformer/ rectifier will be Natural oil cooled (ONAN) completely enclosed IP55 construction. The temperature of the oil measured at the top layer shall not be more than 85 ^{O}C and maximum air temperature of the upper cabinet should not be more than 85^{O}C for ambient temperature of up to
45 ^{O}C.

3.1.12 INPUT AND OUTPUT TERMINALS

DC terminals made of tinned plated copper shall be located convenient to the cable entrance. The terminals shall be suitable for cable sizes as per data sheet. Three negative and three positive output terminals shall be provided.

AC terminals shall be insulated to withstand 2000 volts 50Hz to the enclosure, shall be shielded to prevent accidental contact and shall be sized to take cable sizes as per data sheet.

3.1.13 METERS

The transformer rectifier units shall be equipped with separate continuous reading voltmeter and ammeter for the DC output and the A.C. input voltage, current and Structure to electrolyte Potential measurement meter with selector switch for selection of different Structure to electrolyte Potential measurement meter. All meters shall be electronic digital type with LED display arrangement and should be able to indicate the current and voltage ranges as per data sheet up to a resolution of one decimal place for DC Ammeter & Voltmeter and 2decimal places for PSP meter. Digit size should be 12.5mm (minimum). All meters shall be rectangular in shape and accurate to within 2% at full load at ambient temp. as per data sheet. They shall be temperature compensated to vary no more than 1% per 10% temperature changes.

All AC&DC voltmeters shall be provided with separate fuse and toggle switch whereas all Ammeters shall be provided with only toggle switch.

3.1.14 ANNUNCIATION

Each transformer rectifier shall be supplied with a continuous signal light which will go out at loss of AC input. In addition to this each T/R unit should give annunciation for Auto and manual mode of operation by continuous signal light. T/R unit should also indicate the failure of each fuse in bridge rectifier and two DC output fuses by an independent LED for each.

3.1.15 ENCLOSURES

"The enclosure of T/R unit shall be plinth mounted type having two compartments. Lower compartment shall contain main transformer, Auto-transformer, DC choke and the compartment should be filled with Transformer oil to IEC 296. The upper compartment shall contain the SCRs, Diodes, indicating meters, Protective devices, Electronic control circuits/ control cords etc. and shall be provided with a plexi glass viewing window. Both the compartments shall be completely enclosed type having IP55 construction.

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The enclosure shall have a frame work made of minimum 50mmx 50mm x 3mm angle iron, the upper cabinet body shall be made of minimum 12SWG(2.5mm) W.T. sheet steel, lower cabinet shall be 10 SWG(3.0mm) W.T sheet steel. Size of enclosure shall be minimum 1500(H) x 700(W) x 550mm (D) or higher size than this. Necessary fins for the cooling purpose shall be provided at lower compartment. A detachable sun/ rain shade to be provided of suitable size.

The transformer rectifier shall be provided with the following accessories.

- Steel channel under the base for plinth mounting.
- Lifting lugs of size suitable for lifting complete transformer rectifier unit when full of oil
- Sunshade/ rain shade.
- Oil filing hole with screw cap and drain plug.
- An oil sight gauge comprising a flat toughened glass window through which the oil is viewed. The viewing window shall have a white background.
- Silica gel breather suitable for 10KVA transformer to be located inside the upper cabinet of T/R unit.
- A removable dial type thermometer graduated in degrees Celsius with a red mark on the scale at the maximum oil temperature.
- Thermometer pocket
- Locatable control cabinet with viewing window to IP-55 as a minimum.

Accessibility shall be provided by hinged and removable front and back shutters. A plexi glass viewing window shall be provided at the front shutter to allow the meters to be read without opening the front shutter. One drawing pocket shall be made at inner side of the front shutter. One holder for 5W LED lamp connection shall be provided at a strategic point inside the cabinet to facilitate proper illumination during operation and maintenance. The enclosure shall be supplied with an engraved warning level with the words "DANGER". Two junction boxes shall be provided at both sides of the upper compartment, one of them A.C. cable entries and other for D.C. cable entries. Gland plate should be provided against each junction box for fixing single compression cable glands for A.C DC control/monitoring cables. One 240V, 5A Socket shall be provided at a strategic point inside the cabinet to facilitate connection of soldering iron during maintenance. After fabrication the entire enclosure shall be sand blasted to SA 21/2 surface to surface or chemically treated with Industry Standard 7 Tank treatment process. An inorganic zinc primer shall then be sprayed to a total thickness of 3 mils. The finish coat shall be a dark grey shade of polyamide cured epoxy in three coats to achieve total thickness of 10 mils. Alternatively Powder coating of total thickness 100-125 Microns is also acceptable.

3.1.16 ENCLOSURE EARTHING

All normally dead metallic parts shall be electrically continuous, earthing terminals shall be suitable for 35mm square cable connection, one earthing terminal shall be made for earthing connection to power supply earthing and two earthing terminals shall be made for earthing connection to the local earthing pits.

The earth connection points shall be protected against corrosion. It shall not be necessary to scrape the paint away in order to make an effective earth connection. Provision shall also be made adjacent to each gland plate for cable gland earthing connection.

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3.1.16.1 Cable Terminations

i) Cable glanding and terminating facilities and terminals shall be suitable for the specified cable type and conductor size. Consideration and provision shall be taken by the manufacturer on the equipment design for the use of cables with aluminium conductors. Cable glands & cable lugs shall be in the scope of supply for CP system installation contractor.

ii) Terminal blocks shall be arranged and positioned to afford easy access for carrying out external cable termination, testing, inspection and maintenance. There shall be ample clear space allowed between the terminal block and the gland plate for the spreading and termination of external conductors.

iii) All terminal blocks shall be shrouded or provided with transparent covers. Pinch screw type terminals are not acceptable.

iv) Three positive and three negative post type DC output terminals shall be provided for the T/R Unit. Each post shall be fitted with double nuts and washers.

v) Terminals for different voltages shall be separated by partitions.

vi) A terminal box or chamber with undrilled gland plate or entry panel of sufficient dimensions to terminate the specified incoming and outgoing cables shall be provided. Direction of cable entry shall be from below.

vii) Termination of single core cables shall be through a suitable gland plate and provision made for bonding and earthing any armour and/ or concentric ground conductors.

viii) Cable terminal arrangements for power and control cables may be integrated provided that a barrier separates the two.

ix) Auxiliary wiring shall have copper conductors of the manufacturer's standard sizing (subject to Buyer's approval).

x) Suitable terminals for three nos. ref. cell cables, one no. measurement cables and a selector switch for permanent ref. cell to be provided for T/R unit panel for connection to PSP meter. Wiring shall be crimped using self-insulated compression type terminal blocks which shall be suitably identified. Conductors shall be fitted with sleeve ferrules bearing the same identification as the terminal to which they are connected. Minimum conductor size shall be 1.0mm2 (current density shall not be more than 3A/mm^2 for copper conductor). However, Electronic wiring can be done with 0.5 mm^2 conductor.

3.1.17 NAME PLATE

A permanently stamped stainless steel metal plate shall be attached to outside of the case with the following information.

a. Manufacturer's name

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b. AC input voltage and current rating

c. AC frequency
d. Phase
e. Output DC Volts and Amps. rating
f. Weight in Kg of T/R unit
g. Model number
h. Serial number
i. Year of Manufacture

3.1.18 SPECIFICATION OF 75V, 50A T/R UNIT

A. AC input voltage : 240 Volts ±10% 50 Hz single phase
B. AC input Current : 30A (Max.)
C. DC power output : 3.75 KW (Max.)
D. KVA rating of transformer : 7.5KVA
E. DC output voltage : 75V
F. DC output current : 50A

G. Current rating
- Diodes: 100A(Max. Average forward current)
- SCR : 85A(Average on state current), 133A (RMS on state current)

H. Full load efficiency
- Transformer alone : More than 95%
- Transformer Rectifier Assembly : More than 75%

I. Full load power factor : 0.8 lagging
J. Insulation level : 2KV
K. Peak Inverse Voltage
- Diodes/SCR's : 1500V(PIV)

L. Filtering circuit : L.C.filter
M. Ripple and Hum at rated output : Not more than 5% RMS

N. Surge Diverters
i) For diodes/SCR's : R-C circuitry of rating as advised by manufacturer of SCR/ Diodes or MOV
ii) For input of T/R unit : 2 nos. Zener Diodes of voltage rating 300V RMS, spark over voltage 1000V(Peak), RIR Type A6 FMR 100 BB or equivalent MOV type surge diverters.
iii) For output of T/R : 2 nos. Zener Diodes of voltage unit rating 300V RMS, Spark over voltage 800V(Peak), RIR Type A6 FMR 80 or equivalent MOV type surge diverters.

O. Lightening arrestor: 2 nos. each at the input and output of the T/R unit of voltage rating 500V RMS, Max. 1.2/50 micro Seconds impulse spark over voltage 2.5KV(Peak), Max. discharge residual voltage at 5KA, 8/20 micro second impulse current wave 2.5KV @1.5KA, Max. impulse current discharge capacity 4/10 micro second impulse current wave 10KA(Peak), LAMCO PL01 L.T-2.8 or equivalent make.

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P. Protection : MCB suitable for motor load having thermal over load and magnetic short circuit Protection for input current in addition to separate HRC fuse protection for each Diode, HRC fuse

at out put and input terminals, glass cartridge fuse, in the live line of all lamps, auxiliary power lines to control circuit and voltmeter circuits.

Q. Construction : Plinth mounted outdoor type.

R. Cooling : Oil cooled

S. Meters/ Instruments: As per Sec.3.1.13.

1No.DC voltmeter 0-200V,
1No.DC Ammeter 0-60A
1No.AC voltmeter 0-300V
1No. AC Ammeter 0-30A
1No.Corrosionvoltmeter,0-19.99V,10Mohm input resistance.

Other accessories:

a) Silica Gel Breather
b) Dial type thermometer 8 Dial 2 1/2" graduate in degree celsius with one red mark on the scale at the maximum oil temperature.
c) Thermometer Pocket
d) Oil filling screw cap and drain plug.
e) An oil sight gauge comprising a flat long head glass window with white back-ground through which oil is viewed.
f) Sun shade/rain shade.

T. Enclosure: Per sec. 3.1.15

U. Cable Entry: Through single compression Aluminium gland of following sizes of cables. Gland plates are to be provided at the junction boxes located at both side of upper compartment:
+ve and -ve header : 95mm^2/ 50mm^2 1-core, 4nos.
Power supply cable : 25mm^2 , 3-core, 1 No.
Monitoring cable : 6mm^2, 1-core, 3 nos
(Monitoring cable to be used in case permanent ref.cell is used for monitoring pipe/ structure to soil potential)

V. Enclosure painting : As per sec. 3.1.15

W. Fabrication, Schematic: Supplier to furnish for EIL approval schematic wiring diagram and fabrication drawing prior to fabrication of T/R units.

X. Spare parts & Additional features : Supply as per Sec.3.1.18.

Y. Ambient temp. : 45 deg.C

Z. Type of control required in Auto mode: Constant current control and constant voltage control (AVCC MODE)

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3.1.19 DATA SHEET OF 50V, 25A T/R UNIT

A.	AC input voltage single phase	:	240volts±10%50HZ B.
B.	AC input current	:	10A (max.)
C.	DC power output	:	1.25KW (max.)
D.	KVA rating of transformer	:	2.5 KVA
E.	DC output voltage	:	50V
F.	DC output current	:	25A
G.	CurrentratingSCR:50A (Average onstate current),75A(RMS onstate current)		

Rest same as3.1.18exceptin item(s) where meter rating shall be as under

1No.DC voltmeter0-60V,
1No.DCAmmeter0-30A

1No.AC voltmeter0-300V

1No. AC Ammeter0-10A
1No.Corrosionvoltmeter,0-19.99V,10Mohm input resistance.

3.1.20 Testing of T/R units

All T/R units shall be tested by contractor and inspected by EIL/Owner before despatch, testing shall be conducted in accordance with codes and standards enclosed in this document, as per routine tests done by manufacturer and additional tests as mentioned below:

3.1.20.1 Efficiency test of Transformer Rectifier Assembly at 25%, 50%, 75% and 100% rated output current both in Auto and manual mode of operation.

3.1.20.2 No load output voltage test in Manual mode for each voltage setting using coarse and fine tap switches at rated input voltage of 240V AC.

3.1.20.3 Output voltage and current test in Manual mode for each voltage setting using coarse and fine tap switches for the following conditions.

i) Input voltage 240V AC,load resistance1.5 ohm for 50A T/ R& 2.0ohm for 25AT/R

ii) Input voltage 264V AC,load resistance1.5 ohm for 50A T/R & 2.0ohm for 25AT/R

iii) Input voltage 216V AC,load resistance1.5 ohm for 50A T/R& 2.0ohm for 25AT/R.

3.1.20.4 Output voltage test at rated output current setting in Auto mode for the following conditions.

i) Input voltage 240V AC,load resistance:1.5ohm for 50A T/R & 2.0ohm for 25AT/R

ii) Input voltage 264V AC,load resistance:1.5ohm for 50A T/R & 2.0 ohm for 25AT/R

iii) Input voltage 264V AC,load resistance 0 ohm (short circuit across +ve and-ve terminal of T/R unit). Set back up control 50A & 25A for 50 A & 25A T/R unit respectively.

iv) Input voltage 216V AC,load resistance:1.50 ohm for 50A T/R & 2.0 ohm for 25A T/R

Output current and voltage shall be recorded for each of above conditions (i) to (iv).

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3.1.20.5Heat run test for max. Temp rise to be conducted for main transformer, Autotransformer, filter choke, Diodes and SCR's, at 50A output current for 50A T/R Unit & 25A current for 25A T/R unit for 24hours continuous operation . Number of T/R units to be considered for Heat run tests and actual duration for which test to be conducted up to 24 hours (max.) shall be decided by EIL and owner. Thermocouple instrument shall be used for measurement of temperature. The sensors shall be clamped at different locations inside the closed T/R unit cubical and the cable of the sensors shall be connected to temperature indicator through a selector switch outside the T/R unit cubical during heat run test.

3.1.20.6 Insulation resistance test using 500V megger for Auto transformer and Main transformer between primary and secondary, primary and earth, secondary and earth.

3.1.20.7 Dielectric strength test using 2KV for 1 min. duration for Auto transformer, main transformer between Primary and secondary, primary and earth, secondary and earth.

3.1.20.8 Polarity test in Auto and manual mode of operation of T/R unit.

3.1.20.9 Calibration test for all Ammeters and volt meters.

3.1.20.10 Auto mode over load protection test:

Set back up control at 50 Amp. and increase current from zero to max. Possible using main Auto control for T/R Unit having constant current control. In case of Auto PSP control T/R unit ref. feed back signal to be varied from min. to max. set potential of T/R unit using battery & rheostat in place of ref. half cell signal, current during the test should not exceed more than 50A in both cases.

3.1.20.10.1 Constant Current Test

i) D.C Current Regulation against variation in AC Input

Put the unit in constant current mode and set the output current at 50 A by the help of current setting potentiometer and observe the variation in, if any, of output current with variation of AC input voltage at the steps keeping the output load constant: 216V, 240 V, 264 V.

ii) D.C Current Regulation against variation in Load Voltage

Keeping the AC input voltage at 240 V constant , set the output D.C current at 50 A and observe for any variation of DC current with variation of output load voltage at three different values ensuring that at each output load voltage, taking care voltage limit set value is not exceeded.

Repeat the above at 50A and finally at 25A set output current.

3.1.20.11 Constant voltage test for control circuitory. Supply voltage of T/R unit to be applied 240V 216V and 264V.

For each input supply voltage the reference voltage, +ve DC and -ve DC voltages of Auto mode control circuit to be checked whether they are constant.

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3.1.20.11.1 D.C Voltage Regulation against variation in Load Current

Keeping the AC input Voltage at 240 V constant, set the output D.C voltage at 75 V and observe for any variation of D.C Voltage with variation of output load current at three different values ensuring that each output load current, current limit set value is not exceeded .

Repeat the above at 24 V and finally at 12 V set output Voltage.

3.1.20.12 Ripple factor test

T/R unit shall be operated at full load both in Auto and Manual mode. In each case ripple voltage to be checked on a cathode ray oscilloscope (CRO). Peak to Peak ripple wave from shall be limited within 10.5 volt in CRO screen for7 5 volt TR unit & 7.0 volt for 50 volt TR unit.

3.1.20.13 Annunciation check:

Annunciation check to be done for power on, manual mode operation and auto mode operation.

3.1.20.14 Auto mode constant PSP operation test:

Connect one battery with variable rheostat in place of reference cell feedback signal and conduct the following test:

i) Make both T/R unit set potential & feedback signal from battery 1.0V, Switch on T/R unit & note T/R output current. Increase feedback signal from 1.0V to 1.5V and again bring back to 1.0V. Note change in the T/R output current.

ii) Conduct similar test as item (i) above with decrease of feedback signed from 1.0V to 0.5V and again back to 1.0V. Note change in the T/R output current.

of choke at 50A T/R unit output current =

3.1.20.15 Test certificate/ documents in 6 copies are to be furnished by vendor before despatch of T/R unit to site. The test certificate shall contain results for the tests from 3.1.20.1 to 3.1.20.14 given above in addition the following observations:

- Sl. No. of T/R unit
- D.C. output rating of T/R unit
- External dimensions of T/R unit
- Weight of T/R unit
- Thickness of M.S .sheet steel used for T/R unit enclosure.
- Painting details of enclosure.
- Visual inspection details of T/R unit stating:

a) All components of T/R unit are as per specification

b) All items are labeled properly for identification purpose.

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c) Number used in ferrules of cable leads are matching with schematic/ wiring diagram of T/R unit furnished.

3.1.22 DRAWINGS/ DOCUMENTS

Following drawings/ documents shall be furnished by vendor within 15 days from award of contract for approval of the same by EIL/ OWNER before starting of fabrication. Approved drawings after incorporation of comments (if any from EIL/ OWNER shall be furnished in 6 copies alongwith reproducible during the delivery of T/R units:

3.1.22.1 Fabrication drawings and data sheet of T/R unit giving dimensions, rating, weight, including installation/ foundation arrangement details.

3.1.22.2 Front view and typical sections of T/R unit panel with arrangement of equipment, control, protection and metering.

3.1.22.3 Data sheet of all accessories and circuit element of T/R unit including ratings.

3.1.22.4 Schematic and wiring diagram of T/R unit circuitory giving Auto/ Manual Mode of control including circuit details of all control cards.

3.1.23 INSTRUCTION BOOK

3.1.23.1 The instruction book in 10 copies shall be presented in such manner as to enable it to be used by personnel who are unfamiliar with the operation and maintenance of the T/R unit. The instruction book to be furnished along with supply of T/R unit.

3.1.23.2 CONTENTS

The instruction book shall contain

- A description of the T/R unit.
- Instruction for the installation, testing commissioning and safe operation and maintenance.

The information shall be presented as follows:

1. Index of contents

2. General description giving brief description of the T/R and its use.

Detailed description of T/R unit

This description shall include the technical characteristics, physical and mechanical limitations, and item wise the components, accessories and spare parts.

4. Description of the operation of the T/R unit. This description shall be clear, concise and in

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a logical sequence, using schematic diagram, wiring diagram and fabrication drawing.

5. Procedures for testing and adjusting the T/R unit:

The complete procedure for testing and adjusting the T/R unit during plant operation, periodic maintenance and overhaul shall be covered.

6. Maintenance Instructions:

This section shall be divided into two parts:

a) Preventive maintenance which shall indicate the periodic inspection required the inspection procedure and cleaning procedures.

b) Break down maintenance which shall include instruction for trouble shooting of the electrical circuits. The procedure for the removal and replacement of all parts listed as spares shall be given.

7. Spare parts

The instruction books shall give all the necessary details so as to procure all the spare parts from the manufacture or from open market.

8. Each instruction book shall be accompanied with one set of final approved Drawing/ documents as listed vide item 3.1.21.

- COVERING OF THE INSTRUCTION BOOKS: The instruction book shall be presented in a stiff covered binder with the following information printed on the cover:
    - the client's name
    - the location of the installation
    - the name of the installation
    - the title of the instruction book.

3.1.24 Following additional features are to be provided with T/R Unit

i) T/R UNIT INTERRUPTION

The T/R units shall have programmable current interruption facility according to a schedule defined by the user through the Central Monitoring and Control System. Interruption ON / OFF cycle should be programmable in the time ratio selectable from 0 to 9999 seconds in increments of 1 second. The interruption device shall be solid state type without any mechanical moving parts and shall have arrangement for bypass.

The interrupter clock of TR Unit should accept external time synchronization signal from the

central monitoring system having GPS synchronized current interrupter for measurement and recording of interrupted OFF potential recording in synchronization with other T/R units.

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ii) ANNUNCIATION FOR FUSE FAIL

T/R unit should be provided with Electronic Fuse fail Indicator. The Fuse fail indicator should sense signals from each Fuse in series with diode in the rectifier circuit as well as each fuse in DC

output circuit and on its failure, it should identify the fuse failed with the help of an independent LED for each fuse for local visual alarm.

iii) MANDATORY SPARE PARTS

Mandatory spare parts as mentioned at Section 4.0 in this document need to be supplied for the T/R Units.

IV) T/R UNIT REMOTE MONITORING

T/R Units should be provided with transducers for providing 4-20 mA output signals or direct signals as required for remote monitoring unit (RMU) interface for remote monitoring of T/R Unit output voltage and current. Alternatively, if this feature is built into the RTU, then separate transducers are not required in the T/R unit.
Necessary terminals are to be provided at suitable locations of the T/R unit panel for easy termination of onward wiring by others for remote monitoring purpose.
Each T/R Unit shall accept set point signals for DC Voltage and DC Current from Remote Monitoring & Controlling Panel and accordingly shall control its output from 0 to 100%.

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3.2 SPECIFICATION FOR CP SYSTEM POWER DISTRIBUTION BOARD (PDB)

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3.2 Power Distribution Board (PDB):

The Power distribution board (PDB) shall be plinth mounted outdoor type and shall be installed at non-classified locations near a single or group of T/R Unit under a sun/ rain shed. The enclosure of shall be IP-55 as per relevant IEC/ NEC/ IS codes.

The Power distribution board (PDB) shall be composed of one no.3 phase, 4-wire 250A/ 63A, incoming MCCB and 12/3 no. 1 phase, 63A outgoing MCB for input power supply to TR Unit as well as 6No.6A outgoing MCB for central monitoring system power supply. The incoming switch shall be 3-pole and outgoing switches shall be 2-pole. 4 Nos. of 25x 5mm tinned copper bus bar shall be used which should be taped by PVC tape of red, yellow and blue colours for dentification of the three phases and black colour for neutral. Wiring inside PDB shall be done using $50mm^2$, 1-core, copper conductor, PVC insulated, unarmored cable between TPN switch neutral and neutral bus whereas rest of the wiring shall be done by $25mm^2$, 1-core, copper conductor, PVC insulated unarmored cable. All single core cables shall be used red, yellow and blue coloured for phase connections and black coloured for neutral connection. All cables terminations shall be through Tinned copper cable lugs of matching cable size. All cable entries to the PDB panel shall be through Aluminium single compression glands. One gland for $300mm^2$ / $50mm^2$, 3-phase, 4-core incoming cable connection shall be provided at left side bottom of the panel, 12/3/6 glands to be provided at right side bottom of the panel for outgoing cable connections for 63A PDB. The outgoing cables shall be $25mm^2$, 1-phase, 3-core Aluminum conductor cables for TRU power input and $16mm^2$, 1-phase, 3-core Aluminum conductor cables for central monitoring system power supply. Size of the PDB Panel enclosure shall be adequate to accommodate all components easily and shall be made of 12 SWG sheet steel. Two nos. hinged front shutters shall be provided. The shutters shall be screwed to the panel enclosure structure at the centre in addition it shall have lockable handles. Painting details of inside and outside surfaces of the PDB panel shall be as follows: After fabrications the entire enclosure shall be sand blasted to a SA2½ surface. An inorganic zinc primer shall then be sprayed to a total thickness of 3 mils. The finish coat shall be of polyamide cured epoxy in three coats to achieve total thickness of 15 mils. The finish coat shall be a dark grey or yellow shade as per choice of EIL/ OWNER.

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3.3 SPECIFICATION FOR MIXED METAL OXIDE COATED TITANIUM TUBULAR ANODE FOR CP SYSTEM

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3.3.1.0 Scope

3.3.1.1 Anodes

Mixed Metal oxide coated Titanium tube anodes shall be dimensionally stable and will be supplied with anode lead cable connected to it.

3.3.1.2 ANODE DATA SHEET

Sl.No.	Description	Details
1.	Anode Type	Dimensionally stable Anode (DSA)
2.	Anode Shape & Dimension	Hollow Tubular 750mm long x 25.4mm OD, W.T: 1 mm ± 0.1 mm
3.	Anode weight	0.210 kg ± 5%
4.	Anode Material	Titanium seamless tube of Grade 1, ASTM B 861, overlayed with mixed oxide of noble metals.
5.	Anode design life	30 years
6.	Anode consumption rate (Kg/A-yr) at 100 A/m^2 Current density	2 mg/A-yr.
7.	Metal Oxide coating thickness weight (gm/M^2)	6 gms/m^2(at 100 A/m^2 for 30 years design life)
8.	Optimum Recommended anode current density (A/m^2) i) With Carbonaceous backfill in soil ii) Without backfill in soil iii) Fresh water	 $100A/M^2$ Vendor to furnish Vendor to furnish
9.	Rated current output	6 Amps
10.	Anode Centralizer for 8" NB casing pipe	1 Nos. per anode. Vendor to furnish details.
11.	Mechanical & Physical Properties: i) Electrical Resistivity (ohm Cm) of Metal Oxide ii) Contact resistance of anode to cable iii) Pull out strength iv) Anode fabrication v) Anode to cable connection details vi) Anode to cable joint insulation details	 10^{-5} Ohm Cm 0.9 milli ohms (max.) 200 kg(min) or breaking strength of cable Vendor to furnish details Vendor to furnish details Vendor to furnish details
12.	Dead Weight for Anode	Each anode to be supplied with a dead weight. Details of the same to be furnished by vendor

Note: All information to be furnished by vendor as per data sheet shall be furnished with his offer.

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3.3.1.3 Anode Lead Cable

Anode lead cables to be connected between each anode and AJB shall be 7 strands, 10mm^2 stranded copper conductor, single core, unarmored, with a double insulation system. The primary insulation shall be 0.04/0.1 inch thick cross-linked polyvinylidene floride (PVDF) 1100 Volt grade. The secondary insulation shall be 0.065 inch thick high molecular weight polyethylene (HMWPE) sheathing jacket over the primary insulation. For anode lead cable, manufacturer should have minimum 7 years of manufacturing experience and having proven track record of minimum 5 years of successful performance. The minimum 5 years of performance certificate of this item for any hydro carbon industry /pipelines needs to be furnished by the contractor. The proposed make/model of these items being supplied by contractor shall be subject to acceptance as per sole discretion of EIL/Owner.

Anode to Lead cable jointing and insulation shall be done by using straight through jointing kit which is to be provided by anode manufacturer. Anode to Lead cable jointing and insulation shall be done at manufacturer's work shop.

3.3.1.3.1 Anode to Cable connection

Anode lead cable conductor shall be crimped with tubular anode at the center of anode or at the ends and shall be sealed to prevent ingress of water at the joint. Fabrication details of the joint including sealing arrangement and test procedure of the joint shall be furnished by vendor for EIL's approval before making the joints.

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3.4 SPECIFICATIONS FOR PERMANENT REFERENCE CELL

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3.4 SPECIFICATIONS FOR PERMANENT REFERENCE HALF CELL

3.4.1 For monitoring of soil side potential:

a. Type of ref. half cell : Cu/ $CuSO_4$ type.

b. Body : Impact resistance

d. Each reference shall be supplied in cotton bag of chemical backfill (as per manufacturer recommendation) and complete with 25 M (minimum) cable as per specification. Contractor to measure the actual length of measurement cable required at site during detailed engineering stage and cut the required length from cable drum so as to avoid cable-to-cable joint. Alternatively, moisture proof joints may be carried out at site by trained jointer with holiday testing with manufacturer reference cell cable.

e. Location of half cell : 150 mm from structure

f. Design life : 25 years

g. Stability : ±10 mv with 3 Micro- A load.

h. Make : Shall be suitable for 15-40 deg.C temperature application in sand.

i. Measurement Cable: 4-6mm^2, stranded Cu conductor, Single core, screened/ armoured, PVC insulated and sheathed, 1100 V grade.

Reference Cell Cable: 4-6mm^2, stranded Cu conductor, Single core, screened/ armoured, PVC insulated and sheathed, 1100 V grade.

Contractor shall get the electrodes approved before placement of order. For Reference cell, manufacturer should have minimum 7 years of manufacturing experience and having proven track record of minimum 5 years of successful performance. The minimum 5 years of performance certificate of this item for any hydro carbon industry /pipelines need to be furnished by the contractor. The proposed make/model of these items being supplied by contractor shall be subject to acceptance as per sole discretion of EIL/Owner.
Necessary test certificates from manufacturer giving calibration test, results, date of manufacture shall be furnished during delivery. Any delivery effected without prior approval of owner will be at suppliers risk & cost.

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3.5 SPECIFICATION FOR MIXED METAL OXIDE TITANIUM WIRE ANODE FOR CP SYSTEM

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3.5.1.0 MIXED METAL OXIDE TITANIUM WIRE ANODE

Factory coke backfilled fabric jacketed Mixed Metal Oxide coated Titanium wire anodes shall be a standard product of the manufacturer regularly engaged in the production of such anodes for use in impressed current Cathodic Protection system. The make / model of MMO wire anode being proposed by CP System contractor shall be subject to acceptance as per sole discretion of EIL / OWNER. The anode manufacturer should have minimum 7 years of manufacturing experience for the similar type pre-packed with coke-breeze MMO Ti Wire anodes and also proven track record for minimum five years of successful performance of such anode for UG Vessels/ Tank bottom plate/ Plant piping protection for any hydrocarbon plant need to be furnished by the CP System contractor.

3.5.1.1 Anodes

Mixed Metal oxide anodes shall be dimensionally stable. Each wire anode shall be supplied with anode lead cable piggy back connected to it i.e there will be connection between the Primary anode and the internal header cable at every 3m (max) distance. The connection shall be multi- step and water proof.

Anode Data Sheet:

a.	Anode Type	Dimensionally stable Anode (DSA)
b.	MMO Anode Shape & Dimension	Wire anode 1.5 mm ± 0.10mm*
c.	MMO Anode weight	Vendor to Specify
d.	MMO Anode Material	Commercially pure solid Titanium wire, grade 1/2, ASTM B 863, over laid with mixed oxide of noble metals suitable for soil application
e.	Anode design life	30 years
f.	i) Anode consumption rate (Kg/A-yr.) at 100 A/M2 C. density. ii) Overall OD of anode string with calcined petroleum coke breeze and its fabric jacket enclosure	i) 2 mg/A-yr. ii) 35mm (min.)
g.	Metal Oxide coating thickness weight (gm/M2)	6gms/m^2(min.) / MMO coating on titanium suitable for current output and design life.
h.	Optimum Recommended anode current density (A/M2) i) With Carbonaceous backfill in soil ii) Without backfill in soil iii) Fresh water	i) 100A/m^2 ii) Vendor to furnish iii) Vendor to furnish

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i)	Minimum rated current output in soil/ sand	50mA/m
j)	Mechanical & Physical Properties i) Electrical Resistivity (ohm Cm) of Metal Oxide	 10^{-5} Ohm Cm
k)	Contact resistance of anode to cable	0.9 milli ohms (max.)
l)	Anode fabrication	Vendor to furnish details
m)	Anode to cable connection details	100% water proof. Vendor to furnish
n)	Anode to cable joint insulation details	Vendor to furnish
o)	Allowable attenuation of potential along anode	1% for dry sand of resistivity 20,000 ohm-cm 10% for wet sand of resistivity 500 ohm-cm.
p)	Spacing between consecutive anode to cable joints	3 meters
q)	Coke breeze backfill	Vendor to furnish (as per manufacturer standard)
	Carbon content	99% min
	Coke Resistivity	< 1 ohm
	Bulk density of coke breeze	1180 kg/ m^3 min
r)	FABRIC	The anode wire with surrounding coke breeze should be held together by an Integrated woven, acid resistant and porous jacket assembly.
s)	**Chloride resistance**	**The fabric should pass the 6 month acid immersion test**

- Following Insulation specification to be followed for supply of anode internal header and anode lead cable. Laboratory testing to be done in national/ international reputed laboratory at anode manufacturing country.

Insulation Type	Insulation Specifications**	
Polyvinylidene Fluoride (PVDF) Irradiation Cross-Linked	Tensile Break Strength Break Elongation Flexural Strength Resistivity Dielectric Constant	4500 PSI min. 50% min. 8600 PSI min. 2×10^{14} ohm-cm min. 8.0 min. at 100 Hz
Ethylene Chlorotrifluoroethylene (ECTFE)	Tensile Break Strength Break Elongation Resistivity Dielectric Constant	6500 PSI min. 100% min. 1×10^{15} ohm-cm min. 2.5 min. at 1 Mhz
High Density High Molecular Weight Polyethylene (HMWPE)	Color Density (minimum) ASTM D1248, Type 3, Class C, Category 5, or IEC 60502-1 Temperature Rating	Black 0.941 grams per cm^3 90°C.

** Standard Test Method ASTM D638 shall be used to determine the tensile strength, flexural strength and break elongation. For the resistivity and dielectric constant tests, Standard Test Methods ASTM D257 and ASTM D150 shall be utilized.

Note: All information is required to be furnished by vendor as per data sheet and shall be furnished with his detail engineering package.

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3.5.1.3 ANODE HEADER AND LEAD CABLE

Anode internal header cable and anode lead cable in between each anode string and AJB shall be insulated, 7 strands, 8 AWG/ 10mm^2 stranded copper conductor, single core, unarmoured, with a double insulation system. The primary insulation shall be 0.04/0.1 inch inch **± 0.005 inch** thick cross-linked polyvinylidene floride (PVDF) 1100 Volt grade. The secondary insulation shall be 0.065 inch inch **± 0.005 inch** thick high molecular weight polyethelene (HMWPE) sheathing jacket over the primary insulation.

Jointing of anode lead cable with internal anode header cable and its insulation shall be done by using standard jointing kit which is to be provided by anode manufacturer. However, preference will be given for direct termination of the anode header cable to AJB without any joint in between with internal anode header cable and anode lead cable. Anode lead cable to anode header cable jointing, shall be done at site by a trained cable jointer in case of unavoidable site/ project situation.

3.6.1.3.1 Anode to Cable connection

Vendor should submit procedure and sealing arrangement drawing of the joint and get the Anode lead cable to anode internal piggyback cable joint approved by EIL/ OWNER.

3.5.1.4 QA/ QC for Anodes

Following tests are to be conducted by anode manufacturer. Anodes with cables shall be delivered to site only after EIL/ Owner's approval of the test results, which are to be furnished by anode manufacturer. Detailed procedure for conducting the following tests shall be furnished by manufacturer for EIL/ Owner's approval before commencing tests. All the tests should be conducted in presence of EIL/ OWNER/ TPI (as applicable).

3.5.1.4.1 Visual Inspection Test –

The anode assembly shall be visually inspected for proper compaction of coke breeze and centralization of MMO wire and cable .

3.5.1.4.2 Dimensional check

- Dimensional check of MMO wire anode and OD of complete anode assembly
- Dimensional Check of Anode internal piggyback cable

- Thickness of primary cable insulation
- Thickness of secondary cable insulation

3.5.1.4.3 MMO Wire Anode (Type Test)

- MMO coating loading/ thickness by XRF or SEM method
- Accelerated Life Test NACE TM0108 (latest version)

3.5.1.4.4 Coke Breeze (Type Test)

- Coke Breeze Resistivity as per ASTM G57-06
- Weight of coke breeze per meter of anode

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3.5.1.4.5 Anode Fabric (Type Test)

- Acid Immersion Test for 6months (5N HCl Solution)

3.5.1.4.6 Anode Lead cables (Routine tests)

Routine & type test certificates of cable manufacturer to be furnished for anode lead cable as per IEC std. Cable length and identification tag to be verified by measurement.

3.5.1.4.7 Anode to Cable joint test (Routine tests)

Sample anode lead cable to internal anode header cable joint shall be tested for its electrical contact resistance & its value in ohms shall be recorded.

3.5.1.4.8 a) Prototype Test

First anode string / loop shall be subjected to destructive test to determine pull out strength of cable

to anode joint as well as effectiveness of the joint insulation and coke breeze backfilling to be performed at manufacturer's factory or at site (as applicable).

b) Type Test Frequency: - The type test frequency shall be 3 years or in case of any change in the material whichever is stringent

3.5.1.4.9 Test Reports

After conducting each test, reports showing test results should be submitted to EIL/ Owner for approval. Anode/ cable identification No./ batch No. shall be mentioned in test results against each test result. Any delivery made to site before getting EIL/Owner's approval of test reports shall be at manufacturer risk & cost.

3.5.1.4.10 Anode Fabrication

Manufacturers/ supplier shall furnish detailed dimensioned fabrication drawing of anode as well as details of cable connection and its insulation sealing to EIL/ Owner for approval.

Vendor (Anode Manufacturer/ supplier) shall furnish following information for approval before commencement of Anode to cable joint.

- Procedure for making the entire anode to cable joint.
- Procedure for accelerated ageing test of the string anode or test results.

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3.6 JOB SPECIFICATION FOR ANODE, CATHODE & MONITORING JUNCTION BOXES FOR CP SYSTEM

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3.6.1 Specifications for Anode & Cathode Junction Boxes

3.6.1.1 Anode Junction Boxes and Cathode Junction Box cum test station shall be suitable for Classified Area applications

An anode lead junction box (AJB) will be provided to feed T/R Unit output current to anode strings. These junction boxes will have provision for independent current measurement of each anode output. This will be accomplished by means of individual shunts for each anode circuit.

Drainage cable, reference cell cables and measurement cables from each structure/ equipment shall terminate in its respective cathode junction box cum test station. All the above-mentioned reference cell cables and measurement cables from each CJB shall be terminated into a single Monitoring junction box (MJB). Each CJB shall be connected to the negative terminal of the each T/R unit through loop in loop out arrangement for return of drainage current from structure/ equipment to the T/R unit.

The enclosure of CJB shall be structure/ wall mounted type. Shutter should be provided with closed cell neoprene sealing gaskets. The terminal board shall be of 10mm WT Phenolic laminated sheet on which all terminals and shunts are to be mounted. The terminals shall be made of cadmium plated steel or stainless steel stud nut and washers of M-10 size for termination of anode and cathode lead cables and M-4 size for termination of reference cell and measurement cables. All cable entries shall be through Aluminium double comprehension glands. The external bolt, nuts and clamps to be used for mounting the junction box with back plate/structures shall be MS electro-galvanised or Cadmium plated.

For classified areas, Junction box enclosure shall be of type "Exd" protection Zone 2/Group IIA/IIB application, Temp. Class: T-6, as per IS 5571,5572,2148 & 8289 and relevant IEC/NEC/IS standards. The cable glands shall be FLP double compression type made of Aluminium. Enclosure need to be certified by CMRI. The shutter of the junction box shall be screwed to the body of junction box by using MS electro galvanised/ Cadmium plated nut, bolt and washers. The enclosure of the junction box shall be made of cast aluminium. One earthing terminal shall be provided for earthing the junction box.

3.6.1.2 Monitoring Junction Boxes for non Classified Areas:

Monitoring junction boxes (MJB) will be installed near the T/R Unit and shall be required for monitoring potentials of multiple structure/ equipment . The enclosure for the MJB shall be of IP-55 construction made of 12SWG (2.67) W.T. sheet steel.
The enclosure shall be structure/wall mounted type having removable hinged front shutter with one handle and flush type locking arrangement. Shutter should be provided with closed cell neoprene sealing gaskets. The terminal board shall be of 8mm thick Phenolic laminated sheet on which all terminals shall be made of stainless steel stud, nut and double spring washers of M-4 size for reference cell/ measurement cables. The terminal arrangement shall be such that bottom row is utilised for termination of measurement cables from each structure/ equipment and upper rows one each is allotted for the reference cell cable termination from each structure/ equipment , hence total number of rows shall be one more than the total number of structure/ equipment. All cable entries shall be through Aluminum double compression glands. The external bolt, nuts and clamps to be used for mounting the junction box with back plate/ structures shall be MS electro-galvanised or Cadmium, plated. Shutter should be provided with closed cell neoprene sealing gaskets.

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3.6.1.3 Proper fitting of cables at cable glands

It is essential that all cables should fit tight at cable glands. For this purpose vendor need to make openings for glands at junction box or cast/ procure cable glands as per cable samples to be procured for CP System.

3.6.1.4 Painting

Enclosures of all non classified type anode and Cathode junction boxes shall be surface finished with paint as per guidelines outlined in Section 3.11.

3.6.1.5 Inspection & Testing

Fabrication drawing showing internal terminal arrangement of each type of junction box to be submitted by vendor to OWNER/ PMC to obtain approval for a Prototype construction. After inspection and approval of prototype the mass production shall be started. Calibration test for shunts for each junction box to be inspected by OWNER/ PMC before dispatch.

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3.7 SPECIFICATION FOR CABLES FOR CP SYSTEM

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3.7.1.0 SCOPE

3.7.1.1 CODES AND STANDARDS

In general the cables covered by this specification shall unless otherwise specified be in the line with the requirements of any of the latest applicable standard of IS, IEC, BS and Relevant NEC/ JIS/ JEC standards. Wherever the requirements in this specification are in conflict with any of the above standard, the requirements under this specification shall be binding.

3.7.1.2 ANODE LEAD CABLE

Anode lead cables shall be 7 strands, 10mm^2 stranded copper conductor, single core, unarmoured, with a double insulation system. The primary insulation shall be 0.04/0.1 inch thick cross-linked polyvinylidene floride (PVDF) 1100 Volt grade. The secondary insulation shall be 0.065 inch thick high molecular weight polyethylene (HMWPE) sheathing jacket over the primary insulation.

Insulation Type	Insulation Specifications**	
Polyvinylidene Fluoride (PVDF) Irradiation Cross-Linked	Tensile Break Strength Break Elongation Flexural Strength Resistivity Dielectric Constant	4500 PSI min. 50% min. 8600 PSI min. 2×10^{14} ohm-cm min. 8.0 min. at 100 Hz
Ethylene Chlorotrifluoroethylene (ECTFE)	Tensile Break Strength Break Elongation Resistivity Dielectric Constant	6500 PSI min. 100% min. 1×10^{15} ohm-cm min. 2.5 min. at 1 Mhz
High Density High Molecular Weight Polyethylene (HMWPE)	Color Density (minimum) ASTM D1248, Type 3, Class C, Category 5, or IEC 60502-1 Temperature Rating	Black 0.941 grams per cm^3 90°C.

** Standard Test Method ASTM D638 shall be used to determine the tensile strength, flexural strength and break elongation. For the resistivity and dielectric constant tests, Standard Test Methods ASTM D257 and ASTM D150 shall be utilized.

3.7.1.3 +VE, -VE HEADER CABLE

+ve header and -ve header cables shall be 95mm2, stranded Aluminium conductor, single core, Aluminium wire armoured, PVC insulated and PVC sheathed 1100V grade cable.

3.7.1.4 DRAINAGE CABLE

Drainage cables shall be 50mm2, stranded Copper conductor, single core, Aluminium wire armoured, PVC insulated and sheathed 1100V grade cable.

3.7.1.5 POWER SUPPLY CABLE (Between PDB & T/R Unit)

Power supply cable between Power source or CP System DB and T/R unit shall be 25mm2, stranded Aluminium conductor, 3-core, Aluminium wire armoured, PVC insulated and sheathed 1100V grade cable.

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3.7.1.6 POWER SUPPLY CABLE (between Power Source & PDB).

Power supply cable between Power source & CP System DB shall be 300mm2 /50mm2, stranded Aluminium conductor, 4-core, Aluminium wire armoured, PVC insulated & sheathed 1100 V grade cable.

3.7.1.7 EARTHING CABLE

Earthing cable shall be 35mm2 , stranded Aluminium conductor, 1-core unarmoured, PVC insulated and sheathed 1100V grade cable.

3.7.1.8 REFERENCE CELL / MEASUREMENT CABLE BETWEEN REFERENCE CELL / UG VESSEL/ TANK TO CJB CUM TEST STATION

Instrumentation cable, 4mm^2, 1-core, stranded copper conductor, PE/PVC insulated and PVC sheathed, screened and armoured cable, PE/PVC insulation of each core shall be Numbered or colour coded for easy identification of each core.

3.7.1.9 REFERENCE CELL / MEASUREMENT CABLE BETWEEN CJB TO MJB & MJB TO TRU

Instrumentation cable, 2.5mm^2, 10-core, stranded copper conductor, PE/PVC insulated and PVC sheathed, screened and armoured cable, PE/PVC insulation of each core shall be Numbered or colour coded for easy identification of each core.

3.7.1.10 REFERENCE CELL / MEASUREMENT CABLE BETWEEN MJB & RTU

Instrumentation cable, 2.5mm^2, 20-core, stranded copper conductor, PE/PVC insulated and PVC sheathed, screened and armoured cable, PE/PVC insulation of each core shall be Numbered or colour coded for easy identification of each core.

3.7.1.11 REFERENCE CELL / MEASUREMENT CABLE BETWEEN TRU & RTU

Instrumentation cable, 2.5mm^2, 24-core, stranded copper conductor, PE/PVC insulated and PVC sheathed, screened and armoured cable, PE/PVC insulation of each core shall be Numbered or colour coded for easy identification of each core.

3.7.1.13 POWER SUPPLY CABLE BETWEEN PDB TO RTU FOR CENTRAL MONITORING

Power supply cable between PDB to RTU for central monitoring shall be 16mm2, stranded Aluminum conductor, 3-core, Aluminium wire armoured, PVC insulated and sheathed 1100V grade cable.

3.7.1.14 CABLE DRUMS

All cables to be supplied in wooden drums. Cable lengths in each cable drum shall be 600m (min.) wherever cable lengths are more than 600m.

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3.7.1.15 INSPECTION

All cables along with manufacturer's test certificate as per IS standards shall be inspected by OWNER/EIL at the vendor's shop before dispatch. Minimum 15 days advance notice to be furnished by vendor for this purpose. In case of any doubt OWNER/EIL may insist vendor to conduct the tests as per IS standards in presence of OWNER/ EIL at vendor's work shop or some third party reputed laboratory approved by OWNER/ EIL at no extra cost.

3.7.1.16 CABLE IDENTIFICATION

For easy identification of cable, the over sheath of the cable should have yellow colour and "CP SYSTEM CABLES" should be printed using black colour at one meter interval throughout the length of the cable.

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3.8 JOB SPECIFICATION FOR CALCINED PETROLEUM COKE BREEZE FOR CP SYSTEM

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3.8 SPECIFICATION FOR CALCINED PETROLEUM COKE BREEZE

Calcined Petroleum Coke Breeze shall conform to the following specifications as per latest NACE- SP 0572 std .

A	Chemical Composition:	
	Moisture (on Dry Basis)	< 0.1 (% by mass)
	Fixed Carbon	Minimum 99.0 (% by mass)
B	Bulk density	900 Kg/m^3 to 1200 Kg/m^3
C	Real density	2.03 gm/cc
D	Particle Size	1.00mm (max.), dust free
E	Resistivity	0.1 ohm-cm. at 150 psi.

3.8.1 Test Certificates

Test Certificate shall be furnished for the following:

1. Make of coke breeze
2. Batch no.
3. Chemical composition
4. Bulk density and Real density
5. Particle size analysis
6. Resistivity (ohm-Cm.) at 150 psi compaction

Any delivery effected without prior approval of test certificate by EIL/ Owner will be at suppliers risk & cost.

Above mentioned specification for coke breeze shall be considered for MMO tubular anodes incase required for supplementary design, the coke breeze to be considered for MMO wire anode may be of make as per the anode manufacturer's choice meeting the requirements of the specifications mentioned above.

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3.9 JOB SPECIFICATION FOR THERMIT WELDING FOR CP SYSTEM

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3.9.1 Thermit Weld Connection:

All cable-to-pipe connections shall be made utilizing the exothermic weld process. All thermit weld connections shall be encapsulated with thermit weld cap and flood coating of coal tar enamel. Each thermit weld connection will basically require the following:

- Thermit weld mold vertical/ horizontal
- Thermit weld metal
- Thermit weld cap Steel disc.
- Copper sleeve
- Flint Igniter
- Mold Cleaner
- Mold Packing
- Coal tar enamel/ two part epoxy resin for encapsulation of the joint.

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3.10 MATERIALS/ EQUIPMENT FOR OPERATION AND MAINTENANCE OF CP SYSTEM

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3.10 Materials/ Equipment for Operation and Maintenance of CP System:

Following materials/ equipment shall be supplied by the CP System Contractor for operation and maintenance of CP system.

S.No.	Quantity	Description
1.0	1 No.	Digital Multimeter having minimum input resistance 10 Mohm, complete with leads and leather case.
2.0	10 Nos.	Reference electrodes: Portable Copper/ Copper sulphate type having PVC SCH 40 body with transparent window and threaded ceramic porous plug suitable for 15-40 deg.C temperature application in sand.
3.0	1 No.	DC Clipon ammeter in milliamp. / micro amp. range current measurement.

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3.11 SPECIFICATION FOR PAINTING CORROSION PROTECTION FOR JUNCTION BOXES, PDB, CABLE MARKERS AND JUNCTION BOXES SUPPORT STRUCTURES

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3.11.1.0 Corrosion Protection for Junction boxes, PDB, Cable markers and junction Boxes support structures

All junction Boxes in Non-classified area, PDB and their support structures, MS channels for T/R mounting if any, cable marker Posts shall be galvanized & painted in following manner.

i) Surface preparation

Grit/shot Blasted to SA2 1/2 as per Swedish standard SIS 055900

ii) Galvanizing

Hot dip or spray galvanized to achieve a minimum zinc thickness of 150µm.

iii) Primer Application

Etch Primer with 10 µ DFT based on Polyvinyl Butyral resin + 1 coat of epoxy zinc phosphate primer @40 µ DFT/coat

iv) Paint Application

1 Coat of 2 Pack high build epoxy with Polyamide hardener cure @100 µ DFT/coat followed by 1 Top coat of Acrylic Polyurethane finish paint @40 µ DFT/coat.

Primer & Paint application procedure shall be standard airless spray and as per paint manufacturer's procedure. Name of Paint manufacturer and product should be approved by EIL prior to application. Colour of top coat shall be yellow or grey as per choice of EIL/ OWNER.

3.11.1.1 MS covers for shallow vertical Beds shall be painted with 2 coats of synthetic enamel paint of Asian Paint/Berger or equivalent make. Colour of paint shall be yellow.

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3.12 CENTRAL MONITORING SYSTEM

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CENTRAL MONITORING & CONTROL SYSTEM (RMC)

3.12.1 Common Computerized Central Monitoring and Control is required for the CP System for each TR unit/ items to be protected inside the Unit. For this purpose, the T/R unit & permanent reference cells should be connected to Remote Terminal Unit (RTU) consisting of microprocessor based CPS controller with alpha- numeric LCD display, memory, real time clock, keypad, battery backup and communication ports or equivalent PLC-SCADA system.

- RTU/ PLC system shall be capable to process minimum 8 analogue input signals (including one each for TR Unit output current & voltage), 4 digital input signals, 2 analogue output signals and 1no. digital output signal for monitoring performance of each TR Unit which shall be considered for structure/ equipment protection

- In addition to this some digital and analog (input) signal should also be kept as 20 % spare capacity.

- Single or multiple RTU/ PLC system may be provided for monitoring and control of all TR unit output and monitoring of potential for structures.

Thus considering few spares minimum analogue inputs, digital inputs, digital outputs and analogue outputs to be processed by each RTU/ PLC system is to be designed by vendor for review / approval by EIL/ OWNER. The system should also have inbuilt mechanisms to reduce / nullify induced AC interference voltages.

The RTU/ PLC Unit shall also be provided with 1 No. digital output for switching operation for TR Unit. This output shall be used to turn the rectifier OFF and ON for depolarised and instant "OFF" readings. The rectifier shall have in-built facility to accept these signals and interrupt its output supply. The digital input/ output channels shall be optically isolated. The RTU/ PLC should include a GPS based time synchronization unit for measurement of true OFF potential readings.

Further, RTU/ PLC shall be provided with 1 or 2 analogue output that can be used for controlling the various modes of the TR unit for remote control.

The RTU/ PLC should be capable of generating alarms when the parameter limits are violated and it should communicate the alarm data in real time and should not wait for the monitoring software query. The field RTU/ PLC units will have capability to control & monitor the T/R unit Voltage/ Current/ PSP & Current interruption by means of commands from the Central Monitoring Panel(CMP). The operator will be in a position to set all the parameters of T/R unit like DC Voltage, DC current, T/R unit current interruption timings/ schedules from the Central Monitoring Panel (CMP).

All CP System parameters shall be monitored and controlled from central control room using suitable software. The communication link between the RTU /PLC and Central monitoring and Control station should be cost effective GSM based wireless technology or RS485 fiberoptic/ Copper communication, whichever is decided by EIL/ OWNER as the communication network. CP System Sub-contractor should design, procure and install the requisite communication system and the cables required for this purpose.

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Central monitoring and Control station computer to be provided by the CP System sub- contractor shall consist of standalone computer suitable for CP monitoring application with following minimum specifications:

- Intel Core 2, I-7 (seven) processor
- Genuine Windows latest operating system with License
- 8 GB RAM
- 500 GB HDD
- 24in Flat Panel LCD Color Monitor
- DVD Rom
- Intel Integrated 100/ 1000 Ethernet Network Card
- 1 Serial, 4 USB Ports
- MS SQL Server Latest
- A3 Laser jet printer (HP make)
- Inbuilt UPS system which can operate up to 30 minutes on full load in case of power failure
- Other standard accessories

CP System sub-contractor shall also provide necessary Software for Remote Monitoring & Control as well as for printing of CP reports. The software should be compatible to Windows format and MS SQL Server or Oracle database (10g) with proper License should be used.

3.12.2 Remote Monitoring & Controlling Central Control System

The software and hardware for the proposed SCADA system shall have a proven track record of minimum three years of successful operation in the field of CP monitoring.

The Remote Monitoring & Control Panel (RMCP) shall have a Data Acquisition and Control Hardware operating in Real Time on PC having minimum specification mentioned in item 3.12.1

A Front End Communication Module (FEC) is also required that will be responsible for managing the entire communication traffic between the RMCP and RTU/ PLC.

The T/R Unit Output DC Voltage, DC Current, Reference Electrode Voltages, Alarms are to be extended to RMCP Panel through RTU/PLC units by any of the cost effective communication network such as GSM based wireless technology/ RS485/ fibreoptic/ copper communication whichever is decided by EIL/ OWNER as the communication network for data downloading and remote monitoring & control from master control room.

Each T/R Unit shall accept set point signals for DC Voltage and DC Current from Remote Monitoring & Controlling Panel and accordingly shall control its output from 0 to 100%.

- REMOTE MONITORING SYSTEM - SOFTWARE:

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The Remote Monitoring and Control System shall monitor and control various process parameters of Cathodic protection system. The Monitoring software shall be user friendly, Windows compatible, and should allow easy data transfer to other windows based applications or custom applications having ODBC compliant database. The Software shall have built-in graphic package to display graphical representation of the process on-screen with embedded buttons for switching ON/ OFF TR units. Data security should be ensured through three different types of Access Levels namely Expert, Supervisory and Operator. It should have provisions to accommodate future need of addition of new TRs for equipments & piping as may be required from time to time.

If required by client, The software shall be compatible for interfacing of the available CP System monitoring data on LAN at 10 No. additional nodes for management information system for access and reporting for the management. The monitoring software should be capable of generating notification & visual alarm, as and when signals go outside programmed set points and during RTU/PLC failure and TR Unit input power failure. It should generate customized reports as decided by EIL/ OWNER. The software shall allow configuration of emails of OWNERS employees who are responsible for maintenance.

- Remote Terminal Unit – specifications:

Sl No	Parameter	Specifications
1	Model	As per manufacturer
2	Local display & Local Keypad	The RTU shall consist of a 3 x 6 matrix membrane keypad and a 16 x 2 LCD Display with back-lighting for entering local settings and viewing TR parameters locally. Following Local settings can be done using the Key Pad & Display : - Setting Date/ Time - Setting Periodic Logging Interval - Setting of Scaling factor for DC shunt rating - Setting levels for various Alarm notifications - Setting Field ID.
		The LCD will normally display - TR Voltage - TR Current - Reference Potential - AC supply Voltage The RTU/ PLC should be able to be remotely configured for most of the above parameters from the central station.

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3	Programmable Periodic Interval	The Periodic Logging & Broadcast interval is programmable from 1 reading per 5 Minutes to 1 reading in 24 hours.
4	CPU	Microprocessor based latest generation design. Built-in Real Time Clock (+/- 1 minute accuracy over one month) Watch dog timer which provides a reset signal to the CPU if not toggled due to any hardware or software failure to ensure fail safe operation.
5	Local Memory	The RTU/ PLC will have sufficient local NVRAM memory to store the monitored data locally. Logged Data shall also be stored in the internal non-volatile Memory of RTU. About 30,000 total Data readings should be able to be stored without downloading. The locally stored data should be retained for upto10 years without external power to RTU/PLC. It will be possible to download the locally stored RTU data on a field Laptop reader through the local communication port in the RTU/ PLC whenever desired.
6	Analog Inputs for each TR Unit- (8 T/R Unit parameters viz □ DC Voltage □ DC Current □ Ref. Cell Potential (5 No.) □ AC supply Voltage + spare)	Fully differential Inputs, 12bit /16-bit resolution Should nullify the effect of AC interferences. High accuracy, High Impedance, with high common mode rejection ratio CMRR. CH-1: 0 – 100V DC (For DC Output Voltage) CH-2: 0 - 100mV DC (For DC Output Current through T/R shunt) CH-3 to 7: -5.0V to +5.0 V DC (For 5 No. Reference potential) CH-8: 0 - 300V AC (For AC supply Voltage Monitoring)

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7	Digital Inputs or software for Alarm generation. As required by design	24/12 VDC operated. shall also continuously scan and check for Alarm conditions listed below Following Alarms will be generated using Digital Inputs : • Diode/Output Fuse Fail • Unit Working in Remote Mode • Unit working in Local Mode Following Additional alarms will be generated by Software : • Input AC Supply Fail • Under Protection for Each Ref Electrode • Over Protection for Each Ref Electrode • Reference Fail for Each Ref Electrode The set parameters for the above alarm conditions can be programmed remotely through the central PC
8	Analog Control Outputs for T/R unit control As required by design	4-20mA / 0-5VDC / 0-10 VDC with isolation of 2500Vrms. Resolution – 12 Bit
9	Digital Output – 1 No. For T/R unit Current Interruption	SSR outputs relay 2500 V RMS optical Isolation. Contact rating 2A@ 240 V AC/ 1A @200 V DC On / off delay times 3 msec.
10	Communication	Through RS485 over Copper/ Fibre Optics network for broadcasting data to the Central Station at the programmed periodic interval. E-mail message facility for abnormal condition notification.
11	GPS Interface	Each RTU/ PLC will have built-in GPS module to synchronise the RTC to GPS time. This will ensure uniform real time for all the RTU/ PLCs.
12	Power Supply	230V ± 20%AC, 50 Hz □ 20V to 70V DC □ 12 VDC (Any one type as required by design)
13	Battery Backup	Battery Back-up for up to 2 Hrs of un-interrupted operation including E-mail transmission, in the event of failure of AC supply.
14	Communication Ports	As required by design

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15	Protection	Short Circuit Protection Surge Protection using MOV. Over Voltage protection EMI / EMC protection
16	Mounting	Preferably inside TR Unit if not possible then Wall / Pole mounting
17	Operating Temperature range	0 to 55 deg C
18	Humidity	95% condensing
19	Time Stamping	The RTU/ PLC shall have precise, accurate Real Time Clock (RTC) for exact time stamping of data.
20	Enclosure	The RTU/ PLC shall be housed in a compact & sturdy non corroding enclosure suitable for installation inside the shed common for all TR units. ABS / M.S. With IP 55 degree of protection Mounting : Either mounting inside each TR unit or common for all TR unit located under a single shed with Plinth mounting arrangement. Cable Entry : From Bottom
21	Data Download Port	The RTU/ PLC Unit shall have USB port through which the logged data can be downloaded onto the laptop.
22	Centralised Monitoring	The RTU/ PLC shall have built-in fibre optic modem to communicate with the central station Through RS485 over Fibre Optics Communication network. The RTU / PLC shall send the TR Data with exact time stamp directly to the Master Computer at central station at the programmed Periodic Interval. At the central end a PC shall be installed with a fibre optic Front End Communication (FEC) module and centralized monitoring software. The RTU shall also send alarm information with exact time stamp to the central station Periodic Interval. The PC software shall accept the data received from the RTU/ PLC, display it in graphical and analytical formats and store it in database like MS SQL to generate Reports and Graphs. It shall also possible to remotely program the Field RTU/ PLC Unit through the Central PC for configuration details like Setting Date/Time, Setting/ changing Periodic Interval . PC software should be able to monitor and receive data from up to 50 field RTU/ PLC at a time.
23	Compliance	Relevant BIS/ IEC EMI/ EMC standards

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3.12.3 Reports

The software should generate reports, which can be viewed as well as printed as listed below:

i) A monthly report showing readings from every system. The reports shall highlight readings outside limits and systems, which did not call.

ii) A single page report yearly report for each remote monitoring. This shall be used to show the monthly readings for each site.

iii) Alarm Reports: This particular report shall give all information about the alarms, which occurred in any abnormal conditions.

iv) Report information shall be compatible with standard spread sheet programs.

v) All above reports of different type should be available in graphical presentation, on screen and printer.

vi) Scaling and calibration of analogue channel can be done by use of supplier Editor Software.

3.12.4 DATA BASE SECURITY

Database shall be in the form of SQL Server. The version of SQL shall be latest with proven track. Following security features shall be provided in the server software:

- Roles
- Fixed Server Roles
- Fixed Database Roles
- User-Defined Roles
- Application Roles
- Granting and Denying Permissions to Users and Roles

Over and above the above features, the software supplied by the vendor shall broadly have following essential features to access the database as applicable.

- Group Creation
- User Creation
- User Group Allocation
- Enable - Disable Account Status
- Audit Trail
- Access Level Based on the operation
- Roles and Reasons
- Password Masking

3.12.5 DESIGN REVIEW:

CP System sub-contractor should prepare detailed engineering package for central monitoring and control system along with schematic drawings and equipment/ materials list including make/ model

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of the same and get the same approved by EIL/ OWNER before procurement/execution.

3.12.6 INSPECTION

The prototype inspection along with simulation tests shall be done at specialist agency's office / workshop by EIL/ OWNER before the dispatch of the equipment and materials at site. For this purpose CP System sub-contractor should furnish notice to EIL/ OWNER minimum 15 days before the date of inspection.

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3.13 SPECIFICATION FOR SOIL RESISTIVITY TEST

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3.13.1 SCOPE

The scope of this standard is to conduct the following tests within a plant complex:

- Soil/sand resistivity up to 10m depth to be measured using Wenner's 4-pin method in offsite/ unit areas/ Vessel pit.

3.13.2 OBJECTIVE

The objective of the tests given by Para 1.0 is to assess the corrosiveness of the soil/ sand & to decide suitable locations for anode beds for CP System for prevention of external corrosion of structure/ equipment within a plant complex.

3.13.3 SOIL RESISTIVITY TEST

In general soil resistivity tests covered by this specification shall unless otherwise specified, be in line with the requirements of BS CP 1021. Wherever the requirements in this specification are in conflict with the above standard, the requirements under this specification shall be binding.

3.13.3.1 SOIL RESISTIVITY TEST BY WENNER 4-PIN METHOD

Soil resistivity by Wenner 4-Pin method to be conducted at 4 anode bed locations as per instructions of EIL, at each location soil resistivity readings to be taken for 2m, 4m, 6m &10m depth for distributed anode beds.

$$\rho = 2\pi AR$$

Where,

ρ	=	Soil resistivity in ohm-cm
A	=	Inter electrode spacing in cm
R	=	Resistance observed from soil resistivity meter in ohm.

While inserting electrodes in soil for taking soil resistivity care should be taken to make good contact of electrodes with the soil, for this purpose limited watering may be required at the electrode penetration points wherever soil is dry or less compact. The depth of penetration of electrodes should not exceed 1/10th of the electrode spacing.

3.13.3.2 CALIBRATION OF SOIL RESISTIVITY METER

Soil resistivity meter should be calibrated at a reputed laboratory before use. The calibration certificate must be furnished to ENGINEER-IN-CHARGE for approval of the meter before use of the same for soil resistivity test at site.

3.13.4.0 REPORT PREPARATION

All soil resistivity readings shall be typed and presented in a tabular form giving co-ordinates and other location reference of each test locations & depth of each reading. The soil resistivity is to be expressed in ohm-cm.

Six copies each of soil resistivity report to be furnished to OWNER/ EIL for record.

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4.0 MANDATORY SPARES FOR CATHODIC PROTECTION SYSTEM

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4.0 The Bidder shall supply the following spares for each T/R unit:

-	D.C. Voltmeter	Nos.	1
-	D.C. Ameter	Nos.	1
-	A.C. Voltmeter	Nos.	1
-	A.C. Ammeter	Nos.	1
-	Diodes	Nos.	2
-	SCR's	Nos.	2
-	D.C. Fuses for output side	Nos.	5
-	HRC fuse for Diodes	Nos.	5
-	A.C. fuses for input side	Nos.	5
-	D.C. Lightening arrestor	Nos.	2
-	A.C. Circuit breaker(MCB)	Nos.	2
-	Electronic Control Cards each type	Nos.	2
-	Filter circuit capacitor	Nos.	2
-	Signal light assembly for annunciation	Nos.	2
-	R.C. Surge Diverter	Nos.	2
-	Control transformer	Nos.	2
-	Coarse voltage control switch	Nos.	2
-	Coarse current control switch	Nos.	2
-	Fine voltage control switch	Nos.	2
-	Fine current control switch	Nos.	2
-	Auto Manual Mode selector switch	Nos.	2
-	Toggle switches	Nos.	2
-	Assorted Glass cartridge fuses	set.	15

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5.0 Specification for Sacrificial Anode Cathodic Protection for Coolers and Condensers

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5.1 Sacrificial Anode Cathodic Protection system shall be considered on channel /floating head side of cooler/ heat exchangers containing conductive fluids/cooling water with dissimilar metallurgy in channel/floating head side. The dissimilar metallurgy shall be in the form of Bimetallic (Galvanic) coupling made of Carbon Steel and Stainless Steel or other ferrous or non-ferrous alloys (e.g. Carbon Steel Channel having SS 316 Fixed Tube Sheet etc.).

5.1.1 ANODES

Anodes shall be magnesium/Zinc/Aluminium (as applicable) following specifications:

5.1.1.1 Magnesium Anode

Anodes shall be high purity **Magnesium alloy** of ASTM B843 AZ-63 grade with following compositions

Element	Weight %
Aluminium	5.3-6.7
Silicon	0.1 max
Copper	0.05 max.
Iron	0.005 max.
Lead	0.03 max.
Zinc	2.5-3.5
Mn	0.15-0.7
Ni	0.002 max
Others	0.3 max
Mg	Remainder

Electrochemical Properties

Magnesium anode shall have minimum following guaranteed values in 3.4% NaCl solution at room temperature.

Anode capacity 1100 per AH/Kg.

Closed circuit Potential - 1.45 to -1.5 V (v/s SCE) at 0.6 mA/cm2 anode C. density

5.1.1.2 Zinc Anode

The anode shall conform to the requirements of ASTM B418 Type-I with following composition:

Element	Weight %
Aluminium	0.1 to 0.5
Cadmium	0.025-0.07
Copper	0.005 max.
Iron	0.005 max.
Lead	0.006 max.
Others (Total)	0.1 max.
Zinc	Remainder

Electrochemical Properties

Zinc anode shall have minimum following guaranteed values

Anode capacity 800 per AH/Kg.

Closed circuit Potential - 1.00 V (v/s SCE)

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5.1.1.3 Aluminum Anode

The Anode shall be (Al-Zn-In-Si Alloy) conforming to following composition by wt. % :

Element	Wt%
Fe:	0.12 % Max.
Si:	0.08-0.2%
Cu:	0.006% Max.
Zn:	2.0-4.0%
Indium:	0.01-0.02%
Others:	0.02% Max. (Each)
Aluminum:	Remainder

Electrochemical Properties

Aluminium anode shall have minimum following guaranteed values

Closed circuit potential at 25^0 C (v/s Ag/AgCl) at anodic current density of 100-300 mA/ft2 in 3.4% Nacl:

- 1.10 Volts.

Capacity at 25^0 C at anodic current density of 100-300 mA/ft 2 in 3.4% Nacl.

2500 AH/Kg

5.1.2 Anode Quantity

Vendor shall decide anode quantity for each cooler based on the following design guidelines. Anode Quantity shall be calculated for channel and floating head separately for each cooler.

(a) Anode design life - 4 years

(b) Coating breakdown factor after 4 years - 60%

(c) Anode utilization factor - 0.90

While estimating total protection current density, entire area of all components of Stainless Steel or other metallurgy which are in Galvanic Coupling with Carbon Steel must be taken into consideration for full Cathodic Protection along with Carbon Steel components. While calculating area of tube sheets, the area of the tube holes shall also be considered.

5.1.3 Acceptance Test for Anodes

Before delivery of the anodes, anode manufacturer shall furnish results of following tests from **an independent NABL accredited laboratory** for EIL approval**.** The tests shall be conducted in accordance with applicable ASTM/DNV standards.

- **Chemical composition analysis**
- **Open circuit potential test**
- **Closed circuit potential test**
- **Anode capacity test**

The tests shall be carried out on minimum 3 samples representative of different heats for anode material. In case only one heat is utilized during anodes casting, then of 3 samples, one should be taken during start of pouring, one during from end of heat and one from middle of heat.

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Annexure-1

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VENDOR DATA REQUIREMENTS
FOR
CP SYSTEM FOR PLANT

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
B	13-APR-2026	ISSUED FOR TENDER (T-3001)	-AD-	-SD-	-RC-
A	24-FEB-2026	ISSUED FOR TENDER (T-3001)	-AD-	-SD-	-RC-

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VENDOR DATA REQUIREMENTS

The following drawings/documents marked "✔" shall be furnished by the bidder.

CATHODIC PROTECTION SYSTEM FOR VESSELS

S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
1.	Schedule of Vendor Documents		✔			
2.	Soil/Sand resistivity report			✔	✔	
3.	CP material Data Sheets MMO Wire/Tubular anode		✔		✔	
4.	CP material Data Sheets CPTR unit		✔		✔	
5.	CP material Data Sheets Remote Monitoring Unit for CP		✔		✔	
6.	CP material Data Sheets Reference cell, Surge Diverter and Polarisation Cell, CP cables		✔		✔	
7.	CP material Data Sheets CP Junction boxes (Anode Junction Box(AJB), Cathode Junction Box(CJB) and Monitoring Junction Box(MJB))		✔		✔	
8.	CP material Data Sheets CP Central monitoring system		✔		✔	
9.	CP material Vendor list		✔		✔	
10.	Inspection & Test Plan (ITP) -For review by Inspection Dept. (Refer Note-*)			✔	✔	
11.	CP Design Document		✔		✔	
12.	CP Drawings : MMO anode dimensional GA drawing			✔	✔	
13.	CP Drawings : Anode Bed/Arrangement GA drawings (Clearly showing the clear distance between Bullet surface to anode, clear distance between Mound wall surface to anode, inter anode spacing and reference cell positions etc.)		✔		✔	
14.	CP Drawings : AJB/CJB/MJB GA drawing			✔	✔	
15.	CP Drawings : CPTR Unit GA drawing			✔	✔	
16.	CP Drawings : RMCP Unit GA drawing			✔	✔	

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S. NO.	DESCRIPTION	WITH BID	POST ORDER			REMARKS
			FOR REVIEW	FOR RECORD	WITH DATA BOOK (FINAL)	
17.	CP Drawings : CPTR Unit installation layout			✔	✔	
18.	CP Drawings : Overall CP system layout drawings indicating CPTR, RMCP, AJB, CJB, MJB Central Monitoring system location and Vessel location			✔	✔	
19.	CP Equipment Installation Procedures/QAPs			✔	✔	
20.	CP Commissioning procedure/QAPs			✔	✔	
21.	CP Commissioning reports			✔	✔	
22.	CP Material Test reports			✔	✔	
23.	List of Commissioning Spares			✔	✔	
24.	List of Mandatory Spares		✔		✔	
25.	Data Books/ Manuals : Operating/ Maintenance Manual/ CP Material Manufacturer catalogues				✔	
26.	Equipment storage procedure at site				✔	

Notes :

1. "TICK" denotes applicability.
2. Post order, drawing / document review shall commence only after approval of Document Control Index (DCI).
3. All post order documents shall be submitted / approved through EIL eDMS portal.
4. Final documentation shall be submitted in hard copy (Six prints) and soft (two CDs/DVDs) in addition to submission through EIL eDMS.
5. Refer - 6-78-0001: Specification for quality management system from Bidders.
6. Refer - 6-78-0002: Specification for documentation requirements from Contractors.
7. Refer - 6-78-0003: Specification for documentation requirement from Suppliers.
8. All drawings & documents shall be submitted in A4 or A3 paper sizes. Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in the MR/Tender.
9. Post order- The schedule of drawing / data submission shall be mutually agreed between EIL & the bidder / contractor / supplier during finalization of Document Control Index (DCI).
10. "@" indicates submission of documents to Inspection Agency.
11. Bill of Material shall form part of the respective drawing.
12. Also refer other department's VDR :-
13. Electrical
14. Instrumentation
15. '*' indicates the following:

a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.

b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval

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by EIL Inspection.

16. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.

17. '*' indicates the following:

a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.

b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.

18. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.

19. '*' indicates the following:

a. Equipments whose ITP is attached with Contract -ITP for respective equipment shall be followed. Therefore, no ITP is to be furnished for review for those equipments.

b. Equipments whose ITP is not attached with Contract-Manufacturer's ITP shall be submitted by Packager/ Vendor/Contractor to respective Regional Procurement Office (RPO) near to manufacturer's works for approval by EIL Inspection.

20. All technical details and documents furnished with bids shall be treated as data for engineering. These shall however be subject to Purchasers review after order placement and bidder shall comply to MR/Tender requirements without any cost & time implication to EIL/Owner.

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JOB SPECIFICATION
FOR
CATHODIC PROTECTION SYSTEM

PROJECT	**:**	**MPMC AND PMC/EPCM SERVICES FOR ETHYLENE CRACKER UNIT AND UTILITIES & OFFSITES RELATED TO BINA PETCHEM & REFINERY EXPANSION PROJECT (BPREP)**
UNIT	**:**	**ETHYLENE CRACKER UNIT**
OWNER	**:**	**BHARAT PETROLEUM CORPORATION LIMITED (BPCL)**
PMC	**:**	**ENGINEERS INDIA LIMITED (EIL)**
JOB NO.	**:**	**B957**

Rev No.	Date	Purpose	Prep. By	Checked by	Approved by
0	13/04/2026	ISSUED FOR TENDER	AD	SD	RC

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1.0	Scope of Work
2.0	Design Basis/ Philosophy for CP System
3.0	Specification for CP System Equipment and Materials
4.0	Mandatory Spares for Cathodic Protection System
5.0	Specification for Sacrificial Anode Cathodic Protection for Coolers and Condensers

Annexure-1

1) Standard Specification for Cathodic Protection System for Underground Vessels, 6-45-0032, Rev.1.
2) Specification for installation, pre-commissioning, testing and commissioning of cathodic protection system for vessels, 6-45-0060, Rev 0.

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1.0 SCOPE OF WORK

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1.1 SCOPE OF WORK FOR CATHODIC PROTECTION SYSTEM (CP SYSTEM)

The work to be performed by the EIL/ OWNER approved CP contractor shall comprise of design, detailed engineering, supply, installation, testing and commissioning of Impressed Current Cathodic Protection (CP) System for soil/ sand side corrosion prevention of Underground Vessels inside pit filled with sand/soil as well as sacrificial type CP system for Coolers/ Condensers (as applicable) within the scope of this project. Sacrificial Anode Cathodic Protection system shall be considered on channel and floating head side of cooler/ heat exchangers containing conductive fluids/cooling water with dissimilar metallurgy in channel/floating head side.

This document is not intended to be all-inclusive and the use of the guidelines set forth here do not relieve the CONTRACTOR of his responsibility of providing adequate CP System, which shall be proved performing to the entire satisfaction of the OWNER/ EIL.

The successful EPC contractor shall furnish all necessary details with supporting documents of proposed CP contractor (List of orders executed with copies of work orders/ technical details of work executed, completion certificate of CP contractor during detail engineering stage.

The contractor needs to supply all materials, consumables in his scope of supply from EIL/ Owner approved vendor list. The items which are not listed, the same shall be considered based on proven track record (PTR) basis for application of minimum one year period and five years for critical items such as MMO wire anode (filled with factory coke breeze and connecting lead cable), Surge diverter, SSPC (solid state polarization cell) / DC Decoupler and Reference electrode with satisfactory performance record (Refer technical specification of items). The contractor shall provide all construction tools, tackles, equipment and personnel necessary for the work and prepare detailed engineering package including construction drawings before starting of the work. After commissioning of the system commissioning report along with as built drawings including soft copies in latest version of AutoCAD and operating manuals to be prepared.

The Contractor needs to keep vigilance and take all precautionary measures to prevent fire hazards during execution of job.

1.2 SCOPE OF WORK FOR CATHODIC PROTECTION SYSTEM INSTALLATION

1.2.1 Item wise works envisaged under this Contract will comprise of the following:

Preparation and submission of Detail Engineering package as per Design basis and job specifications enclosed in this document. The detail engineering package shall include, as a minimum, design calculations, Bill of quantities, layout drawings of all materials/ equipment of CP System, Connection schemes and wiring diagrams, Installation procedures, name of equipment suppliers, shop/ field testing & inspection plan for equipment, necessary technical information/ datasheets, fabrication/ construction drawings, testing and commissioning procedures and formats, Quality control/ Quality assurance documents etc. & obtain approval from OWNER/ EIL before execution of work. CONTRACTOR needs to obtain approval on all layout drawings of cathodic protection materials/ equipment at site from OWNER/ EIL before starting the installation work.

1.2.2 Carry out Soil Resistivity test, detailed engineering, Supply all materials, equipment and perform all

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erection and installation work as per approved detail-engineering package. Provision of all service connection to T/R units including power cable starting from power source to PDB and PDB to TRU shall be in CONTRACTOR's scope of work.

1.2.3 Shop testing of all major contractor supplied CP equipment (T/R, Anode, Cables, Junction Boxes, and RTU etc.) and submission to EIL of Test results/ certificates for approval before delivery of equipment.

1.2.4 Field-testing of individual components of CP System as per approved detail engineering package. Final commissioning of installed system as per approved procedure and submission to EIL of results thereof.

1.2.5 Liaison with other agencies, seek and obtain all permission related and obligatory to his part of the work.

1.2.6 Preparation and submission of 1 set of soft copy and 6 sets of hard copies to client and one set each soft and hard copy to EIL for records for all as built CP System package comprising of operation and maintenance manual for equipment, as-built drawings, Material specifications and Pre-commissioning/ Commissioning results.

1.2.7 After Commissioning of the CP System, if it is found that structure to electrolyte potential achieved at some location is in the range which is below acceptable limit as per code, then a supplementary CP System need to be installed to bring the potential level at such locations within acceptable limit as mentioned vide section 2.0 for "Design Basis/ Philosophy for CP System".

1.2.8 CONTRACTOR shall give performance guarantee for CP System for applicable equipments/ UG piping as per design basis and job specifications and operation guarantee of the material and equipment supplied by him as well as guarantee against defective workmanship for installation work carried out by him.

1.3 INSTRUCTION TO BIDDERS

1.3.1 Site Particulars

It shall be the bidder's responsibility to have a thorough understanding of the reference documents, site conditions and specification included therein. The intending bidders shall be deemed to have visited the site and have studied the conditions before submitting the Bids. Non-familiarity with the site conditions will not be considered a reason either for extra claims or for not carrying out the work in strict conformity with the drawings and specifications.

1.3.2 Every item of work and supply by CONTRACTOR shall be subject to Engineer-In-Charge scrutiny, supervision and approval. Any work carried out or supplies affected without such approval shall stand automatically rejected and his claim for compensation for such unauthorized work shall be null and void.

1.4 SPECIFIC REQUIREMENTS FOR CP SYSTEM WORKS

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1.4.1 General

Clauses given under specific requirements for CP System works shall be read in conjunction with General conditions of contract and in case of any conflict, the provisions of specific requirements for CP System works will override the provision of general conditions of contract.

1.4.2 EIL/ OWNER shall have the right to inspect the following:

- Workshop & production facilities available with CONTRACTOR or its tie up agency.
- Fabrication/ testing of material/ equipment to be supplied by CONTRACTOR or its tie up agency for CP system.

1.4.3 It shall be Bidder's responsibility to arrange access for EIL/ OWNER Personnel for such visits. All costs related with travel, boarding, lodging for EIL/ OWNER personnel for such visits (if any) shall be borne by EIL/ OWNER.

1.4.4 Materials

1.4.4.1 Material Supplied By Owner

No material for CP System shall be supplied by owner.

1.4.4.2 Material Supplied by Contractor

The Contractor shall procure, supply all materials, equipment and consumables required for the work in his scope. Technical specifications of major items are given in section 3.0 for "Job specification for CP System", of this document. Supply of all balance materials, consumables not covered in section 3.0 for "Job specification for CP System", but required for completion of work as per this specification shall be entirely Contractor's responsibility. The rates quoted for the execution of the Contract shall be inclusive of all Contractor supplied material and equipment.

1.4.5 Warranty

Contractor needs to provide design guarantee for the system as per codes and standards & the protection criteria mentioned in the section Design basis/ Philosophy of this document also shall replace/ repair or reinstall free of cost any material/ equipment supplied or installed by him in case it fails to operate due to defective material or workmanship as per requirements of this specification within 12 (Twelve) months from the date of issue of completion certificate and acceptance of the CP System by Owner. Contractor shall replace at his own cost if any item found defective or missed before handing over the system to owner.

Comprehensive Annual Maintenance (AMC) for CP System for 1 year is in CP Contractor’s scope after Guarantee/ Warrantee period is over.

1.4.6 Construction Aids, Equipment, Tools and Tackles

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Contractor shall be solely responsible for making available for executing the work, all requisite construction equipment, special Aids, tools, tackles and testing equipment and appliances, all instruments including automatic Programmable current interrupters required for commissioning and interference testing of the system. Such construction equipment shall be in first class operating condition. Any discrepancies pointed out by Owner/ EIL shall be immediately got rectified, repaired or the equipment replaced all together by Contractor. Owner/ EIL shall not in any way be responsible for providing any such equipment, machinery tools and tackles etc. The Owner/ EIL reserves the right to re-arrange such deployment depending upon the progress and priority of work in various sections at no extra cost to Owner.

1.4.7 Transportation, Packing and Handling

Contractor shall be responsible for transportation of all equipment/ materials required for CP system work and unload the same at allotted area at site.

1.4.7.1 To protect all the material during period of dispatch, storage and erection against corrosion, incidental damage due to vermin, sunlight, rain, high temperature, humid atmosphere, rough handling in transit and storage in open during monsoon including delays in transit. Bidder shall be responsible for any damage to equipment/ material due to above reasons.

1.4.7.2 Bidder to refer Section 2.0 for "Design Basis/ Philosophy for CP System", Section 3.0 for "Specification for CP System material & equipment", Section 4.0 for “Mandatory Spares for Cathodic Protection System”,

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2.0 DESIGN BASIS/ PHILOSOPHY FOR CP SYSTEM

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ABBREVIATION

AJB	:	Anode Junction Box
CP	:	Cathodic Protection
CPTR	:	Cathodic Protection Transformer Rectifier
CJB	:	Cathode Junction Box
MJB	:	Monitoring junction Box
MMO	:	Mixed Metallic Oxide
PCP	:	Permanent Cathodic Protection
CMS	:	Central monitoring system
RTU	:	Remote Terminal Unit
PLC	:	Programmable logic controller
DW	:	Deep well
GL	:	Ground Level

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1.0 Codes and Standards

The entire work shall be performed as per the following codes/ standards.

NACE	: SP-0169, SP-0285, SP-0177, SP-0286
OISD	: OISD 150
DIN EN 50162 VDE 015:	Protection against corrosion by stray current from direct current (DC) systems.
BS EN 12954	: Cathodic protection of buried or immersed metallic structures
IEC/ NEC/ IS	: Relevant codes
IS/ IEC: 60079	: Electrical Apparatus for Explosive Gas Atmosphere
IS/ IEC: 60529	: Classification of Degree of Protection Provided by Enclosures

Indian electricity act and rules framed there under.

Fire insurance regulations.
Regulations laid by Chief Electrical Inspector of State.
Regulations laid by Chief Inspector of Explosives.
Regulation laid by Factory Inspector of State.

Wherever the requirements in this specification are in conflict with any of the above standards, the requirements of this specification shall be binding.

2.0 Design basis:

Impressed Current Cathodic Protection (CP) System to be provided for Carbon Steel material for soil side corrosion prevention of underground vessels inside the pit and their connecting lines as applicable for the tender. Anodes to be considered for impressed current CP System shall be close distributed long line mixed metal oxide (MMO) wire anode piggyback connected with anode lead cable, factory pre-packed with coke breeze with factory connected tail cables as per structure design and site condition. Also, Sacrificial Anode Cathodic Protection system shall be considered on channel and floating head side of cooler/ heat exchangers containing conductive fluids/cooling water with dissimilar metallurgy in channel/floating head side. The dissimilar metallurgy shall be in the form of Bimetallic (Galvanic) coupling made of Carbon Steel and Stainless Steel or other ferrous or non-ferrous alloys (e.g. Carbon Steel Channel having SS 316 Fixed Tube Sheet etc.).

No Insulating joints shall be installed to isolate any incidental structures from CP System within the Battery limit. Hence the structures intended to be cathodically protected shall be in electrical continuity with many foreign structures within the plant complex such as RCC pavements, RCC foundations, earthing grids, other U/G structures, which are not intended to be protected. The CP current requirement therefore shall be governed by following factors:

- Surface area and coating quality of structures to be protected.
- Surface area and surface condition of nearby foreign structures including earth grid.
- Relative position of anode between foreign structure and structure intended to be protected.

To take care of such situation CP System shall be designed & installed in two stages by providing one preliminary design and another supplementary design for Impressed Current CP System as follows:

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Preliminary design:

A preliminary design shall be made as per required scheme which shall be approved by Owner/ consultant. The quantities required for T/R units, Power Distribution Boards, anode beds of various configurations, Junction boxes (AJB, CJB, MJB, etc.), Cables of various sizes, Thermit weld connections, and any other materials as required shall be calculated by CP CONTRACTOR. The locations of T/R units, Distribution Boards, anode beds of various configurations, Junction boxes (AJB, CJB, MJB, etc.), Cables of various sizes, Thermit weld connections, shall be marked by CONTRACTOR in appropriate layout drawings and shall be submitted along with Detail engineering package to OWNER/ EIL for approval. The T/R Units, PDB, and MJB shall be installed at one location under a common sun/ rain shed in non-classified area near the equipment. Based on site condition, CP contractor shall decide location/distance of the CP equipment from the site plot plan/layout. Cathodic protection Transformer Rectifier unit (CPTR Unit) shall be oil cooled, outdoor type. The power supply for the T/R Unit/ PDB shall be drawn from the identified cubical of the electrical substation nearest to the equipment.

Supplementary design:

After energising CP System as per preliminary design, the unprotected/ under protected and over protected areas shall be identified and a supplementary design is to be made to bring all structures intended to be protected within acceptable potential limits.

The following criteria shall be followed to determine the protection levels:

- Maximum allowable equipment to soil potential with respect to Cu/ $CuSO_4$ ref. Cell: –1.10V (Instant OFF) for impressed current system.
- Minimum allowable equipment to soil potential with respect to Cu/ $CuSO_4$ ref. Cell: –0.850 V (Instant OFF) or –100mV polarization shift .
- Discretion to use any of the criteria shall solely rest with Owner/ Owner's Representative.
- Interference Criteria: +50mV positive shift.
- Design life of Anode = 25 years (minimum) for impressed current CP system.

a) While deciding number of modular type 75V/75A, 50V/50A, 25V/25A , 50V/75A, 50V/25A, 25A/12 V capacity T/R units, considerations must be given to see no T/R unit is loaded more than 75% of its rated output voltage & current capacity throughout design life while feeding load to a single or group of anode beds.

b) For continuous wire anode the anode current capacity shall be considered as 30mA/m for design purpose.

c) Identification and mitigation of interference between structures to be protected as well as between the structures to be protected and foreign structures need to be carried out by the contractor as per the requirements of the codes mentioned in this document.

d) Earthing of all T/R Units, PDB and Junction Boxes need to be done by connecting the same with plant earthing grids, wherever plant earthing grids are not available nearby, a separate earth pit approved by OWNER/ EIL may be considered by contractor.

e) To avoid cable damage in the long run, all cables are to be laid at the cable trays wherever possible; underground cable laying through PVC/ HDPE conduit should be considered only when

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no cable trays are available nearby. All CP System cables need to be laid at power cable trays, all multi core- monitoring cables may be laid in either electrical or instrumentation cable trays whichever is available.

f) The type of coating and operating temperature of each Equipment should be taken into consideration for all detail-engineering calculations.

g) Wherever specific guidelines are not furnished for cathode structure current density, a current density shall be considered for coated piping: 3.0 mA/m2 and for bare cathode/incidental structures: 25 mA/m2.

h) If operating temperature of Equipment exceeds 25 deg C, protective current density shall be corrected @ 0.5mA/m2/deg. C up to 60 deg.C.

i) Connection of drainage cables and measurement cables to the structure shall be done by Thermit welding method.

j) Sand resistivity need to be considered for the structure CP System design as minimum 200 ohm- m or as measured at site whichever is higher.

k) The structure shall have suitable paint for the soil side corrosion protection

l) Reference cell shall be supplied along with required length of lead cable connected at manufacturer's factory as far as possible.

2.1 Design Scheme for Cathodic Protection (CP) System:

Free ends of each string anode shall be terminated to AJB through loop connection on sand cushions. Outdoor type, Transformer-Rectifier unit (T/R Unit) shall be installed to energise the anode strings through anode junction boxes (AJB). Rating of T/R unit shall be 75V/75A, 50V/50A, 25V/25A, 50V/75A, 50V/25A, 25A/12 V based on design calculations. T/R Unit shall have one or two outgoing positive header cables, which shall be terminated to post/ structure mounted AJB to be installed at suitable location near the structures. T/R Unit shall have one out going negative header cable, which shall be terminated, to a cathode junction box cum test station (CJB). CJB cum test station (CJB) shall be located at suitable location near the structures for the drainage connection and potential measurement. Two drainage cables and two measurement cables from each structure shall be terminated to its CJB. Power supply for the T/R Unit shall be drawn from the nearest S/S. OWNER shall provide one 63A/ 250A, 415V, TP circuit breaker/ Switch Fuse unit at the nearest S/S. CONTRACTOR need to lay one 3-phase, 4-wire (Required cable size) power supply cable from this circuit breaker/ Switch Fuse unit outlet to one outdoor type PDB near the T/R Unit location for distribution of power to the T/R Unit. The reference cell cables and the measurement cables from each structures shall be routed through the respective cathode junction box cum test station (CJB) to a single Monitoring Junction Box (MJB), which shall be located near the T/R Units and have the provision of measurement of structure to soil potential.

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Also for monitoring of structure to soil potentials at the T/R unit, monitoring cables consisting of reference cell and measurement cables shall be laid between MJB and T/R unit for connection of at least three reference cells to T/R Unit panel. Rotary Selector shall be used at the TR Unit for measurement of potential for each reference cell. The T/R Units, PDB, MJB and RTU shall be installed at one location under a common sun/ rain shed in non-classified area near the Electrical S/S or near the process unit/ offsite area to be decided jointly at the detailed engineering stage by EIL / OWNER.

Common Computerized central monitoring of all T/R units and the permanent reference cells of CP System shall be provided with the help of microprocessor based CP System remote terminal unit (RTU) for subject unit area. The central monitoring unit shall be located at Central Electrical substation.

2.1.1 U/G vessels:

RCC pit shall be provided for the U/G vessel, Anodes string employed for C.P. System of U/g vessels shall be located within the RCC pit. Specific installation requirements of String Anode shall be as follows:

- Anode strings shall be installed in the sand cushion surrounding the vessel at a distance of 500 mm from the vessel.
- Separation distance between consecutive String anode loop shall be uniform.
- Length of each longer side of the loop string anode shall be same as the length of the vessel + 0.6m.
- Minimum 4 No. of strings should be considered for each vessel

Free ends of each anode string should be connected to AJB located at each end of the vessel. Thus 2 No. of anode lead cables from each anode string shall be terminated to AJB.

2.2 Detailed Engineering Works to be performed by Contractor for CP System:

Following detailed engineering works are to be performed by contractor based on scheme given vide item no. 2.1 and design basis given vide item no. 2.0 of this document for CP System:

- List of materials/ equipment to be procured from Indian market/ foreign market.
- Item wise list of vendors with their reference lists for supply of materials/ equipment.
- Calculation and Preparation of Bill of Quantities for all CP system materials and equipment required.

Bill of quantity along with detailed calculations and preparation of specifications, installation work procedures & fabrication/ construction drawings for following items:

- CP System power distribution board (PDB): Total quantity and connection scheme showing group of T/R units to be connected with each CP System PDB and connection details between owner's switch board and each CP System PDB.
- T/R unit: Total quantity, detailed circuit diagrams and their installation drawings.
- AJB/ CJB/ MJB: Total quantity and connection Scheme showing how group of anodes, anode beds and structure/ equipment are to be connected with each AJB/ CJB/ MJB. Also,

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fabrication drawing & schematic drawing for internal terminal arrangements and installation drawings for a typical AJB/ CJB/ MJB.

- Anodes: Total nos. of Anode strings and anode string to anode lead cable joint details for entire CP System and their layout arrangement drawings showing no. of anode strings in each. structure/ equipment. Construction drawings and work procedures for anode to cable jointing and also for installation of anode strings.

Design calculations showing:

- Cables: Total quantity of cables and their layout drawing for each CP Station as well as for entire CP System for +ve header cables, -ve header cables, anode lead cables, earthing cables, drainage cables, power supply cables and multi-core monitoring cables.

- Cable to structure/ equipment joint: Total quantity of joints and details of a typical joint.

T/R unit wise CP System layout drawing showing how each T/R unit is connected with group of anode strings for UG Vessel/ Tank bottom plate/ UG piping through AJB/ CJB/ MJB.

- Test points: All reference cells and anode strings should be marked in a single layout drawing.

- Overall CP System layout drawing including all test points, anodes, anode beds, AJB, CJB, MJB, cable routes on a plot plan. All CP System materials/ equipment shall be marked properly for easy identification on all appropriate drawings as well as on site.

- Preparation of testing & commissioning procedure for CP System.

- Preparation of construction drawings with soft copies before starting of installation/ procurement work, Preparation of Soft & hard copies of as built drawings after completion of CP System work, shall also be furnished.

- Quantified list of the major construction equipment, tools, tackles etc. including Diesel engine pump set for dewatering at cable/ pipe trench the BIDDER proposes to use for execution of the work.

- Details & list of vehicles proposed to be used by the CONTRACTOR during the entire construction & commissioning period for transportation of material, equipment, as well as movement of personnel within the plant area.

- Bar chart giving details how BIDDER plans to execute the work within the specified time schedule.

- Quality Assurance Plans/ Procedure

The CONTRACTOR shall establish document and maintain an effective Quality Assurance system as outlined in recognized codes etc. and Quality Assurance Plans included in Specifications etc. to ensure that the work is performed in a planned, systematic manner to the best quality standards and properly

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documented to provide confidence that materials supplied and/ or work executed and services performed by him conform to the applicable specifications and all the requirements of contract document and work executed by him shall perform satisfactorily over the entire period of its life.

The Quality Assurance Systems Plans/ Procedures of the CONTRACTOR shall generally cover the following aspects/ details, which shall be furnished by BIDDER along with, his detail- engineering package.

i) A Quality Assurance Organogram with curriculum vitae of key personnel responsible for the Quality Assurance at site.

ii) Complete details pertaining to the responsibility authority and accountability of the Quality Assurance Organization of the CONTRACTOR at site.

iii) Equipments, material, Erection, Installation, Testing and commissioning control plans for quality testing/ inspection etc.

iv) Quality Control of processes such as Thermit welding, anode to cable jointing etc.

v) Control Procedures/ Plans for calibration and safe up-keep of instruments, gauges and similar testing equipment etc.

vi) Quality audit & Maintenance/ records/ procedures etc.

vii) Other relevant details.

Quality Assurance System Plans/ Procedures of the CONTRACTOR shall be furnished in the form of a QA manual. BIDDER shall be required to provide explanation pertaining to the details furnished by him in accordance with provisions contained in this clause and any further details, as sought for by OWNER/ EIL. In addition, all the Quality Assurance Programs/ Plans as per specifications enclosed with the Contract shall be fully complied with by the Contractor.

- Precautionary measures to be taken to prevent fire hazard during Thermit welding and Pin Brazing of structure/ equipment for the purpose of cable to structure/ equipment joint as well as during installation, operation & maintenance of CP System.

- All other information as required in individual job specifications shall be furnished by CONTRACTOR in his detail-engineering package.

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3.0 SPECIFICATION FOR CP SYSTEM EQUIPMENT AND MATERIALS

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3.1 SPECIFICATION
FOR OIL COOLED TRANSFORMER/ RECTIFIER UNIT

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SPECIFICATIONS AND TESTING OF OIL COOLED TRANSFORMER RECTIFIER UNITS

The specifications and testing procedure of transformer units are given as follows:

3.1 TRANSFORMER RECTIFIER UNITS (T/R UNITS)

The transformer rectifier units shall be a standard product of a manufacturer regularly engaged in production of cathodic protection power supplies. The units shall be supplied in accordance with the following specifications and data sheets.

3.1.1 CODES AND STANDARDS

In general the T/R Unit covered by this specification shall unless otherwise specified, be in line with the requirements of any of the latest applicable standard of:

a) Indian Standards Institution (ISI)

b) International Electrotechnical commission (IEC)

c) American Standards Institution (ANSI)

d) British Standards Institution (BS)

Wherever the requirements in this specification are in conflict with any of the above standards, the requirements under this specification shall be binding.

3.1.2 TRANSFORMER

The main transformer will be the isolation type having separate primary and secondary windings. An electrostatic shield, composed of heavy copper foil, shall be placed between the two windings and grounded to the rectifier cabinet, for this purpose a visible lead should be brought out from the copper foil which shall be connected to any of the mounting stud of the transformer core. Transformer winding wire insulation, winding interlayer insulation, core to winding insulation shall be class F type. The transformer core and winding will be dipped in thermosetting varnish and baked. Transformer varnish will meet the standards for 155 degree C operation. The transformer winding shall withstand 2,000 volt (RMS at 50 hertz) applied for one minute between the windings and between each winding and the transformer core. Maximum temperature of transformer oil will not exceed 85 Deg.C and air temperature inside the upper cabinet will not exceed 85 Deg.C at full load current at ambient temperature of up to 45 deg.C. Transformer full load efficiency will not be less than 95%.The auto transformer shall be similar to main transformer except it will have single winding and tapping for manual mode of control.

3.1.3 RECTIFYING ELEMENTS

The power rectification shall be done by Silicon diodes mounted on heat sinks of sufficient size to prevent the diode case temperature from exceeding 100^{o}C at ambient temperature as per data sheet. The peak inverse voltage rating and current ratings of the diodes shall be as per data sheet. The diodes shall be connected in Bridge circuitory for full wave rectification. Each diode in the bridge circuit shall be protected by a HRC fuse.

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3.1.4 A.C. INPUT

The transformer rectifier units shall be designed to operate on 240 volts (±10%) AC single phase, 50 Hz power supply. Inrush current limiting reactor of suitable rating to be provided at input line of the main transformer to avoid possibility of abnormal tripping of MCB while closing circuit using MCB.

3.1.5 D.C OUTPUT

The transformer rectifier shall be designed to operate continuously at 100% rated output current and 100% rated output voltage at input supply voltage 240v (±10%) without exceeding specified hot spot temperature limit and without damaging any components.

3.1.6 D.C OUTPUT ADJUSTMENTS

The DC output control shall be available in any of the following modes, with the help of a selector switch.

3.1.6.1 MANUAL MODE

Output voltage at 23 equal steps up to 100% rated voltage shall be available by means of coarse and fine tap changing switches for rated input supply voltage and 100% rated output current. Tapping for output voltage control shall be taken from a separate auto transformer. The controlled output voltage of the auto transformer shall be fed to main transformer input. The output of the main transformer shall be rectified for DC load supply.

3.1.6.2 AUTO MODE

Unit shall have CONSTANT OUTPUT CURRENT/ VOLTAGE CONTROL (AVCC MODE) in AUTO MODE as per Data Sheet.

CONSTANT CURRENT AND VOLTAGE CONTROL (AVCC MODE)

It will be possible to operate the T/R unit in either Constant Voltage Mode or Constant Current Mode.

Constant Voltage control feature shall be achieved by automatically adjusting T/R unit output voltage between 0 to 100% rated voltage through close loop control using T/R unit output voltage as feedback taken from the voltage divider inside the T/R unit so that T/R unit output voltage of any value between 0 to 100% rated voltage does not vary more than ±0.5V of set value when there is a change in input supply voltage of ±10% or change in load resistance over a specified range decided by the ratio of output voltage & current rating of the T/R Unit

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3.1.7 DC OUTPUT RIPPLE

The filter circuit shall be designed in such a manner that ripple factor does not exceed 5% RMS at rated load both in Auto and manual mode.

3.1.8 INPUT OVERLOAD PROTECTION

Protection from overloads on the input will be provided by Miniature circuit breakers of suitable rating on the input side. The trip point will be unaffected by ambient temperature. The trip handles of individual poles of circuit breaker will be mechanically linked so that all lines are opened when an overload occurs. In addition to above MCB, HRC fuse of suitable rating should be connected before MCB so that AC .input current is limited to max. 10% excess rated input current as per data sheet.

3.1.9 OUTPUT OVERLOAD PROTECTION

Protection from overload on the output in auto mode for T/R unit having either constant current control or constant pipe to soil potential control will be provided by another close loop SCR control circuitry giving automatic constant current control same as mentioned vide 3.1.6.2(i) except that it will act as back up control to main auto mode control. Separate PCB shall be used for main auto mode control and the backup control. The current limit for backup control is to be set by two limit switches marked "coarse" and "fine". The limits of the two switches shall be algebraically additive and shall give equal 30 steps up to 110% rated current. One scale calibrated in Ampere shall be provided with each limit switches so that current limit can be set by operator at any desired value in 30 equal steps. In any circumstances even in case of short circuit the T/R unit output current should not exceed the current limit set by the backup control.

In addition to above electronic current limiting feature HRC fuse of suitable ratings to be used at positive and negative terminals as well as one double pole MCB of suitable rating to be connected after HRC fuse at the output to disconnect T/R unit quickly in case of over loads in the output circuit or for ease of isolating T/R Unit from the circuit when it is desired to keep the T/R Unit in standby mode.

3.1.10 VOLTAGE SURGE PROTECTION

Each silicon controlled rectifier (SCR) and Diodes shall be protected from voltage surges by means of R-C/MOV circuitry. This R-C circuitry/MOV will be rated as recommended by the manufacturer of the SCR/

Diodes so that they will conduct heavily before the peak inverse voltage ratings of the SCR/ Diodes are reached. In addition, lighting arrestors and zener Barrier type or MOV type surge Diverters shall be provided in the AC input and DC output circuit of the Transformer rectifier as per data sheet.

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3.1.11 COOLING

The transformer/ rectifier will be Natural oil cooled (ONAN) completely enclosed IP55 construction. The temperature of the oil measured at the top layer shall not be more than 85 ^{O}C and maximum air temperature of the upper cabinet should not be more than 85^{O}C for ambient temperature of up to
45 ^{O}C.

3.1.12 INPUT AND OUTPUT TERMINALS

DC terminals made of tinned plated copper shall be located convenient to the cable entrance. The terminals shall be suitable for cable sizes as per data sheet. Three negative and three positive output terminals shall be provided.

AC terminals shall be insulated to withstand 2000 volts 50Hz to the enclosure, shall be shielded to prevent accidental contact and shall be sized to take cable sizes as per data sheet.

3.1.13 METERS

The transformer rectifier units shall be equipped with separate continuous reading voltmeter and ammeter for the DC output and the A.C. input voltage, current and Structure to electrolyte Potential measurement meter with selector switch for selection of different Structure to electrolyte Potential measurement meter. All meters shall be electronic digital type with LED display arrangement and should be able to indicate the current and voltage ranges as per data sheet up to a resolution of one decimal place for DC Ammeter & Voltmeter and 2decimal places for PSP meter. Digit size should be 12.5mm (minimum). All meters shall be rectangular in shape and accurate to within 2% at full load at ambient temp. as per data sheet. They shall be temperature compensated to vary no more than 1% per 10% temperature changes.

All AC&DC voltmeters shall be provided with separate fuse and toggle switch whereas all Ammeters shall be provided with only toggle switch.

3.1.14 ANNUNCIATION

Each transformer rectifier shall be supplied with a continuous signal light which will go out at loss of AC input. In addition to this each T/R unit should give annunciation for Auto and manual mode of operation by continuous signal light. T/R unit should also indicate the failure of each fuse in bridge rectifier and two DC output fuses by an independent LED for each.

3.1.15 ENCLOSURES

"The enclosure of T/R unit shall be plinth mounted type having two compartments. Lower compartment shall contain main transformer, Auto-transformer, DC choke and the compartment should be filled with Transformer oil to IEC 296. The upper compartment shall contain the SCRs, Diodes, indicating meters, Protective devices, Electronic control circuits/ control cords etc. and shall be provided with a plexi glass viewing window. Both the compartments shall be completely enclosed type having IP55 construction.

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The enclosure shall have a frame work made of minimum 50mmx 50mm x 3mm angle iron, the upper cabinet body shall be made of minimum 12SWG(2.5mm) W.T. sheet steel, lower cabinet shall be 10 SWG(3.0mm) W.T sheet steel. Size of enclosure shall be minimum 1500(H) x 700(W) x 550mm (D) or higher size than this. Necessary fins for the cooling purpose shall be provided at lower compartment. A detachable sun/ rain shade to be provided of suitable size.

The transformer rectifier shall be provided with the following accessories.

- Steel channel under the base for plinth mounting.
- Lifting lugs of size suitable for lifting complete transformer rectifier unit when full of oil
- Sunshade/ rain shade.
- Oil filing hole with screw cap and drain plug.
- An oil sight gauge comprising a flat toughened glass window through which the oil is viewed. The viewing window shall have a white background.
- Silica gel breather suitable for 10KVA transformer to be located inside the upper cabinet of T/R unit.
- A removable dial type thermometer graduated in degrees Celsius with a red mark on the scale at the maximum oil temperature.
- Thermometer pocket
- Locatable control cabinet with viewing window to IP-55 as a minimum.

Accessibility shall be provided by hinged and removable front and back shutters. A plexi glass viewing window shall be provided at the front shutter to allow the meters to be read without opening the front shutter. One drawing pocket shall be made at inner side of the front shutter. One holder for 5W LED lamp connection shall be provided at a strategic point inside the cabinet to facilitate proper illumination during operation and maintenance. The enclosure shall be supplied with an engraved warning level with the words "DANGER". Two junction boxes shall be provided at both sides of the upper compartment, one of them A.C. cable entries and other for D.C. cable entries. Gland plate should be provided against each junction box for fixing single compression cable glands for A.C DC control/monitoring cables. One 240V, 5A Socket shall be provided at a strategic point inside the cabinet to facilitate connection of soldering iron during maintenance. After fabrication the entire enclosure shall be sand blasted to SA 21/2 surface to surface or chemically treated with Industry Standard 7 Tank treatment process. An inorganic zinc primer shall then be sprayed to a total thickness of 3 mils. The finish coat shall be a dark grey shade of polyamide cured epoxy in three coats to achieve total thickness of 10 mils. Alternatively Powder coating of total thickness 100-125 Microns is also acceptable.

3.1.16 ENCLOSURE EARTHING

All normally dead metallic parts shall be electrically continuous, earthing terminals shall be suitable for 35mm square cable connection, one earthing terminal shall be made for earthing connection to power supply earthing and two earthing terminals shall be made for earthing connection to the local earthing pits.

The earth connection points shall be protected against corrosion. It shall not be necessary to scrape the paint away in order to make an effective earth connection. Provision shall also be made adjacent to each gland plate for cable gland earthing connection.

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3.1.16.1 Cable Terminations

i) Cable glanding and terminating facilities and terminals shall be suitable for the specified cable type and conductor size. Consideration and provision shall be taken by the manufacturer on the equipment design for the use of cables with aluminium conductors. Cable glands & cable lugs shall be in the scope of supply for CP system installation contractor.

i) Terminal blocks shall be arranged and positioned to afford easy access for carrying out external cable termination, testing, inspection and maintenance. There shall be ample clear space allowed between the terminal block and the gland plate for the spreading and termination of external conductors.

iii) All terminal blocks shall be shrouded or provided with transparent covers. Pinch screw type terminals are not acceptable.

iv) Three positive and three negative post type DC output terminals shall be provided for the T/R Unit. Each post shall be fitted with double nuts and washers.

v) Terminals for different voltages shall be separated by partitions.

vi) A terminal box or chamber with undrilled gland plate or entry panel of sufficient dimensions to terminate the specified incoming and outgoing cables shall be provided. Direction of cable entry shall be from below.

vii) Termination of single core cables shall be through a suitable gland plate and provision made for bonding and earthing any armour and/ or concentric ground conductors.

viii) Cable terminal arrangements for power and control cables may be integrated provided that a barrier separates the two.

ix) Auxiliary wiring shall have copper conductors of the manufacturer's standard sizing (subject to Buyer's approval).

x) Suitable terminals for three nos. ref. cell cables, one no. measurement cables and a selector switch for permanent ref. cell to be provided for T/R unit panel for connection to PSP meter. Wiring shall be crimped using self-insulated compression type terminal blocks which shall be suitably identified. Conductors shall be fitted with sleeve ferrules bearing the same identification as the terminal to which they are connected. Minimum conductor size shall be 1.0mm2 (current density shall not be more than 3A/mm^2 for copper conductor). However, Electronic wiring can be done with 0.5 mm^2 conductor.

3.1.17 NAME PLATE

A permanently stamped stainless steel metal plate shall be attached to outside of the case with the following information.

a. Manufacturer's name

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b. AC input voltage and current rating

c. AC frequency
d. Phase
e. Output DC Volts and Amps. rating
f. Weight in Kg of T/R unit
g. Model number
h. Serial number
i. Year of Manufacture

3.1.18 SPECIFICATION OF 75V, 50A T/R UNIT

A. AC input voltage : 240 Volts ±10% 50 Hz single phase
B. AC input Current : 30A (Max.)
C. DC power output : 3.75 KW (Max.)
D. KVA rating of transformer : 7.5KVA
E. DC output voltage : 75V
F. DC output current : 50A

G. Current rating
- Diodes: 100A(Max. Average forward current)
- SCR : 85A(Average on state current), 133A (RMS on state current)

H. Full load efficiency
- Transformer alone : More than 95%
- Transformer Rectifier Assembly : More than 75%

I. Full load power factor : 0.8 lagging
J. Insulation level : 2KV
K. Peak Inverse Voltage
- Diodes/SCR's : 1500V(PIV)

L. Filtering circuit : L.C.filter
M. Ripple and Hum at rated output : Not more than 5% RMS

N. Surge Diverters
i) For diodes/SCR's : R-C circuitry of rating as advised by manufacturer of SCR/ Diodes or MOV
ii) For input of T/R unit : 2 nos. Zener Diodes of voltage rating 300V RMS, spark over voltage 1000V(Peak), RIR Type A6 FMR 100 BB or equivalent MOV type surge diverters.
iii) For output of T/R : 2 nos. Zener Diodes of voltage unit rating 300V RMS, Spark over voltage 800V(Peak), RIR Type A6 FMR 80 or equivalent MOV type surge diverters.

O. Lightening arrestor: 2 nos. each at the input and output of the T/R unit of voltage rating 500V RMS, Max. 1.2/50 micro Seconds impulse spark over voltage 2.5KV(Peak), Max. discharge residual voltage at 5KA, 8/20 micro second impulse current wave 2.5KV @1.5KA, Max. impulse current discharge capacity 4/10 micro second impulse current wave 10KA(Peak), LAMCO PL01 L.T-2.8 or equivalent make.

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P. Protection : MCB suitable for motor load having thermal over load and magnetic short circuit Protection for input current in addition to separate HRC fuse protection for each Diode, HRC fuse

at out put and input terminals, glass cartridge fuse, in the live line of all lamps, auxiliary power lines to control circuit and voltmeter circuits.

Q. Construction : Plinth mounted outdoor type.

R. Cooling : Oil cooled

S. Meters/ Instruments: As per Sec.3.1.13.

1No.DC voltmeter 0-200V,
1No.DC Ammeter 0-60A
1No.AC voltmeter 0-300V
1No. AC Ammeter 0-30A
1No.Corrosionvoltmeter,0-19.99V,10Mohm input resistance.

Other accessories:

a) Silica Gel Breather
b) Dial type thermometer 8 Dial 2 1/2" graduate in degree celsius with one red mark on the scale at the maximum oil temperature.
c) Thermometer Pocket
d) Oil filling screw cap and drain plug.
e) An oil sight gauge comprising a flat long head glass window with white back-ground through which oil is viewed.
f) Sun shade/rain shade.

T. Enclosure: Per sec. 3.1.15

U. Cable Entry: Through single compression Aluminium gland of following sizes of cables. Gland plates are to be provided at the junction boxes located at both side of upper compartment:
+ve and -ve header : 95mm^2/ 50mm^2 1-core, 4nos.
Power supply cable : 25mm^2 , 3-core, 1 No.
Monitoring cable : 6mm^2, 1-core, 3 nos
(Monitoring cable to be used in case permanent ref.cell is used for monitoring pipe/ structure to soil potential)

V. Enclosure painting : As per sec. 3.1.15

W. Fabrication, Schematic: Supplier to furnish for EIL approval schematic wiring diagram and fabrication drawing prior to fabrication of T/R units.

X. Spare parts & Additional features : Supply as per Sec.3.1.18.

Y. Ambient temp. : 45 deg.C

Z. Type of control required in Auto mode: Constant current control and constant voltage control (AVCC MODE)

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3.1.19 DATA SHEET OF 50V, 25A T/R UNIT

A.	AC input voltage single phase	:	240volts±10%50HZ B.
B.	AC input current	:	10A (max.)
C.	DC power output	:	1.25KW (max.)
D.	KVA rating of transformer	:	2.5 KVA
E.	DC output voltage	:	50V
F.	DC output current	:	25A
G.	CurrentratingSCR:50A (Average onstate current),75A(RMS onstate current)		

Rest same as3.1.18exceptin item(s) where meter rating shall be as under

1No.DC voltmeter0-60V,
1No.DCAmmeter0-30A

1No.AC voltmeter0-300V

1No. AC Ammeter0-10A
1No.Corrosionvoltmeter,0-19.99V,10Mohm input resistance.

3.1.20 Testing of T/R units

All T/R units shall be tested by contractor and inspected by EIL/Owner before despatch, testing shall be conducted in accordance with codes and standards enclosed in this document, as per routine tests done by manufacturer and additional tests as mentioned below:

3.1.20.1 Efficiency test of Transformer Rectifier Assembly at 25%, 50%, 75% and 100% rated output current both in Auto and manual mode of operation.

3.1.20.2 No load output voltage test in Manual mode for each voltage setting using coarse and fine tap switches at rated input voltage of 240V AC.

3.1.20.3 Output voltage and current test in Manual mode for each voltage setting using coarse and fine tap switches for the following conditions.

i) Input voltage 240V AC,load resistance1.5 ohm for 50A T/ R& 2.0ohm for 25AT/R

ii) Input voltage 264V AC,load resistance1.5 ohm for 50A T/R & 2.0ohm for 25AT/R

iii) Input voltage 216V AC,load resistance1.5 ohm for 50A T/R& 2.0ohm for 25AT/R.

3.1.20.4 Output voltage test at rated output current setting in Auto mode for the following conditions.

i) Input voltage 240V AC,load resistance:1.5ohm for 50A T/R & 2.0ohm for 25AT/R

ii) Input voltage 264V AC,load resistance:1.5ohm for 50A T/R & 2.0 ohm for 25AT/R

iii) Input voltage 264V AC,load resistance 0 ohm (short circuit across +ve and-ve terminal of T/R unit). Set back up control 50A & 25A for 50 A & 25A T/R unit respectively.

iv) Input voltage 216V AC,load resistance:1.50 ohm for 50A T/R & 2.0 ohm for 25A T/R

Output current and voltage shall be recorded for each of above conditions (i) to (iv).

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3.1.20.5Heat run test for max. Temp rise to be conducted for main transformer, Autotransformer, filter choke, Diodes and SCR's, at 50A output current for 50A T/R Unit & 25A current for 25A T/R unit for 24hours continuous operation . Number of T/R units to be considered for Heat run tests and actual duration for which test to be conducted up to 24 hours (max.) shall be decided by EIL and owner. Thermocouple instrument shall be used for measurement of temperature. The sensors shall be clamped at different locations inside the closed T/R unit cubical and the cable of the sensors shall be connected to temperature indicator through a selector switch outside the T/R unit cubical during heat run test.

3.1.20.6 Insulation resistance test using 500V megger for Auto transformer and Main transformer between primary and secondary, primary and earth, secondary and earth.

3.1.20.7 Dielectric strength test using 2KV for 1 min. duration for Auto transformer, main transformer between Primary and secondary, primary and earth, secondary and earth.

3.1.20.8 Polarity test in Auto and manual mode of operation of T/R unit.

3.1.20.9 Calibration test for all Ammeters and volt meters.

3.1.20.10 Auto mode over load protection test:

Set back up control at 50 Amp. and increase current from zero to max. Possible using main Auto control for T/R Unit having constant current control. In case of Auto PSP control T/R unit ref. feed back signal to be varied from min. to max. set potential of T/R unit using battery & rheostat in place of ref. half cell signal, current during the test should not exceed more than 50A in both cases.

3.1.20.10.1 Constant Current Test

i) D.C Current Regulation against variation in AC Input

Put the unit in constant current mode and set the output current at 50 A by the help of current setting potentiometer and observe the variation in, if any, of output current with variation of AC input voltage at the steps keeping the output load constant: 216V, 240 V, 264 V.

ii) D.C Current Regulation against variation in Load Voltage

Keeping the AC input voltage at 240 V constant , set the output D.C current at 50 A and observe for any variation of DC current with variation of output load voltage at three different values ensuring that at each output load voltage, taking care voltage limit set value is not exceeded.

Repeat the above at 50A and finally at 25A set output current.

3.1.20.11 Constant voltage test for control circuitory. Supply voltage of T/R unit to be applied 240V 216V and 264V.

For each input supply voltage the reference voltage, +ve DC and -ve DC voltages of Auto mode control circuit to be checked whether they are constant.

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3.1.20.11.1 D.C Voltage Regulation against variation in Load Current

Keeping the AC input Voltage at 240 V constant, set the output D.C voltage at 75 V and observe for any variation of D.C Voltage with variation of output load current at three different values ensuring that each output load current, current limit set value is not exceeded .

Repeat the above at 24 V and finally at 12 V set output Voltage.

3.1.20.12 Ripple factor test

T/R unit shall be operated at full load both in Auto and Manual mode. In each case ripple voltage to be checked on a cathode ray oscilloscope (CRO). Peak to Peak ripple wave from shall be limited within 10.5 volt in CRO screen for7 5 volt TR unit & 7.0 volt for 50 volt TR unit.

3.1.20.13 Annunciation check:

Annunciation check to be done for power on, manual mode operation and auto mode operation.

3.1.20.14 Auto mode constant PSP operation test:

Connect one battery with variable rheostat in place of reference cell feedback signal and conduct the following test:

i) Make both T/R unit set potential & feedback signal from battery 1.0V, Switch on T/R unit & note T/R output current. Increase feedback signal from 1.0V to 1.5V and again bring back to 1.0V. Note change in the T/R output current.

ii) Conduct similar test as item (i) above with decrease of feedback signed from 1.0V to 0.5V and again back to 1.0V. Note change in the T/R output current.

of choke at 50A T/R unit output current =

3.1.20.15 Test certificate/ documents in 6 copies are to be furnished by vendor before despatch of T/R unit to site. The test certificate shall contain results for the tests from 3.1.20.1 to 3.1.20.14 given above in addition the following observations:

- Sl. No. of T/R unit
- D.C. output rating of T/R unit
- External dimensions of T/R unit
- Weight of T/R unit
- Thickness of M.S .sheet steel used for T/R unit enclosure.
- Painting details of enclosure.
- Visual inspection details of T/R unit stating:

a) All components of T/R unit are as per specification

b) All items are labeled properly for identification purpose.

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c) Number used in ferrules of cable leads are matching with schematic/ wiring diagram of T/R unit furnished.

3.1.22 DRAWINGS/ DOCUMENTS

Following drawings/ documents shall be furnished by vendor within 15 days from award of contract for approval of the same by EIL/ OWNER before starting of fabrication. Approved drawings after incorporation of comments (if any from EIL/ OWNER shall be furnished in 6 copies alongwith reproducible during the delivery of T/R units:

3.1.22.1 Fabrication drawings and data sheet of T/R unit giving dimensions, rating, weight, including installation/ foundation arrangement details.

3.1.22.2 Front view and typical sections of T/R unit panel with arrangement of equipment, control, protection and metering.

3.1.22.3 Data sheet of all accessories and circuit element of T/R unit including ratings.

3.1.22.4 Schematic and wiring diagram of T/R unit circuitory giving Auto/ Manual Mode of control including circuit details of all control cards.

3.1.23 INSTRUCTION BOOK

3.1.23.1 The instruction book in 10 copies shall be presented in such manner as to enable it to be used by personnel who are unfamiliar with the operation and maintenance of the T/R unit. The instruction book to be furnished along with supply of T/R unit.

3.1.23.2 CONTENTS

The instruction book shall contain

- A description of the T/R unit.
- Instruction for the installation, testing commissioning and safe operation and maintenance.

The information shall be presented as follows:

1. Index of contents

2. General description giving brief description of the T/R and its use.

Detailed description of T/R unit

This description shall include the technical characteristics, physical and mechanical limitations, and item wise the components, accessories and spare parts.

4. Description of the operation of the T/R unit. This description shall be clear, concise and in

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a logical sequence, using schematic diagram, wiring diagram and fabrication drawing.

5. Procedures for testing and adjusting the T/R unit:

The complete procedure for testing and adjusting the T/R unit during plant operation, periodic maintenance and overhaul shall be covered.

6. Maintenance Instructions:

This section shall be divided into two parts:

a) Preventive maintenance which shall indicate the periodic inspection required the inspection procedure and cleaning procedures.

b) Break down maintenance which shall include instruction for trouble shooting of the electrical circuits. The procedure for the removal and replacement of all parts listed as spares shall be given.

7. Spare parts

The instruction books shall give all the necessary details so as to procure all the spare parts from the manufacture or from open market.

8. Each instruction book shall be accompanied with one set of final approved Drawing/ documents as listed vide item 3.1.21.

- COVERING OF THE INSTRUCTION BOOKS: The instruction book shall be presented in a stiff covered binder with the following information printed on the cover:
    - the client's name
    - the location of the installation
    - the name of the installation
    - the title of the instruction book.

3.1.24 Following additional features are to be provided with T/R Unit

i) T/R UNIT INTERRUPTION

The T/R units shall have programmable current interruption facility according to a schedule defined by the user through the Central Monitoring and Control System. Interruption ON / OFF cycle should be programmable in the time ratio selectable from 0 to 9999 seconds in increments of 1 second. The interruption device shall be solid state type without any mechanical moving parts and shall have arrangement for bypass.

The interrupter clock of TR Unit should accept external time synchronization signal from the

central monitoring system having GPS synchronized current interrupter for measurement and recording of interrupted OFF potential recording in synchronization with other T/R units.

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ii) ANNUNCIATION FOR FUSE FAIL

T/R unit should be provided with Electronic Fuse fail Indicator. The Fuse fail indicator should sense signals from each Fuse in series with diode in the rectifier circuit as well as each fuse in DC

output circuit and on its failure, it should identify the fuse failed with the help of an independent LED for each fuse for local visual alarm.

iii) MANDATORY SPARE PARTS

Mandatory spare parts as mentioned at Section 4.0 in this document need to be supplied for the T/R Units.

IV) T/R UNIT REMOTE MONITORING

T/R Units should be provided with transducers for providing 4-20 mA output signals or direct signals as required for remote monitoring unit (RMU) interface for remote monitoring of T/R Unit output voltage and current. Alternatively, if this feature is built into the RTU, then separate transducers are not required in the T/R unit.
Necessary terminals are to be provided at suitable locations of the T/R unit panel for easy termination of onward wiring by others for remote monitoring purpose.
Each T/R Unit shall accept set point signals for DC Voltage and DC Current from Remote Monitoring & Controlling Panel and accordingly shall control its output from 0 to 100%.

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3.2 SPECIFICATION FOR CP SYSTEM POWER DISTRIBUTION BOARD (PDB)

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3.2 Power Distribution Board (PDB):

The Power distribution board (PDB) shall be plinth mounted outdoor type and shall be installed at non-classified locations near a single or group of T/R Unit under a sun/ rain shed. The enclosure of shall be IP-55 as per relevant IEC/ NEC/ IS codes.

The Power distribution board (PDB) shall be composed of one no.3 phase, 4-wire 250A/ 63A, incoming MCCB and 12/3 no. 1 phase, 63A outgoing MCB for input power supply to TR Unit as well as 6No.6A outgoing MCB for central monitoring system power supply. The incoming switch shall be 3-pole and outgoing switches shall be 2-pole. 4 Nos. of 25x 5mm tinned copper bus bar shall be used which should be taped by PVC tape of red, yellow and blue colours for dentification of the three phases and black colour for neutral. Wiring inside PDB shall be done using $50mm^2$, 1-core, copper conductor, PVC insulated, unarmored cable between TPN switch neutral and neutral bus whereas rest of the wiring shall be done by $25mm^2$, 1-core, copper conductor, PVC insulated unarmored cable. All single core cables shall be used red, yellow and blue coloured for phase connections and black coloured for neutral connection. All cables terminations shall be through Tinned copper cable lugs of matching cable size. All cable entries to the PDB panel shall be through Aluminium single compression glands. One gland for $300mm^2$ / $50mm^2$, 3-phase, 4-core incoming cable connection shall be provided at left side bottom of the panel, 12/3/6 glands to be provided at right side bottom of the panel for outgoing cable connections for 63A PDB. The outgoing cables shall be $25mm^2$, 1-phase, 3-core Aluminum conductor cables for TRU power input and $16mm^2$, 1-phase, 3-core Aluminum conductor cables for central monitoring system power supply. Size of the PDB Panel enclosure shall be adequate to accommodate all components easily and shall be made of 12 SWG sheet steel. Two nos. hinged front shutters shall be provided. The shutters shall be screwed to the panel enclosure structure at the centre in addition it shall have lockable handles. Painting details of inside and outside surfaces of the PDB panel shall be as follows: After fabrications the entire enclosure shall be sand blasted to a SA2½ surface. An inorganic zinc primer shall then be sprayed to a total thickness of 3 mils. The finish coat shall be of polyamide cured epoxy in three coats to achieve total thickness of 15 mils. The finish coat shall be a dark grey or yellow shade as per choice of EIL/ OWNER.

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3.3 SPECIFICATION FOR MIXED METAL OXIDE COATED TITANIUM TUBULAR ANODE FOR CP SYSTEM

(DELETED)

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3.3.1.0 Scope

3.3.1.1 Anodes

Mixed Metal oxide coated Titanium tube anodes shall be dimensionally stable and will be supplied with anode lead cable connected to it.

3.3.1.2 ANODE DATA SHEET

Sl.No.	Description	Details
1.	Anode Type	Dimensionally stable Anode (DSA)
2.	Anode Shape & Dimension	Hollow Tubular 750mm long x 25.4mm OD, W.T: 1 mm ± 0.1 mm
3.	Anode weight	0.210 kg ± 5%
4.	Anode Material	Titanium seamless tube of Grade 1, ASTM B 861, overlayed with mixed oxide of noble metals.
5.	Anode design life	30 years
6.	Anode consumption rate (Kg/A-yr) at 100 A/m^2 Current density	2 mg/A-yr.
7.	Metal Oxide coating thickness weight (gm/M^2)	6 gms/m^2(at 100 A/m^2 for 30 years design life)
8.	Optimum Recommended anode current density (A/m^2) i) With Carbonaceous backfill in soil ii) Without backfill in soil iii) Fresh water	 $100A/M^2$ Vendor to furnish Vendor to furnish
9.	Rated current output	6 Amps
10.	Anode Centralizer for 8" NB casing pipe	1 Nos. per anode. Vendor to furnish details.
11.	Mechanical & Physical Properties: i) Electrical Resistivity (ohm Cm) of Metal Oxide ii) Contact resistance of anode to cable iii) Pull out strength iv) Anode fabrication v) Anode to cable connection details vi) Anode to cable joint insulation details	 10^{-5} Ohm Cm 0.9 milli ohms (max.) 200 kg(min) or breaking strength of cable Vendor to furnish details Vendor to furnish details Vendor to furnish details
12.	Dead Weight for Anode	Each anode to be supplied with a dead weight. Details of the same to be furnished by vendor

Note: All information to be furnished by vendor as per data sheet shall be furnished with his offer.

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3.3.1.3 Anode Lead Cable

Anode lead cables to be connected between each anode and AJB shall be 7 strands, 10mm^2 stranded copper conductor, single core, unarmored, with a double insulation system. The primary insulation shall be 0.04/0.1 inch thick cross-linked polyvinylidene floride (PVDF) 1100 Volt grade. The secondary insulation shall be 0.065 inch thick high molecular weight polyethylene (HMWPE) sheathing jacket over the primary insulation. For anode lead cable, manufacturer should have minimum 7 years of manufacturing experience and having proven track record of minimum 5 years of successful performance. The minimum 5 years of performance certificate of this item for any hydro carbon industry /pipelines needs to be furnished by the contractor. The proposed make/model of these items being supplied by contractor shall be subject to acceptance as per sole discretion of EIL/Owner.

Anode to Lead cable jointing and insulation shall be done by using straight through jointing kit which is to be provided by anode manufacturer. Anode to Lead cable jointing and insulation shall be done at manufacturer's work shop.

3.3.1.3.1 Anode to Cable connection

Anode lead cable conductor shall be crimped with tubular anode at the center of anode or at the ends and shall be sealed to prevent ingress of water at the joint. Fabrication details of the joint including sealing arrangement and test procedure of the joint shall be furnished by vendor for EIL's approval before making the joints.

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3.4 SPECIFICATIONS FOR PERMANENT REFERENCE CELL

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3.4 SPECIFICATIONS FOR PERMANENT REFERENCE HALF CELL

3.4.1 For monitoring of soil side potential:

a. Type of ref. half cell : Cu/ $CuSO_4$ type.

b. Body : Impact resistance

d. Each reference shall be supplied in cotton bag of chemical backfill (as per manufacturer recommendation) and complete with 25 M (minimum) cable as per specification. Contractor to measure the actual length of measurement cable required at site during detailed engineering stage and cut the required length from cable drum so as to avoid cable-to-cable joint. Alternatively, moisture proof joints may be carried out at site by trained jointer with holiday testing with manufacturer reference cell cable.

e. Location of half cell : 150 mm from structure

f. Design life : 25 years

g. Stability : ±10 mv with 3 Micro- A load.

h. Make : Shall be suitable for 15-40 deg.C temperature application in sand.

i. Measurement Cable: 4-6mm^2, stranded Cu conductor, Single core, screened/ armoured, PVC insulated and sheathed, 1100 V grade.

Reference Cell Cable: 4-6mm^2, stranded Cu conductor, Single core, screened/ armoured, PVC insulated and sheathed, 1100 V grade.

Contractor shall get the electrodes approved before placement of order. For Reference cell, manufacturer should have minimum 7 years of manufacturing experience and having proven track record of minimum 5 years of successful performance. The minimum 5 years of performance certificate of this item for any hydro carbon industry /pipelines need to be furnished by the contractor. The proposed make/model of these items being supplied by contractor shall be subject to acceptance as per sole discretion of EIL/Owner.
Necessary test certificates from manufacturer giving calibration test, results, date of manufacture shall be furnished during delivery. Any delivery effected without prior approval of owner will be at suppliers risk & cost.

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3.5 SPECIFICATION FOR MIXED METAL OXIDE TITANIUM WIRE ANODE FOR CP SYSTEM

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3.5.1.0 MIXED METAL OXIDE TITANIUM WIRE ANODE

Factory coke backfilled fabric jacketed Mixed Metal Oxide coated Titanium wire anodes shall be a standard product of the manufacturer regularly engaged in the production of such anodes for use in impressed current Cathodic Protection system. The make / model of MMO wire anode being proposed by CP System contractor shall be subject to acceptance as per sole discretion of EIL / OWNER. The anode manufacturer should have minimum 7 years of manufacturing experience for the similar type pre-packed with coke-breeze MMO Ti Wire anodes and also proven track record for minimum five years of successful performance of such anode for UG Vessels/ Tank bottom plate/ Plant piping protection for any hydrocarbon plant need to be furnished by the CP System contractor.

3.5.1.1 Anodes

Mixed Metal oxide anodes shall be dimensionally stable. Each wire anode shall be supplied with anode lead cable piggy back connected to it i.e there will be connection between the Primary anode and the internal header cable at every 3m (max) distance. The connection shall be multi- step and water proof.

Anode Data Sheet:

a.	Anode Type	Dimensionally stable Anode (DSA)
b.	MMO Anode Shape & Dimension	Wire anode 1.5 mm ± 0.10mm*
c.	MMO Anode weight	Vendor to Specify
d.	MMO Anode Material	Commercially pure solid Titanium wire, grade 1/2, ASTM B 863, over laid with mixed oxide of noble metals suitable for soil application
e.	Anode design life	30 years
f.	i) Anode consumption rate (Kg/A-yr.) at 100 A/M2 C. density. ii) Overall OD of anode string with calcined petroleum coke breeze and its fabric jacket enclosure	i) 2 mg/A-yr. ii) 35mm (min.)
g.	Metal Oxide coating thickness weight (gm/M2)	6gms/m^2(min.) / MMO coating on titanium suitable for current output and design life.
h.	Optimum Recommended anode current density (A/M2) i) With Carbonaceous backfill in soil ii) Without backfill in soil iii) Fresh water	i) 100A/m^2 ii) Vendor to furnish iii) Vendor to furnish

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i)	Minimum rated current output in soil/ sand	50mA/m
j)	Mechanical & Physical Properties i) Electrical Resistivity (ohm Cm) of Metal Oxide	 10^{-5} Ohm Cm
k)	Contact resistance of anode to cable	0.9 milli ohms (max.)
l)	Anode fabrication	Vendor to furnish details
m)	Anode to cable connection details	100% water proof. Vendor to furnish
n)	Anode to cable joint insulation details	Vendor to furnish
o)	Allowable attenuation of potential along anode	1% for dry sand of resistivity 20,000 ohm-cm 10% for wet sand of resistivity 500 ohm-cm.
p)	Spacing between consecutive anode to cable joints	3 meters
q)	Coke breeze backfill	Vendor to furnish (as per manufacturer standard)
	Carbon content	99% min
	Coke Resistivity	< 1 ohm
	Bulk density of coke breeze	1180 kg/ m^3 min
r)	FABRIC	The anode wire with surrounding coke breeze should be held together by an Integrated woven, acid resistant and porous jacket assembly.
s)	**Chloride resistance**	**The fabric should pass the 6 month acid immersion test**

- Following Insulation specification to be followed for supply of anode internal header and anode lead cable. Laboratory testing to be done in national/ international reputed laboratory at anode manufacturing country.

Insulation Type	Insulation Specifications**	
Polyvinylidene Fluoride (PVDF) Irradiation Cross-Linked	Tensile Break Strength Break Elongation Flexural Strength Resistivity Dielectric Constant	4500 PSI min. 50% min. 8600 PSI min. 2×10^{14} ohm-cm min. 8.0 min. at 100 Hz
Ethylene Chlorotrifluoroethylene (ECTFE)	Tensile Break Strength Break Elongation Resistivity Dielectric Constant	6500 PSI min. 100% min. 1×10^{15} ohm-cm min. 2.5 min. at 1 Mhz
High Density High Molecular Weight Polyethylene (HMWPE)	Color Density (minimum) ASTM D1248, Type 3, Class C, Category 5, or IEC 60502-1 Temperature Rating	Black 0.941 grams per cm^3 90°C.

** Standard Test Method ASTM D638 shall be used to determine the tensile strength, flexural strength and break elongation. For the resistivity and dielectric constant tests, Standard Test Methods ASTM D257 and ASTM D150 shall be utilized.

Note: All information is required to be furnished by vendor as per data sheet and shall be furnished with his detail engineering package.

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3.5.1.3 ANODE HEADER AND LEAD CABLE

Anode internal header cable and anode lead cable in between each anode string and AJB shall be insulated, 7 strands, 8 AWG/ 10mm^2 stranded copper conductor, single core, unarmoured, with a double insulation system. The primary insulation shall be 0.04/0.1 inch inch **± 0.005 inch** thick cross-linked polyvinylidene floride (PVDF) 1100 Volt grade. The secondary insulation shall be 0.065 inch inch **± 0.005 inch** thick high molecular weight polyethelene (HMWPE) sheathing jacket over the primary insulation.

Jointing of anode lead cable with internal anode header cable and its insulation shall be done by using standard jointing kit which is to be provided by anode manufacturer. However, preference will be given for direct termination of the anode header cable to AJB without any joint in between with internal anode header cable and anode lead cable. Anode lead cable to anode header cable jointing, shall be done at site by a trained cable jointer in case of unavoidable site/ project situation.

3.6.1.3.1 Anode to Cable connection

Vendor should submit procedure and sealing arrangement drawing of the joint and get the Anode lead cable to anode internal piggyback cable joint approved by EIL/ OWNER.

3.5.1.4 QA/ QC for Anodes

Following tests are to be conducted by anode manufacturer. Anodes with cables shall be delivered to site only after EIL/ Owner's approval of the test results, which are to be furnished by anode manufacturer. Detailed procedure for conducting the following tests shall be furnished by manufacturer for EIL/ Owner's approval before commencing tests. All the tests should be conducted in presence of EIL/ OWNER/ TPI (as applicable).

3.5.1.4.1 Visual Inspection Test –

The anode assembly shall be visually inspected for proper compaction of coke breeze and centralization of MMO wire and cable .

3.5.1.4.2 Dimensional check

- Dimensional check of MMO wire anode and OD of complete anode assembly
- Dimensional Check of Anode internal piggyback cable

- Thickness of primary cable insulation
- Thickness of secondary cable insulation

3.5.1.4.3 MMO Wire Anode (Type Test)

- MMO coating loading/ thickness by XRF or SEM method
- Accelerated Life Test NACE TM0108 (latest version)

3.5.1.4.4 Coke Breeze (Type Test)

- Coke Breeze Resistivity as per ASTM G57-06
- Weight of coke breeze per meter of anode

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3.5.1.4.5 Anode Fabric (Type Test)

- Acid Immersion Test for 6months (5N HCl Solution)

3.5.1.4.6 Anode Lead cables (Routine tests)

Routine & type test certificates of cable manufacturer to be furnished for anode lead cable as per IEC std. Cable length and identification tag to be verified by measurement.

3.5.1.4.7 Anode to Cable joint test (Routine tests)

Sample anode lead cable to internal anode header cable joint shall be tested for its electrical contact resistance & its value in ohms shall be recorded.

3.5.1.4.8 a) Prototype Test

First anode string / loop shall be subjected to destructive test to determine pull out strength of cable

to anode joint as well as effectiveness of the joint insulation and coke breeze backfilling to be performed at manufacturer's factory or at site (as applicable).

b) Type Test Frequency: - The type test frequency shall be 3 years or in case of any change in the material whichever is stringent

3.5.1.4.9 Test Reports

After conducting each test, reports showing test results should be submitted to EIL/ Owner for approval. Anode/ cable identification No./ batch No. shall be mentioned in test results against each test result. Any delivery made to site before getting EIL/Owner's approval of test reports shall be at manufacturer risk & cost.

3.5.1.4.10 Anode Fabrication

Manufacturers/ supplier shall furnish detailed dimensioned fabrication drawing of anode as well as details of cable connection and its insulation sealing to EIL/ Owner for approval.

Vendor (Anode Manufacturer/ supplier) shall furnish following information for approval before commencement of Anode to cable joint.

- Procedure for making the entire anode to cable joint.
- Procedure for accelerated ageing test of the string anode or test results.

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3.6 JOB SPECIFICATION FOR ANODE, CATHODE & MONITORING JUNCTION BOXES FOR CP SYSTEM

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3.6.1 Specifications for Anode & Cathode Junction Boxes

3.6.1.1 Anode Junction Boxes and Cathode Junction Box cum test station shall be suitable for Classified Area applications

An anode lead junction box (AJB) will be provided to feed T/R Unit output current to anode strings. These junction boxes will have provision for independent current measurement of each anode output. This will be accomplished by means of individual shunts for each anode circuit.

Drainage cable, reference cell cables and measurement cables from each structure/ equipment shall terminate in its respective cathode junction box cum test station. All the above-mentioned reference cell cables and measurement cables from each CJB shall be terminated into a single Monitoring junction box (MJB). Each CJB shall be connected to the negative terminal of the each T/R unit through loop in loop out arrangement for return of drainage current from structure/ equipment to the T/R unit.

The enclosure of CJB shall be structure/ wall mounted type. Shutter should be provided with closed cell neoprene sealing gaskets. The terminal board shall be of 10mm WT Phenolic laminated sheet on which all terminals and shunts are to be mounted. The terminals shall be made of cadmium plated steel or stainless steel stud nut and washers of M-10 size for termination of anode and cathode lead cables and M-4 size for termination of reference cell and measurement cables. All cable entries shall be through Aluminium double comprehension glands. The external bolt, nuts and clamps to be used for mounting the junction box with back plate/structures shall be MS electro-galvanised or Cadmium plated.

For classified areas, Junction box enclosure shall be of type "Exd" protection Zone 2/Group IIA/IIB application, Temp. Class: T-6, as per IS 5571,5572,2148 & 8289 and relevant IEC/NEC/IS standards. The cable glands shall be FLP double compression type made of Aluminium. Enclosure need to be certified by CMRI. The shutter of the junction box shall be screwed to the body of junction box by using MS electro galvanised/ Cadmium plated nut, bolt and washers. The enclosure of the junction box shall be made of cast aluminium. One earthing terminal shall be provided for earthing the junction box.

3.6.1.2 Monitoring Junction Boxes for non Classified Areas:

Monitoring junction boxes (MJB) will be installed near the T/R Unit and shall be required for monitoring potentials of multiple structure/ equipment . The enclosure for the MJB shall be of IP-55 construction made of 12SWG (2.67) W.T. sheet steel.
The enclosure shall be structure/wall mounted type having removable hinged front shutter with one handle and flush type locking arrangement. Shutter should be provided with closed cell neoprene sealing gaskets. The terminal board shall be of 8mm thick Phenolic laminated sheet on which all terminals shall be made of stainless steel stud, nut and double spring washers of M-4 size for reference cell/ measurement cables. The terminal arrangement shall be such that bottom row is utilised for termination of measurement cables from each structure/ equipment and upper rows one each is allotted for the reference cell cable termination from each structure/ equipment , hence total number of rows shall be one more than the total number of structure/ equipment. All cable entries shall be through Aluminum double compression glands. The external bolt, nuts and clamps to be used for mounting the junction box with back plate/ structures shall be MS electro-galvanised or Cadmium, plated. Shutter should be provided with closed cell neoprene sealing gaskets.

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3.6.1.3 Proper fitting of cables at cable glands

It is essential that all cables should fit tight at cable glands. For this purpose vendor need to make openings for glands at junction box or cast/ procure cable glands as per cable samples to be procured for CP System.

3.6.1.4 Painting

Enclosures of all non classified type anode and Cathode junction boxes shall be surface finished with paint as per guidelines outlined in Section 3.11.

3.6.1.5 Inspection & Testing

Fabrication drawing showing internal terminal arrangement of each type of junction box to be submitted by vendor to OWNER/ PMC to obtain approval for a Prototype construction. After inspection and approval of prototype the mass production shall be started. Calibration test for shunts for each junction box to be inspected by OWNER/ PMC before dispatch.

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3.7 SPECIFICATION FOR CABLES FOR CP SYSTEM

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3.7.1.0 SCOPE

3.7.1.1 CODES AND STANDARDS

In general the cables covered by this specification shall unless otherwise specified be in the line with the requirements of any of the latest applicable standard of IS, IEC, BS and Relevant NEC/ JIS/ JEC standards. Wherever the requirements in this specification are in conflict with any of the above standard, the requirements under this specification shall be binding.

3.7.1.2 ANODE LEAD CABLE

Anode lead cables shall be 7 strands, 10mm^2 stranded copper conductor, single core, unarmoured, with a double insulation system. The primary insulation shall be 0.04/0.1 inch thick cross-linked polyvinylidene floride (PVDF) 1100 Volt grade. The secondary insulation shall be 0.065 inch thick high molecular weight polyethylene (HMWPE) sheathing jacket over the primary insulation.

Insulation Type	Insulation Specifications**	
Polyvinylidene Fluoride (PVDF) Irradiation Cross-Linked	Tensile Break Strength Break Elongation Flexural Strength Resistivity Dielectric Constant	4500 PSI min. 50% min. 8600 PSI min. 2×10^{14} ohm-cm min. 8.0 min. at 100 Hz
Ethylene Chlorotrifluoroethylene (ECTFE)	Tensile Break Strength Break Elongation Resistivity Dielectric Constant	6500 PSI min. 100% min. 1×10^{15} ohm-cm min. 2.5 min. at 1 Mhz
High Density High Molecular Weight Polyethylene (HMWPE)	Color Density (minimum) ASTM D1248, Type 3, Class C, Category 5, or IEC 60502-1 Temperature Rating	Black 0.941 grams per cm^3 90°C.

** Standard Test Method ASTM D638 shall be used to determine the tensile strength, flexural strength and break elongation. For the resistivity and dielectric constant tests, Standard Test Methods ASTM D257 and ASTM D150 shall be utilized.

3.7.1.3 +VE, -VE HEADER CABLE

+ve header and -ve header cables shall be 95mm2, stranded Aluminium conductor, single core, Aluminium wire armoured, PVC insulated and PVC sheathed 1100V grade cable.

3.7.1.4 DRAINAGE CABLE

Drainage cables shall be 50mm2, stranded Copper conductor, single core, Aluminium wire armoured, PVC insulated and sheathed 1100V grade cable.

3.7.1.5 POWER SUPPLY CABLE (Between PDB & T/R Unit)

Power supply cable between Power source or CP System DB and T/R unit shall be 25mm2, stranded Aluminium conductor, 3-core, Aluminium wire armoured, PVC insulated and sheathed 1100V grade cable.

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3.7.1.6 POWER SUPPLY CABLE (between Power Source & PDB).

Power supply cable between Power source & CP System DB shall be 300mm2 /50mm2, stranded Aluminium conductor, 4-core, Aluminium wire armoured, PVC insulated & sheathed 1100 V grade cable.

3.7.1.7 EARTHING CABLE

Earthing cable shall be 35mm2 , stranded Aluminium conductor, 1-core unarmoured, PVC insulated and sheathed 1100V grade cable.

3.7.1.8 REFERENCE CELL / MEASUREMENT CABLE BETWEEN REFERENCE CELL / UG VESSEL/ TANK TO CJB CUM TEST STATION

Instrumentation cable, 4mm^2, 1-core, stranded copper conductor, PE/PVC insulated and PVC sheathed, screened and armoured cable, PE/PVC insulation of each core shall be Numbered or colour coded for easy identification of each core.

3.7.1.9 REFERENCE CELL / MEASUREMENT CABLE BETWEEN CJB TO MJB & MJB TO TRU

Instrumentation cable, 2.5mm^2, 10-core, stranded copper conductor, PE/PVC insulated and PVC sheathed, screened and armoured cable, PE/PVC insulation of each core shall be Numbered or colour coded for easy identification of each core.

3.7.1.10 REFERENCE CELL / MEASUREMENT CABLE BETWEEN MJB & RTU

Instrumentation cable, 2.5mm^2, 20-core, stranded copper conductor, PE/PVC insulated and PVC sheathed, screened and armoured cable, PE/PVC insulation of each core shall be Numbered or colour coded for easy identification of each core.

3.7.1.11 REFERENCE CELL / MEASUREMENT CABLE BETWEEN TRU & RTU

Instrumentation cable, 2.5mm^2, 24-core, stranded copper conductor, PE/PVC insulated and PVC sheathed, screened and armoured cable, PE/PVC insulation of each core shall be Numbered or colour coded for easy identification of each core.

3.7.1.13 POWER SUPPLY CABLE BETWEEN PDB TO RTU FOR CENTRAL MONITORING

Power supply cable between PDB to RTU for central monitoring shall be 16mm2, stranded Aluminum conductor, 3-core, Aluminium wire armoured, PVC insulated and sheathed 1100V grade cable.

3.7.1.14 CABLE DRUMS

All cables to be supplied in wooden drums. Cable lengths in each cable drum shall be 600m (min.) wherever cable lengths are more than 600m.

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3.7.1.15 INSPECTION

All cables along with manufacturer's test certificate as per IS standards shall be inspected by OWNER/EIL at the vendor's shop before dispatch. Minimum 15 days advance notice to be furnished by vendor for this purpose. In case of any doubt OWNER/EIL may insist vendor to conduct the tests as per IS standards in presence of OWNER/ EIL at vendor's work shop or some third party reputed laboratory approved by OWNER/ EIL at no extra cost.

3.7.1.16 CABLE IDENTIFICATION

For easy identification of cable, the over sheath of the cable should have yellow colour and "CP SYSTEM CABLES" should be printed using black colour at one meter interval throughout the length of the cable.

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3.8 JOB SPECIFICATION FOR CALCINED PETROLEUM COKE BREEZE FOR CP SYSTEM

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3.8 SPECIFICATION FOR CALCINED PETROLEUM COKE BREEZE

Calcined Petroleum Coke Breeze shall conform to the following specifications as per latest NACE- SP 0572 std .

A	Chemical Composition:	
	Moisture (on Dry Basis)	< 0.1 (% by mass)
	Fixed Carbon	Minimum 99.0 (% by mass)
B	Bulk density	900 Kg/m^3 to 1200 Kg/m^3
C	Real density	2.03 gm/cc
D	Particle Size	1.00mm (max.), dust free
E	Resistivity	0.1 ohm-cm. at 150 psi.

3.8.1 Test Certificates

Test Certificate shall be furnished for the following:

1. Make of coke breeze
2. Batch no.
3. Chemical composition
4. Bulk density and Real density
5. Particle size analysis
6. Resistivity (ohm-Cm.) at 150 psi compaction

Any delivery effected without prior approval of test certificate by EIL/ Owner will be at suppliers risk & cost.

Above mentioned specification for coke breeze shall be considered for MMO tubular anodes incase required for supplementary design, the coke breeze to be considered for MMO wire anode may be of make as per the anode manufacturer's choice meeting the requirements of the specifications mentioned above.

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3.9 JOB SPECIFICATION FOR THERMIT WELDING FOR CP SYSTEM

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3.9.1 Thermit Weld Connection:

All cable-to-pipe connections shall be made utilizing the exothermic weld process. All thermit weld connections shall be encapsulated with thermit weld cap and flood coating of coal tar enamel. Each thermit weld connection will basically require the following:

- Thermit weld mold vertical/ horizontal
- Thermit weld metal
- Thermit weld cap Steel disc.
- Copper sleeve
- Flint Igniter
- Mold Cleaner
- Mold Packing
- Coal tar enamel/ two part epoxy resin for encapsulation of the joint.

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3.10 MATERIALS/ EQUIPMENT FOR OPERATION AND MAINTENANCE OF CP SYSTEM

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3.10 Materials/ Equipment for Operation and Maintenance of CP System:

Following materials/ equipment shall be supplied by the CP System Contractor for operation and maintenance of CP system.

S.No.	Quantity	Description
1.0	1 No.	Digital Multimeter having minimum input resistance 10 Mohm, complete with leads and leather case.
2.0	10 Nos.	Reference electrodes: Portable Copper/ Copper sulphate type having PVC SCH 40 body with transparent window and threaded ceramic porous plug suitable for 15-40 deg.C temperature application in sand.
3.0	1 No.	DC Clipon ammeter in milliamp. / micro amp. range current measurement.

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3.11 SPECIFICATION FOR PAINTING CORROSION PROTECTION FOR JUNCTION BOXES, PDB, CABLE MARKERS AND JUNCTION BOXES SUPPORT STRUCTURES

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3.11.1.0 Corrosion Protection for Junction boxes, PDB, Cable markers and junction Boxes support structures

All junction Boxes in Non-classified area, PDB and their support structures, MS channels for T/R mounting if any, cable marker Posts shall be galvanized & painted in following manner.

i) Surface preparation

Grit/shot Blasted to SA2 1/2 as per Swedish standard SIS 055900

ii) Galvanizing

Hot dip or spray galvanized to achieve a minimum zinc thickness of 150µm.

iii) Primer Application

Etch Primer with 10 µ DFT based on Polyvinyl Butyral resin + 1 coat of epoxy zinc phosphate primer @40 µ DFT/coat

iv) Paint Application

1 Coat of 2 Pack high build epoxy with Polyamide hardener cure @100 µ DFT/coat followed by 1 Top coat of Acrylic Polyurethane finish paint @40 µ DFT/coat.

Primer & Paint application procedure shall be standard airless spray and as per paint manufacturer's procedure. Name of Paint manufacturer and product should be approved by EIL prior to application. Colour of top coat shall be yellow or grey as per choice of EIL/ OWNER.

3.11.1.1 MS covers for shallow vertical Beds shall be painted with 2 coats of synthetic enamel paint of Asian Paint/Berger or equivalent make. Colour of paint shall be yellow.

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3.12 CENTRAL MONITORING SYSTEM

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CENTRAL MONITORING & CONTROL SYSTEM (RMC)

3.12.1 Common Computerized Central Monitoring and Control is required for the CP System for each TR unit/ items to be protected inside the Unit. For this purpose, the T/R unit & permanent reference cells should be connected to Remote Terminal Unit (RTU) consisting of microprocessor based CPS controller with alpha- numeric LCD display, memory, real time clock, keypad, battery backup and communication ports or equivalent PLC-SCADA system.

- RTU/ PLC system shall be capable to process minimum 8 analogue input signals (including one each for TR Unit output current & voltage), 4 digital input signals, 2 analogue output signals and 1no. digital output signal for monitoring performance of each TR Unit which shall be considered for structure/ equipment protection

- In addition to this some digital and analog (input) signal should also be kept as 20 % spare capacity.

- Single or multiple RTU/ PLC system may be provided for monitoring and control of all TR unit output and monitoring of potential for structures.

Thus considering few spares minimum analogue inputs, digital inputs, digital outputs and analogue outputs to be processed by each RTU/ PLC system is to be designed by vendor for review / approval by EIL/ OWNER. The system should also have inbuilt mechanisms to reduce / nullify induced AC interference voltages.

The RTU/ PLC Unit shall also be provided with 1 No. digital output for switching operation for TR Unit. This output shall be used to turn the rectifier OFF and ON for depolarised and instant "OFF" readings. The rectifier shall have in-built facility to accept these signals and interrupt its output supply. The digital input/ output channels shall be optically isolated. The RTU/ PLC should include a GPS based time synchronization unit for measurement of true OFF potential readings.

Further, RTU/ PLC shall be provided with 1 or 2 analogue output that can be used for controlling the various modes of the TR unit for remote control.

The RTU/ PLC should be capable of generating alarms when the parameter limits are violated and it should communicate the alarm data in real time and should not wait for the monitoring software query. The field RTU/ PLC units will have capability to control & monitor the T/R unit Voltage/ Current/ PSP & Current interruption by means of commands from the Central Monitoring Panel(CMP). The operator will be in a position to set all the parameters of T/R unit like DC Voltage, DC current, T/R unit current interruption timings/ schedules from the Central Monitoring Panel (CMP).

All CP System parameters shall be monitored and controlled from central control room using suitable software. The communication link between the RTU /PLC and Central monitoring and Control station should be cost effective GSM based wireless technology or RS485 fiberoptic/ Copper communication, whichever is decided by EIL/ OWNER as the communication network. CP System Sub-contractor should design, procure and install the requisite communication system and the cables required for this purpose.

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Central monitoring and Control station computer to be provided by the CP System sub- contractor shall consist of standalone computer suitable for CP monitoring application with following minimum specifications:

- Intel Core 2, I-7 (seven) processor
- Genuine Windows latest operating system with License
- 8 GB RAM
- 500 GB HDD
- 24in Flat Panel LCD Color Monitor
- DVD Rom
- Intel Integrated 100/ 1000 Ethernet Network Card
- 1 Serial, 4 USB Ports
- MS SQL Server Latest
- A3 Laser jet printer (HP make)
- Inbuilt UPS system which can operate up to 30 minutes on full load in case of power failure
- Other standard accessories

CP System sub-contractor shall also provide necessary Software for Remote Monitoring & Control as well as for printing of CP reports. The software should be compatible to Windows format and MS SQL Server or Oracle database (10g) with proper License should be used.

3.12.2 Remote Monitoring & Controlling Central Control System

The software and hardware for the proposed SCADA system shall have a proven track record of minimum three years of successful operation in the field of CP monitoring.

The Remote Monitoring & Control Panel (RMCP) shall have a Data Acquisition and Control Hardware operating in Real Time on PC having minimum specification mentioned in item 3.12.1

A Front End Communication Module (FEC) is also required that will be responsible for managing the entire communication traffic between the RMCP and RTU/ PLC.

The T/R Unit Output DC Voltage, DC Current, Reference Electrode Voltages, Alarms are to be extended to RMCP Panel through RTU/PLC units by any of the cost effective communication network such as GSM based wireless technology/ RS485/ fibreoptic/ copper communication whichever is decided by EIL/ OWNER as the communication network for data downloading and remote monitoring & control from master control room.

Each T/R Unit shall accept set point signals for DC Voltage and DC Current from Remote Monitoring & Controlling Panel and accordingly shall control its output from 0 to 100%.

- REMOTE MONITORING SYSTEM - SOFTWARE:

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The Remote Monitoring and Control System shall monitor and control various process parameters of Cathodic protection system. The Monitoring software shall be user friendly, Windows compatible, and should allow easy data transfer to other windows based applications or custom applications having ODBC compliant database. The Software shall have built-in graphic package to display graphical representation of the process on-screen with embedded buttons for switching ON/ OFF TR units. Data security should be ensured through three different types of Access Levels namely Expert, Supervisory and Operator. It should have provisions to accommodate future need of addition of new TRs for equipments & piping as may be required from time to time.

If required by client, The software shall be compatible for interfacing of the available CP System monitoring data on LAN at 10 No. additional nodes for management information system for access and reporting for the management. The monitoring software should be capable of generating notification & visual alarm, as and when signals go outside programmed set points and during RTU/PLC failure and TR Unit input power failure. It should generate customized reports as decided by EIL/ OWNER. The software shall allow configuration of emails of OWNERS employees who are responsible for maintenance.

- Remote Terminal Unit – specifications:

Sl No	Parameter	Specifications
1	Model	As per manufacturer
2	Local display & Local Keypad	The RTU shall consist of a 3 x 6 matrix membrane keypad and a 16 x 2 LCD Display with back-lighting for entering local settings and viewing TR parameters locally. Following Local settings can be done using the Key Pad & Display : - Setting Date/ Time - Setting Periodic Logging Interval - Setting of Scaling factor for DC shunt rating - Setting levels for various Alarm notifications - Setting Field ID.
		The LCD will normally display - TR Voltage - TR Current - Reference Potential - AC supply Voltage The RTU/ PLC should be able to be remotely configured for most of the above parameters from the central station.

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3	Programmable Periodic Interval	The Periodic Logging & Broadcast interval is programmable from 1 reading per 5 Minutes to 1 reading in 24 hours.
4	CPU	Microprocessor based latest generation design. Built-in Real Time Clock (+/- 1 minute accuracy over one month) Watch dog timer which provides a reset signal to the CPU if not toggled due to any hardware or software failure to ensure fail safe operation.
5	Local Memory	The RTU/ PLC will have sufficient local NVRAM memory to store the monitored data locally. Logged Data shall also be stored in the internal non-volatile Memory of RTU. About 30,000 total Data readings should be able to be stored without downloading. The locally stored data should be retained for upto10 years without external power to RTU/PLC. It will be possible to download the locally stored RTU data on a field Laptop reader through the local communication port in the RTU/ PLC whenever desired.
6	Analog Inputs for each TR Unit- (8 T/R Unit parameters viz □ DC Voltage □ DC Current □ Ref. Cell Potential (5 No.) □ AC supply Voltage + spare)	Fully differential Inputs, 12bit /16-bit resolution Should nullify the effect of AC interferences. High accuracy, High Impedance, with high common mode rejection ratio CMRR. CH-1: 0 – 100V DC (For DC Output Voltage) CH-2: 0 - 100mV DC (For DC Output Current through T/R shunt) CH-3 to 7: -5.0V to +5.0 V DC (For 5 No. Reference potential) CH-8: 0 - 300V AC (For AC supply Voltage Monitoring)

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7	Digital Inputs or software for Alarm generation. As required by design	24/12 VDC operated. shall also continuously scan and check for Alarm conditions listed below Following Alarms will be generated using Digital Inputs : • Diode/Output Fuse Fail • Unit Working in Remote Mode • Unit working in Local Mode Following Additional alarms will be generated by Software : • Input AC Supply Fail • Under Protection for Each Ref Electrode • Over Protection for Each Ref Electrode • Reference Fail for Each Ref Electrode The set parameters for the above alarm conditions can be programmed remotely through the central PC
8	Analog Control Outputs for T/R unit control As required by design	4-20mA / 0-5VDC / 0-10 VDC with isolation of 2500Vrms. Resolution – 12 Bit
9	Digital Output – 1 No. For T/R unit Current Interruption	SSR outputs relay 2500 V RMS optical Isolation. Contact rating 2A@ 240 V AC/ 1A @200 V DC On / off delay times 3 msec.
10	Communication	Through RS485 over Copper/ Fibre Optics network for broadcasting data to the Central Station at the programmed periodic interval. E-mail message facility for abnormal condition notification.
11	GPS Interface	Each RTU/ PLC will have built-in GPS module to synchronise the RTC to GPS time. This will ensure uniform real time for all the RTU/ PLCs.
12	Power Supply	230V ± 20%AC, 50 Hz □ 20V to 70V DC □ 12 VDC (Any one type as required by design)
13	Battery Backup	Battery Back-up for up to 2 Hrs of un-interrupted operation including E-mail transmission, in the event of failure of AC supply.
14	Communication Ports	As required by design

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15	Protection	Short Circuit Protection Surge Protection using MOV. Over Voltage protection EMI / EMC protection
16	Mounting	Preferably inside TR Unit if not possible then Wall / Pole mounting
17	Operating Temperature range	0 to 55 deg C
18	Humidity	95% condensing
19	Time Stamping	The RTU/ PLC shall have precise, accurate Real Time Clock (RTC) for exact time stamping of data.
20	Enclosure	The RTU/ PLC shall be housed in a compact & sturdy non corroding enclosure suitable for installation inside the shed common for all TR units. ABS / M.S. With IP 55 degree of protection Mounting : Either mounting inside each TR unit or common for all TR unit located under a single shed with Plinth mounting arrangement. Cable Entry : From Bottom
21	Data Download Port	The RTU/ PLC Unit shall have USB port through which the logged data can be downloaded onto the laptop.
22	Centralised Monitoring	The RTU/ PLC shall have built-in fibre optic modem to communicate with the central station Through RS485 over Fibre Optics Communication network. The RTU / PLC shall send the TR Data with exact time stamp directly to the Master Computer at central station at the programmed Periodic Interval. At the central end a PC shall be installed with a fibre optic Front End Communication (FEC) module and centralized monitoring software. The RTU shall also send alarm information with exact time stamp to the central station Periodic Interval. The PC software shall accept the data received from the RTU/ PLC, display it in graphical and analytical formats and store it in database like MS SQL to generate Reports and Graphs. It shall also possible to remotely program the Field RTU/ PLC Unit through the Central PC for configuration details like Setting Date/Time, Setting/ changing Periodic Interval . PC software should be able to monitor and receive data from up to 50 field RTU/ PLC at a time.
23	Compliance	Relevant BIS/ IEC EMI/ EMC standards

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3.12.3 Reports

The software should generate reports, which can be viewed as well as printed as listed below:

i) A monthly report showing readings from every system. The reports shall highlight readings outside limits and systems, which did not call.

ii) A single page report yearly report for each remote monitoring. This shall be used to show the monthly readings for each site.

iii) Alarm Reports: This particular report shall give all information about the alarms, which occurred in any abnormal conditions.

iv) Report information shall be compatible with standard spread sheet programs.

v) All above reports of different type should be available in graphical presentation, on screen and printer.

vi) Scaling and calibration of analogue channel can be done by use of supplier Editor Software.

3.12.4 DATA BASE SECURITY

Database shall be in the form of SQL Server. The version of SQL shall be latest with proven track. Following security features shall be provided in the server software:

- Roles
- Fixed Server Roles
- Fixed Database Roles
- User-Defined Roles
- Application Roles
- Granting and Denying Permissions to Users and Roles

Over and above the above features, the software supplied by the vendor shall broadly have following essential features to access the database as applicable.

- Group Creation
- User Creation
- User Group Allocation
- Enable - Disable Account Status
- Audit Trail
- Access Level Based on the operation
- Roles and Reasons
- Password Masking

3.12.5 DESIGN REVIEW:

CP System sub-contractor should prepare detailed engineering package for central monitoring and control system along with schematic drawings and equipment/ materials list including make/ model

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of the same and get the same approved by EIL/ OWNER before procurement/execution.

3.12.6 INSPECTION

The prototype inspection along with simulation tests shall be done at specialist agency's office / workshop by EIL/ OWNER before the dispatch of the equipment and materials at site. For this purpose CP System sub-contractor should furnish notice to EIL/ OWNER minimum 15 days before the date of inspection.

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3.13 SPECIFICATION FOR SOIL RESISTIVITY TEST

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3.13.1 SCOPE

The scope of this standard is to conduct the following tests within a plant complex:

- Soil/sand resistivity up to 10m depth to be measured using Wenner's 4-pin method in offsite/ unit areas/ Vessel pit.

3.13.2 OBJECTIVE

The objective of the tests given by Para 1.0 is to assess the corrosiveness of the soil/ sand & to decide suitable locations for anode beds for CP System for prevention of external corrosion of structure/ equipment within a plant complex.

3.13.3 SOIL RESISTIVITY TEST

In general soil resistivity tests covered by this specification shall unless otherwise specified, be in line with the requirements of BS CP 1021. Wherever the requirements in this specification are in conflict with the above standard, the requirements under this specification shall be binding.

3.13.3.1 SOIL RESISTIVITY TEST BY WENNER 4-PIN METHOD

Soil resistivity by Wenner 4-Pin method to be conducted at 4 anode bed locations as per instructions of EIL, at each location soil resistivity readings to be taken for 2m, 4m, 6m &10m depth for distributed anode beds.

$$\rho = 2\pi AR$$

Where,

ρ	=	Soil resistivity in ohm-cm
A	=	Inter electrode spacing in cm
R	=	Resistance observed from soil resistivity meter in ohm.

While inserting electrodes in soil for taking soil resistivity care should be taken to make good contact of electrodes with the soil, for this purpose limited watering may be required at the electrode penetration points wherever soil is dry or less compact. The depth of penetration of electrodes should not exceed 1/10th of the electrode spacing.

3.13.3.2 CALIBRATION OF SOIL RESISTIVITY METER

Soil resistivity meter should be calibrated at a reputed laboratory before use. The calibration certificate must be furnished to ENGINEER-IN-CHARGE for approval of the meter before use of the same for soil resistivity test at site.

3.13.4.0 REPORT PREPARATION

All soil resistivity readings shall be typed and presented in a tabular form giving co-ordinates and other location reference of each test locations & depth of each reading. The soil resistivity is to be expressed in ohm-cm.

Six copies each of soil resistivity report to be furnished to OWNER/ EIL for record.

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4.0 MANDATORY SPARES FOR CATHODIC PROTECTION SYSTEM

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4.0 The Bidder shall supply the following spares for each T/R unit:

-	D.C. Voltmeter	Nos.	1
-	D.C. Ameter	Nos.	1
-	A.C. Voltmeter	Nos.	1
-	A.C. Ammeter	Nos.	1
-	Diodes	Nos.	2
-	SCR's	Nos.	2
-	D.C. Fuses for output side	Nos.	5
-	HRC fuse for Diodes	Nos.	5
-	A.C. fuses for input side	Nos.	5
-	D.C. Lightening arrestor	Nos.	2
-	A.C. Circuit breaker(MCB)	Nos.	2
-	Electronic Control Cards each type	Nos.	2
-	Filter circuit capacitor	Nos.	2
-	Signal light assembly for annunciation	Nos.	2
-	R.C. Surge Diverter	Nos.	2
-	Control transformer	Nos.	2
-	Coarse voltage control switch	Nos.	2
-	Coarse current control switch	Nos.	2
-	Fine voltage control switch	Nos.	2
-	Fine current control switch	Nos.	2
-	Auto Manual Mode selector switch	Nos.	2
-	Toggle switches	Nos.	2
-	Assorted Glass cartridge fuses	set.	15

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5.0 Specification for Sacrificial Anode Cathodic Protection for Coolers and Condensers

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5.1 Sacrificial Anode Cathodic Protection system shall be considered on channel /floating head side of cooler/ heat exchangers containing conductive fluids/cooling water with dissimilar metallurgy in channel/floating head side. The dissimilar metallurgy shall be in the form of Bimetallic (Galvanic) coupling made of Carbon Steel and Stainless Steel or other ferrous or non-ferrous alloys (e.g. Carbon Steel Channel having SS 316 Fixed Tube Sheet etc.).

5.1.1 ANODES

Anodes shall be magnesium/Zinc/Aluminium (as applicable) following specifications:

5.1.1.1 Magnesium Anode

Anodes shall be high purity **Magnesium alloy** of ASTM B843 AZ-63 grade with following compositions

Element	Weight %
Aluminium	5.3-6.7
Silicon	0.1 max
Copper	0.05 max.
Iron	0.005 max.
Lead	0.03 max.
Zinc	2.5-3.5
Mn	0.15-0.7
Ni	0.002 max
Others	0.3 max
Mg	Remainder

Electrochemical Properties

Magnesium anode shall have minimum following guaranteed values in 3.4% NaCl solution at room temperature.

Anode capacity 1100 per AH/Kg.

Closed circuit Potential - 1.45 to -1.5 V (v/s SCE) at 0.6 mA/cm2 anode C. density

5.1.1.2 Zinc Anode

The anode shall conform to the requirements of ASTM B418 Type-I with following composition:

Element	Weight %
Aluminium	0.1 to 0.5
Cadmium	0.025-0.07
Copper	0.005 max.
Iron	0.005 max.
Lead	0.006 max.
Others (Total)	0.1 max.
Zinc	Remainder

Electrochemical Properties

Zinc anode shall have minimum following guaranteed values

Anode capacity 800 per AH/Kg.

Closed circuit Potential - 1.00 V (v/s SCE)

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5.1.1.3 Aluminum Anode

The Anode shall be (Al-Zn-In-Si Alloy) conforming to following composition by wt. % :

Element	Wt%
Fe:	0.12 % Max.
Si:	0.08-0.2%
Cu:	0.006% Max.
Zn:	2.0-4.0%
Indium:	0.01-0.02%
Others:	0.02% Max. (Each)
Aluminum:	Remainder

Electrochemical Properties

Aluminium anode shall have minimum following guaranteed values

Closed circuit potential at 25^0 C (v/s Ag/AgCl) at anodic current density of 100-300 mA/ft2 in 3.4% Nacl:

- 1.10 Volts.

Capacity at 25^0 C at anodic current density of 100-300 mA/ft 2 in 3.4% Nacl.

2500 AH/Kg

5.1.2 Anode Quantity

Vendor shall decide anode quantity for each cooler based on the following design guidelines. Anode Quantity shall be calculated for channel and floating head separately for each cooler.

(a) Anode design life - 4 years

(b) Coating breakdown factor after 4 years - 60%

(c) Anode utilization factor - 0.90

While estimating total protection current density, entire area of all components of Stainless Steel or other metallurgy which are in Galvanic Coupling with Carbon Steel must be taken into consideration for full Cathodic Protection along with Carbon Steel components. While calculating area of tube sheets, the area of the tube holes shall also be considered.

5.1.3 Acceptance Test for Anodes

Before delivery of the anodes, anode manufacturer shall furnish results of following tests from **an independent NABL accredited laboratory** for EIL approval**.** The tests shall be conducted in accordance with applicable ASTM/DNV standards.

- **Chemical composition analysis**
- **Open circuit potential test**
- **Closed circuit potential test**
- **Anode capacity test**

The tests shall be carried out on minimum 3 samples representative of different heats for anode material. In case only one heat is utilized during anodes casting, then of 3 samples, one should be taken during start of pouring, one during from end of heat and one from middle of heat.

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Annexure-1

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JOB SPECIFICATION FOR SURFACE PREPARATION AND PROTECTIVE COATING (SMMS)

PROJECT : MPMC AND PMC/EPCM SERVICES FOR ETHYLENE CRACKER UNIT AND UTILITIES & OFFSITES RELATED TO BINA PETCHEM & REFINERY EXPANSION PROJECT (BPREP)

OWNER : M/s BHARAT PETROLEUM CORPORATION LIMITED

MPMC : ENGINEERS INDIA LIMITED

JOB NO : B957

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
2	10/03/2025	Revised & reissued for tendering	JATIN	SAHIL	S. SRIDHAR
1	11/02/2025	Issued for tendering	JATIN	SAHIL	S. SRIDHAR
0	09/10/2024	Issued as Job Specification	JATIN	SAHIL	S. SRIDHAR

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Abbreviations:

AS	:	Alloy Steel
ASTM	:	American Society for Testing and Materials
AWWA	:	American Water Works Association
CS	:	Carbon Steel
DFT	:	Dry Film Thickness
GI	:	Galvanized Iron
ID	:	Internal Diameter
ISO	:	International Organization for Standardization
LTCS	:	Low temperature Carbon Steel
MS	:	Mild Steel
MR	:	material requisition
NB	:	Nominal Bore
NA	:	Not applicable
OD	:	Outside Diameter
OEM	:	Original Equipment Manufacturer
OSHA	:	Occupational Safety and Health Act
RCC	:	Reinforced Cement Concrete
RH	:	Relative humidity
SS	:	Stainless Steel
SOR	:	Schedule of Rate
SSPC	:	Steel Structure Painting Council
WFT	:	Wet Film Thickness
EIC	:	Engineer-In-Charge
SMMS	:	Specialist Materials & Maintenance Services

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1.0 GENERAL

1.1 This specification shall be applicable for the work covered by the contract and without prejudice to the provisions of various international codes of practice, standard specifications etc. It is understood that the CONTRACTOR shall carry out the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer-In-Charge in consultation with EIL-SMMS.

1.2 This specification covers the requirement for protective coating for new construction, revamp and refurbishment.

2.0 SCOPE

2.1 Scope of work covered in the specification shall include, without being limited to, the following:

This specification defines the requirements for surface preparation, selection and application of primers and coatings on external surfaces of items mentioned in clause 2.2 of this specification and quality control, inspection & testing of the coating systems. The items listed in clause 2.2 and the heading of tables of paint systems are non-exhaustive. However, the CONTRACTOR is fully responsible for carrying out all the necessary painting, coating and lining job on external and internal surfaces as per the contract requirement, technical data sheets and drawings etc.

As a special requirement of this PROJECT, Contractor/fabricator/supplier of insulated equipment like vessels, reactors, columns and equipment shall identify the type of under insulation coating required based on the criticality of the equipment in consultation with BPCL/EIL. Prior approval of BPCL/EIL is a mandatory requirement in this case.

2.2 Extent of work covered in this specification

2.2.1 The following surfaces and materials shall require shop, pre-erection and field painting, as applicable:

a. All Carbon Steel structures.

b. All Carbon Steel and Alloy steel piping, equipment, valves, fittings & stacks.

c. All Carbon Steel and Alloy steel tanks.

d. Tanks internal as per applicable datasheets, drawings & contract requirements.

e. All insulated CS, LAS, & alloy steel pipes, equipment, vessels, reactors, valves, fittings & stacks.

f. All insulated SS, DSS & SDSS pipes, equipment, vessels, reactors valves, fittings, vessels & stacks.

g. All insulated critical CS, LTCS. SS & alloy steel equipment like vessels, reactors, column & equipment

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(application of Thermally sprayed aluminum coating based on the criticality)

h. All structural steel supports, walkways, handrails, ladders, platforms etc.

i. Flare lines, external surfaces of steel chimney with or without refractory lining and internal surfaces of steel chimney without refractory lining.

j. RCC structures as per applicable drawings/relevant documents.

2.2.2 Marking and Identification of painted items:

a. Identification of color bands on all piping, as required, including aluminum cladding over insulation, galvanized, SS and nonferrous piping.

b. Identification lettering/ numbering on all painted surfaces of equipment/piping, aluminum cladding over insulation, galvanized, SS and non-ferrous piping.

c. Marking / identification signs on painted surfaces of equipment and piping including hazardous service.

2.2.3 Supply and prequalification testing of all primers, paints and all other materials required for painting (other than OWNER supplied materials)

2.2.4 Application of pre-erection/fabrication and shop primer.

2.2.5 Repair work of damaged pre-erection/ fabrication and shop primer and weld joints in the field/site before and after erection.

2.2.6 Quality control, testing and inspection during all stages of work (surface preparation, application of coating and testing of applied coating).

2.2.7 Exclusions:

(a). All metallic surfaces do require painting except for following materials. These materials are not painted unless specified by the contractual provisions and the same shall be painted as per the relevant specifications:

- Un-insulated stainless steel.
- Plastic and/or plastic-coated materials.
- Galvanized Iron.
- Aluminum.
- Ni-Alloys.
- Glass.
- Ceramics.
- Machined surfaces.

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- Label and names plates.

Note: Galvanized steel doesn't require painting for corrosion protection. However, if painting is mandated due to OWNERs instructions/contractual provision/ for colour coding requirement mentioned in this specification or by OWNER, then the coating system in Table 4.0 shall be followed.

(b). This specification does not include fire retardant paints/intumescent epoxy coatings for steel structure, and the EIL specification B957-999-06-43-IF01 addresses the same.

3.0 REFERENCE CODES & STANDARDS

3.1 Latest editions of the following codes and standards are applicable for the work covered by this specification:

American Society for Testing and Materials (ASTM):

ASTM Volume 6.01	Paint - Tests for Chemical, Physical, and Optical Properties; Appearance
ASTM Volume 6.03	Paint -- Pigments, Polymers, Resins, Naval Stores, Cellulosic Esters, and Ink Vehicles
ASTM D6677	Standard Test Method for Evaluating Adhesion by Knife
ASTM D5894	Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
ASTM D870	Standard Practice for Testing Water Resistance of Coatings Using Water Immersion
ASTM D2485	Standard Test Methods for Evaluating Coatings for High Temperature Service
ASTM D2247	Standard Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity
ASTM D4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D4060	Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4752	Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D4940	Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blast Cleaning Abrasives
ASTM D4285	Standard Test Method for Indicating Oil or Water in Compressed Air
ASTM D543	Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents

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ASTM C868	Standard Test Method for Chemical Resistance of Protective Linings
ASTM G42	Standard Test Method for Cathodic Disbonding of Pipeline Coatings Subjected to Elevated Temperatures
ASTM B117	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D1475	Standard Test Method for Density of Liquid Coatings, Inks, and Related Products
ASTM D823	Standard Practices for Producing Films of Uniform Thickness of Paint, Coatings and Related Products on Test Panel
ASTM D2369	Standard Test Method for Volatile Content of Coatings
ASTM D1640/D1640M-14	Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings
ASTM D522/D522M	Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings
ASTM D968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1044	Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion
ASTM D1849	Standard Test Method for Package Stability of Paint
ASTM D2247	Standard Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity
ASTM D5146	Standard Guide to Testing Solvent-Borne Architectural Coatings
ASTM D4258	Standard Practice for Surface Cleaning Concrete for Coating
ASTM D4259	Standard Practice for Preparation of Concrete by Abrasion Prior to Coating Application

Steel Structures Painting Council (SSPC)

SSPC SP-1	Solvent cleaning
SSPC Painting manual Vol.1	Good Painting practices
SSPC Painting manual Vol.2	Systems & specification
SSPC VIS 1	Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning
SSPC AB1	Mineral and Slag Abrasives
SSPC PA 2	Measurement of Dry Paint Thickness with Magnetic Gauges
SSPC-PA-9	Measurement of Dry Coating Thickness Using Ultrasonic Gages

Association for Materials Protection and Performance (AMPP)

NACE RP 0287	Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape
NACE SP 0198	Control of Corrosion under Thermal Insulation and Fireproofing Materials

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NACE SP 0188	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

International Organization for Standardization (ISO):

ISO 12944	Corrosion Protection of steel Structures by Protective Paint System
ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles-Specifications and test methods.
ISO 8501-1/ SIS-05 59 00	Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness— Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
ISO 8502-3	Preparation of steel substrates before application of paints and related products -Tests for the assessment of surface cleanliness - Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)
ISO 8502-9	Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness—Part 9: Field method for the conductometric determination of water-soluble salts
ISO 2808	Paints and varnishes - Determination of film thickness
ISO 2811	Paints and varnishes — Determination of density

Other Standards

IS 5	Colors for ready mix paints and enamel
NORSOK M-501	Surface preparation and protective coating
RAL CLASSIC	Color matching system
ACI 308	External Curing of Cast-in-Place Concrete— Specification
ACI 301	Specifications for Structural Concrete
ACI 562	Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures
ACI 546	Concrete repair guide

4.0 SURFACE PREPARATION

4.1 General

Adhesion of the paint film to the surface depends largely on the degree of cleanliness of the metal surface and proper surface preparation have large contribution to the success of the paint protective system. Following method shall be employed for surface preparation:

a. Abrasive blast cleaning: Applicable in all cases.
b. Mechanical or power tool cleaning: Shall be used for repair & touch up, and any other area due to practical constraints with prior permission from EIL Engineer-in charge.

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4.2 Applicable Standards:

Latest editions of the following codes and standards are applicable for the surface preparation work:

TABLE-1: SURFACE PREPARATION STANDARDS

Sl. No.	GRADE OF SURFACE CLEANLINESS	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)		
		ISO 8501-1/ SIS-05 59 00	SSPC, USA	NACE, USA
1.	Solvent cleaning	-	SSPC-SP-1	-
2.	Manual or hand tool cleaning	St 2	SSPC-SP-2	-
3.	Mechanical or power tool cleaning	St 3	SSPC-SP-3	-
4.	White metal	Sa 3	SSPC-SP-5	NACE No.1
5.	Near white metal	Sa 2½	SSPC-SP-10	NACE No.2
6.	Commercial Blast	Sa 2	SSPC-SP-6	NACE No.3
7.	Brush-off Blast for SS, galvanized steel and non-ferrous metals	-	SSPC-SP-16	-
8.	Surface Preparation of Concrete	-	SSPC-SP-13	NACE No.6

4.3 Sequence of surface preparation:

4.3.1 Solvent Cleaning

Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. Unless otherwise specified, surface preparation shall be done as per provisions of relevant tables given elsewhere in this specification. Before surface preparation by blast cleaning, the surface shall be cleaned to remove all grease, oil etc. as per SSPC-SP-1.

4.3.2 Blast cleaning with abrasives

The surfaces shall be blast cleaned using one of the abrasives listed below and at an appropriate distance & angle depending on nozzle size maintaining constant velocity and pressure.

a. The quality of abrasives shall be free from contaminants and impurities and shall meet the requirements of SSPC AB1.

b. The compressed air shall be free from moisture and oil.

c. On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust. Blast cleaning shall not be done outdoors in bad weather without adequate protection. If there is dew on the metal surface, it shall be cleaned. If possible, a vacuum collector shall be installed to collect and recycle the abrasives.

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d. Surface roughness profile: The surface roughness profile for carbon steel and low alloy steels to be coated shall be in accordance with the written recommendations of the paint Manufacturer and shall be measured as per ASTM D4417, method B. When roughness profile is not specified by the paint Manufacturer, then surface roughness profile as specified below in this specification shall be followed.

- The surface roughness profile shall be between 40 µm and 70 µm for coatings up to thickness 500 µm and between 70 µm and 125 µm for coating systems over 500 µm thickness. In all cases, the surface roughness shall have a sharp angular profile.

- If stainless steel, hot dip galvanised or non-ferrous metal surfaces are to be painted then blast cleaning shall be carried out as per SSPC-SP-16, using a fine non-iron containing abrasive.

- On galvanised surfaces, the zinc layer shall not be damaged; a smooth uniform surface roughness shall be achieved. No defects such as break through or crisping of the zinc layer shall occur. The surface roughness shall be in the range of 20 µm to 30 µm or as agreed with the paint Manufacturer.

e. Abrasives: Abrasive for use in blast cleaning steels shall be in accordance with ISO 8504-2. Steel or iron grit is commonly used as recyclable abrasives. When steel shot is used, it shall be used together with steel grit. The shot content of such a mix shall not exceed 67 %.For blasting stainless steel, non-(free) iron containing abrasive shall be used, e.g. Garnet or aluminium oxide. Abrasives used for blast cleaning shall be free from oil, grease, moisture, chloride contamination etc. and shall have crystalline silica not more than 1%.

Test methods for abrasives shall be in accordance with the tests specified in the ISO 11125 and ISO 11127 series for metallic and non-metallic abrasives respectively. Each batch of abrasive should be tested to check that the abrasive meets the requirements as specified in the relevant ISO standard. The conductivity of non-metallic abrasives to be used for stainless steels shall be maximum 15 mS/m. For all other non-metallic abrasives, the conductivity shall not exceed 25 mS/m. OWNER/PMC shall approve the use of alternative abrasive materials. Abrasive used shall be as per following specification:

Type	Generic Name	Standard
Metallic	Iron grit	ISO 11124-2
	Steel grit	ISO 11124-3
Natural mineral	Staurolite	ISO 11126-9
	Garnet	ISO 11126-10
Synthetic material	Aluminium oxide	ISO 11126-7
	Cu Slag	ISO 11126-3

Note:

Aluminum oxide or other abrasive (free from any chloride or iron/steel contamination) shall be used for blasting stainless steel. Copper slag and sand shall not be used.

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4.3.3 Mechanical or power tool cleaning

Power tool cleaning shall be done by mechanical striking tools, chipping hammers, grinding wheels or rotating steel wire- brushes. Excessive burnish of the surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust, mill scale etc. shall be removed by clean rags and /or washed by water/steam and thoroughly dried with compressed air jet before application of paint.

4.4 General Notes for surface preparation/blasting and paint application:

a. Surface shall not be coated in rain, wind or in an environment where injurious airborne elements exist.

b. Surface shall not be coated when the steel surface temperature is less than 3°C above dew point.

c. Surface shall not be coated, when the relative humidity is greater than 85%.

d. Surface shall not be coated when the temperature is below 10°C and the ambient/substrate temperature is below the paint manufacturers recommended temperature of application and curing.

e. Surface shall not be coated when surface temperature is greater than 40°C (unless a higher temperature is agreed by the paint manufacturer)

f. The paint application shall not be done when the wind speed exceeds 20 km per hour.

g. The illuminance during coating and inspection shall be at least 500 Lux.

4.5 Use of Dehumidifier

In case of internal coating of storage tanks, dehumidifier shall be used to control humidity level below 60%. Dehumidifier should depress the dew point of air in the enclosed space, sufficient enough so as to maintain it more than 3ºC below the metal substrate temperature during entire period of blasting and coating application. During the interval time between application of primer coat and subsequent intermediate and top coats or between blast cleaning completion and start of application of primer coat, dehumidifier unit should be in continuous operation to ensure that no condensation occurs on the substrate.

The Engineer in-Charge shall have the right to disallow usage of dehumidifier if the performance is not meeting the specified requirements. Under such circumstances, the CONTRACTOR shall remove the equipment and replace the same with another equipment to provide satisfactory results without any additional cost to the OWNER.

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4.6 Surface preparation of concrete:

The external surface of RCC to be painted shall be dry and clean. Any loose particle of sand, cement, aggregate etc. shall be removed and surface shall be prepared as per SSPC-SP-13.

5.0 COATING APPLICATION

5.1 Blast cleaned surface shall be coated with complete application of primer as soon as practicable but in no case later than 4 hours the same day. However, at times of unfavorable weather conditions, the Engineer-In-Charge shall have the liberty to control the time period, at his sole discretion and/or to insist on re-cleaning before primer application is taken up. In general, during unfavorable weather conditions, blasting and painting shall be avoided as far as practicable.

5.2 To the maximum extent practicable, each coat of paint shall be applied as a continuous film with uniform thickness and free of probes. Any spots or areas missed in application shall be re-coated and permitted to dry before the next coat is applied.

5.3 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for re-coating when an additional coat can be applied without the development of any detrimental film irregularities such as lifting or loss of adhesion of the under coat. Manufacturer's instructions shall be followed for inter-coat interval.

5.4 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate the complete coverage of the surface. The tinting material shall be compatible with the material underneath and shall not be detrimental to its service life and shall be recommended by the original paint manufacturer.

5.5 Airless spray application shall be in accordance with steel structure paint manual Vol.1 & Vol.2 by SSPC, USA

5.6 Brush application of paint shall be in accordance with the following:

a. Brushes shall be of a style and quality that will enable proper application of paint.

b. Round or oval brushes are most suitable for rivets, bolts, irregular surfaces, and rough/ pitted steel. Wide flat brushes are suitable for large flat areas but they shall not have width over 5 inches.

c. Paint shall be applied into all corners.

d. Any runs or sags shall be brushed out.

e. There shall be a minimum of brush marks left in the applied paint.

f. Surfaces not accessible to brushes shall be painted by spray, daubers, or sheepskin.

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5.7 Applied paint should have the desired wet film thickness specified by manufacturer. For each coat, the painter should know the WFT corresponding to the specified DFT and standardize the paint application technique to achieve the desired WFT. This has to be ensured in the qualification trial.

5.8 Irregular surfaces such as sharp edges, welds, small brackets, and interstices may stripe coated to ensure specified DFT is achieved. Paint manufacturer recommendation should be followed before deciding for brush application.

5.9 Unless otherwise instructed, final coating (i.e. application of field primer, intermediate and top coats) on pre-erection/ shop primed equipment shall be applied at site, only after all welding & testing like NDT are completed as well as after completion of steam blowing.

5.10 Drying of coated surfaces

a. No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat. If this exceeds, the paint material has possibly deteriorated or mixing is faulty.

b. No paint shall be force dried under conditions which will cause chalking, wrinkling, blistering formation of pores, or detrimentally affect the conditions of the paint.

c. No drier shall be added to paint on the job unless specifically called for in the manufacturers' specification for the paint.

d. Paint shall be protected from rain, condensation, contamination, snow and freezing until dried to the fullest extent practicable.

5.11 Spot repair of damaged primer

a. Where pre-erection/shop primer has been damaged at isolated localized spots during handling and transportation or after erection / welding, its repair shall be done as given below and as per the Table-3 of this specification.

b. Surface preparation: Quickly remove the primer from damaged area by mechanical scraping and emery paper conforming to SSPC-SP-3 to expose the white metal. Blast clean the surface, if possible. Feather the primed surface, over the intact adjacent surface surrounding the damaged area, by emery paper.

Primer shall be applied (as per the applicable design temperature and in conjunction with Table-3) wherever damage was observed on pre-erection / pre fabrication or shop primer.

c. If damaged areas are found to be extensive and spread over large areas (as required by Engineer-in charge), then entire pre-erection/pre-fabrication/shop primer shall be removed by blasting to achieve

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SSPC-SP-10 and entire blasted surface shall be primed again with F-8/ F-9 or F-16, as applicable, for the intended design temperature. (See note of Table-3). If the prepared surface lies adjacent to a sound coated surface, the surface preparation shall overlap the coated surface by at least 50mm. The remainder of existing coated surface shall be properly protected with shields or screens to prevent any possible damage to the coating.

5.12 Equipment:

a. All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning, all equipment, scaffolding materials, shot & grit blasting equipment, air compressors etc. required shall be suitable for the work and shall be arranged by the CONTRACTOR in sufficient quantity at the site. The manufacturers test certificates ***/*** data sheets for all the above-mentioned items shall be reviewed by Engineer-In-Charge at site before start of the work.

b. All paint spraying equipment, including mixers, shall be thoroughly cleaned before mixing of new materials. All coating materials shall be mixed and thoroughly stirred in accordance with the instructions of the paint Manufacturer. Sufficient agitation to maintain good mixing shall be applied until the product is used. If air is entrapped in the product during mixing/stirring, sufficient time should be allowed for the air bubbles to escape before application. Only thinners specified by the paint Manufacturer shall be used.

5.13 Shop coating

a. Shop coated equipment (coated with primer & finishing coat) should not be repainted unless paint is damaged. Repair of primer shall be carried out as per Table-3 of paint systems depending upon the compatibility of paint. Intermediate and final coats over repaired primer shall be as per applicable tables mentioned in this specification. The recommendations of paint manufacturer's datasheets including maximum overcoat interval shall be followed and recorded in the coating inspection logbook.

c. Shop primed equipment and surfaces will only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer, unless otherwise specified. If shop primer is not compatible with field primer, then shop coated primer should be completely removed before application of selected paint system for a particular environment.

d. For package units/Items/ OEM equipment, shop primer & coating system should be as per the paint system given in this specification. However, manufacturers' standard may be followed after review by EIL but shall adhere to the minimum DFT specified in ISO-12944-5; C5 (Very high durability). For system under insulation, minimum guidelines as per NACE RP 0198 shall be followed.

In this case, guarantee of the coating system lies with package supplier/OEM. EIL's decision in this regard is final and binding on Supplier/Contractor/manufacturer.

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5.14 Guidelines for Documentation / records

a. A written quality plan with procedure for qualification trials and for the actual work including test and inspection plan & procedure for approval before start of work.

b. Daily progress report with details of weather conditions, particular of applications, no. of coats, overcoating intervals, pot life and type of materials applied, anomalies, progress of work versus program.

c. Results of measurement of temperatures, relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.

d. Particulars of surface preparation and paint application during trials and during the work.

e. Details of non-compliance, rejects and repairs.

f. Type of testing equipment and calibration.

g. Code and batch numbers of paint materials used.

Note: The coating applicator must maintain a job record consisting of all the information as per 5.12.b. to 5.12.g above as well as the approved procedure of work (5.12.a. above). The job record consisting of information in accordance to 5.12.b. to 5.12.g shall be entered on daily basis and should be daily signed by Engineer-in-charge. A sample template for daily coating inspection report is given in Annexure-III as reference.

6.0 PAINT MATERIALS

Typical characteristics and codes of various paint materials used in this specification are as follows.

TABLE-2: PAINT MATERIALS
(Refer to general notes at the end of this table)

DESCRIPTION	P-6	P-7	P-4	F9
Technical name	Epoxy Zinc Phosphate Primer	Cold Galvanizing product	Etch Primer/Wash Primer	Inorganic zinc silicate coating
Type and composition	Two component polyamide cured epoxy resin medium, pigmented with zinc phosphate.	One pack synthetic resin-based zinc galvanizing containing min 92% of electrolytic zinc	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate.	Inorganic zinc silicate Coating containing zinc content min. 80%. Shall pass MEK rub test as per

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		dust of 99.95% purity.		ASTM D4752 with resistance rating >4
Volume solids % Minimum	49	37	9	57
DFT per coat, µ	40-50	40-50	8-10	65-75
Theoretical covering capacity in m^2/coat/ litre	9.8-12.2	3.4-4.4 m^2/kg	9.0-11.2	7.6-8.8
Weight per liter in Kg/litre (min.)	1.4±0.05	2.67 kg at 15°C	1.2±0.05	2.3
Touch dry at 30°C (max.)	30 min.	10 min.	2 hrs.	0.5 hrs.
Hard dry at 30°C (max.), Hrs.	8	24	24	12 hrs.
Over-coating interval, hrs. *Note 11	Min. 8	Min. 4	Min. 4-6	Min. 12 hrs. at 20°C & 50% RH
Pot life at 30°C for two Component paints, hrs.	6 - 8	NA	NA	4-6
Adhesion (ASTM D 4541)	>7	NA	NA	>5
Temperature resistance (min) °C (ASTM D 2485) *Note 8	80 (Method A)	50 (Method A)	NA	400 (Method B)

TABLE- 2: PAINT MATERIALS (Contd.)

DESCRIPTION	F-2	F-3	F-6A/B	F-6C
Technical name	Acrylic Polyurethane finish paint	Chlorinated rubber-based finish paint	Epoxy-High Build coating	Solvent less epoxy coating
Type and composition	Two-pack aliphatic isocynate cured acrylic finish	Single pack Plasticized chlorinated rubber based	F-6A Two-Pack Aromatic polyamine cured epoxy resin medium suitably	Two pack, cured with Amine Adduct;

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	paint (free of alkyd/polyester resins).	medium with chemical and weather resistant pigments.	pigmented. F-6B: polyamide cured epoxy resin medium suitably pigmented.	catalyzed epoxy resin suitably pigmented
Volume Solids % (min.)	40	36	57	98
DFT per coat, µ	30-40	30-40	100-125	300-450
Theoretical covering capacity in m^2/coat/litre	10-13.3	9-12	4.6-5.7	2-3.9
Weight per liter in Kg/litre (min.)	1.15	1.15	1.42	1.40
Touch dry at 30°C (max)	30 min.	30 min.	3 hrs.	3 hrs.
Hard dry at 30°C (max.).	8 hrs.	8 hrs.	16 hrs.	16 hrs.
Full cure at 30°C (for immersion/ high temperature service)	NA	NA	5 days	5 days
Over-coating Interval, hrs. *Note 11	Min.12.	Min. Overnight	Min. Overnight Max. 5 days	Min. 8. Max. 48
Pot life (approx.) at 30°C for two component paints, hrs.	5-8	NA	3-6	0.5
Adhesion (ASTM D 4541)	>5	>4	>7	>8
Abrasion Resistance (ASTM D4060) For 1000 g load	<300 mg /1000 cycles/CS17 or <100 mg /1000 cycles/CS10	NA	NA	NA
Temperature resistance (min.) °C (ASTM D 2485) *Note 8	80 (Method A)	60 (Method A)	80 (Method A)	120 (Method A)

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TABLE- 2: PAINT MATERIALS (Contd.)

DESCRIPTION	F-7	F-8	F-11	F-12	F19
Technical name	High build coal tar epoxy coating.	Self-priming type surface tolerant high build epoxy coating (complete rust control Coating)	Heat resistant synthetic medium based two pack Aluminum Paint suitable up to 250°C dry temp. *Note: 10	Heat resistant silicone Aluminum Paint suitable up to 540°C dry temp.	High build Epoxy Ceramic Filled tank liner Type and composition: High build Epoxy Novolac Ceramic Filled tank liner for sustained immersion service in Hydrocarbon cargoes, refinery distillates, furnace oils etc., kept at elevated
Volume Solids % Minimum.	62	75	35	18	-
DFT per coat in µm	100-125	100-125	15-20	15-20	150-200
Theoretical covering capacity in m^2/coat/ litre	5-6.2	6-7.5	17.5-23.3	9-12	3.5-4.7
Weight per liter in Kg/litre (min.)	1.40	1.41	0.95	1.00	-
Touch dry at 30°C (maximum)	4 hrs.	3 hrs.	3 hrs.	0.5 hrs.	2-3 hrs.
Hard dry at 30°C (maximum),	48 hrs.	24 hrs.	12 hrs	24 hrs.	10 hrs.
Full cure 30^{O}C (for immersion /high Temperature service.)	5 days	5 days	NA	NA	-
Over-coating interval, hrs. *Note 11	Min. 24 hrs Max.5days	Min. 10	Min. 24	Min. 24	Min: 12 Hrs. Max: 3 days

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Pot life at 30°C for two components Paints, hrs.	4-6	1.5	NA	NA	1-2 hrs.
Adhesion MPa (ASTM D 4541)	>5	>5	NA	NA	-
Temperature resistance (min.) °C (ASTM D 2485) *Note 8	80 (Method A)	80 (Method A)	250 (Method A)	540 (Method B)	180 (Method A)

TABLE- 2: PAINT MATERIALS (Contd.)

DESCRIPTION	F-14	F-15	F-16	F-17	F-20
Technical name	Polyamine cured coal tar epoxy	Two-component Epoxy phenolic coating cured with Polyamine adduct hardener	Inert polymeric matrix coating suitable for under insulation for CS and SS.	Novolac epoxy phenolic coating cured with Polyamine adduct hardener	Glass flake reinforced vinyl ester coating.
Type & composition	Specially formulated polyamine cured coal tar epoxy suitable for application under insulation	Two pack ambient temperature curing epoxy phenolic coating system suitable for application under insulation CS/SS piping	Suitable for high temperature service and under insulation coating for CS, alloy steel and SS	Novolac epoxy phenolic coating cured with Polyamine adduct hardener	Two component glass flake filled vinyl ester lining for under immersion services up to 90 deg. C.
Volume Solids % Minimum.	67	67	50	98	98
DFT per coat in microns	100-125	100-125	100-125	300-450	500-600
Theoretical covering capacity in m^2/coat/ litre	5.4-6.7	6.7-8.9	4-5	2.2-3.3	1.6-2

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Weight per liter in Kg/litre (min.)	1.45	1.65	>1.3	1.7	>1.2
Touch dry at 30°C (max)	4 hrs.	3 hrs.	1 hrs.	2 hrs.	2 hrs.
Hard dry at 30°C (max).	24 hrs.	24 hrs.	16 hrs.	24 hrs.	4 hrs.
Full cure 30°C (for immersion / high temp service)	168 hrs (7 days)	168 hrs (7 days)	NA	168 hrs (7 days)	96 hrs (4 days)
Over-coating Interval *Note 11	Min. 6 hrs Max.5 days	Min. 36 hrs Max.21 days	Min.6 hrs Max. Not applicable	Min. 16 hrs Max.21 days	Min. 4 hrs Max.3 days
Pot life at 30°C, hrs (for two component paints)	4	4-6	\ 1	1	50 min-1 hr.
Adhesion, MPa (ASTM D 4541)	>6	>7	NA	>8	>7, Tensile strength >20N/mm2 (ASTM D 638)
Temperature resistance (min.) °C (ASTM D 2485) *Note 8	125 (Method A)	150 (Method A)	650 (Method B)	200 (Method A)	90 (Method A)

General notes for TABLE-2:

1. Covering capacity and DFT achieved per coat depends on method of application. Covering capacity specified above is theoretical. For estimation of actual quantity of paints required, include the losses during application. Minimum specified DFT should be maintained in any case.

2. All primers and finish coats should be ambient temperature curing and air drying unless otherwise specified.

3. All paints shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. Wherever a deviation is noticed from the specification in manufacturer data sheet, more stringent one between the data sheet and the specification shall prevail e.g. if this specification recommends Sa 2 ½ and the manufacturer data sheet requires Sa3, the surface preparation shall be done as per Sa 3. However, in another case if this specification

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requires the surface preparation of Sa 2 ½ and the manufacturer data sheet recommends only Sa 2 as minimum, the surface preparation shall be done as per Sa 2 ½.

4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.

5. Internationally recognized & acceptable testing method shall be used for lab testing wherever testing standards are not mentioned.

6. Touch dry, hard dry, pot life, full cure period, & over coating interval shall be as per manufacturer's data sheets and no testing is required. Slight variation in the values of these parameters along with weight per liter may be permissible with the discretion of engineer-in-charge in consultation with EIL-SMMS.

7. Temperature resistance tests (ASTM D2485) shall be carried out for minimum required temperature resistance indicated.

8. Wherever ASTM D 2485 method B is applicable, test results of the panels subjected to salt spray (ASTM B 117) after muffle furnace exposure shall be submitted for pre-qualification purpose.

9. F6-C shall be suitable for drinking water service and should have certification from competent authority.

10. Alkyd type paint system have potential flaking problems and therefore, F11 shall not be alkyd type.

11. Maximum overcoat interval shall be as per Paint manufacturer's datasheet.

7.0 SELECTION OF COATING SYSTEMS

The external coating system for EIL projects should be selected based on the C5 environment (very high durability) as per ISO12944-2, design temperature, involved services of the steel substrate and plant location.

The paint system to be applied for a specific job shall be arrived at sequentially as given below:

a. Identify the environment from area classification details and choose the appropriate table.
b. Identify the design temperature from the technical documents.
c. Identify the specific field paint system and surface preparation requirement from the above identified table and temperature range.
d. Identify the shop priming requirement from based on compatibility of the above paint system.
e. Identify the need of repair of shop primer and execute as per Table-3.

7.1 Classification based on plant location:

a) Plant located in inland area (more than 50 km from coast).

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- For offsite areas and utilities: Table-5 to be followed.

- For process units, DM plant, CPP and Cooling towers, ETP, RWTP: Table-6/7 as applicable to be followed.

b) Plant located on sea coast or within 50 km from sea coast.

- For process units, DM plant, CPP, Cooling tower, ETP, RWTP, offsite & utilities etc.: Table-6/7 as applicable to be followed.

c) For external surface of above ground tanks, Table-8 to be followed for all locations (inland or coastal)

TABLE-3: REPAIR OF PRE-ERECTION/PRE-FABRICATION OR SHOP PRIMER AFTER ERECTION/WELDING

(For all un-insulated CS, LTCS & alloy steel items in all environments)

Sl. No.	Design Temp. in ºC	Surface Preparation	Coating System	Total DFT in Microns (min.)	Remarks
3.1	-45 to 80	SSPC-SP-3	1 coat of F-8 @ 125 µ DFT/coat+ 1 coat of P-6 @ 40 µ DFT/coat	165	See Note-1 below and clause 5.11
3.2	81 to 250	SSPC-SP-11	1 coat of F-9 @ 65-75 µ DFT/coat + 1 coat of F-11 @ 20 µ DFT/coat	85-95	
3.2	251 to 400	SSPC-SP-11	1 coat of F-9 @ 65-75 µ DFT/coat + 1 coat of F-12 @ 20 µ DFT/coat	85-95	
3.3	401 to 550	SSPC-SP-3	1 coat of F-16 @ 125 µ DFT/coat	125	

Note for Table-3:

1. The application and repair of pre-erection/pre-fabrication and shop primer given in above tables shall be done for all the items to be painted. In case the damages of primer are severe and spread over large area as per Engineer In charge discretion, entire primer shall be removed by blasting to achieve SSPC-SP-10 and surfaces shall be suitably primer coated as mentioned in Table 5.0 to Table 18.0. After the repairs of the primer, suitable intermediate and final coats shall be applied as per applicable coating systems mentioned in Table 5.0 to Table 18.0.

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TABLE-4: COATING SYSTEM FOR GALVANIZED ITEMS (Refer clause 2.2.7)

Sl. No.	Design Temp. in °C	Coating System	Total DFT in Microns (min.)	Remarks
4.1	Up to 60	Hot Dip Galvanizing with thickness as per ISO 1461, Surface preparation over galvanization as per SSPC SP 16 & ISO 12944-4; 1 coat of F-6B @ 100µ DFT/coat + 1 coat of F-2 @ 40 microns DFT/coat	140µ of finish coat (excluding the thickness of galvanizing)	Special primers like etch primer (surface preparation) may also be considered for coating on galvanized surfaces

Notes for Table-4:

1. F-6B shall be modified type and suitable for coating over galvanization. Paint suppliers confirmation is mandatory.

2. Repair of the damaged areas of galvanized coatings due to welding during erection shall be carried out as per recommended practice ISO 1461, using cold galvanizing spray process. Organic paint systems are not acceptable for the repair.

3. After repair of damaged galvanized coating by cold galvanization (P-7), the repaired area shall be top coated with paint system as given in table-4 above (i.e. 1 coat of F-6B @ 100µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat).

4. Galvanized gratings don't require painting in general until otherwise specified elsewhere or as per the requirement of the OWNER. Galvanized items may require painting to meet the colour coding requirement of the OWNER. Contractor has to ensure the applicable colour coding prior to application of coating as per this clause.

TABLE-5: COATING SYSTEMS FOR INLAND PLANTS (OFFSITES & UTLITIES)

(For all new un-insulated above ground CS, LTCS & Alloy steel piping, equipment, structures, valves, Vessels & columns, stacks etc.)

Sl. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT in Microns (min.)	Remarks
			Intermediate Coat	Finish Coat		
5.1	-45 to -15	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	-	-	65-75	a. No over-coating shall be done on

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5.2	-14 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat + 1 coat of P-6 @ 40 µ DFT/ coat	1 coat of F-6B @ 100 µ DFT/coat	1 coat of F-2 @ 40µ DFT/coat	245-255	F-9. b. Surface profile for F-9 shall be 30-40 µm c. F11 shall not be Alkyd type. d. F-12 shall be ambient temperature curing type
5.3	81 to 250	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat + 1 coats of F-11 @ 20µ DFT/coat	-	1 coats of F-11 @ 20µ DFT/coat	105-115	
5.4	251 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat + 1 coats of F-12 @ 20µ DFT/coat	-	1 coats of F-12 @ 20µ DFT/coat	105-115	
5.5	401-650	SSPC-SP-10; 1 coat of F-16 @ 125 µ	-	1 coat of F-16 @ 125 µ	250-300	-

TABLE-6: COATING SYSTEMS FOR CORROSIVE AREAS (PROCESS UNITS, COOLING TOWER, DM, CPP, ETP, RWTP etc.)

(For all new un-insulated above ground CS, LTCS & Alloy steel piping, equipment, structures, valves, vessels & columns, furnace stacks etc.)

Sl. No.	Design Temp. °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total DFT in Microns (min.)	Remarks
			Intermediate coat	Finish Coat		
6.1	-45 to -15	SSPC-SP-10; 1coat of F-9 @ 65-75µ	-	-	65-75	a)No over coating on F-9

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6.2	-14 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/ coat + 1 coat of P-6 @ 40 µ DFT/ coat	2 coats of F-6B @ 100 µ DFT/coat	1 coat of F-2 @ 40µ DFT/coat	345-355	is allowed b) F-12 shall be ambient temperature curing type c) F11 shall not be Alkyd type. d) Surface profile for F-9 shall be 30-40 µm
6.3	81 to 250	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat + 1 coats of F-11 @ 20µ DFT/coat	-	1 coat of F-11 @ 20µ DFT/coat	105-115	
6.4	251 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/ coat + 1 coats of F-12 @ 20µ DFT/coat	-	1 coat of F-12 @ 20µ DFT/coat	105-115	
6.5	401-650	SSPC-SP-10; 1 coat of F-16 @ 125 µ	-	1 coat of F-16 @ 125 µ	250-300	-

NOTES for TABLE-5 & TABLE-6:

1. The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The CONTRACTOR is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated as per contract document and scope of work.

2. If the application of pre-erection/pre-fabrication/shop primer has already been completed, the same shall not be repeated in the field. In case the damages to the primer coat are severe and spread over large areas, the Engineer-In-Charge may decide & advise re-blasting and re-application of the primer coat. Repair of pre-fabrication/pre-erection primer, if required, shall be done as per Table-3.

3. Flare line within unit or offsite areas shall be coated as per clause 6.4 of Table-6.

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4. For external surface of RCC Chimney, 2 coats of F-6 B@ 100µ DFT/coat to obtain a total DFT of 200 µ shall be applied after proper surface preparation as per guidelines in clause 4.6. Suitable PU top coat shall also be considered.

5. At the site, shop primer coated prefabricated items/structures/equipment/vessels shall be stored in the shed area and contractor shall brush off any chalking observed with emery paper, prior to application of subsequent coats.

TABLE-7: COATING SYSTEMS FOR EFFLUENT TREATMENT PLANT (ETP) & RODM

Sl. No.	Design Temp. in °C	Surface Preparation	Coating system		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
7.1	For external surfaces of steel items: screens, walk way bridges, clarifier/thickener scrapping mechanism, baffles, Media filters/vessels (PSF, DMF, MMF, & ACF etc.), vertical pumps, CS/MS tanks/ vessels and structures.					
	-14 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75µ DFT/coat + 1 coat of P-6 @ 40 µ DFT/ coat	2 coats of F-6B @100µ DFT/coat + 1 coat of F-2 @ 40µ DFT/coat (2x100+40= 240)	345-355	Note 1
7.2	For internal surfaces of steel items: all effluent handling units such as TPI, DAF, tube settlers, clarifiers, tanks, sludge tanks and sewage tank, wet slop oil tanks etc., scrapping mechanism in clarifier etc.					
	-14 to 80	SSPS-SP-10	1 coat of F-15 @ 100µ DFT/coat.	2 coats of F-15 @100µ DFT/coat (2x100=200)	300	-
7.3	All R.C.C./concrete surfaces exposed to effluent water / liquid such as tanks, structures, drains etc., all effluent handling units such as API, TPI, DAF, tube settlers, clarifiers, tanks, sumps, sludge sumps/tanks and sewage sumps/tank, wet slop oil sump/tanks etc.					
	-14 to 80	As per clause 4.6 of this specification	Epoxy screed lining		3000	Note 1
7.4	Internal surface of equipment like Media filters/vessels (PSF, DMF, MMF, & ACF etc.), activated carbon filters, alkaline, acids & other high corrosive service					
	Up to 90	SSPC-SP-10	1 coat of clear two component solvent free vinyl ester primer @ 100µ DFT/ Coat + 2 coats of F-20 @ 500µ DFT/ Coat		1100	Note-2

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NOTES for TABLE-7:

1. Contractor shall follow manufacturer recommendations to develop epoxy screed lining procedure for EIL review and approval.

2. This coating system is applicable in conjunction with relevant PDS of the equipment.

TABLE-8: EXTERNAL COATING SYSTEMS FOR CARBON STEEL AND LOW ALLOY STEEL STORAGE TANKS
(except for crude tanks. Refer Annexure-II for Crude Oil Tanks painting)

Sl. No.	Design Temp. in °C	Surface Preparation	Coating system (Note-1)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
8.1	All external surfaces of shell, wind girders, appurtenances, roof tops of all above ground tank including top side of external and internal floating roof and associated external structural works.					
8.1.1	-14 to 80	SSPC-SP-10	1coat of F-9 @ 65-75µ DFT/coat + 1coat of P-6 @ 40µ DFT/ coat	2 coats of F-6B @ 100µ DFT /coat + 1 coat of F-2 @ 40µ DFT/ coat	345-355	
8.1.2	81 to 450	SSPC-SP-10	1coat of F-9 @ 65-75µ DFT/coat	1 coat of F-16 @ 125 µ DFT / coat	190-200	
8.2	External surfaces of bottom plate (in contact with soil) for all storage tanks.					
8.2.1	-14 to 80	SSPC-SP-10	1 coat of F-9 @ 65-75µ DFT/ coat	3 coats of F-7@ 150µ DFT/coat (3x150=450)	515-525	-
8.2.2	81 to 200	SSPC-SP-10	1 coat of F-17 primer @ 400µ DFT/ coat	1 coat of F-17 finish coat @ 400µ DFT/ coat	800-825	Note-4
8.3	For underside of the bottom plate (not in contact with soil) (in case tank is not lifted during PWHT) (Note- 2)					

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8.3.1	-29 to 400	SSPC SP-10	1 coat of F-16 @ 125 µ	2 coat of F-16 @ 125 µ/coat	375	Note-3

Notes for TABLE-8:

1. All paint coating application including primer for tanks shall be carried out at field after erection and completion of entire welding.
2. For underside of bottom plate as per clause no.8.3.1:

   a) Painting shall be carried out before laying the bottom plate for tanks with non-Post Weld Heat Treatment (PWHT).

   b) For tanks with PWHT, painting shall be carried out after PWHT.

   c) In case tank is not lifted during PWHT then painting shall be applied before laying the bottom plate.

3. This coating system is also applicable for temperature ranges not covered in 8.2 above.

4. This coating system is also applicable for bottom plates having MOC as Stainless Steel.

TABLE-9: INTERNAL COATING SYSTEMS FOR CARBON STEEL AND ALLOY STORAGE TANKS
(except for all crude tanks. Refer Annexure-II for Crude Oil Tanks)

Sl. No.	Design Temp. in °C	Surface Preparation	Coating system		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
9.1	Internal surface of cone roof with supporting structures, top shell course for free board height, underside of floating roof, oil side surface of pontoons, support structures and ladders and other CS internals etc., inside of bottom plate, internal surface of bare shell for 1.5 mtr from bottom, for storing petroleum products and intermediates such as Isomerate, Reformate, NHT / CCR / DHT feed, HSD, Gasoline, Naphtha, SKO, MS - Motor Spirits, LCGO, MTBE and Dry Slop.					
9.1.1	-14 to 45	SSPC-SP-10	1 coat of F-9 @ 65-75 µ DFT/coat	-	65-75	-

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9.1.2	46 to 90	SSPC-SP-10	1 coat of F-15 primer @ 100µ DFT/ coat	1 coat of F-15 intermediate coat @ 100µ DFT/coat + 1 coat of F-15 finish coat @ 100µ DFT/ coat	300	-
9.2	Internal surface of cone roof with supporting structures, top shell course for free board height, underside of floating roof, oil side surface of pontoons, support structures and ladders and other CS internals etc., inside of bottom plate, internal surface of bare shell for 1.5 mtr from bottom, for storing petroleum products and intermediates such as VR, VGO, IFO/RFO, HCGO and Black Slop and other high temp. hydrocarbons					
9.2.1	91 to 150	SSPC-SP-10	-	1 coat of F-17 @ 400µ DFT/coat	400	-
9.2.2	151 to 180	SSPC-SP-10	-	3 Coat of F-19 @ 125	375	F-19 shall be suitable for immersion service of the given products
9.3	Amine and Sour water storage tank All internal surfaces but not limited to internal surfaces of shell for full height, bottom plate, accessories, roof and roof structures of cone and dome roof tanks etc.					
9.3.1	up to 90	SSPC-SP-10	1 coat of F-15 primer @ 100µ DFT/ coat	1 coat of F-15 intermediate coat @ 100µ DFT/coat + 1 coat of F-15 finish coat @ 100µ DFT/ coat	300	-
9.4	Potable, Raw, Fire water, De-mineralized (DM) water & Condensates etc. All internal surfaces but not limited to internal surfaces of shell for full height, bottom plate, accessories, roof and roof structures of cone and dome roof tanks etc.					
9.4.1	-14 to 60	SSPC-SP-10	1 Coat of F-6A @ 100µ DFT/coat	1 coat of F-6C @ 300-350 µ DFT/ coat	400-450	-
9.4.2	61 to150	SSPC-SP-10	1 coat of F-15 primer @ 100µ DFT/ coat	1 coat of F-15 intermediate coat @ 100µ DFT/coat + 1 coat of F-15 finish coat @ 100µ DFT/ coat (100+100=200)	300	-
9.5	Hydrochloric acid (HCl) 10 % All internal surfaces but not limited to internal surfaces of shell for full height, bottom plate, accessories, roof and roof structures of cone and dome roof tanks etc.					

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9.5.1	-14 to 60	SSPC-SP-10	1 Coat of clear two component solvent free vinyl ester primer @ 100µ DFT/ Coat	2 Coats of F-20 @ 500µ DFT/ Coat	1100	-
9.6	Aggressive solvents like hexane, hexene, benzene, xylene and toluene etc.: All internal surfaces but not limited to internal surfaces of shell for full height, bottom plate, accessories, roof and roof structures of cone and dome roof tanks etc.					
9.6.1	-14 to 65	SSPC-SP-10	1 coat of F-9 @ 65-75µ DFT/ coat	-	65-75	-
9.7	Ethylene glycol tanks: All internal surfaces but not limited to internal surfaces of shell for full height, bottom plate, accessories, roof and roof structures of cone and dome roof tanks etc.					
9.7.1	All	SSPC-SP-10	-	3 coats of F-17 @ 75µ /Coat; (3x75=225)	225	-
9.8	Inside pontoon and inside of double deck of all floating roofs					
9.8.1	-14 to 80	SSPC-SP-3	1 coat of F-8 @ 100µ DFT/coat	1 coat of F-8 @ 100µ DFT/coat	200	-
9.8.2	81 to150	SSPC-SP-10	1 coat of F-15 primer @ 100µ DFT/ coat	1 coat of F-15 intermediate coat @ 100µ DFT/coat + 1 coat of F-15 finish coat @ 100µ DFT/ coat (100+100=200)	300	-
9.8.3	151 to 200	SSPC-SP-10	-	1 coat of F-17 @ 400µ DFT/coat	400	-
9.9	Alkalis up to 50 % concentration: All internal surfaces but not limited to internal surfaces of shell for full height, bottom plate, accessories, roof and roof structures of cone and dome roof tanks etc.					
9.9.1	Up to 60°C	SSPC-SP-10	1 coat of F-15 primer @ 100µ DFT/ coat	2 Coats of F-6 A @ 100µ DFT/coat (2x100=200)	300	-
9.10	Internal surface of underside of floating roof, bottom plate, complete shell course for full tank height, including immersed gauge pipe, still well etc. and their supporting structure, ladders and other CS internals etc. for storing **ATF-Aviation Turbine Fuel**.					

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9.10.1	Up to 80˚C	SSPC-SP-10	1 coat of primer* @ 75µ DFT/ coat	1 Coats of F-6 C @ 300µ DFT/coat (1x300=300)	375	**Primer shall be compatible with F6C. F6C shall comply with the requirements of EI-standard 1541. Shade of the paint shall be Off-white.**
9.11	Internal surface of underside of fixed roof and supporting structure for internal floating roof tank for storing **ATF-Aviation Turbine Fuel**.					
9.11.1	Up to 80˚C	SSPC-SP-10	1coat of F-9 @ 65-75µ DFT/coat + 1coat of P-6 @ 40µ DFT/ coat	2 coats of F-6A @ 100µ DFT /coat	305	

General Note for Table-9: The list of surfaces to be painted are not exhaustive. All internal surfaces of all type of tanks including structural items shall be coated as per the above table. No CS surface shall be kept un-painted.

TABLE-10: COATING SYSTEMS FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL PLANT PIPING AND VESSELS

Sl. No.	Design Temp. in °C	Surface Preparation & Shop Primer	Coating system		Total DFT in Microns (min.)	Remarks
			Surface Preparation & Primer	Finish Coat		
10.1	Underground carbon steel plant piping.					
10.1.1	25 to 80	-	As per document B957-000-06-42-PLS-04	3layer polyethylene (3LPE) coating as per document B957-000-06-42- PLS-04	3.5 mm	--

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10.1.2	81 to 200	-	SSPC-SP-10; 1 coat of F-17 primer @400 µ DFT/ coat	1 coat of F-17 @ 400 DFT/coat	800	-
10.1.3	201 to 400	SSPC-SP -10	1 coat of F-16 primer @125 µ DFT/ coat	2 coats of F-16 @125µ DFT/ coat	375	Note 1
10.2	External side of underground vessels					
10.2.1	-45 to 80	SSPC-SP -10; 1 coat of F-9 @ 65-75µ DFT/ coat + 1 coat of F-7 @ 100µ DFT/coat	-	2 coats of F-7 @ 100µ DFT/coat	365-375	-
10.2.2	81 to 200	SSPC-SP -10	1 coat of F-17 primer @400 µ DFT/ coat	1 coat of F-17 @400µ DFT/ coat	800	-
10.2.3	201 to 400	SSPC-SP -10	1 coat of F-16 primer @125 µ DFT/ coat	2 coats of F-16 @125µ DFT/ coat	375	-

Notes for TABLE-10:

1. Coating system as per Sl. No. 10.1.3 is applicable for underground CBD line subjected to higher temperature (201-400 deg. C) and in cyclic service. Contractor shall submit suitable product datasheet, PTR and test certificate, for EIL review and approval.

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TABLE-11: COATING SYSTEMS FOR UNDER INSULATION (ALL UNIT AREAS & OFFSITES)
(For insulated piping, equipment, storage vessels, tanks, columns etc. of CS, LTCS, Alloy steel, SS, DSS and SDSS in all environments.)

Sl. No.	Design Temp. °C	Surface Preparation & Pre-erection/Shop Primer	Coating system		Total DFT Microns (min.)	Remarks
			Primer	Finish paint		
11.1	Carbon steel, LTCS and Alloy steel Piping, Storage tanks, Vessels, Equipment etc.					
11.1.1	-45 to 125	SSPC-SP-10; 1coat of F-15 @ 100µ DFT/coat	None	2 coats of F-15 @100µ DFT/coat	300	Note 1
11.1.2	126 to 560	SSPC-SP-10; 1 coat of F-16 @ 125µ DFT/coat	None	1 coat F-16 @ 125µ DFT/coat	250	
For Carbon steel, LTCS and Alloy steel Critical equipment like vessels, reactors, columns & equipment						
11.1.3	200-540	Temporary oil based varnish coating to be provided for transport and storage	Thermally Sprayed Aluminium coating (TSAC) Refer ANNEXURE-I			Critical equipment is identified through respective data sheets. Note 4
11.2	Stainless Steel, Duplex Stainless steel, Super Duplex stainless steel & Piping, Tanks, Vessels & Equipment etc.					
11.2.1	-45 to 125	SSPC-SP-16; (15-25µ surface profile) 1 coat of F-15 @100 µ DFT/coat	None	2 coats of F-15 @100µ DFT/coat	300	Note 1
11.2.2	126 to 650	SSPC-SP-16; (15-25µ surface profile) 1 coat of F-16 @125µ DFT/coat	None	1 coat of F-16 @125µ DFT/coat	250	
11.3	Cyclic service of CS, LTCS, SS, DSS, SDSS & Alloy Steels (Note-1)					

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11.3.1	-45 to 150 (Note-1)	SSPC-SP-10 For CS, LTCS & Alloy steel. SSPC-SP-16 for SS; (15-25µ surface profile) 1 coat of F-15 @100 µ DFT/coat	None	2 coats of F-15 @100µ DFT/coat	300	Note-2&3
11.3.2	-180 to 650	SSPC-SP-10 for CS, LTCS & Alloy steel. SSPC-SP-16 for SS (15-25µ surface profile) 1 coat of F-16 @ 125µ DFT/coat	None	1 coat of F-16 @ 125µ DFT/coat	250	

Notes for TABLE 11

1. Coating system for any other design temperature range not covered in Sr. No. 11.1 & Sr. No. 11.2 shall be as per Sr. No. 11.3.2.

2. In case of overlapping of cyclic temperature ranges as mentioned in 11.3.1 and 11.3.2 then clause 11.3.1 shall be followed.

3. Alternatively, for this temperature range, 1 coat of F-17 @ 400 µ is also acceptable.

4. For all insulated CS, LTCS & LAS vessels, reactors, column & equipment, Contractor/supplier shall verify with BPCL/EIL for applicability of TSA as under insulation coating.

General notes for TABLE-11:

1. “Cyclic Service” is characterized by rapid or periodical temperature fluctuation or temperature cycles or as defined in the process datasheet.

2. The blasting abrasives for SS and alloy steels shall be aluminum oxide or garnet only.

3. The coating system applicable for any other temperature range shall be reviewed if it is encountered.

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TABLE-12: INTERNAL COATING SYSTEMS FOR WATER SIDE COMPONENTS OF CS, SS, DSS & NON-FERROUS HEAT EXCHANGERS

Sl. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
12.1	Up to 80	SSPC-SP-10 for CS and SSPC-SP-16 for SS	1 coat of F-15 @ 100 µ DFT/coat	2 coats of F-15 @ 100 µ DFT/coat	300	-
12.2	81 to 200	SSPC-SP-10 for CS and SSPC-SP-16 for SS	-	2 coats of F-17@ 400µ/coat	800	-

Note for Table-12:

1. Coating systems are applicable as per requirement specified in the data sheets of the respective exchangers or equipment.

TABLE-13: COATING SYSTEMS FOR CORROSIVE AREAS - BROWN FIELD PAINTING (REVAMP, REFURBISHMENT AND MAINTENANCE)

(For all existing un-insulated above ground CS, LTCS & Alloy steel piping, equipment, structures, valves, vessels & columns, furnace stacks etc.)

Sl. No.	Design Temp. °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total DFT in Microns (min.)	Remarks
			Intermediate Coat	Finish Coat		
13.1	-45 to -15	SSPC-SP-3; 1coat of F-8 @ 100µ	-	-	100	-
13.2	-14 to 80	SSPC-SP-3; 1coat of F-8 @ 100µ DFT/ coat	2 coats of F-6B @ 100 µ DFT/coat	1 coat of F-2 @ 40µ DFT/coat	340	
13.3	81-650	SSPC-SP-3; 1 coat of F-16 @ 125 µ	-	1 coat of F-16 @ 125 µ	250-300	-

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TABLE-14: EXTERNAL AND INTERNAL COATING SYSTEM FOR CRUDE OIL TANKS PAINTINGS (REFER ANNEXURE-II)

TABLE-15: COATING SYSTEMS FOR GI TOWERS

Sl. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
15.1	Up to 80	SSPC-SP-3	1 coat of F-8 @ 100 µ DFT/coat	1 coats of F-2@ 40 µ DFT/coat	140	Shade shall be as per defense requirement.

TABLE-16: COATING SYSTEMS FOR STREET POLES

Sl. No.	Description	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
16.1	Street Light Poles	SSPC-SP-3	1 coat of P-6 @ 40 µ DFT/coat	2 coats of F-2@ 40 µ DFT/coat	120	-

Note for Table-15 & 16:

1. For revamp and refurbishment, surface preparation shall be SSPC-SP3 and coating system shall be same as mentioned in Table 15 & 16.

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TABLE-17: COATING SYSTEMS FOR PSV

Sl. No.	Description	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
17.1	PSV, PRV, PV, RV, TRV	SSPC-SP10/SP-3	1 coat of F-8 @ 100 µ DFT/coat	1 coats of F-2@ 40 µ DFT/coat	140	- LPG service: RAL 5013 (cobalt blue) - Conventional type: RAL 3024 (Luminous Red) - Bellow Type: RAL 1026 (Luminous yellow color)

TABLE-18: TEMPERATURE INDICATING PAINT

Sl. No.	Description	Max Temp °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT in Microns (min.)	Remarks
				Primer	Finish paint		
18.1	Cold Collector, Transfer line, TPR & PG boiler inlet channel at HGU	400	Note-1				

Notes for TABLE-18:

1. Contractor shall propose suitable product for the temperature indicative paint application in the given temperature range, and submit their datasheet, Past Track Record and test certificate, for EIL review and approval.

GENERAL NOTES FOR TABLE: 5 TO 18

1. For uninsulated or insulated items, scope of surface preparation, application of primers to finish coat including repair shall be as per applicable contractual documents like SOR, MR, and PR etc. The list of items is not exhaustive.

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2. At the site, shop primer coated prefabricated items/structures/equipment/vessels shall be stored in the shed area and contractor shall brush off any chalking observed with emery paper, prior to application of subsequent coats.

8.0 GUIDELINES FOR STORAGE & HANDLING

8.1 All paints and painting materials shall be stored in rooms only which are to be arranged by CONTRACTOR and approved by Engineer-In-Charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the word "PAINT STORAGE- NO NAKED LIGHT-HIGHLY INFLAMMABLE" shall be clearly displayed outside. Manufacturers' recommendation /Materials safety datasheet shall be followed for storage and handling of paint materials.

Note: This standard doesn't address all the safety concerns if any, associated with its use. It is responsibility of the user of this specification to establish appropriate safety and health practice and determine the applicability of regulatory limitations prior to use.

9.0 COLOUR CODE, IDENTIFICATION AND MARKING

9.1 For identification of pipelines, the following color-coding scheme shall be followed (except for ATF)

TABLE-19: COLOR CODING

SR. No.	SERVICE	RECOMMENDED COLOUR FOR PAINT SYSTEM	RAL COLOUR CODE	
			BASE COLOUR	BAND COLOUR
HYDROCARBON LINES (UNINSULATED)				
1	CRUDE SOUR	Basalt Grey with 1 deep orange band	7012	2011
2	CRUDE SWEET	Basalt Grey with 1 signal red band	7012	3001
3	LUBE OILS	Basalt Grey with 1 grass green band	7012	6010
4	FLARE LINES	White Aluminum	9006	
5	LPG	Deep Orange with 1 oxide red band	2011	3009
6	PROPYLENE	Deep Orange with 2 Cobalt blue bands	2011	5013
7	NAPTHA	Deep Orange with 1 grass green band	2011	6010
8	M.S.	Deep Orange with 1 Basalt Grey band	2011	7012

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9	AV. GASOLINE (96 RON)	Deep Orange with 1 band each of grass green, white and signal red bands	2011	6010	9010	3001
10	GASOLINE (regular, leaded)	Deep Orange with 1 Jet black band	2011		9005	
11	GASOLINE (premium, leaded)	Deep Orange with 1 Cobalt blue band	2011		5013	
12	GASOLINE (white)	Deep Orange with 1 white band	2011		9010	
13	GASOLINE (Aviation 100/130)	Deep Orange with 1 signal red band	2011		3001	
14	GASOLINE (Aviation 115/145)	Deep Orange with 1 traffic purple band	2011		4006	
15	N-PENTANE	Deep Orange with 2 Cobalt blue bands	2011		5013	
16	DIESEL OIL (White)	Oxide red with 1 white band	3009		9010	
17	DIESEL OIL (Black)	Oxide red with 1 traffic yellow band	3009		1023	
18	KEROSENE	Oxide red with 1 grass green band	3009		6010	
19	HY. KEROSENE	Oxide red with 2 grass green bands	3009		6010	
20	DISUFIDE OIL (EX-MEROX)	Oxide red with 1 jet black band	3009		9005	
21	M.T.O	Oxide red with 3 grass green bands	3009		6010	
22	DHPPA	Oxide red with 2 white bands	3009		9010	
23	FLUSHING OIL	Oxide red with 2 jet black bands	3009		9005	
24	LAB FS	Oxide red with 2 Basalt Grey bands	3009		7012	
25	LAB RS	Oxide red with 3 Basalt Grey bands	3009		7012	
26	LAB (Off. Spec)	Oxide red with 1 light grey band	3009		7035	
27	N-PARAFFIN	Oxide red with 1 Cobalt blue band	3009		5013	
28	HEAVY ALKYLATE	Oxide red with signal red band	3009		3001	
29	BLOW DOWN, VAPOR LINE	Off white / Aluminum with 1-Brown band	9006		8004	
30	BLOWDOWN	Off white / Aluminum with 2 copper brown bands	9006		8004	
32	TOULENE	Clay Brown with 1 traffic yellow band	8003		1023	
33	BENZENE	Clay Brown with 1 grass green band	8003		6010	
34	LAB PRODUCT	Clay Brown with 1 Cobalt blue band	8003		5013	
35	FUEL OIL	Jet Black with 1 traffic yellow band	9005		1023	

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36	FULE OIL (Aromatic rich)	Jet Black with 2 traffic yellow bands	9005	1023
37	ASPHALT	Jet Black with 1 white band	9005	9010
38	SLOP AND WASTE OILS	Jet Black with 1 deep orange band	9005	2011
39	SLOP AROMATICS	Jet Black with 2 deep orange bands	9005	2011
CHEMICAL LINES				
40	TRI-SODIUM PHOSPHATE	Lemon Yellow with 1 violet blue band	1012	5000
41	CAUSTIC SODA	Lemon Yellow with 1 jet black band	1012	9005
42	SODIUM CHLORIDE	Lemon Yellow with 1 white band	1012	9010
43	AMMONIA	Lemon Yellow with 1 Cobalt blue band	1012	5013
44	CORROSION INHIBITOR	Lemon Yellow with 1 Aluminum band	1012	9006
45	HEXAMETA PHOSPHATE	Lemon Yellow with 2 jet black bands	1012	9005
46	ACID LINES	Golden Yellow with 1 signal red band	1004	3001
47	RICH AMINE	Lemon Yellow with 2 Cobalt blue bands	1012	5013
48	LEAN AMINE	Lemon Yellow with 3 Cobalt blue bands	1012	5013
49	SOLVENT	Lemon Yellow with 1 grass green band	1012	6010
50	LCS	Lemon Yellow with 1 Blue Grey	1012	7031
WATER LINES				
51	RAW WATER	Yellow Green with 1 jet black band	6018	9005
52	INDUSTRIAL WATER	Yellow Green with 2 signal red band	6018	3001
53	TREATED WATER	Yellow Green with 1 oxide red band	6018	3009
54	DRINKING WATER	Yellow Green with 1 grass green band	6018	6010
55	COOLING WATER	Yellow Green with 1 light brown band	6018	1011

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56	SERVICE WATER	Yellow Green with 1 signal red brown	6018	3001
57	TEMPERED WATER	Yellow Green with 2 grass green bands	6018	6010
58	DM WATER	Yellow Green with 1 aluminum band	6018	9006
59	DM WATER ABOVE 150°F	Yellow Green with 2 jet black bands	6018	9005
60	SOUR WATER	Yellow Green with 2 traffic yellow bands	6018	1023
61	STRIPPED WATER	Yellow Green with 2 Cobalt blue bands	6018	5013
62	ETP TREATED WATER	Yellow Green with 2 oxide red bands	6018	3009
FIRE PROTECTION SYSTEM (ABOVE GROUND)				
63	FIRE WATER FOAM & EXTINGUISHERS	Carmine Red	3002	
AIR & OTHER GAS LINES (UNINSULATED)				
64	SERVICE AIR	Sky blue with 1 signal red band	5015	3001
65	INSTRUMENT AIR	Sky blue with 1 jet black band	5015	9005
66	NITROGEN	Lemon Yellow with 1 deep orange band	1012	2011
67	FREON	Yellow green with 1 traffic yellow band	6018	1023
68	CHLORINE	Lemon Yellow with 1 oxide red band	1012	3009
69	SO_2	Lemon Yellow with 2 white bands	1012	9010
70	H_2S	Deep Orange with 2 oxide red bands	2011	3009
71	GAS (Fuel)	Deep Orange with 1 aluminum band	2011	9006
72	GAS (Sour)	Deep Orange with 2 aluminum bands	2011	9006
73	GAS (Sweet)	Deep Orange with 2 signal red band	2011	3001
74	HYDROGEN	Deep Orange with 1 Pale green band	2011	6021

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STEAM AND CONDENSATE LINES (UNINSULATED)				
75	HP STEAM	White Aluminum with 1 traffic yellow band	9006	1023
76	MP STEAM	White Aluminum with 1 signal red band	9006	3001
77	MLP STEAM	White Aluminum with 1 orange band	9006	2011
78	LP STEAM	White Aluminum with 1 light green band	9006	6021
79	CONDENSATE	Yellow green with 1 white band	6018	9010
80	CONDENSATE ABOVE 150°F	Yellow green with 3 oxide red band	6018	3009
81	BFW	Yellow green with 2 signal red bands	6018	3001
Note: For all insulated steam lines, the colour coding shall be followed as given for un-insulated lines with the specified length of colour bands.				
INSULATED HYDROCARBON PIPING				
82	IFO SUPPLY	Jet Black ground colour with 1 traffic yellow band in centre	9005	1023
83	IFO RETURN	Jet Black ground colour with 1 grass green band in centre	9005	6010
84	HPS	Jet Black ground colour with 1 signal red band in centre	9005	3001
85	BITUMEN	Jet Black ground colour with 2 signal red bands in centre	9005	3001
86	CLO	Jet Black ground colour with 1 brown band in centre	9005	8004
87	VB TAR	Black ground colour with 2 copper brown bands in centre	9005	8004
88	VR AM (BITUMEN / VBU FEED)	Jet Black ground colour with 1 Cobalt blue band in centre	9005	5013
89	VR BH	Black ground colour with 2 Cobalt blue bands in centre	9005	5013
90	VAC. SLOP	Black ground colour with 1 white band in centre	9005	9010
91	SLOP	Black ground colour with 1 deep orange band in centre	9005	2011
92	CRUDE SWEET	Basalt Grey ground colour with 1 signal red band in centre	7012	3001

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93	CRUDE SOUR	Basalt Grey ground colour with 1 deep orange band in centre	7012	2011
94	VGO / HCU	Oxide red ground colour with 2 iron grey bands in centre	3009	7011
95	OHCU BOTOM / FCCU FEED	Oxide red ground colour with 2 iron grey bands in centre	3009	7011
UNINSULATED EQUIPMENT, TANKS AND STRUCTURES				
96	HEATER STRUCTURE	Iron grey	7011	
97	HEATER CASING	White Aluminum	9006	
98	VESSELS & COLUMNS	White Aluminum	9006	
99	HYDROGEN BULLETS	Antique Pink	3014	
100	LPG VESSELS	Oxide red	3009	
101	SO_2 VESSEL	Lemon Yellow	1012	
102	HEAT EXCHANGER	White Aluminum	9006	
103	FO TANK AND HOT TANKS	Jet Black	9005	
104	ALL OTHER TANKS *Note 2	Pure White	9010	
105	CAUSTIC / AMINE / ACID TANKS	Golden yellow	1004	
106	SOUR WATER	Sky Blue		
107	OUTER SURFACE IN BOILER HOUSE	Aluminum	9006	
108	COMPRESSORS AND BLOWERS	Basalt Grey	7012	
109	PUMPS	Pigeon Blue	5014	
110	MOTORS & SWITCH GEAR	Pastel Blue	5024	
111	HAND RAILING	Signal red	3001	
112	STAIRCASE, LADDER AND WALKWAYS	Jet Black	9005	
113	LOAD LIFTING EQUIPMENT AND MONORAILS ETC	Clay Brown	8003	
114	GENERAL STRUCTURE	Steel blue (equivalent to British Airways Blue as per British Standard)	5011	
115	FLUE GAS STACK	Jet Black	9005	

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PIPES AND FITTINGS OF ALLOY STEEL AND SS MATERIAL IN STORE				
115	IBR	Signal red	3001	
116	9Cr-1Mo	Pale Green	6021	
117	5Cr-0.5Mo	Light Blue	5012	
118	$2_{1/4}$Cr-1 Mo	Luminous Yellow	1026	
119	$1_{1/4}$Cr-½ Mo	Traffic Yellow	1023	
120	SS-304	Grey Blue	5008	
121	SS-316	Blue Lilac	4005	
122	SS-321	Pigeon Blue	5014	
SAFETY COLOUR SCHEMES				
123	DANGEROUS OBSTRUCTION	Jet Black and Briht Red Orange band	9005	2008
124	DANGEROUS OR EXPOSED PARTS OF MACHINERY	Bright Red Orange	2008	

Note for Table-19:

1. As per latest DGCA guide line for ATF service color coding shall be Leaf Brown with two black bands.

2. Sr. no 104 - “All other tanks” having pure white (RAL 9010) as top coat shall have intermediate coat in colour: Signal white (RAL 9003) or Traffic White (RAL- 9016) to have lighter intermediate coat.

9.2 Ground Color

The system of colour coding consists of a ground colour and secondary colour bands superimposed over the ground colour. The ground colour identifies the basic nature of the service and secondary colour band over the ground colour distinguishes the particular service. The ground colour shall be applied over the entire length of the un-insulated pipes. For insulated lines, ground colour shall be provided as per specified length and interval to identify the basic nature of service and secondary colour bands to be painted on this specified length to identify the particular service. Above colour code is applicable for both unit and offsite pipelines.

9.3 Color band & Identification lettering (except for ATF service)

For ATF service, 2 color bands of 100 mm with 50 mm gap in between them shall be provided.

The following specifications of color bands shall be followed for identifying the piping contents, size and location of bands & letters. The bandwidth and size of letters in legends will depend to some

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extent upon the pipe diameter. Either white or black letters are selected to provide maximum contrast to the band color. Bands are spaced 25 mm apart when two bands are employed.

Outside dia of pipe or covering in mm	Width of color band in mm
19-32	200
38-51	200
64-150	300
200-250	600
Over 250	800

In addition, ground colour as per specified length should be provided on insulated piping for easy identification of nature of fluid, on which the colour bands should be painted for identification of each service. The length of the ground colour should be 3 times the width of normal band or 2 meters, whichever is suitable depending on the length of the pipe.

Size of letters stenciled/ written for equipment shall be as given below:

Column and vessel: 150 mm (Height)

Pump, compressor and other machinery: 50 mm (Height)

9.3.1 Color band

In addition, the contents of the pipe and/or direction of flow may be further indicated by arrows and legend. If a hazard is involved it must be identified clearly by legend.

The location and size of bands, as recommended, when used, shall be applied to the pipe.

• On both sides of the valves, tees and other fittings of importance.

• Where the pipe enters and emerges from walls and where it emerges from road & walkway overpasses, unit battery limits.

• At uniform intervals along long sections of the pipe.

• Adjacent to tanks, vessels, and pumps.

9.3.2 Color band specification

The location and size of bands, as recommended, when used, shall be applied to the pipe.

• Unit Area: Bands at intervals of 6.0 meters.

• Offsite Area: Bands at intervals of 10.0 meters.

• Each pipe segment will have minimum one band indication, irrespective of length.

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- The bands shall also be displayed near walkways, both sides of culverts, tanks dykes, tanks, vessels, suction and discharge of pumps/ compressors, unit battery limit, near valves of line, etc.

9.3.3 For piping, writing of name of service and direction of flow for all the lines shall be done at following locations

• The letters will be in black on pipes painted with light shade colors and white on pipes painted with dark shade colors to give good contrast.

• Only writing of service name shall be done on stainless steel lines. Precautions should be taken while painting by using low chloride content painting to avoid any damage to the stainless-steel pipes. It is preferable to use adhesive plastic tapes to protect stainless steel pipes.

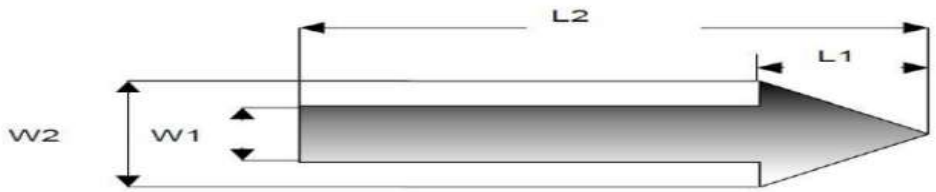
Size of Lettering and Direction Arrow shall be as follows:

Lettering

Pipe diameter	Width x Height- spacing
2" to 6" inclusive	30 x 30mm - 10 mm min.
6" to 50" inclusive	80 x 80mm - 25 mm min.
Greater than 50"	100 x 100mm - 30 mm min.

Direction arrow

Pipe Diameter	W1 (mm)	W2 (mm)	L1 (mm)	L2 (mm)
2" to 6" inclusive	10	30	45	135
6"to50" inclusive	40	80	90	270
Greater than 50"	50	100	150	450



10.0 QUALITY CONTROL, INSPECTION AND TESTING

10.1 All painting materials including primers and thinners brought to site by CONTRACTOR for application shall be procured directly from manufactures as per specifications and shall be accompanied by manufacturers' test certificates. Paint formulations without certificates are not acceptable (see section 12.0 & 13.0).

10.2 The CONTRACTOR must produce test certificate from pre-qualified paint manufacturer for various tests as detailed out in section 15.0 of this document. The Engineer-In-Charge, in consultation with SMMS, shall have the right to test wet samples of paint at random for verifying quality of paint supplied.

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CONTRACTOR shall arrange to have such tests, as instructed, performed at his cost at any one of the NABL accredited laboratories under a TPI agency.

Samples for the test will be drawn at random in presence Engineer-In-Charge or his representations. Following tests to be carried out if called:

a. Specific Gravity
b. % solids by weight (% zinc content in case of inorganic or organic zinc primer)
c. Drying time (touch dry & full curing)
d. Adhesion test on a test panel prepared at the site (ASTM D 6677).

Test methods for above tests shall be as per relevant ASTM or ISO Standard.

10.3 The painting work shall be subject to inspection by Engineer-In-Charge at all times. In particular, following stage-wise inspection will be performed and CONTRACTOR shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

a. Surface preparation
b. Primer application
c. Each coat of paint

10.3.1 Following tests are to be carried out during surface preparation:

a. Test for presence of oil/grease and contamination

The steel substrate after degreasing as per SSPC-SP-1 shall be tested as per following procedure to validate absence of oil and grease contamination:

- Visual inspection - continue degreasing until all visible signs of contamination are removed.

- Conduct a solvent evaporation test by applying several drops or a small splash of residue-free tri-chloromethane on the suspect area especially pitting, crevice corrosion areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination. Continue degreasing and inspection till test is passed.

b. **Tests for surface finish of blasted surface** shall be done by visual inspection using SSPC-VIS1. Clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on blasted surface. Checks shall be done on each component at least once per 200 m^2 of blasted surface and a minimum of 3 checks per shift.

c. **Test for presence of soluble salt** as per method ISO 8502-9. Maximum allowable salt content shall be considered 20 mg/m^2.Checks shall be done on each component at least once per 200 m^2 of blasted surface and minimum of 3 checks per shift. In case salt exceeds specified limit,

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the contaminated surface shall be cleaned by method as per Annexure-C of ISO 12944-4 (water cleaning). After cleaning, surface shall be retested for salt after drying.

d. **Blast Profile Measurement**: (In-Process testing during actual production before application coating). The angular profile depth measurement shall be done by profile tape as per method ASTM D 4417 method B (Profile depth gauge micrometer)/ calibrated Digital gauge meter. Spot measurement shall be carried out every 15m^2 of blasted surface. At each spot three measurements shall be taken over an area of 10 m^2 and average of measurements to be recorded and reported. If profile is less than specified range, blasting shall continue till greater specified depth profile is achieved.

e. **Tests for blasting media:** Blasting Media (For every fresh batch of media and one random test during blasting)**.** Blasting Media shall be visually inspected for absence of contamination and debris using 10 X magnification.

- Inspection for the absence of oil contamination shall be conducted using following procedure:
  - Fill a small clean 200 ml bottle half full of abrasive.
  - Fill the bottle with potable water, cap and shake the bottle.
  - Inspect water for oil film/slick. If present, the blasting media is not to be used.

- Soluble salt contamination if suspected shall be verified by method ASTM D 4940. If present, media to be replaced.

- Clean blasting equipment, especially pot and hoses, and then replace blasting media and retest.

f. **Test for Blasting Air** (Once Daily before start of blasting and once at random during Blasting). The air for blasting shall be free from moisture and oil. The compressor air shall be checked for oil and water contamination per ASTM D 4285.

In addition to above, record should include type of shop primer already applied on equipment e.g. zinc silicate or zinc rich epoxy or zinc phosphate. Any defect noticed during the various stages of inspection shall be rectified by the CONTRACTOR to the entire satisfaction of Engineer-In-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, CONTRACTOR shall be responsible for rectifying any defects found during final inspection/guarantee period/defect liability period as defined in general conditions of the contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to OWNER, the extra coat should have prior approval of Engineer-in-charge.

10.4 Final inspection of finished coating shall consist of the following:

Coating DFT & WFT check: DFT measurement shall be as per ISO 2808. Type-II electronic gauge shall be used as described in ASTM D7091. DFT gauge calibration, adjustment of gauge coating thickness, frequency and number of coating thickness measurement shall be as per ASTM D7091

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and SSPC-PA2. Measured DFT shall have a tolerance as per SSPC-PA-2 level-3 of the dry film thickness, specified in this specification. Once in every layer of coating application, spot checks of WFT shall be carried out during the coating application according to ISO 2808, Method No. 1A- comb gauge. This is to ensure that film thickness is being achieved as per the specification. The frequency of WFT check shall be one per 10 m^2.

Adhesion testing: Adhesion of the primer to the steel substrate and inter-coat adhesion of the subsequent coat(s) after curing for at least a week after application of the topcoat shall be examined by a knife test in accordance with ASTM D6677. For the knife test, if the rating is better than 8, the adhesion is considered acceptable. The adhesion is destructive and tested areas shall be repaired afterward using the spot repair procedure. Alternatively, the applicator may perform the adhesion test on a steel panel coated using the same surface preparation and coating application procedure as the work piece. Adhesion testing shall be carried out for each component at least once per 200 m^2 of coated surface.

Holiday detection check: Holiday testing of non-conductive coatings shall be carried out in accordance with NACE SP0188. For immersion, buried & under insulation services, 100% of coated area shall be inspected for holidays. For atmospheric exposure, 10% of coated area which must include weld seams, corners and edges to be holiday tested. Voltage at which test is to be carried out will depend upon DFT of coating being tested and shall be as per NACE SP0188. Any holiday is unacceptable and should be marked and repaired immediately**.**

The CONTRACTOR shall arrange for spot checking of paint materials for specific gravity, glow time (ford cup) and spreading rate.

11.0 PAINT MATERIAL GUARANTEE CERTIFICATE

The CONTRACTOR shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work and shall submit necessary certificate of the paint material.

12.0 QUALIFICATION CRITERIA OF PAINTING CONTRACTOR/SUB-CONTRACTOR

Painting CONTRACTOR who is awarded any job for EIL, Projects under this standard must have necessary equipment, machinery, tools and tackles for surface preparation, paint application and inspection. The CONTRACTOR must have qualified, trained and experienced surface preparator, paint applicator, inspector and supervisors. The CONTRACTOR supervisor, inspector, surface preparator and paint applicator must be conversant with the standards referred in this specification.

13.0 PRE-QUALIFICATION/ACCEPTANCE CRITERIA FOR PAINT COATING SYSTEM

13.1 Pre-qualification of paint coating manufacturer and their products

Paint manufacturer meeting the following requirements shall be considered by the CONTRACTOR for supply of the paint products.

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a) Manufacturer should have been in continuous business of paint coating formulation and manufacturer for at least past 5 years.
b) Manufacturer should possess past experience of supplying products to hydrocarbon, petrochemical, fertilizer, chemical processing, offshore or heavy industry in the past 5 years.

c) Coating manufacturer should have supplied at least 10000 litre of an individual product to hydrocarbon, petrochemical, fertilizer, chemical processing, offshore or heavy industry.

d) The manufacturer's manufacturing procedure & QA/QC system shall meet ISO 9001 requirements and preferably should possess ISO 14000 certificate.

e) The Quality control set up should be manned by qualified paint technologists whose biodata should be sent along with quality control organization chart.

The Past Track record of the manufacturers as mentioned above shall be substantiated by providing relevant documents to EIL-SMMS for their review and acceptance. This shall include Work Orders, Purchase orders and ISO 9001 certification covering all the requirements mentioned from bullets a) to e) above.

CONTRACTOR shall procure the paint materials from the qualified manufacturer meeting above requirements and after obtaining prequalification testing approval as per requirements mentioned in clause 15.2 below.

13.2 Pre-Qualification Testing procedure:

The paint manufacturer engaged by the mechanical contractor shall carry out the tests in NABL accredited government laboratories or in suggested list of laboratories below, as a part of qualification. Paint manufacturer shall provide the paint samples to laboratory for testing of the parameters mentioned in Table-2 (typical characteristics) and Table-20 (tests on coating systems) of this specification. The testing laboratory will confirm the compliance of the paint material with respect to the acceptance criteria mentioned in the respective tables.

Colored photographs of coated test panels should be taken before and after the test and should be enclosed along with test report. Contractor shall furnish these test certificates along with all necessary supporting documents/information to EIL-SMMS for approval/ acceptance. The paint manufacturer will be qualified and approved by EIL-SMMS for supply of paints after review/assessment of the submissions made by the contractor. Test certificates which are more than 3 years old will not be considered. Paint manufacturers are advised to carryout pre-qualification testing accordingly for paints supply to EIL projects.

List of suggested laboratories:

1. National Test house – Kolkata
2. National Test house-Mumbai

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3. HBTU- Kanpur
4. GIRDA (Gujarat Industrial Research & Development Agency)- Vadodara
5. Indian institute of chemical technology – Hyderabad
6. RITES – Kolkata
7. ICT- Mumbai

TABLE-20: PRE-QUALIFICATION TESTING

SYSTEM No.	COATING SYSTEM	REFERENCE CLAUSE (from table-3 to 12)	TOTAL DFT µ (min)
1.	F-9+P6+F6B+F2	6.2	345
2.	F9+F12+F12	6.4	105
3.	F9+F11+F11	6.3	105
4.	F15+F15+F15	11.1.1	240
5.	F16+F16	8.3.1	250
6.	F17	9.2.1	400
7.	F8	3.1	125
8.	F20+F20	9.5.1	1100
9.	F6C+ F6C + F6C	Annexure II	675
10.	F9+F7+F7+F7	10.2.1	365
11.	F15+F6A+F6A	9.9.1	280
12.	F19+F19+F19	9.2.2	375

S. No.	TEST	FOR SYSTEM NUMBER	DURATION	ACCEPTANCE CRITERIA
1.	Cyclic Test Salt Spray : 72 hrs. Drying in air: 16 hrs. UV-A340 nm weather meter: 80 hrs. One cycle: 168 hrs. (25 cycles at 168 hrs. each cycle) (ASTM D5894)	1	4200 hrs.	Shall pass. No chalking, cracking, flaking, blistering or peeling shall be observed.
2.	Chemical Resistance Test (ASTM D543)			
2a.	10% & 40% NaOH	4, 6, 8, 10 11 & 12	1000 hrs.	Shall pass. No cracking, discoloration, blistering, peeling or softening of film shall be observed.
2b.	5% H2SO4		168 hrs.	
2c.	Xylene		4 weeks	
2d.	Acetone		4 weeks	

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2e.	Ethanol		4 weeks	
2f.	Kerosene		4 weeks	
2g.	Sea water		2000 hrs.	
3.	Immersion in DM/DI water @90^0 (ASTM C868)	4, 6, 8, 10 11 & 12	30 days	No softening, blistering or film damage.
4.	Resistance to DM water using water immersion. (ASTM D870)	9	2000 hrs.	Shall pass. No chalking, cracking, flaking, blistering or peeling.
5.	100% Humidity Test (ASTM D2247)	1 to 12 (except system-2 & 3)	1440 hrs.	Shall pass
6.	Thermal Shock Resistance Test; 5 cycles @ 30 minutes in furnace at 120 º C and 15 minutes in water after quenching in water for each cycle. (ASTM D2485 method A)	2, 3, 5, & 11 (For system-2, testing to be done after heating the panels at 400°C for 2 hrs.) & (For system-3, testing to be done after heating the panels at 250°C for 2 hrs.)	-	Shall pass
7.	Cathodic Disbondment Test (ASTM G42 @80°C)	4, 5, 10, 6 & 11	-	Diameter of cathodic

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				Disbondment < 10 mm with 6 mm diameter artificial holiday.
8.	Assessment of Adhesion and artificial ageing as per ISO 19277	4, 5, 6, 7, 11 & 12	-	Shall Pass

Each coating product to be qualified shall be identified by the Specific gravity of base and curing agent (ISO 2811). The identification shall be carried out on the batch, which is used for the pre-qualification testing.

13.3 Information to be furnished during delivery of paint materials:

CONTRACTOR along with delivery of paint material has to furnish following information from paint manufacturer to EIL for acceptance/approval of products:

a) Batch test certificates:

Along with paint products delivery to site from the pre-qualified coating manufacturer, CONTRACTOR has to produce test certificate (from paint manufacturer) for each category of product for the following test items. All test results must mention clearly the batch no. and category of product tested. Tests to be conducted for following properties:

- Specific Gravity
- % solids by weight (% zinc content in case of inorganic or organic zinc primer) ~ ASTM D521.

b) Product information sheet/ technical data sheet for each category of product.
The contractor shall be fully responsible for the quality of the paints products as per prequalification testing. After the paint materials are supplied to site, the supplier shall organize random sampling and testing in a NABL laboratory as per discretion of the Engineer-in-charge in consultation with SMMS. Failing to meet the specified quality requirements may cause rejection of the paint products.

c) Remaining Shelf life shall be at least 50% of the total duration at the time of above application of procured material by contractor / owner. However, it is preferred to have the materials from the fresh stock for better performance of coatings.

14.0 METHOD OF SAMPLING & DISPATCH FOR LABORATORY TESTING

(Pre-Qualification tests (sec. 13.2), Batch testing (sec. 13.3) and Inspection testing (sec. 10.0))

14.1 Samples of coating materials should be submitted to the laboratory in sealed containers with batch no. and test certificate on regular format of manufacturer's testing laboratory.

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14.2 All test panels should be prepared by testing laboratory. Surface preparation for a system shall be done in accordance with this specification. For individual products testing, minimum shall be Sa 2.5. Colour photographs of test panels should be taken before and after the test and should be enclosed along with test report. Sample batch no. and manufacturer's test certificate should be enclosed along with the report. Test report must contain details of observation and rusting if any, as per the testing code.

14.3 Manufacturers should intimate EIL, details of sample submitted for testing, name of testing agency, date, and contact personnel of the testing agency.

15.0 RCC PAINTING

RCC structures shall be coated with protective coatings as per the requirements laid out in respective drawings/relevant documents.

15.1 Concrete surface preparation and coating application

a. The proper surface preparation of concrete surface is critical for ensuring strong adhesion of coatings, sealants, overlays, and repair materials. The surface preparation removes contaminants, weak layers (like laitance), and provides a rough texture for mechanical bonding.

b. The prepared concrete surface should be free of contaminants, laitance, loosely adhering concrete, and dust, and should provide a sound, uniform substrate suitable for the application of protective coating or lining systems.

c. The surface preparation shall remove protrusions such as from sharp edges, fins, and concrete spatter, voids and other defects that are at or near the surface. Concrete damaged by exposure to chemicals shall be removed so that only sound concrete remains. All contamination, form-release agents, efflorescence, laitance and curing compounds shall be removed.

d. Detergent water cleaning as described in ASTM D4258 shall be used to remove oils and grease from concrete.

e. The minimum surface preparation shall be as per SSPC-SP-13, Clauses 4.3.1, 4.3.2 & 4.4. The surface preparation method, or combination of methods, should be chosen based on the condition of the concrete and the requirements of the coating system to be applied by the CONTRACTOR. Inspection testing and acceptance criteria as applicable shall be as described in sections 5 & 6 of SSPC-SP-13.

f. The DFT of the applied coating shall be checked by using ultrasonic DFT gauge in accordance with SSPC-PA-9

g. All concrete surfaces to be prepared and coated shall be visually inspected for signs of concrete defects, physical damage, chemical damage, contamination, and excess moisture.

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h. All concrete should be cured using the procedures described in ACI 308. Curing requires maintaining of sufficient moisture and temperatures for a minimum time period. The surface preparation performed on insufficiently cured or low-strength concrete may result in excessively coarse surface profile or excess removal of concrete.

i. Concrete that has been damaged because of physical forces such as impact, abrasion, or corrosion of reinforcement shall be repaired before surface preparation if the damage would affect coating performance. Repairs should be made in accordance with ACI 301, ACI 562, ACI 546.

15.2 RCC coating system

Table 21- Coating system on concrete surface

S. No	Description	Coating system	Remarks
1	RCC super structure surfaces	1 Priming coat of water based 100% Acrylic exterior emulsion anti-carbonation primer with light fast pigments and resistant to fungus and algae growth, alkali and UV degradation @ 50µ per coat + 3 coats of finish coat with water based 100% acrylic exterior emulsion anti-carbonation paint with light fast pigments and resistant to fungus and algae growth, alkali and UV degradation @ 50 µ per coat = 3×50 = 150 µ	Note 1
2	All external Cooling tower RCC surfaces and structures, which are prone to carbonization as well as algae & fungus attack due to continuous exposure of water & sea water etc.	1 Priming coat of water based 100% Acrylic exterior emulsion anti-carbonation primer with light fast pigments and resistant to fungus and algae growth, alkali and UV degradation @ 50µ per coat + 3 coats of finish coat with water based 100% acrylic exterior emulsion anti-carbonation paint with light fast pigments and resistant to fungus and algae growth, alkali and UV degradation @ 50 µ per coat = 3×50 = 150 µ	Note 1
3	Cooling tower internal surfaces including all the inner surfaces but not limited to walls, columns, beams, basins, sumps, channels, all RCC above fills and below fills etc.	3 coats of F-7 @ 125 µ per coat. Total DFT=375 µ	-

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Notes for Table 21:

1. Contractor shall propose suitable coating product and submit their necessary datasheet, test certificates and Past Track record for EIL review and approval.
2. No painting shall be done in rainy season.
3. Painting shall be done in given pattern in desired colors preferably bright in shades. Colour Shall be Azure Blue for RCC foundations of pumps & Equipment and Ivory for Piperack. and track. For any other RCC structures, contractors shall propose suitable color code for EIL review and approval.

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ANNEXURE-I

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SPECIFICATION FOR THERMALLY SPRAYED ALUMINIUM (TSA) COATING

1.0 SCOPE

The following sections outlines the requirement of supply, application and testing of thermally sprayed aluminum coatings (TSAC) for corrosion protection of insulated critical carbon steel, LTCS, LAS equipment like vessels, reactors, columns & equipment within the design temperature range of 200-540°C. Contractor shall establish the criticality in consultation with BPCL/EIL, and finalize the type of under insulation coating required.

2.0 ITEMS TO BE THERMALLY SPRAYED

Vessels, reactors, columns & equipment to be protected by TSAC shall be as per Table 11.0 of this specification. Components thermally sprayed shall not have any uncoated area or shall not be in mechanically connected by flanges etc. to any uncoated bare steel work. Such adjacent areas to TSA coated areas, if not coated by TSA shall have suitable paint coating system as per the standard specification.

3.0 TSAC REQUIREMENTS

3.1 Surface Preparation

All the parts to be sprayed shall be degreased according to SSPC-SP 1. The absence of oil and grease after degreasing shall be tested by method given elsewhere in the specification (Refer Sec. 6.7 of this annexure). Thereafter the surface to be abrasive blasted to white metal finish as per NACE 1/SSPC-SP 5 for marine and immersion service. Using SSPC VIS 1, it is to be visually assessed that the blast cleaned surface meets requirement of SSPC-SP 5. Thereafter clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on the blasted surface. Finally blasted surface shall be tested for presence of soluble salts as per method ISO 8502-9. Maximum allowable salt content shall be considered 20mg/m^2 (2 micrograms/cm^2). In case salt content exceeds specified limit. The contaminated surface shall be cleaned by method as per Annex C of IS 12944-4 (Water Cleaning). After cleaning the surface shall be retested for salt content after drying. Testing shall be carried out at least on each component, once per 200 m^2 and a min of 3 times per shift during progress of work.

The blasting media shall be either chilled iron or angular steel grit as per SSPC-AB-3 of mesh size G-16 to G-40. Copper, Nickel slag, Garnet or Aluminum Oxide as abrasives will also be suitable having mesh size in the range of G16 to G24 (10-30 mesh), conforming to SSPC-AB-1. Mesh size shall be required as appropriate to the anchor tooth depth profile requirement and blasting equipment used. The blasted surface should be having angular profile depth not less than 65 microns with sharp angular shape but shall not exceed 85 microns. The profile depth shall be measured according to NACE standard RP 0287 (Replica Tape) or ASTM D 4417 method B (Profile depth gauge).

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For manual blasting one profile depth measurement shall be taken every 10-20 m^2 of blasted surface.

Surface preparation shall be completed in one abrasive blast cleaning operation wherever possible.

If rust bloom (visual appearance of rust) appears on the blast cleaned surface before thermal spraying, the affected area shall be reblasted to achieve specified degree of cleanliness after which only thermal spraying shall commence.

Air blasting pressure at nozzle shall be normally maintained at 100 psi. Air pressure and media size should be reduced and adjusted to preclude damage/distortion to thin gauge materials. Blasting time on work piece should be adjusted to only clean the surface and cut required anchor tooth with minimum loss of metal. Blast angle should be as close to perpendicular as possible but in no case greater than $\pm$ 30 ^{0} from perpendicular to work surface. Blasting media must be free of debris, excessive fines, and contaminants such as NaCl and sulfur salts (Ref. Sec. 6.0 of this annexure). Blast cleaning shall not be performed when the surfaces to be blasted are wet or less than 3°C above dew point temperature or when the relative humidity in the vicinity of the work is greater than 85%.

3.1.1 Blasting Equipment

The TSAC applicator shall use mechanical (centrifugal wheel) or pressure pot blast cleaning equipment and procedures. Suction blasting equipment shall not be used. Sec 6.6.2 of this annexure shall be used to validate clean and dry air.

3.1.2 Feed Stock

The feed stock shall be in the form of wire. The feed stock shall be 99.5% aluminum of commercial purity grade, its composition shall be in accordance with requirement of BS 1475 or ISO 209-1 type A1 (wrought aluminum and aluminum alloys, wire). Wire shall be supplied in protective wrapping indicating batch number and other details.

3.1.3 Thickness Requirement

The nominal thickness of finished TSAC shall be 250 microns having minimum value of 225 microns at low thickness areas (valleys) and not more than 275 microns at peak areas.

The finished thickness shall be measured using SSPC-PA 2 type 1 fixed probe gauge (Magnetic Gauge).

3.1.4 Coating Bond Strength Requirement

The TSAC coating shall have a minimum individual tensile-bond strength value of 1000 psi for flame sprayed and 1500 psi for arc sprayed coating with an average of 2000 psi for arc

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sprayed coatings. Minimum tensile bond strength should be achieved by proper anchor tooth profile of blasted surface, laying down the TSA thickness in multiple passes and carrying out TSA application under controlled environment

3.1.5 Porosity

All thermally sprayed metallic coatings will have porosity. For thermally sprayed aluminum coatings porosity shall not exceed 15% of total surface area for flame sprayed coating and 8% for arc spray coating.

4.0 Thermal Spray Application Procedure

Items in the atmospheric zone to be coated by TSA shall be applied by either Flame spray or Arc spray method only. For coating under insulation, application shall be by arc wire method.

4.1 Equipment Set Up

4.1.1 Thermal spray equipment shall be set up calibrated, operated (1) according to manufacturer instructions/technical manuals and also TSAC applicators refinement thereto and (2) as validated by Procedure Qualification (Sec 7.0 of this annexure).

4.1.2 Spray Parameters

Spray parameters (see 4.1.3 below) and thickness of each crossing pass shall be set and shall be validated with bend test (See 6.5 of this annexure).

4.1.3 Spray Parameters

Spray Parameters	Method of Application	
Arc voltage	Arc wire Spray	Flame Wire Spray
	27 V	-
Air pressure	80 psi	80 psi
Steel surface cleanliness	NACE-1 white metal	NACE-1 white metal / or near white metal
Steel surface profile	60-75 microns	60-75 microns
Arc current	250-280A	-
Coating thickness	225 microns (nominal)	225 microns(Nominal)
Coating adhesion	> 1500 psi (Total coating), see 3.1.4	>1000 psi
Coating porosity	Less than 8%	Less than 15%.
Spray distance (spray Gun work piece)	6-8”	5-7”
Spray Pass width	40mm	20 mm

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The above parameters to be validated with a bend test by the contractor before start of work (for details of bend test see Sec 6.5 of this annexure).

4.2 Post Blasting Substrate Condition and Thermal Spraying Period.

4.2.1 The steel surface temperature shall be at least 3^0C above dew point of ambient air temperature.

Steel substrate surface temperature shall be recorded by with a contact pyrometer.
Thermal spraying should commence within 15 minutes from the time of completion of blasting

4.2.2 Holding Period

Time between the completion of final anchor tooth blasting and completion of thermal spraying of blasted surface should be no more than four hours. If within this period rust bloom appears Sec 4.4.1 of this annexure will apply.

4.3 Pre-Heating

For flame spraying, the initial starting area of 1-2 square feet to be preheated to approx.120 °C to prevent condensation of moisture in the flame on the substrate. For arc spraying the preheating is not required.

4.4 Thermal Spraying

Spraying should commence only after validation of equipment set up by procedure qualification test and spray parameter validation tests described in Sec 7.0 and 6.5 respectively. Thermal spraying must commence within 15 minutes from the time of completion of blast cleaning

The specified coating thickness shall be applied in several crossing passes. The coating bond strength is greater when the spray passes are kept thin. Laying down an excessively thick spray pass increases the internal stresses in TSAC and decreases the bond strength of total TSAC. The suitable thickness for crossing passes shall be determined by procedure qualification test described in Sec 7.0 of this annexure.

For manual spraying, spraying to be done in perpendicular crossing passes to minimize thin spots in coating. Approx. 75-100 microns of TSAC shall be laid down in each pass.

The surface geometry of the item or area to be sprayed should be inspected before application. The spraying pass and sequence shall be planned according to following.

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- Maintain Gun as close to perpendicular as possible and within $\pm 30^0$ from perpendicular to the substrate.

- Maintain nominal standoff distance and spray pass width as given below:

Spray method	Standoff (Inches)	Spray pass width (Inches)
Arc Wire	6-8	1 ½ (40mm)
Flame wire	5-7	¾ (20mm)

4.4.1 Rust Bloom (Visual appearance of rust or Discoloration)

If rust bloom appears on the blasted surface before thermal spraying, the affected area shall be re-blasted to achieve the specified level of cleanliness.
If Rust bloom in form of discoloration, or any blistering or a degraded coating appears at any time during application of TSAC, then spraying shall be stopped and acceptable sprayed area shall be marked off. The unsatisfactory areas shall be repaired to the required degree of surface cleanliness and profile.
Blast the edges of the TSAC to provide for 2-3" feathered area overlaps of the new work into existing TSAC.
Then apply TSAC to the newly prepared surfaces and overlap the existing TSAC to the extent of feathered edge so that overlap is a consistent thickness.

4.4.2 Masking

Masking all those parts and surfaces which are not required to be thermally sprayed as instructed by purchaser should be inspected by applicator to ensure that they are properly marked and covered by purchaser.

Complex geometries (flanges, valve manifolds, intersections) shall be masked by applicator to minimize overspray i.e. TSAC applied outside spray parameters (primarily gun to substrate distance and spray angle).

4.4.3 TSAC Finish

The deposited TSAC shall be uniform without blisters, cracks, loose particles, or exposed steel as examined with 10 X magnification.

5.0 SEALER

Sealant shall be applied after satisfactory application of TSAC and completion of all testing and measurements of the finished TSAC as per Sec 6.0 of this annexure. For shop work, sealer shall be applied immediately after thermal spraying and for field work sealer

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shall be applied within 8 hours. The sealcoat shall be thin enough to penetrate into the body of TSAC.

The sealant shall be silicone alkyd aluminium paint having DFT not more than 35-40 micron. Typically seal coat shall be applied at a spreading rate resulting in theoretical 38 microns DFT. The seal coat shall be applied in accordance with SSPC-PA 1 and the paint manufacturer instruction for sealing.

6.0 TESTING AND MEASUREMENT SCHEDULE

6.1 Surface Finish

That the blasted cleaned surface meets the required criteria (NACE 1/SSPC-SP 5) shall be visually inspected using SSPC-VIS 1. The clear cellophane-tape test as per ISO 8502-3 shall be used to confirm absence of dust or foreign debris on the cleaned surface. Checks shall be done on each component at least once per 200 m^2 of blasted surface and minimum of 3 checks per shift.

6.2 Blast Profile Measurement: (In-Process testing during actual production before application of TSA coating)

The angular profile depth measurement shall be done by profile tape as per method NACE Standard RP 0287 or ASTM D 4417 method B (Profile depth gauge micrometer). Spot measurement shall be carried out every 15m^2 of blasted surface. At each spot three measurements shall be taken over an area of 10 cm^2 and average of measurements to be recorded and reported.
If profile is <65 microns blasting shall continue till greater than 65 microns depth profile is achieved.

6.3 TSAC Thickness (In-Process Testing For finished coating during regular production)

6.3.1 TSAC finished thickness shall be measured using SSPC-PA 2 type 1 fixed probe gauge.

6.3.2 For flat surfaces, measurements shall be taken along a straight measurement line, one measurement line for every 15 m^2 of applied TSAC shall be selected along which 5 measurements to be taken at 25 mm internal and average to be reported.

6.3.3 For curved surface or complex geometry, 5 measurements shall be taken at a spot measuring 10 cm^2 in area. One spot to be taken for every 15 m^2 of applied TSAC area.

6.3.4 The TSAC thickness in surface changes or contour changes, welds and attachments shall be also measured and reported.

6.3.5 If TSAC is less than specified minimum thickness, apply additional TSAC until specified thickness range is achieved.

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6.3.6 All locations and values of TSAC thickness measurements shall be recorded in Job Record (JR).

6.4 Tensile Bond Testing (In-Process testing for finished coating during regular production)

- Tensile Bond strength of the TSAC finish coat shall be determined according to ASTM D 4541 using a self-aligning adhesion tester.

- One measurement shall be made every 50 m^2. If tensile bond at any individual spot is less than 1000 psi for flame sprayed coating and 1500 psi for arc sprayed coating the degraded TSAC shall completely remove and reapplied.

- The tensile bond portable test instrument to be calibrated according to ASTM C 633

6.5 Bend Tests

Bend test shall be carried out at beginning of each work shift. Bend tests shall also be conducted on sample coupons before start of thermal spraying work to qualify the following as mentioned earlier in this specification.

- To qualify spray parameters and thickness of each crossing pass.

6.5.1 Test Procedure

a) Five corrosion control steel coupons each of dimension 50 mm x 150 mm x 1.3 mm thk. to be prepared.

b) Surface shall be prepared by dry abrasive blast cleaning as per this specification.

c) TSAC shall be applied as per specified thickness range. TSAC should be sprayed in crossing passes laying down approx. 75-100 microns in each pass.

d) TSAC applied coupons shall be bent 180^0 around a 13 mm diameter mandrel.

e) Bend test shall be considered passed if on bend radius there is

- No cracking or spalling or lifting by a knife blade from the substrate

- Only minor cracking that cannot be lifted from substrate with a knife blade.

f) Bend test fails if coating cracks with lifting from substrate.

6.6 Tests for blasting media, blasting air

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6.6.1 Blasting Media (For every fresh batch of media and one random test during blasting)

Blasting Media shall be visually inspected for absence of contamination and debris using 10 X magnification.

a) Inspection for the absence of oil contamination shall be conducted using following procedure:

- Fill a small clean 200 ml bottle half full of abrasive.
- Fill the bottle with potable water, cap and shake the bottle.
- Inspect water for oil film/slick. If present, the blasting media is not to be used.

b) Soluble salt contamination if suspected shall be verified by method ASTM D 4940. If present, media to be replaced.

c) Clean blasting equipment, especially pot and hoses, and then replace blasting media and retest.

6.6.2 Test for Blasting Air (Once Daily before start of blasting and once at random during blasting)

The air for blasting shall be free from moisture and oil. The compressor air shall be checked for oil and water contamination per ASTM D 4285.

6.7 Test for presence of oil/grease and contamination

The steel substrate after degreasing as per SSPC-SP 1 shall be tested as per following procedure to validate absence of oil and grease contamination.

a) Visual inspection - Continue degreasing until all visible signs of contamination are removed.
b) Conduct a solvent evaporation test by applying several drops or a small splash of residue-free trichloromethane on the suspect area especially pitting, crevice corrosion areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination.
Continue degreasing and inspection till test is passed.

7.0 TSAC APPLICATOR QUALIFICATION

Following tests to be carried out as part of procedure qualification test for the applicator.

- Thickness measurement
- Coating bond strength
- Porosity test
- Bend strength

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TSAC applicator's surface finishing and application process and equipment set up, calibration and operation shall be qualified by application of TSA on a reference sample which shall be used as a comparator to evaluate the suitability of application process. Only that applicator will be permitted to carry out the work when test specimens coated by the applicator meets the desired requirements as cited below.

The sample shall be made of a steel plate measuring approx. 18"x 18" x ¼" thick. If the actual work is less than ¼" thick then the sample to be made from material of representative thickness.

The surface preparation, TSAC application shall be made with actual field equipment and process/spray parameters and procedures as per the specification. The depth profile of blasted surface, TSAC coating thickness for each cross pass and total thickness range shall be as per specification.

The surface preparation and thermal spraying shall be carried out in representative environmental conditions spraying with makeshift enclosure.

7.1 After application of coating, thickness and tensile bond measurements shall be made in following manner.

- Divide the sample piece into four quadrants.
- Measure thickness along the diagonal line of each quadrant.
- Four each quadrant five in-line thickness measurements at 1" interval shall be done using SSPC-PA 2 type 2 fixed probe gauge. Thus, a total of four "five in line" thickness measurements to be done for the whole sample.
- One tensile bond measurement using ASTM D 4541 type III or IV portable self-aligning test instrument to be done at center of each quadrant. Total of 4 measurements for the sample.
- One porosity evaluation test by Metallographic examination shall be conducted to demonstrate the achievement of porosity within the limits specified. Sample shall be prepared for Metallographic examination as per ASTM E-3.
- The procedure shall be considered qualified if thickness and tensile-bond strength and porosity values meet the specification requirement.

7.2 Bend test: Bend test shall be carried out as detailed at sec. 6.5 of this annexure.

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Applicators thermal spray equipment set-up, operation and procedure of application including in-process QC checkpoints adopted during procedure qualification as described above should be always subsequently followed during entire duration of work.

8.0 DOCUMENTATION

The following information shall be provided by TSAC applicator before award of work.

- TSAC application process consisting of equipment capabilities and their technical parameters, feed stock material and source of procurement.

- Detailed application procedure and in-process quality control check points for (a) surface preparation (b) thermal spraying (c) seal coats.

- Type and specification of instruments to be deployed for measurement of blast profile depth, TSAC thickness and tensile bond.

- Paint manufacturer data sheet for the selected sealing coat to be applied.

- Applicator shall submit repair procedure and all relevant documents for restoring the existing TSAC which will be removed for routine maintenance/NDT testing.

9.0 RECORDS

- The TSAC applicator shall maintain job record to record production and QC information. All the results of the tests and quality control checks shall be entered in the record for each component/part thermally sprayed. All the result of tests (thickness, tensile bond, bend tests) and other validation tests (e.g. procedure qualification test, test for surface cleanliness after abrasive blasting, test for cleanliness of abrasives and air) shall also be recorded and duly signed by owner.

- All the information mentioned in Sec 8.0 above should also form part of the Job record.

- Any modification affected after procedure qualification in the procedure, QC, spray parameter, equipment spec to the original information (submitted before award of the work) must also form part of Job record.

10.0 WARRANTY

The TSAC applicator shall warrant the quality of material used by providing the purchaser with a certificate of materials used to include

- Spray feed stock: Alloy type/designation, Lot Number, wire diameter, chemical analysis, name of supplier, manufacturer.

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- Sealant: Name of manufacturer, application data sheet.

11.0 SAFETY

The TSAC applicator shall follow all safety procedures required by the purchaser/owner. Owner shall also give compliance requirement to be followed by applicator. The applicator shall follow all appropriate regulatory requirements.

12.0 CODES AND STANDARDS

This specification shall apply in case of conflict between specification and following applicable standards:

AWS C. 2.17	Recommended Practice for Electric arc Spray.
ASTM C 633	Test Method for Adhesive/Cohesive Strength of Flame Sprayed Coatings.
ASTM D 4285	Method for indicating Oil or Water in Compressed Air.
ASTM D 4417	Test Method for Field Measurement of Surface Profile of Blasted Steel.
BS 2569	Specification for Sprayed Metal Coating.
NACE Standard RP 0287	Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using a Replica Tape.
ASTM D 4541	Test method for Pull-Off Strength of Coating Using Portable Adhesion Testers.
ANSI/AWS C2.18	Guide for the Protection of Steel with Thermal Spray Coatings of Aluminum, Zinc and Their Alloys and Composites.
NACE No. 12/AWS C2.23M/SSPC-CS 23.00	Specification for the application of thermal spray coatings (Metallizing) of aluminum, zinc, and their alloys and composites for the corrosion protection of steel.
SSPC Publication	The inspection of coatings and linings: A Handbook of Basic practice for Inspectors, Owners, and Specifiers.
SSPC-AB 1	Mineral and Slag Abrasives.
SSPC-AB 3	Ferrous Metallic Abrasives.
SSPC-PA 1	Shop, Field, and Maintenance Painting of Steel.
SSPC-PA 2	Measurement of Dry Coating Thickness with Magnetic Gages.
NACE No. 1/SSPC-SP 5	White Metal Blast Cleaning.
NACE No. 2/SSPC-SP 10	Near –White Metal Blast Cleaning.
SSPC-VIS 1	Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.

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Annexure-II

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25. CRUDE OIL TANKS PAINTINGS

25.1 Scope

This standard exclusively covers the painting of crude oil storage tanks in BORL Refinery including COT, Vadinar. This standard has been derived from existing SOP/09/11, Rev.-1 & AE-S-5430, Rev. 2 (BPCL, MR) and painting practices being followed at BPCL MR. Intent of this standard is to have better protection of Crude tanks against adverse environments.

25.2 Tank operating conditions

Operating temperature: Not above 65 degree Celsius.
Operating pressure: Ambient.

25.3 Surface preparation

The purpose of surface preparation is to create a continuous highly adherent, homogeneous and defect free paint film with an even thickness over the tank surfaces. For new painting, **all the internal & external surfaces shall be blasted to achieve the surface profile as given in Annexure – A.** Light shades and streaks are not allowed. When steel shot is used, it shall be used together with steel grit. The purpose of surface preparation is to create a continuous highly adherent, homogeneous and defect free paint film with an even thickness over the tank surface. Compressed air used shall be free of moisture and oil. Adequate separators and traps shall be provided, installed in the coolest part of the system. The presence of oil and water shall be determined at least two (2) times per eight hours and following every compressor start-up. The air discharge temperature shall not exceed 100 °C. The blasting nozzles should be venturi style with tungsten carbide or boron carbide as the materials for liners. Blasting nozzles shall be replaced when the specified minimum blast pressure, surface cleanliness and surface roughness can no longer be achieved. Blasting equipment and the equipment being blasted shall be properly earthed to prevent the occurrence of electrostatic discharges. If possible, vacuum collector shall be installed for collecting the abrasives for recycling. Recycled shot shall be used only after ensuring that it is clean enough to provide the minimum surface preparation mentioned above.

When working in confined spaces, adequate ventilation and intrinsically safe lighting shall be used. As a minimum, ventilation shall ensure sufficient air changes such that the threshold limit value (TLV) of the various coating materials in use shall not be exceeded. Access for coating work should be constructed so as to provide easy and sufficient access for surface preparation, painting and inspection of all surfaces

25.4 Recommended environment conditions for Paint Application

For all cases, paint manufacturer guidelines shall be followed. Following restrictions are given as

recommended practices:

25.4.1 Coating application shall not be permitted in the following conditions.

4.1.1 During fog, mist or rain.

4.1.2 When the relative humidity is 85 percent or above.

4.1.3 When the steel surface temperature and/or ambient temperature is below 10°C (50°F).

4.1.4 When the steel surface temperature and/or ambient temperature is above 50°C (120°F).

4.1.5 When the steel surface temperature is less than 3°C (5°F) above the dew point.

25.4.2 For all internal painting work, the dehumidification of the surrounding air dew point shall be maintained 5 degree Celsius below the prevailing surface temperature. The relative humidity shall be maintained not more than 45% from preparation to curing of coatings. It is strongly recommended to use Dehumidifiers to maintain the better conditions for painting and effective results.

25.4.3 The measurement of the following shall ensure prior to start of work and shall be done every three hours for the entire duration of the painting work and shall extend till the paint is dried and cured.

4.3.1 Relative Humidity (RH).

4.3.2 Ambient air temperature.

4.3.3 Surface temperature of the object being painted.

4.3.4 Air temperature at surrounding of the painting.

4.3.5 Air flow

25.4.4 There shall be no welding activity or radiography testing on the shell during and after installation of coating system.

25.4.5 Humidity and dew point readings shall be taken with a sling Psychometric meter and calculated using psychometric tables.

25.4.6 Coatings shall not be applied before the surface has been inspected and the preparatory work approved.

25.4.7 All edges shall be ground to a minimum radius of 3.2 mm. Flame cut areas and weld spatter shall have been ground flush. All rough welds shall be ground to remove sharp edges and other such irregularities. The amount of grinding performed shall be judicious and performed only to the extent necessary to prepare the weld surface and surrounding metal surfaces in accordance with the specification. Over grinding, which would result in

decreasing the wall thickness or the integrity of the weld beyond the limitations imposed by good welding practices, applicable welding codes, or tank or vessel ratings, shall be avoided. All weld spatter and arc strikes must be removed. (Refer NACE SP 0178).

25.4.8 Salt water spray areas shall require fresh water blasting or fresh water (Max. Chloride content 50 ppm) mopping to remove the salts deposited on metal surface before application of primer. Mopping can be repeated before application of other coats to remove salts deposited on previous coats, if such deposits are suspected.

25.4.9 Blast cleaned steel surfaces shall not be touched by bare hand.

25.4.10 If the surface being cleaned is adjacent to a coated surface, the blast cleaning shall cut in to the coated surface by at least 50 mm. The edges of the existing coating system shall be feathered. The remainder of the existing coated surface shall be properly protected with shields or screens to prevent any over blast damage.

25.4.11 To prevent dust and abrasive contamination, blast cleaning shall not be carried out adjacent to painting operations or wet (painted) surfaces.

25.5 Mixing and Painting

25.5.1 Mixing & Thinning

All paint spraying equipment, including mixers, shall be thoroughly cleaned before mixing of new materials. All coating materials shall be mixed and thoroughly stirred in accordance with the instructions of the paint Manufacturer. Sufficient agitation to maintain good mixing shall be applied until the product is used. If air is entrapped in the product during mixing/stirring, sufficient time should be allowed for the air bubbles to escape before application.

25.5.2 Application of paint/primer:

5.2.1 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs. the same day or as per the time frame stipulated in the technical data sheet of the paint, whichever is earlier.

5.2.2 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of porous. Any spots or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

5.2.3 No coat shall be applied until the preceding coat has dried and cured as

recommended by Paint Manufacturer. Next coat shall be applied within the time stipulated by the paint manufacturer. Before over coating, over-runs, drips and smears shall be removed and any coating damage or imperfection shall be repaired. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has possibly deteriorated or mixing is faulty.

5.2.4 No paint shall be force dried under conditions, which will cause cracking, wrinkling, blistering formation of pores, or detrimentally affect the conditions of the paint. No drier shall be added to paint on the job unless specifically called for in the manufacturer's specification for the paint. Paint shall be protected from rain, condensation and contamination until dry.

5.2.5 All paints and painting materials shall be stored only in rooms to be arranged by contractor and approved by Engineer-in-charge for the purpose. All necessary precautions shall be taken to prevent fire.

5.2.6 Surface preparation and paint application shall be done in presence of Manufacturer’s representative. Manufacturer’s representative shall have necessary certification from agency like NACE to supervise and ensure the quality of paint applied.

5.2.7 All personnel shall be provided with personnel protection, e.g. protective clothing, safety glasses, safety shoes, hard hats, goggles, respirators, earplugs, fresh air-fed hood and any other necessary safety equipment. All safety equipment shall be maintained in a good working condition. Warning signs shall be prominently displayed at all access points to areas where abrasive blasting and painting is in progress.

5.2.8 The Contractor shall protect all equipment, structures and any other areas from mechanical damage, environmental damage, blockage or obstruction and damage caused by over blasting, dripping paint, paint splashes and overspray.

5.2.9 To minimize the risk of damage, no lifting, transportation, erection or fabrication operations shall be done before the paint has been fully dried and/or cured.

5.2.10 Abrasive blast cleaning and coating operations should be carried out during daylight hours. However, grit blasting and coating may be carried out at night providing the lighting and environmental conditions are acceptable. Minimum lighting requirements for abrasive blasting, painting and inspection are 500 lux.

5.2.11 For internal tank coatings and the external coatings of buried or immersed equipment and structures, pinhole testing for electrically non-conductive coatings shall be carried out in accordance with NACE SP0188. The high voltage technique shall be used; nominally set at 5 V/µbased on DFT, or as agreed with the paint Manufacturer but not exceeding 25 kV in total. For coating thickness < 500 µ DFT, the low voltage wet sponge technique shall be used.

25.5.3 Spray application

Spraying is the required method of application. The painting Contractor shall supply the required range of spray tips, sizes and fan angles for the work being undertaken. The spray pressure shall be uniform and the spray pattern smooth.

25.5.4 Brush application

Brush application may be done for Maintenance operations, in those cases where spray application may affect other plant, equipment, property or personnel in or near the work site. Where the coating product is specified as only being suitable for brush application. Manufacturer shall confirm in writing that paint is suitable for brush application and will able to meet the guarantee period. Brush application shall be done only with concurrence of Engineer in charge. Coatings applied by brush shall be smooth and even

25.5.5 Roller application

Roller application shall only be allowed for steel floors and for panels and equipment inside climate-controlled areas. Rollers shall be of good quality to ensure uniformity of the applied coating.

25.5.6 Stripe coat

Before spray application of each coat, irregular surfaces such as sharp edges, welds, small brackets, interstices etc. shall be stripe-coated, usually by brush, to ensure the specified film thickness is provided. Stripe coat shall be applicable in all the painting systems.

25.5.7 Repair of coating defects

Damaged areas, defects in the coating system such as over-runs, drips and smears that have to be removed or areas with inadequate dry film coating thickness shall be re-cleaned. The re-cleaning shall carry over on to the sound coating for not less than 50 mm all round, the edges of which shall be feathered.

After the surface cleaning, the specified coating system shall be re-applied. Any additional coats shall blend in with the final coating at adjoining areas. Paint Manufacturers shall be consulted if the existing coating requires abrading before over-coating to obtain good bonding.

25.5.8 Only thinners specified by the paint Manufacturer shall be used

25.6 Paint Procurement

Painting Contractor shall procure paint material from BORL approved manufacturers only.

25.7 Inspection and testing

25.7.1 Refer **section 18** or point no. **25.12** for testing of paint material

25.7.2 Minimum suggested stages of inspection shall be:

a. Surface Preparation
b. Primer application
c. Each coat of paint

25.7.3 All defects noticed during stages of inspection, shall be rectified free of cost by the contractor. All records shall be kept by the contractor.

25.7.4 Wet film thickness measurements shall be made throughout the course of painting in order to ascertain the adequacy and uniformity of thickness. The readings shall be taken at least one every ten (10) square meters.

25.7.5 Dry film thickness shall be taken on each coat after drying and curing of the coat. Dry film thickness (DFT) readings shall be taken using a non-destructive dry film thickness instrument capable of storing the readings. Sufficient readings shall be taken covering each coat prior to application of the following coat to ensure the correct required DFT.

25.7.6 The DFT indicated against each system shall be obtained by applying one or more coat of the paint based on paint properties. The Contractor is responsible to obtain the indicated DFT as per painting system specification.

25.7.7 DFT meter used shall be calibrated before each inspection and shall be witnessed by the Inspector. It is the duty of the Inspector to satisfy him/herself with the performance of the DFT meter.

25.7.8 Criteria for acceptance of painting work shall be in accordance with table – 2.

TABLE - 2

Test	Standard	Frequency	Acceptance criteria
Surface cleanliness	ISO 8501-1	One per ten (10) square meters	Sa 2 ½
Surface Profile	ISO 8503-2	One per ten (10) square meters	As per coating procedure / data sheet
Total Soluble salt contamination [1]	ISO 8502-9	One per twenty (20) square meters or minimum 5 tests whichever is more.	<5 g/cm^2
Dust	ISO 8502-3	One per ten (10) square meters	Rating 2 or better
Adhesion	ISO 4624	One pretest panel, per shift	5 MPa
Holiday Detection	NACE SP0188	100% of surface	Zero defects
Dry Film Thickness [1]	SSPC PA-2	As per Annexure - F	Shall not be less than 80 % and more than 120 % of the Specified dry film thickness. (DFT).
Wet Film Thickness	ISO 2802	One per ten (10) square meters	Consistent with providing required DFT

25.8 Painting Contractor's Responsibility

25.8.1 Contractor shall mobilize the adequate capacity dehumidification unit at site for all internal painting work, if required. The surrounding air dew point shall be maintained 5 degree Celsius below the prevailing surface temperature. The relative humidity shall be maintained not more than 45% from preparation to curing of coatings.

25.8.2 The contractor shall ensure proper functioning of the dehumidification unit, measuring RH and temperature, measuring air flows and maintained 24 hours till coating work is completed in the tank.

25.8.3 All paints and consumables for a particular tank painting work shall be sourced from one manufacturer only to have desired paint performance, guarantee and single point responsibility.

25.8.4 Painting contractor shall deploy adequate number of NACE CIP Level 2 qualified

coating Inspectors to supervise, monitor, inspect & control entire painting process right from the surface preparation, storage, handling, mixing and application on substrate of the painting/coating and to ensure the compliance of this specification. These qualified painting inspectors will report to and shall get guided by BORL Inspection Dept.

25.8.5 Each contractor shall possess relevant standards and deploy all inspection tool/instrument to carry out the all above inspection and testing as per relevant standard.

25.8.6 Organizing of testing all the painting parameters, supply of all the testing instruments, consumables for testing each parameter as defined in clause 7.10 above, including getting accepted by BORL, shall be the responsibility of painting contractor.

25.8.7 The Inspection test plan which will be mandatory part of the contract shall be prepared by the above qualified coating inspector and get it approved by BORL inspection department. The Contractor's qualified coating inspector and BORL shall sign an inspection report as per approved inspection test plan.

25.8.8 The report shall consist, as a minimum, of the following in addition to the inspection parameters and acceptable criteria:

8.8.1 Names of the applicator and the responsible personnel.
8.8.2 Dates when work was carried out.
8.8.3 Paint testing parameters tested
8.8.4 Equipment and techniques used.
8.8.5 Type and calibration of instruments used.
8.8.6 Weather and ambient conditions.

25.9 Frequency and Guarantee of painting

25.9.1 Frequency of Crude oil tanks Painting system for both internal and external painting shall be once in 10 years.

25.9.2 Painting Contractor shall furnish Guarantee for minimum 10 years for both internal and external painting with shot blasting as per Annexure – B, C, D & E.

25.9.3 BORL reserves the right to invoke the guarantees in case contractor (paint applicator) or contractor fail to repair the paint failed area within reasonable time.

25.10 Painting system

25.10.1 The painting system shall be as mentioned in Annexure – A.

25.10.2 No painting is considered for roof legs for new tanks. Roof legs to be hot dip galvanized. Schedule 80 pipes to be used for both roof legs and sleeves. The sufficient clearance shall be ensured between sleeves and roof legs. However, painting shall be as per directions & recommendations of inspection in case of Old roof legs with CS pipes or as applicable.

25.11 SIGN WRITING

All painting work information shall be mentioned (sign writing) with date of completion on Tank shell as per Engineer-in-charge instructions.

25.12 INSPECTION AND TESTING OF PAINTING MATERIAL

25.12.1 All the procured paint material along with batch/test certificates shall be offered for BORL inspection for approval. Remaining Shelf life shall be at least 90% of the total duration at the inspection above.

25.12.2 All paint materials shall be accompanied by Manufacturer Test Certificate. Inspection Engineer at his discretion may test paint formulations, if required.

ANNEXURE – A

THIS PAINTING SYSTEM SHALL BE APPLICABLE FOR CRUDE TANKS AT COT VADINAR FOR ALL EXTERNAL PAINTINGS EXPOSED TO ENVIRONMENT AND FOR CRUDE TANKS AT BINA REFINERY FOR TOP SHELL COURSE PAINTING (FREE BOARD) & EXPOSED PORTION OF FLOATING ROOF
(APPLICATION - AIRLESS SPRAY)

SR. NO.	SURFACES	SURFACE PREPARATION	SURFACE PROFILE	PRIMER	FINISH COAT	TOTAL DFT, MICRONS
1	Bottom plate under side (soil side)	Blast cleaning with grit and shot to Sa 2.5	Profile of 40-70 microns	1 Coat of F-15@ 100 DFT/Coat	2 Coats of F-15@ 100 DFT/Coat 2x100 = 200	300
2	Top shell internal 100 mm above top of shunt of secondary seal marked at safe filling height during hydro test. (Free Board area)	Blast cleaning with grit and shot to Sa 2.5	40 microns	1 coat of F9 (VS 65%; 85% zinc on dry film minimum) – 1X 70 Microns DFT + 1 coat of P-6 @ 40µ DFT/ coat (Two component polyamide cured epoxy resin medium, pigmented with zinc phosphate)	1) Low VOC (Volatile Organic Compounds) two component internally flexibilised high build surface tolerant epoxy pigmented with Aluminum & Lamellar Micaceous Iron oxide coating – 2 X 125 µ - Note 1 2) F2- One (1) coats of aliphatic acrylic polyurethane with minimum 55% vol solids - 2 x 40 microns DFT.(in approved colour only)	400

SR. NO.	SURFACES	SURFACE PREPARATION	SURFACE PROFILE	PRIMER	FINISH COAT	TOTALDFT, MICRONS
3	a) Shell external surface. b) Vertical Gauging band.	Blast cleaning with grit and shot to Sa 2.5	40 microns	1 coat of F9 (VS 65%; 85% zinc on dry film minimum) – 1X 70 Microns DFT + 1 coat of P-6 @ 40µ DFT/ coat (Two component polyamide cured epoxy resin medium, pigmented with zinc phosphate)	1) Low VOC (Volatile Organic Compounds) two component internally flexibilised high build surface tolerant epoxy pigmented with Aluminum & Lamellar Micaceous Iron oxide coating – 2 X 125 µ- Note 1 2) F2- Two (2) coats of aliphatic acrylic polyurethane with minimum 55% vol solids - 2 x 40 microns DFT.(in approved colour only)	440

SR. NO.	SURFACES	SURFACE PREPARATION	SURFACE PROFILE	PRIMER	FINISH COAT	TOTALDFT, MICRONS
4	Roof deck plates top surface (Floating roof top surface)	Blast cleaning with grit and shot to Sa 2.5	40 microns		1) Two component Amine / Amine adduct cured high solid glass flake epoxy coating (in conformance to ISO 20340) – 2 X 300 micron DFT – Note- 1 2) F2- Aliphatic acrylic modified high solids weather resistant recoatable two pack polyurethane (finish coat) – 2 X 40 micron DFT	680
5	Pontoon inside surface	SSPC-SP10 / SA 2 ½ **OR** SSPC – SP2/ST2	Not applicable	1 coat of F9 (VS 65%; 85% zinc on dry film minimum) – 1X 70 Microns DFT **OR** 1 Coat of F-8 @ 100µ DFT/Coat	1) Low VOC (Volatile Organic Compounds) two component internally flexibilised high build surface tolerant epoxy pigmented with Aluminum & Lamellar Micaceous Iron oxide coating – 2 X 125 µ- Note -1	320 **OR** 350

SYSTEM FOR EXTERNAL PAINTING OF CRUDE TANKS AT BORL, BINA REFINERY (EXCEPT FREE BOARD INTERNAL AND FLOATING ROOF TOP SURFACE WHICH SHALL BE AS PER ABOVE TABLE)

SR. NO.	SURFACES	SURFACE PREPARATION	SURFACE PROFILE	PRIMER	FINISH COAT	TOTALDFT, MICRONS, MIN
1	External surfaces of bottom plate (soil side) for Crude tanks.	Blast cleaning with grit and shot to SA 2.5	Profile of 40-70 microns	1 Coat of F-15@ 100 DFT/Coat	2 Coats of F-15@ 100 DFT/Coat 2x100 = 200	300
2	External shell, wind girders, rolling and stationary ladders, spiral stairways, hand rails for all environments for crude oil	Blast cleaning with grit and shot to SA 2.5	Profile of 40 microns	1 coat of F-9 @ 65-75µ + 1coat of P6 @ 40 µ DFT / coat	2 coats of F-6A @ 100µ DFT /coat + 1 coat of F-2 @ 40µ DFT/ coat	345

SYSTEM FOR INTERNAL PAINTING OF CRUDE TANKS AT BPCL, BINA REFINERY (EXCEPT FREE BOARD) & AT COT, VADINAR (FOR INTERNAL FREE BOARD SECTION OF CRUDE TANK AT BORL, BINA, REFER ABOVE TABLES)

SR. NO.	SURFACES	SURFACE PREPARATION	SURFACE PROFILE	PRIMER	FINISH COAT	TOTALDFT, MICRONS, MIN
1	Underside of floating roof, oil side surface of pontoons, support structures and ladders and other CS internals etc, inside of bottom plate, internal surface of bare shell for 1.5 mtr from bottom , for storing **Crude Oil and Crude +**	Blast cleaning with grit and shot to SA 2.5	Profile of 40 microns	1 coat of Primer* @ 75 µ DFT/ coat (Primer shall be compatible with F-6C & F-6C should be suitable for immersion service of products given)	2 Coats of F-6C @ 300µ DFT/ Coat 2X300=600	675

	Water Tank (52-TT-CR-15).					

SR. NO.	SURFACES	SURFACE PREPARATION	SURFACE PROFILE	PRIMER	FINISH COAT	TOTALDFT, MICRONS, MIN
2	Internal surfaces of bare shell above 1.5 mtrs from bottom including underside of cone roof and supporting structures for Crude + Water Tank (52-TT-CR-15).	Blast cleaning with grit and shot to SA 2.5	Profile of 40 microns	1 Coat of F-15 @ 100 µ DFT/Coat	2 Coats of F-15 @ 100µ DFT/ Coat 2X100=200	300
3	Inside surface of pontoon of all floating roofs.	Blast cleaning with grit and shot to SA 2.5		1 Coat of F-8 @ 100µ DFT/Coat	1 Coat of F- 8 @ 100µ DFT/Coat	200

Notes

1) Contractor shall submit suitable product datasheet, PTR and test certificate, for EIL review and approval.
2) Stripe coat is must for weld area, edges and corners.
3) Over zinc silicate, intermediate coat to be applied in mist coat and full coat technique.
4) In PU paint of silver shade, total thickness to be built in two coats.
5) For PU paint QUVA 340 requirement of 80 % gloss retention after 3000 hrs.
6) All sharp edges to be grinded well before painting.
7) Pitted area having width greater than 2mm or depth greater than 5 mm to be filled with solvent less polyamine adduct cured epoxy.
8) Camouflaging not to be done

Annexure-III

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Paint Inspection
Daily Coating Inspection Report

Project/Client:	Date: / / Su M Tu W Th F Sa	Pg ____ of ____
Location:	Project #:	Copy to: ☐ QC Super ☐ Owner ☐ Contr ☐ ____
Description:	Inspector:	Attachments: ☐ DFT Sheet ☐ NCR/CAR ☐ ____
Requirements:		
Contractor:	Spec #:	Revision #:

Description of Areas and Work Performed

Hold Point Inspections Performed

- ☐ 1. Pre Surface Preparation/Condition and Cleanliness
- ☐ 2. Surface Preparation Monitoring
- ☐ 3. Post Surface Preparation/Cleanliness and Profile
- ☐ 4. Pre Application Prep/Surface Cleanliness
- ☐ 5. Application Monitoring/Wet Film Thickness (WFT)
- ☐ 6. Post Application/Application Defects
- ☐ 7. Post Cure/Dry Film Thickness (DFT)
- ☐ 8. Nonconformance/Corrective Actions Follow-Up
- ☐ 9. Final Inspection

Approved by:

Surface Conditions

☐ New ☐ Maint ☐ Primer/Paint ☐ Age/Dry/Cure ____
☐ Steel ☐ Galvanize ☐ Concrete ☐ Other ____
☐ Hazard ____ ☐ Sample Report # ____
☐ Degree of contamination: ____
Test: ☐ Cl ____ µg/cm² (µs/cm) ☐ Fe ____ ppm ☐ pH ____
☐ Degree of Corrosion: ____
☐ Scale ☐ Pitting/Holes ☐ Crevices ☐ Sharp Edges
☐ Weld ____ ☐ Moisture ☐ Oils ☐ Other ____
☐ Painted Surface Condition: ____
Dry to: ☐ Touch ☐ Handle ☐ Recoat
☐ Dry/Over Spray ☐ Runs/Sags ☐ Pinholes ☐ Holidays
☐ Abrasion ☐ Fall Out ☐ Other ____

Ambient Conditions

Time (Indiciate AM or PM)	:	:	:	:
Dry Bulb Temp° (C/F)	°	°	°	°
Wet Bulb Temp° (C/F)	°	°	°	°
% Relative Humidity	%	%	%	%
Surface Temp° (C/F) Min/Max	/ °	/ °	/ °	/ °
Dew Point Temp° (C/F)	°	°	°	°
Wind Direction/Speed				
Weather Conditions				

Surface Preparation

Start Time: Finish Time: Est Sq Ft:
☐ Solvent Clean ☐ Hand Tool ☐ Power Tool
☐ HP Wash PSI ____ ☐ Other ____
☐ Abrasive Blast ☐ Abrasive Type ____ ☐ Sample
☐ Blast Hose Size ____ ☐ Nozzle Size/PSI ____
☐ Air Supply CFM ____ ☐ Air Supply Cleanliness
☐ Water/Oil Trap Check ☐ Equipment Condition Check

Application

Start Time: Finish Time: Est Sq Ft:
☐ Primer ☐ Intermediate ☐ Topcoat ☐ Touch-Up

Generic Type:	Qty Mixed:
Mfr:	Mix Ratio:
Prod Name:	Mix Method:
Prod #:	Strain/Screen:
Color:	Material Temp: °F
Kit Sz/Cond:	Sweat-In Time: Min/Hrs
Shelf Life:	Pot Life: Min/Hrs
Batch #s	Reducer #:
(A)	Qty Added: Pt/Qt/Gal
(B)	% by Vol: %
(C)	Specified WFT Avg: Mils
Reducer:	Achieved WFT Avg: Mils

☐ Airless/Conv Spray ☐ Brush ☐ Roller ☐ Other ____

Pump Pot:	Hose Diameter:	Air Check:
Ratio/Size:	Hose Length:	SEP/Trap:
GPM/CFM:	Spray Gun:	Filter:
PSI:	Tip Size:	Agitator:

Inspector Signature: Date:

Surface Cleanliness and Profile Measurement

☐ Job Specification ☐ SSPC/NACE SP ____
☐ SSPC/NACE Spec/Visual Stds ☐ ____
☐ Profile Check ____ ☐ Disc ☐ Tape ☐ Gage
☐ Specified ____ mils avg/Achieved ____ mils
☐ Surface Effect on DFT Gage/BMR ____ mils

Dry Film Thickness (DFT) Gage Calibration Record

Gage Type/ Model	Gage Serial #	Plate/Shim Mils/µm	Gage Adj +/–	Spec Avg DFT	DFT Last Coat	DFT This Coat

JOB SPECIFICATION FOR PRETREATMENT CUM ON-STREAM CLEANING OF RECIRCULATING FRESH COOLING WATER SYSTEM (SMMS)

PROJECT : MPMC AND PMC/EPCM SERVICES FOR ETHYLENE CRACKER UNIT AND UTILITIES & OFFSITES RELATED TO BINA PETCHEM & REFINERY EXPANSION PROJECT (BPREP)

OWNER : M/s BHARAT PETROLEUM COOPERATION LIMITED

EPCM : ENGINEERS INDIA LIMITED

JOB NO : B957

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
B	18/12/2024	ISSUED FOR TENDER	JATIN	SAHIL	S. SRIDHAR
A	25/11/2024	ISSUED FOR FEED	JATIN	SAHIL	S. SRIDHAR

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CONTENT

1.0 GENERAL
2.0 PRE-TREATMENT INSPECTION
3.0 FLUSHING
4.0 CLEANING WITH LOW pH WATER
5.0 PHOSPHATE / PHOSPHONATE CLEANING CUM PASSIVATION
6.0 MONITORING
7.0 PRE-TREATMENT EVALUATION
8.0 SPECIFICATION OF CHEMICALS
9.0 SAFETY PRECAUTION
10.0 TECHNICAL SUPERVISION

ANNEXURE-I: TEST PROCEDURE FOR INHIBITOR EFFICIENCY

Abbreviations:

CS	:	Carbon Steel
CW	:	Cooling Water
CI	:	Corrosion Inhibitor
HEDP	:	Hydroxy Ethylidene Diphosphonic acid
SHMP	:	Sodium Hexa-Meta Phosphate
ATMP	:	Amino Tri-Methylene Phosphoric acid
TSS	:	Total suspended solids

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1.0 GENERAL

1.1 This recommended procedure provides the measures for on-stream cleaning and passivation of CS metal surfaces of CW system. The pretreatment involves two steps as follows:

i. Thorough cleaning of the metal surface.

ii. Development of a protective (passive) film on the metal surface.

Pre-treatment applies to all metals except SS (Stainless Steel) and SDSS but is directed primarily to CS surfaces. Pre-treatment applies to pipeline, piping, coolers and any equipment which will come in contact with the cooling water.

Exchangers whose cooling water side MOC is other than CS (like SS & SDSS) need not be included for cleaning cum passivation procedure as per this procedure.

1.2 This specification defines the procedure for the chemical cleaning and passivation. However, EPC/LSTK Contractor shall prepare the detailed chemical cleaning markup on the applicable P&IDs and submit for EIL review & approval.

1.3 Normally microbiological fouling, deposits of phosphates, iron oxides and calcium carbonate scales are expected on CW side. For effective film formation/maintenance by the CI, the metal surfaces shall be free from the foulants and deposits. Fouled surfaces can give rise to severe pitting and localized corrosion.

1.4 Pre-cleaning cum passivation shall be applied to the entire CW system.

1.5 After the pre-treatment is over, the system shall be rapidly switched over to the regular chemical treatment by a suitable specialized CW treatment chemical agency for continuous protection of passivated CW exchangers.

1.6 In case of pre-cleaning cum passivation of isolated units (like new units in an existing plant or non-availability of cooling tower sump/pumps), contractor shall arrange the following:

a) Temporary tanks of suitable volume.
b) Pumps (1 working + 1 standby) of suitable capacity and head to maintain min. flow velocity of 1.5 m/s and full bore flow.
c) Temporary piping from temporary tank to unit cooling water inlet and outlet headers.

1.7 Where lines are required to be chemically cleaned, the limit of cleaning in branch lines (which are not marked or not necessary) shall be to the first block valve or flange.

2.0 PRE-TREATMENT INSPECTION

Prior to pre-treatment, the equipment shall be inspected and if found to contain excessive corrosion products, deposits or foulant, the equipment shall be cleaned with an appropriate cleaning procedure. The CW treatment vendor shall ensure the completion of the cleaning and inspection.

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3.0 FLUSHING

3.1 Cooling tower basin and sump should be filled with fresh water, drained and cleaned. All sludge should be mechanically removed if required.

3.2 All coolers/exchangers shall be kept isolated during entire period of flushing. Prior to the flushing, jump-over shall be provided at the inlet & outlet of the exchangers in such a manner that exchangers can be taken into line at a later stage quickly.

3.3 Provision shall be made to flush out water at dead ends of all units. Permanent dummying /capping of farthest ends of CW circuits (both supply and return headers) shall be carried out only after flushing of the circuits. Necessary temporary piping to discharge chemical cleaning effluent away from process units shall be made by the contractor.

3.4 Start filling the system with fresh water for open flushing. Open flushing is to be carried out thoroughly to remove all extraneous matter, loose scales, corrosion products, microbiological debris, mud, lumber chips, paper etc from entire CW system. Once the system is filled, return water to the CW tower is to be drained from the blow down valves. Also, intermittent blowdown from lowest drain points in the unit shall be done during open flushing. Flushing is to be carried out till return water is visibly clear.

3.5 Fill the system with fresh water with the blow down valve closed and start circulating the water. All exchangers shall remain offline. Intermittent blow down are to be carried out from cell basin and from the unit lowest points.

3.6 Open the blow down valve and flush the system with fresh raw water make up for 24 hours. At the end of closed flushing, blow down water quality shall be equal to make-up fresh water.

4.0 CLEANING WITH LOW pH WATER

4.1 All the equipment, headers, piping and coolers shall be taken into circuit and the system shall be put into circulation. Blow down shall be stopped. However coolers/exchangers shall be kept isolated during the initial stage for the first 24 hrs of low pH cleaning.

4.2 The pH of circulating water shall be adjusted in the range of 4.5-5.0 by addition of sulphuric acid.

4.3 Before addition of acid for low pH cleaning, approx. 1% or manufacturers recommended dosage of Corrosion Inhibitor (Rodine-92 or equivalent) shall be added to sulphuric acid. Prior to the start of chemical cleaning, Contractor shall demonstrate the efficiency of CI by using CS coupons dipped in non inhibited and inhibited acid solutions as per the annexure-I.

4.4 The pH shall be held in this range for at least 24 hours. Intermittent blow down/draining is required from blinded or isolated lines, equipments, exchangers etc.

4.5 Thereafter blow down is to be carried out to reduce TSS & iron content. Those lines which are isolated or blinded shall be thoroughly open flushed. Subsequently, makeup water is added to raise the pH to 6.5. Blow down is to be carried out till TSS and iron content of make-up and effluent water are same.

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4.6 All jump-over provided at exchangers are to be removed and exchangers are to be taken into line.

4.7 The pH shall be adjusted to 5.0-5.5 by addition of inhibited acid and circulation shall be continued.

4.8 After 48 hours of circulation, blow down shall be started & continued till suspended solids/Turbidity are < 30 mg/l/30 NTU or close to the make-up water quality.

5.0 PHOSPHATE / PHOSPHONATE CLEANING CUM PASSIVATION

5.1 The pH of the circulating water shall be adjusted in the range of 7.5- 8.0 by reducing the acid dose and shall be held in this range throughout the phosphate / phosphonate cleaning operation. All blow down from the system shall be closed.

5.2 Organo Phosphonate HEDP shall be added by gravity to build up a level of 80-100 mg/l as PO_4. HEDP shall be dosed very slowly as this will depress the pH of the CW. If necessary, caustic soda may be added in CW system to maintain pH in the range of 7.5-8.0.

5.3 SHMP solution shall be added to build up a level of 40-50 mg/l as PO_4 .SHMP shall be dosed after HEDP addition is complete and pH is stabilized.

5.4 When phosphate / phosphonate levels and pH are stabilized, preferably ethylene oxide based non-ionic surfactant or alkyl aryl sulphonate based anionic surface active agents @ 30 mg/l (based on total hold up) shall be dosed slowly. This shall also be dosed at the same rate again after 24 hours. This will produce foam in the system. Hence precautions shall be taken for operation of CW pumps.

5.5 Circulation shall be continued under this condition for a period of 7 days and following levels of chemicals shall be maintained in the CW system for this period:

SHMP as PO_4	40-50 mg/l
Organo phosphonate as PO_4 (HEDP,50-60% active acid content)	80-100 mg/l
pH	7.5 –8.0
Non ionic/anionic surfactant (the calculated quantity shall be based on 30 mg/l and added twice only as given in sub clause 5.4)	30 mg/l

5.6 After circulating for 7 days, the system shall be given a heavy blow down without pH adjustment. Regular treatment shall be started when TSS is less than 30 mg/l or close to make up water quality and HEDP is less than 10mg/l as PO_4.

6.0 MONITORING

The pH, phosphate and phosphonate levels shall be monitored regularly throughout the entire operation and recommended levels shall be maintained.

Frequency of analysis is as follows:

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During cleaning with low pH water (clause 4.0) *

pH	:	Once in two hours
TSS/Turbidity	:	Once in four hours
Iron content (Fe)	:	Once in four hours

During phosphate cleaning (clause 5.0) *

pH	:	Once in two hours
Inorganic phosphate	:	Once in two hours
Organic phosphate (Phosphonate)	:	Once in four hours
Iron content (Fe)	:	Once in four hours

*One sample from each unit shall also be collected for analysis.

Before starting the pre-cleaning, contractor shall submit all necessary laboratory analysis procedures for review. Contractor shall make arrangements to set-up a fully equipped laboratory with all the necessary chemicals and instruments along with a qualified chemist prior to the start-up for pre-cleaning. Supply of all the reagents and chemicals are in contractors' scope.

7.0 PRE-TREATMENT EVALUATION

To assure that cleaning and passivation have been effective, a slightly rusted CS corrosion specimen shall be inserted into standard coupon testing assembly fitted to the CW return line or the specimen may be immersed in the cold water channel of the cooling tower and shall be inspected visually from time to time. A standard corrosion coupon may be inserted in the corrosion rack at the cooling tower. This may be used to evaluate the efficiency of the passivation along with the rusted coupon observation. Standard coupon shall show a thin uniform passivation layer. Cleaned and passivated surfaces of any piping or exchangers shall contain no loose rust.

8.0 SPECIFICATION OF CHEMICALS

The chemicals shall conform to the following specifications:

Organo phosphonate (HEDP, active acid content 50-60%)	Testing as per ASTM D515-72 and To be obtained from reputed manufacturer.
SHMP	IS : 574 (latest)
H_2SO_4 (98%)	IS : 266 (latest)
Caustic Soda	Technical grade as per IS:252 (latest)

Contractor shall submit relevant test certificates of his chemicals as a proof of presence of minimum active ingredients in the respective chemical products.

9.0 SAFETY PRECAUTIONS

Normal safety precautions shall be taken for handling of chemicals. Protective clothing and safety items shall be used to prevent any injury during the pre-treatment

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operation. Temporary barricades shall be provided around the area where acid and alkali is being handled and entry in to the barricaded area shall be strict with proper safety gears. Contractor shall bring only flame proof pumps and equipment.

NOTES:

1. CW System shall be started with the above pre-treatment program prior to normal treatment.
2. HEDP shall only be used. ATMP shall not be used.
3. During on-stream cleaning, if CW temperature exceeds 40^0C, SHMP level as specified in sub clause nos. 5.3 and 5.5 shall be reduced to 20-25mg/l as PO_4.
4. Approximate chemicals requirement for 1000 m^3 hold up of CW system:

Organo phosphonate (HEDP, active acid content 50-60%)	140-180 Kg to maintain level of 80-100 mg/l as PO_4
SHMP	50-60 Kg to maintain a level of 40-50 mg/l as PO_4
Surfactant	30 Kg To maintain a level of 30 mg/l

Actual requirement of chemicals shall be calculated based on actual hold-up of the system and dosage to maintain specified levels. Further additions of chemicals will depend on laboratory results and to be dosed to maintain specified levels for entire operation.

10.0 TECHNICAL SUPERVISION

The chemical cleaning operation shall be conducted under close chemical controls by the contractor and EIL site. The EIL site may have technical guidance from SMMS.

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ANNEXURE-I

TEST PROCEDURE FOR INHIBITOR EFFICIENCY

1.0 PREPARATION OF TEST COUPONS

CS coupons of size 7.5cm x 5cm shall be cut from hot rolled (AISI 1020 or equivalent grade) steel strip or plate. The edges and sharp corners shall be ground smooth. A 5mm diameter hole shall be provided for suspension. The coupons thus prepared shall be used in the tests.

2.0 IDENTIFICATION

The coupons shall be provided with letters and/ or number at one corner using punch.

3.0 SURFACE PREPARATION

For conducting the test to determine inhibitor efficiency, the coupons shall be free from mill-scale by grinding followed by polishing using emery paper. The final surface shall be made bright using emery paper. Coupons for conducting the test of action of cleaning solution in removing mill-scale shall be with the mill scale on. All the coupons shall be weighed separately correct to 1mg using a balance.

4.0 CLEANING SOLUTION

The cleaning solution is the inhibited sulphuric acid. Before addition of acid for low pH cleaning, approx. 1% (or in recommend dosage) CI shall be added to sulphuric acid. The pH of sulphuric acid solution shall be in the range of 4.5-5.0.The solution thus prepared, shall be used for conducting the tests.

5.0 TESTS FOR INHIBITOR EFFICIENCY

Test shall be carried out in duplicates in glass containers preferably in one litre capacity beakers. One litre of cleaning solution each shall be transferred to beakers and the solution shall be heated to the maximum temperature in the specified range for the process. The coupons shall be completely exposed to the action of the acid by suspension from the hole so that the upper edge shall be at least 1cm below the liquid surface. The temperature shall be held as above through-out the duration of the test.

5.1 Identical test shall be carried out using un-inhibited acid of the strength equivalent to that of the cleaning solution.

5.2 After the exposure of the coupons to the cleaning solution for the duration of actual cleaning, all the coupons shall be removed from the acid solution and cleaned in running tap water to remove acid and finally in distilled water. The coupons shall be dried and transferred to desiccator before weighing.

5.3 The weight loss of the coupons shall be determined and the corrosion rates shall be calculated. The average corrosion rate of the coupons exposed to the cleaning solution shall be less than 3% of the average rate thus obtained for the coupons exposed to un-inhibited acid. (I.e. percent corrosion inhibition shall be 97% (min.). Approval of the Engineer-in-Charge shall be obtained for the inhibitor efficiency obtained in the test.

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JOB SPECIFICATION FOR DEGREASING OF CARBON STEEL PIPING VESSELS & EQUIPMENT IN AMINE SERVICE (SMMS)

PROJECT : MPMC AND PMC/EPCM SERVICES FOR ETHYLENE CRACKER UNIT AND UTILITIES & OFFSITES RELATED TO BINA PETCHEM & REFINERY EXPANSION PROJECT (BPREP)

OWNER : M/s BHARAT PETROLEUM COOPERATION LIMITED

EPCM : ENGINEERS INDIA LIMITED

JOB NO : B957

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
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1.0 INTENT

This specification governs the requirements of degreasing for Carbon Steel piping, vessels & equipment in amine service. The degreasing of carbon steel piping shall be done by circulation method with 1-2% Sodium Carbonate (Soda Ash) solution and 200 ppm of non-foaming type non-ionic surfactant at 60-80°C temperature till oil and grease level in circulating degreasing liquid become constant.

2.0 SCOPE OF WORK

Scope of work by Contractor shall consist of carrying out degreasing of piping and vessels as indicated in the applicable P & IDs. Work shall include supply of all chemicals, temporary facilities, auxiliaries, boilers & heating coils for heating, laboratory chemicals and equipments, thermometers, valves, pressure gauges, safety gears etc required for satisfactory completion of work. The contractor should make a preliminary assessment of the site conditions and its existing facilities especially availability of HP/MP steam, circulating pumps. Amine tanks etc to make a final assessment of the temporary facilities, auxiliaries and spares that has to be arranged by him for deployment at site. Required numbers of skilled operating and supervisory staff for the degreasing operation need to be deployed by the contractor so as to ensure continuous availability of manpower during the entire operation.

2.1 This specification defines the procedure for the degreasing. However, EPC/LSTK Contractor shall prepare the detailed degreasing markup on the applicable P&IDs and submit for EIL review & approval.

3.0 OPERATING CONDITIONS

3.1 Degreasing Chemical: 1-2% Sodium Carbonate Solution (Soda Ash) + 200 ppm of non-foaming type non-ionic surfactant (Periminol OTS of M/s. ICI Chemicals, Thane / Surfa Additive X 100 from Kun Chem. Mumbai / M/s. Navdeep Chemicals, Baroda or equivalent).

3.2 Degreasing Temperature: 60-80°C.

3.3 Potable water can be used for making solution of the degreasing chemical. Heating of the chemical solution can be carried out by steam injection in the solution hold-up tank. In the case of plant steam is not available, then contractor has to arrange his own heating facility by auxiliary boiler or heating coils. If the circuit contain SS piping, vessels & equipment then entire degreasing including flushing shall be done with DM water.

3.4 Degreasing period: Degreasing process shall be considered complete when oil and grease level in circulating degreasing liquid becomes constant.

3.5 Existing Amine Tank/Pump shall be used as hold-up tank for preparation of degreasing chemical solution. Existing amine pump can be used for transferring chemical solution to the piping/ vessel and circulation.

One additional pump of adequate capacity needs to be kept as *standby* by Contractor which will be taken back by him after completion of work.

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4.0 DEGREASING PROCEDURE

4.1 Preparation of Temporary Circuit:

The cleaning shall be carried out by filling and circulating the specified solution in the specified sequence and conditions. Temporary piping and pump of appropriate capacity minimum 100 HP suitable for chemical cleaning to be used for the purpose. All necessary temporary piping, fittings, flanges, pumps, heater coils(if plant steam in not available for heating), boilers, thermometers, flow meter, pressure gauges and temperature gauges, valves, spares, temporary chemical analysis facility with all accessories required for conducting test during cleaning operation, chemicals and safety accessories shall be made available at site prior to chemical cleaning.

4.2 Fill the entire circuit with water. Circulate the water with amine pump. Increase the temperature to 60-80°C by MP/HP steam heating in amine tank / sump. Start adding required quantity of soda ash gradually in the amine tank/sump to attain a concentration of 1-2% in the circulating solution followed by 200 ppm non-foaming non-ionic surfactant. Continue circulation of the soda-ash to solution containing surfactant while maintaining the temperature at 60-80°C and monitoring concentration of soda-ash in the circulating solution at 1 hour interval. Follow all permissible operational procedures, including for draining of circulation chemical, as required for safe operation.

Monitor oil / grease every 4 hours in circulating degreasing solution. Continue circulation until oil / grease becomes constant. Drain under permissible conditions. Rinse by several filling and draining operation with DM water. Water used for rinsing shall be DM water only. If amine sump is used for receiving de-aerated water, additional pump will be required to transfer the solution to the circuit.

5.0 NEUTRALIZATION AND DISPOSAL

Contractor shall finalize the disposal scheme in consultation with OWNER/PMC before start of the chemical cleaning activity and shall comply to all the necessary OWNER's requirements. The contractor shall make necessary arrangement for complete neutralization of all effluents like acids & alkalis. The effluents shall be analyzed before discharging and if necessary, additional chemicals shall be added for neutralization so that discharged mixtures shall have pH ~7.0.

6.0 PRECAUTIONS

6.1 All piping and vessels shall be taken into circuit for degreasing. Strainers, demisters, activated carbon media, storage tanks and drainage system shall, however, be isolated.

6.2 All insulation jobs shall be completed before starting degreasing operations.

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JOB SPECIFICATION FOR CHEMICAL CLEANING OF VHP / HP STEAM PIPING (SMMS)

PROJECT : MPMC AND PMC/EPCM SERVICES FOR ETHYLENE CRACKER UNIT AND UTILITIES & OFFSITES RELATED TO BINA PETCHEM & REFINERY EXPANSION PROJECT (BPREP)

OWNER : M/s BHARAT PETROLEUM COOPERATION LIMITED

EPCM : ENGINEERS INDIA LIMITED

JOB NO : B957

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
B	18-12-2024	ISSUED FOR TENDER	JATIN	SAHIL	S.SRIDHAR
A	25-11-2024	ISSUED FOR FEED	JATIN	SAHIL	S.SRIDHAR

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1.0 SCOPE

This technical specification covers the minimum requirement for chemical cleaning and passivation of the fabricated and erected carbon steel VHP/HP Steam piping at site prior to commissioning by chemical circulation method.

This specification defines the procedure for the chemical cleaning. However, EPC/LSTK Contractor shall prepare the detailed chemical cleaning markup on the applicable P&IDs and submit for EIL review & approval.

2.0 OBJECTIVE

The objective of chemical cleaning of carbon steel VHP/HP Steam piping is to remove the loose rust, dislodging the burs, welding slag and mill scales adhering to the internal surfaces of piping. This procedure specifies the method of cleaning and passivation of internal surface of piping based on the use of inhibited ammoniated citric acid followed by passivation with Tri sodium phosphate (Na_3PO_4) + Sodium nitrate ($NaNO_2$) circulation. Any deviation to this specification should be recorded and discussed with OWNER/EIL prior to application.

3.0 SEQUENCE OF OPERATION

The cleaning of piping shall be carried out in the following sequence:-

(a) Flushing with potable water to remove dirt, dust, loose rust and foreign matter followed by DM / BFW water flushing.
(b) Degreasing with Sodium Hydroxide (caustic Soda).
(c) Flushing with DM/ BFW till inlet and outlet water pH is same.
(d) Circulating with ammoniated inhibited citric acid
(e) Flushing with DM/ BFW
(f) Circulating with Tri sodium phosphate (Na_3PO_4) + Sodium Nitrite ($NaNO_2$)
(g) Drain, dry and take the system into service
(h) If the pipe is not taken into service immediately after drying the pipe should be filled with N2 and capped at both ends.

4.0 PREPARATION OF TEMPORARY CIRCUITS:

Temporary piping, pumps of suitable capacity, fittings, flanges, tanks, gaskets, heating arrangement, hydrometers, valves, test coupons, spares, laboratory facilities with all accessories required for conducting tests during cleaning operation, chemicals and safety accessories for operation, qualified personnel etc. shall be arranged by contractor at site prior to cleaning operation. The contractor of chemical cleaning shall prepare all the necessary temporary chemical cleaning circuits at site and submit for approval by owner before execution. Quantity of chemicals required should be calculated based on the total hold-up volume. Pumps of suitable capacity shall be arrange at site by the contractor.

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5.0 PROCEDURE

5.1 The circuit (Loop) shall be checked with circulation of potable water to check tightness. Any leakage if observed to be attended and tightened.

5.2 The circuit shall be flushed initially with potable water to remove all extraneous matter, dirt and dust etc. followed by DM water flushing.

5.3 Filling and circulation of sodium Hydroxide (caustic soda) solution of 1% wt in DM/BFW (concentration on 100% purity basis) at 65-75^{0}C temperature for 2 hrs.

5.4 Drain the sodium Hydroxide solution. Fill with DM/BFW and drain. The operation of rinsing with DM water should be continued till pH of water at inlet and outlet ends are same.

5.5 Filling and circulation of ammoniated citric acid of 3% concentration (on 100% purity basis) by weight in DM/BFW with pH being adjusted to 3.5 - 4.0 with ammonia and 0.1% corrosion inhibitor Rodine- 92 or equivalent by weight. The temperature of circulating citric acid solution should be 80^{0}C. The circulation should be continued for 6 hrs. or till iron and acid concentration are stabilized.

5.6 During circulation of ammoniated citric acid, the total iron content of the circulating solution should not exceed 5000 mg/litre (with 3% w/w citric acid solution) and pH should be maintained at 3.5-4.0. If at any stage total iron content exceeds 5000 mg/liter, the acid should be drained in part and replaced with fresh acid.

5.7 Drain the citric acid and rinse with DM/BFW. Fill with DM/BFW and the operation of rinsing should be continued till pH at inlet and outlet ends of water are same.

5.8 Fill with Tri Sodium phosphate (1%) + Sodium Nitrite(0.5%) by weight (on 100% purity basis) and circulate for 2 hrs. drain, allow to self dry and finally dry with compressed instrument air.

5.9 If the pipe is not taken into service immediately after drying, the pipe should be filled with N2 and capped at both ends.

5.10 Suitable highpressure pumps with necessary flow rate should be provided by the contractor to maintain good velocity (preferably 0.5-1.0 M/Sec.) throughout operations of chemical cleaning and there should be effective return of flow from the outlet and the vent.

6.0 CHEMICALS & UTILITIES

Chemicals used for chemical cleaning should conform to the following specifications.

6.1 Citric acid monohydrate conforming to IS : 5464-1970-Gr.2 (latest edition)

6.2 Rodine 92 or equivalent

6.3 Ammonia (Technical grade.)

6.4 Sodium Hydroxide (NaOH) Technical grade conforming to IS:252 latest edition

6.5 Tri sodium phosphate (Na_3PO_4) technical grade as per IS :573

6.6 $NaNO_2$ IS-879-1981 (latest edition)

6.7 Potable water (chlorides 50ppm maximum)

6.8 DM water

7.0 NEUTRALIZATION AND DISPOSAL OF CHEMICALS

The necessary arrangement for neutralization like HDPE tank/temporary neutralization pit shall be made available for complete neutralization of pickling acids and alkalis. Prior to discharging of effluent in the sewer system, it shall be analyzed and if necessary, additional chemicals shall be added for complete neutralization so that discharged mixtures shall have pH 7.0 in order to prevent any damage to

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paving, manholes and sewers etc. Permission shall be taken from engineer-in-charge/OWNER for disposal of neutralized effluent into storm water drain / nearest Effluent pit etc.

8.0 SAFETY PRECAUTIONS

The alkali and acid solutions involved for chemical cleaning are corrosive for the skin and proper care shall be taken in the handling of the chemicals.

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JOB SPECIFICATION FOR CHEMICAL CLEANING & PASSIVATION OF COMPRESSOR CIRCUITS (SMMS)

PROJECT : MPMC AND PMC/EPCM SERVICES FOR ETHYLENE CRACKER UNIT AND UTILITIES & OFFSITES RELATED TO BINA PETCHEM & REFINERY EXPANSION PROJECT (BPREP)

OWNER : M/s BHARAT PETROLEUM COOPERATION LIMITED

EPCM : ENGINEERS INDIA LIMITED

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ANNEXURE-I: INHIBITOR EFFICIENCY TEST PROCEDURE

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1.0 SCOPE

1.1 This specification covers the requirement of pre-commissioning chemical cleaning and post-cleaning passivation treatment of fabricated and erected carbon steel compressor suction lines, inter stage suction lines, knock out drums and spillback lines of compressors at plant site prior to commissioning by chemicals circulation method. This technical procedure is applicable and suitable only for carbon steel surfaces. Materials other than carbon steel should not come in contact with pickling solutions. Refer clause 1.4 of this specification for exceptions.

1.2 This specification defines the procedure for the chemical cleaning and passivation. However, EPC/LSTK Contractor shall prepare the detailed chemical cleaning markup on the applicable P&IDs and submit for EIL review & approval

1.3 All valves, gaskets, control valves including butterfly valves, filters, venturies, instruments etc. that may be damaged during chemical cleaning should be dropped before chemical cleaning.

1.4 All accessories dropped from the loop prior to cleaning/pickling are to be boxed up as per the procedures after successful completion of cleaning/pickling process and inspection of the loop. After boxing up the loop, the same shall be inspected for completeness by contractor / EIL.

1.5 In case the valves, a portion of piping and equipment made of material other than carbon steel can't be isolated from the loop, then the procedure given in clause 15.0 shall be followed.

1.6 In case of contractor wish to use HCL method then it is mandatory to ensure that, HCL method will not impart any adverse effect to the service or catalysts.

1.7 Where lines are required to be chemically cleaned, the limit of cleaning in branch lines (which are not marked or not necessary) shall be to the first block valve or flange.

2.0 OBJECTIVE

The object of chemical cleaning of carbon steel items is to remove the loose rust, dislodging the burs, welding slag and mill scales adhering to the internal surface so that maintenance of compressors is reduced due to frequent choking of strainers. This procedure specifies the method of cleaning and passivation of internal surface of carbon steel items, based on use of inhibited hydrochloric acid followed by passivation with SHMP (Sodium Hexa-Meta Phosphate), prior to taking in service for the first time after installation/ fabrication.

This cleaning will enable the removal of:

a) Paint or varnish, if used for protective purposes.
b) Grease or oil
c) Mill scales
d) Loose rust
e) Welding slag

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Any deviation from this specification should be recorded and shall have approval from owner/ owner's representative prior to application. The final result of this cleaning is that the metal surfaces are completely clean, dry and passivated without signs of corrosion.

3.0 PREPARATION OF TEMPORARY CIRCUITS AND SPECIFIC REQUIREMENT OF EQUIPMENT AND FACILITIES FOR CARRYING OUT CHEMICAL CLEANING

3.1 The cleaning may be carried out by circulating the specified solutions in the specified sequence and conditions.

3.2 Temporary piping and a pump of appropriate capacity suitable for chemical cleaning may be used for this purpose as part of the circuit.

3.3 The pump capacity shall be adequate to the required head of the highest point of the chemical cleaning circuit and to obtain a flow velocity of approximately 0.5 m/s in the maximum diameter piping of the circuit with full bore liquid flow.

3.4 Flow meter, pressure gauges and temperature gauges at discharge of the pump and highest point of the circuit both shall be installed in the chemical cleaning circuit. The flow, temperature and pressure gauges must have been prior tested, calibrated by the contractor / agency and the calibration certificates shall be submitted to EIL for review prior to the installation in the cleaning /pickling loop.

3.5 All necessary temporary piping, fittings, flanges, pumps, tanks, heater coils, gaskets, thermometers, hydrometers, valves, test coupons, spares, field laboratory facilities with all accessories required for conducting testing during cleaning operation, chemicals and safety accessories for operation personnel etc. shall be arranged by the contractor at site prior to chemical cleaning.

3.6 Approximately one meter length of a rusted spool piece of CS with flange at both the ends and having minimum diameter of 4" or above shall be kept in chemical cleaning circuit so as to visually inspect the same after chemical cleaning and passivation is done.

3.7 The temporary piping should be of carbon steel with minimum 3" dia size including drain line. The chemical solution tank capacity shall be 40% of the hold up volume of the cleaning circuit.

3.8 The contractor should arrange for at least 3 nos. HDPE / MSRL tanks of 10 cubic meter capacity for acid solution, alkali solution and water.

3.9 Heating shall be done by purging of medium Pressure (MP) / Low Pressure (LP) steam or by using boiler / electrical heater etc. In case of heating by media other than steam, the contractor shall arrange the equipment for the same.

3.10 The required number of operating and supervisory manpower to be involved and deployed in the cleaning /pickling operations shall be submitted by the contractor to EIL so as to ensure continuous availability of manpower for supervision, monitoring and making reports during the operation.

4.0 SEQUENCE OF OPERATION

The sequence of operations shall be as follows:

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a) Flushing with water to remove dirt, dust, loose rust and any foreign matter.
b) Degreasing by alkali circulation.
c) Inhibited acid circulation.
d) Neutralization with soda ash / caustic soda.
e) Rinsing.
f) Passivation by SHMP solution circulation.
g) Drying and preservation.

5.0 CHEMICALS

The following chemicals are recommended for use in chemical cleaning operation:

5.1 Caustic Soda- technical grade conforming to IS: 252 (latest edition).

5.2 Hydrochloric acid-commercial / technical grade conforming to IS: 265 (latest edition).

5.3 Corrosion inhibitor- Rodine-213 special or equivalent.

5.4 Glassy SHMP conforming to IS: 574 (latest edition).

5.5 Soda ash, technical grade, conforming to IS: 251 (latest edition).

5.6 Potable water should be used for preparation of chemicals solution and flushing / rinsing operation etc.

5.7 All chemicals used for chemical cleaning should be as per specifications and shall be with test certificates from manufacturers. The same shall be reviewed by EIL. All chemicals used for chemical cleaning shall be tested in owners' laboratory for purity, specific gravity, chlorides, iron (Fe), and other impurities, if any. The same shall be submitted to EIL for review.

6.0 INSPECTION OF CORROSION INHIBITOR EFFICIENCY

A solution of inhibitor shall be prepared in hydrochloric acid as specified by the manufacturer and shall be tested for (a) the inhibitor efficiency and (b) the effectiveness of the solution in removing mill scale as per Annexure-I. The same shall be witnessed by EIL.

7.0 CLEANING PROCEDURE

The chemical cleaning shall be carried out as follows:

7.1 The circuit (loop) shall be checked with circulation of water to test its tightness. Any leakage, if observed, shall be attended and tightened.

7.2 The circuit (loop) shall be flushed with water to remove all extraneous matter, dirt and dust etc.

7.3 Filling and circulation of sodium hydroxide solution for 2 hours (min.)

7.3.1 Temperature of sodium hydroxide solution during circulation should be 55-65^{0}C.

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7.3.2 Concentration of sodium hydroxide should be 20 g/ l (on 100% purity basis).

7.4 Drain the sodium hydroxide solution. Fill with water and drain. This operation of rinsing with water should be continued till the pH of water at inlet and outlet ends are same.

7.5 Filling and circulation of inhibited hydrochloric acid solution for 6 hrs. (min)

7.5.1 Temperature of inhibited hydrochloric acid solution during circulation should be 50-60 ^{0}C.

7.5.2 Concentration of hydrochloric acid solution should be 5-10% (typically 8%) by wt. HCl (on 100% purity basis) and Rodine-213 special or equivalent should be added in the acid solution in proportion of 1 litre of Rodine-213 special or its equivalent to 100 liters of 30-33% HCl. However, exact concentration and duration of acid solution used shall be decided based on visual inspection of carbon steel piping for presence of rust and mil scale.

7.6 Drain the inhibited HCl solution. Fill the system with 1-2 % solution of soda ash or caustic soda and circulate for 1 hour at 40-45 ^{0}C.

7.7 Drain the neutralizing solution. Fill with water and drain. This operation of rinsing with water should be continued till the pH of water at the inlet and outlet ends is same.

7.8 Filling and circulation of SHMP solution for 2 hrs. Then hold for 10-12 hrs.

7.8.1 Concentration of SHMP solution should be 2-3% by wt. (on 67% P2O5 basis).

7.8.2 Temperature of SHMP solution during circulation should be 70-75 deg C.

Note: To prevent re-oxidation, the passivation solution must be introduced immediately after the flushing operation as per clause 7.7.

7.8.3 Drain the passivated solution without flushing with water. Then allow self-drying.

7.9 Finally dry the circuit with clean dry instrument air circulation.

7.10 The operations (7.1 to 7.9) in any one loop, when commenced, must be completed without interruptions.

8.0 OPERATION AND MONITORING:

Satisfactory performance of the chemical cleaning depends upon proper operation. Following steps should be considered during preparation of loops and operation:

8.1 Full bore flow should be ensured while circulating various chemicals. Pressure and temperature gauges shall be provided in the circuit for monitoring of pressure and temperature during the chemical cleaning job.

8.2 Vents should be provided in all high points including large diameter horizontal pipes for effective removal of air and acid fumes during cleaning operation. All vents should be operated intermittently to ensure full bore flow throughout the operation and no air pockets should be left in the system during pickling operation.

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8.3 Drain valves should be provided at all low points for effective circulation of pickling solution and removal of sludge, if any, and no trapping of chemicals at time of changing of chemicals.

8.4 Suitable high-pressure pumps of at least 100 HP capacity with 50 m head and with necessary flow rate of 50-100 m^3/hr should be provided to maintain good velocity (approximately 0.5 m/s) throughout operation and there should be effective return of flow from all outlets and vent lines. Minimum two pumps should be provided (one under operation and another standby). The pumps should be of adequate head to maintain the required velocity in the circuit. The efficiency of pump should be checked periodically.

8.5 While preparation of loop, equipment like coolers and suction drums should not be taken into circuit. Pickling of equipment or suction drums should be done separately.

8.6 Flushing should be done with high velocity water in reverse direction for effective removal of dirt, dust, loose rust and any foreign matter etc.

8.7 The corrosion inhibitor efficiency should be determined in the laboratory before pickling is started and witnessed by EIL.

8.8 All chemicals should be tested as per specifications before use. The contractor should also furnish the test certificates for all chemicals used for pickling operation for review by EIL.

8.9 Whenever acid is added, the corrosion inhibitor should be added first.

8.10 Standard solution for determination of iron in acid solution is required prior to pickling operation.

8.11 During pickling operation, 2 weighted carbon steel test coupons should be exposed, one inside the inhibited acid solution in the tank and another at the return line. The mill scale free coupons should be removed after acid circulation is over for determination of loss of weight. The coupons with mill scale are intended for indicating removal of mill scale after acid circulation and can be removed after completion of operation for final inspection.

8.12 Acid strength, total iron and ferric iron should be determined every hour during operation. Periodically acid strength should also be checked from all outlets, vents and drain lines.

8.13 After acid pickling and neutralization, water flushing will be carried out and continued till a pH ~ 7.0 is obtained at outlets so that it facilitates the subsequent passivation with sodium hexametaphosphate.

8.14 During SHMP circulation, presence of phosphate should be checked from all outlets, vents and drain lines.

8.15 All data should be recorded in checklist during pickling operation including chemicals consumption and observations, if any.

8.16 Segment(s) of CS piping, if any, which cannot be conveniently cleaned by chemicals circulation method may be cleaned by filling and/or dipping/immersion method. All the conditions of above operations are generally applicable for this method.

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9.0 CONTROLS FOR THE CLEANING PROCESS

9.1 All the specified parameters shall be followed during the cleaning process. All tests should be conducted by the contractor to control the process.

9.2 The strength of the cleaning solutions shall be checked for acid concentration every hour during the cleaning operation. If the strength is found to below 5% by wt., the solution shall be drained in part and brought in the specified range of 5-10% wt. by addition of fresh acid.

9.3 The total iron and ferric iron content of the cleaning solution should be monitored to avoid the attack on the metal. The total iron content shall not exceed 5000 mg as Fe in 1 liter of the cleaning solution. The limits for iron as ferric iron shall not exceed 0.4% by wt. If the limits for total iron and ferric iron are attained, the cleaning solution shall be drained in part and brought in the specified range by addition of fresh solution.

9.4 During the cleaning / pickling operations, care should be taken not to exceed the design temperature and pressure of the loop at any point of time.

10.0 PRESERVATION

The pickled and passivated lines should be preserved in clean and dry condition. The necessary preservation procedure should be followed as recommended by EIL/ owner as per the preservation period. The preservation shall be done by filling with nitrogen if the compressor is not commissioned immediately.

11.0 NEUTRALISATION

Contractor shall finalize the disposal scheme in consultation with OWNER/PMC before start of the chemical cleaning activity and shall comply to all the necessary OWNER's requirements. The contractor shall make necessary arrangement for complete neutralization of all effluents like acids & alkalis. The effluents shall be analyzed before discharging and if necessary, additional chemicals shall be added for neutralization so that discharged mixtures shall have pH ~7.0.

12.0 INSPECTION

In the temporary piping loop, a temporary carbon steel spool of approximately one meter length shall be incorporated at a suitable location. After pickling and drying operation, visual inspection of the temporary spool, coupons and of the loop should be carried out at convenient location(s) as seen from ends to ensure the surfaces are completely clean, dry and free from rust giving uniform gray appearance on the original surface. The visual observations shall be recorded.

13.0 SAFETY PRECAUTIONS

The alkali and hydrochloric acid solutions involved for chemical cleaning are corrosive for the skin and proper care shall be taken in the handling of the chemicals.

13.1 Adequate ventilation shall be provided during the acid cleaning operation to protect the health of workmen.

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13.2 The handling of acid preparation bath etc. and heating must be supervised by a competent supervisor.

13.3 Safety goggles shall be worn by operators and workmen during pickling operation.

13.4 Rubber aprons, protective boots and hand gloves shall be worn by workmen.

13.5 Temporary barricades shall be provided around the areas where acid and alkali is being handled and entry in to the barricaded areas shall be strictly with proper safety gears

14.0 TECHNICAL SUPERVISION AND QUALITY ACCEPTANCE

The chemical cleaning operation should be conducted under close chemical controls by the contractor and EIL site construction department. The EIL site may have technical guidance from the EIL, Process department during the execution and quality acceptance. SMMS may be consulted for technical guidance for initial startup during the execution the chemical cleaning and passivation. The acceptance of cleaning shall be done by EIL site as per the contractual requirements.

15.0 ALTERNATE PROCEDURE TO BE USED IN CASE OF CS/ LOW ALLOY STEEL IN COMBINATION WITH SS

PROCEDURE FOR CHEMICAL CLEANING OF CARBON STEEL, LOW ALLOY STEELIN COMBINATION WITH STAINLESS STEEL PIPING AND STAINLESS STEELVALVES /VESSELS, PRIOR TO COMMISSIONING BY INHIBITED AMMONIATED CITRIC ACID CIRCULATION METHOD.

1.0 SCOPE

This specification covers the chemical cleaning (pickling) of the fabricated and erected, carbon steel, low alloy steel and with stainless steel combination piping at site prior to commissioning by chemicals circulation method. The technical specifications describe the procedure and sequence of operations for chemical cleaning (pickling) and passivation of the piping.

2.0 OBJECTIVE

The objective of chemical cleaning of, carbon steel, low alloy steel with stainless steel combination piping is to remove the loose rust, dislodging the burs, welding slag and mill scales adhering to the internal surfaces of piping. The procedure specifies the method of cleaning and passivation of internal surface of piping based on the use of ammoniated citric acid followed by passivation with tri-sodium phosphate (Na_3PO_4) + $NaNO_2$ circulation. Any deviation from this specification should be recorded and discussed with owner/EIL prior to application.

3.0 SEQUENCE OF OPERATION

The cleaning of piping shall be carried out in the following sequence:

(a) Flushing with potable water to remove dirt, dust, loose rust and foreign matter followed by DM water flushing.

(b) Degreasing with potassium hydroxide (caustic potash).

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(c) Flushing with DM water till inlet and outlet water pH is same

(d) Circulating with ammoniated inhibited citric acid

(e) Flushing with DM water

(f) Circulating with tri-sodium phosphate (Na_3PO_4) + sodium nitrite (NaNO2)

(g) Drain, dry and take the system into service

(h) If the pipe is not taken into service immediately after drying the pipe should be filled with N2 and capped at both ends.

4.0 PREPARATION OF TEMPORARY CIRCUITS

Temporary piping, pumps of suitable capacity, fittings, flanges, tanks, gaskets, heating arrangement, hydrometers, valves, test coupons, spares, laboratory facilities with all accessories required for conducting tests during cleaning operation, chemicals and safety accessories for operation, personnel etc. shall be arranged by contractor at site prior to cleaning operation. Quantity of chemicals required should be calculated based on the holdup volume of the temporary circuit.

5.0 PROCEDURE

5.1 The circuit (loop) shall be checked with circulation of potable water to check tightness. Any leakage if observed to be attended and tightened.

5.2 The circuit (loop) shall be flushed initially with potable water to remove all extraneous matter, dirt and dust etc. followed by DM water flushing.

5.3 Filling and circulation of potassium hydroxide (caustic potash) solution of 2% concentration on 100% purity basis in DM Water at 55-65^{0}C temperature for 2 hours.

5.4 Drain the potassium hydroxide solution. Fill with DM water and drain. The operation of rinsing with DM water should be continued till pH of water at inlet and outlet ends are same.

5.5 Filling and circulation of ammoniated citric acid of 3% concentration by weight (on 100% purity basis) in DM water with pH being adjusted to 3.5-4.0 with ammonia and 0.1% corrosion inhibitor Rodine 92 or equivalent by weight. The temperature of circulating citric acid solution should be 80^{0}C. The circulation should be continued for 6 hrs.

5.6 During circulation of ammoniated citric acid, the total iron content of the circulating solution should not exceed 5000 mg/l (with 3% w/w citric acid solution) and pH should be maintained at 3.5-4.0. If at any stage total iron content exceeds 5000 mg/l, the acid should be drained in part and replaced with fresh acid.

5.7 Drain the citric acid and rinse with DM water. Fill with DM water and the operation of rinsing with potable water should be continued till pH at inlet and outlet ends of water are same.

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5.8 Fill with tri-sodium phosphate (1%) + sodium nitrite (0.5%) by weight (on 100% purity basis) and circulate for 2 hours. Drain, allow to self dry and finally dry with compressed air.

5.9 Suitable high pressure pumps with necessary flow rate should be provided to maintain good velocity (preferably 0.5m-1m/s) throughout operations of chemical cleaning and there should be effective return of flow from the outlet and the vent.

6.0 CHEMICALS

Chemicals used for chemical cleaning should conform to the following specifications.

6.1 Citric acid monohydrate, conforming to IS:5464-1970 Gr.2
6.2 Corrosion inhibitor Rodine 92 or equivalent
6.3 Ammonia liquor technical grade, conforming to IS: 799-1978
6.3 Potassium hydroxide (KOH) conforming to IS:6831 latest edition
6.5 Tri sodium phosphate (Na_3PO_4) technical grade as per IS:573.
6.6 $NaNO_2$ IS-879-1981 sodium nitrite
6.7 Potable water for flushing should have chlorides of 50 ppm maximum.
6.8 DM water.

7.0 SAFETY PRECAUTIONS:

The alkali and acid solutions involved for chemical cleaning are corrosive for the skin and proper care shall be taken in the handling of the chemicals.

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ANNEXURE-I

INHIBITOR EFFICIENCY TEST PROCEDURE

1.0 PREPARATION OF TEST COUPONS

Carbon steel coupons of size 7.5cm x 5cm shall be cut from hot rolled (AISI 1020 or equivalent grade) steel strip or plate. The edges and sharp corners shall be ground smooth. A 5mm diameter hole shall be provided for suspension. The coupons thus prepared shall be used in the tests.

2.0 IDENTIFICATION

The coupons shall be provided with letters and/ or number at one corner using punch.

3.0 SURFACE PREPARATION

For conducting the test to determine inhibitor efficiency the coupons shall be free from mill-scale by grinding followed by polishing using emery paper. The final surface shall be bright using Oakey emery paper No.0. Coupons for conducting the test of action of cleaning solution in removing mill-scale shall be in the as received condition of the surface i.e. with the mill scale on.
All the coupons shall be weighed separately correct to 1mg using a balance.

4.0 CLEANING SOLUTION

The cleaning solution is the inhibited hydrochloric acid. The concentration of hydrochloric acid solution should be 5-10% by wt. and inhibitor should be added in the proportion of 1 litre Rodine 213(special) or equivalent to 100 litre commercial hydrochloric acid(30-33% wt./wt.). The solution, thus, prepared shall match with the actual solution to be used in the chemical cleaning. The acid strength of the solution shall be determined by titration with standard alkali.

5.0 TEST FOR INHIBITOR EFFICIENCY

Test shall be carried out in duplicates in glass containers preferably in one litre capacity beakers. One litre of cleaning solution each shall be transferred to beakers and the solution shall be heated to the maximum temperature in the specified range for the process. The coupons shall be completely exposed to the action of the acid by suspension from the hole so that the upper edge shall be at least 1cm below the liquid surface. The temperature shall be held as above through-out the duration of the test.

5.1 Identical test shall be carried out using un-inhibited acid of the strength equivalent to that of the cleaning solution.

5.2 After the exposure of the coupons to the cleaning solution for the duration of actual cleaning, all the coupons shall be removed from the acid solution and clean is running tap water to remove acid and finally in distilled water. The coupons shall be dried and transferred to desiccator before weighing.

5.3 The weight loss of the coupons shall be determined and the corrosion rates calculated. The average corrosion rate of the coupons exposed to the cleaning solution shall be less

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5.4 than 3% of the average rate thus obtained for the coupons exposed to uninhibited acid. (I.e. percent corrosion inhibition should be 97% (min.). Approval of the Engineer-in-Charge should be obtained for the inhibitor efficiency obtained in the test.

5.5 If chemical cleaning using citric acid method is being adopted, Rodine 92 (or equivalent) shall be used for the efficiency test in line with the procedure mentioned in this annexure.

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JOB SPECIFICATION FOR CHEMICAL CLEANING OF HP/MP/LP STEAM GENERATORS (SMMS)

PROJECT : MPMC AND PMC/EPCM SERVICES FOR ETHYLENE CRACKER UNIT AND UTILITIES & OFFSITES RELATED TO BINA PETCHEM & REFINERY EXPANSION PROJECT (BPREP)

OWNER : M/s BHARAT PETROLEUM COOPERATION LIMITED

EPCM : ENGINEERS INDIA LIMITED

JOB NO : B957

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
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1.0 SCOPE

1.1 This specification covers the chemical cleaning and passivation of the fabricated and erected carbon steel HP/MP/LP steam generators at site prior to commissioning by chemical circulation method. The technical specification describes the procedure and sequence of operations for chemical cleaning and passivation of the steam generating exchangers. This specification shall be applicable in conjunction with tender mark up issued to contractor for chemical cleaning. It is in the contractor's scope to identify the exchangers which do require chemical cleaning in-line with tender requirements.

1.2 All valves, gaskets, control valves including butterfly valves, filters, venturies, instruments etc., which are sensitive to the chemical cleaning should be dropped before chemical cleaning.

1.3 This specification defines the procedure for the chemical cleaning. However, EPC/LSTK Contractor shall prepare the detailed markup on the applicable P&IDs and submit for EIL review & approval.

2.0 OBJECTIVE

The objective of chemical cleaning of carbon steel HP/MP/LP steam generators is to remove the loose rust, dislodging the burs, welding slag and mill scales adhering to the internal surfaces. The procedure specifies the method of cleaning and passivation of internal surface based on the use of inhibited ammoniated citric acid followed by passivation with Tri sodium phosphate (Na_3PO_4) + $NaNO_2$ circulation. Any deviation from this specification should be recorded and discussed with owner/PMC prior to application.

3.0 SEQUENCE OF OPERATION

The cleaning of piping shall be carried out in the following sequence: -

(a) Flushing with potable water to remove dirt, dust, loose rust and foreign matter followed by D.M/BFW water flushing.

(b) Degreasing with Sodium Hydroxide (caustic Soda).

(c) Flushing with DM/ BF water till inlet and outlet water pH is same.

(d) Circulating with ammoniated inhibited citric acid.

(e) Flushing with DM/ BF water

(f) Circulating with Tri sodium phosphate (Na_3PO_4) + Sodium Nitrite (NaNO2).

(g) Drain, dry and take the system into service.

(h) If the pipe is not taken into service immediately after drying the pipe should be filled with N2 and capped at both ends.

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4.0 PREPARATION OF TEMPORARY CIRCUITS:

Temporary piping, pumps of suitable capacity, fittings, flanges, tanks, gaskets, heating arrangement, hydrometers, valves, test coupons, spares, laboratory facilities with all accessories required for conducting tests during cleaning operation, chemicals and safety accessories for operation, personnel etc. shall be arranged by contractor at site prior to cleaning operation. The contractor of chemical cleaning shall prepare all the necessary temporary chemical cleaning circuits at site and submit for approval by owner before execution. Quantity of chemicals required should be calculated based on the hold-up volume of the temporary circuit.

5.0 PROCEDURE

5.1 The circuit (Loop) shall be checked with circulation of potable water to check tightness. Any leakage if observed to be attended and tightened.

5.2 The circuit (Loop) shall be flushed initially with potable water to remove all extraneous matter, dirt and dust etc. followed by DM water flushing

5.3 Filling and circulation of sodium Hydroxide (caustic soda) solution of 1% in DM/BF water (concentration on 100% purity basis) at 65-75^{0}C temperature for 2 hrs.

5.4 Drain the sodium Hydroxide solution. Fill with DM/BF water and drain. The operation of rinsing with DM water should be continued till pH of water at inlet and outlet ends are same.

5.5 Filling and circulation of ammoniated citric acid of 3% concentration (on 100% purity basis) by weight in DM/BF water with pH being adjusted to 3.5-4.0 with ammonia and 0.1% corrosion inhibitor Rodine 92 or equivalent by weight. The temperature of circulating citric acid solution should be 80˚C. The circulation should be continued for 6 hrs. or till iron and acid concentration are stabilized.

5.6 During circulation of ammoniated citric acid, the total iron content of the circulating solution should not exceed 5000mg/litre (with 3% w/w citric acid solution) and pH should be maintained at 3.5-4.0. If at any stage total iron content exceeds 5000 mg/litre, the acid should be drained in part and replaced with fresh acid.

5.7 Drain the citric acid and rinse with DM/BF water. Fill with DM/BF water and the operation of rinsing should be continued till pH at inlet and outlet ends of water are same.

5.8 Fill with Tri Sodium phosphate (1%) + Sodium Nitrite (0.5%) by weight (on 100% purity basis) and circulate for 2 hrs. drain, allow to self dry and finally dry with compressed instrument air.

5.9 If the pipe is not taken into service immediately after drying, the pipe should be filled with N2 and capped at both ends.

5.10 Suitable high-pressure pumps with necessary flow rate should be provided to maintain good velocity (preferably 0.5M-1M/Sec.) throughout operations of chemical cleaning and there should be effective return of flow from the outlet and the vent.

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6.0 CHEMICALS

Chemicals used for chemical cleaning should conform to the following specifications.

6.1 Citric acid monohydrate, conforming to IS: 5464-1970-Gr.2.

6.2 Rodine 92 or CORONIL-92 or NEVAMIN or equivalent.

6.3 Ammonia liquor: Technical grade.

6.4 Sodium Hydroxide (NaOH) Technical grade conforming to IS:252 latest edition.

6.5 Tri sodium phosphate (Na_3PO_4) technical grade as per IS: 573.

6.6 $NaNO_2$ IS-879-1981 Sodium Nitrite.

6.7 Potable water for flushing should have chlorides of 50ppm maximum.

6.8 DM water

7.0 NEUTRALIZATION AND DISPOSAL OF CHEMICALS

Contractor shall finalize the disposal scheme in consultation with OWNER/PMC before start of the chemical cleaning activity and shall comply to all the necessary OWNER's requirements. The contractor shall make necessary arrangement for complete neutralization of all effluents like acids & alkalis. The effluents shall be analyzed before discharging and if necessary, additional chemicals shall be added for neutralization so that discharged mixtures shall have pH ~7.0.

8.0 SAFETY PRECAUTIONS

The alkali and acid solutions involved for chemical cleaning are corrosive for the skin and proper care shall be taken in the handling of the chemicals.

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JOB SPECIFICATION

FOR

CHEMICAL CLEANING OF BOILERS

BY ALKALI BOIL OUT METHOD

(SMMS)

PROJECT : MPMC AND PMC/EPCM SERVICES FOR ETHYLENE CRACKER UNIT AND UTILITIES & OFFSITES RELATED TO BINA PETCHEM & REFINERY EXPANSION PROJECT (BPREP)

OWNER : M/s BHARAT PETROLEUM COOPERATION LIMITED

EPCM : ENGINEERS INDIA LIMITED

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1.0 GENERAL

This specification describes the steps for pre-commissioning Alkali boil out chemical cleaning of CS steam generation boilers. The purpose of alkali boil out is to remove oil, grease, coating materials, foreign matter etc from the boiler internals. This specification is intended for carbon steel surfaces, materials other than carbon steel should not come in contact with the boil out solutions. Filters, venturies, instruments etc., which are sensitive to alkali boil out solutions should be dropped before alkali boil out. Entire steam generating loop staring from BFW inlet to steam drum, risers and downcomers etc. shall be taken into alkali boil out.

This specification defines the procedure for the alkali boilout. However, EPC/LSTK Contractor shall prepare the detailed markup on the applicable P&IDs and submit for EIL review & approval.

2.0 SEQUENCE OF OPERATION

The sequence of operation shall be as follows:

2.1 Flushing with DM water / BFW (Boiler Feed Water)
2.2 Alkali boil out with Tri sodium phosphate (TSP) and Caustic soda.
2.3 Final flushing with DM/ BFW water

3.0 CHEMICALS

The following chemicals are recommended for use in chemical cleaning operations:

3.1 Trisodium phosphate, technical grade, conforming to IS:573
3.2 Caustic soda technical grade conforming to IS : 252
3.3 DM water / B.F. water should be used for preparation of chemical solutions and flushing/rinsing.

4.0 EQUIPMENT AND ACCESSORIES

The equipment and accessories consists of a tank, temporary piping, valves and pumps of appropriate capacity suitable to maintain good velocity (about 0.5 m/sec.), If circulation method is used. All necessary fittings, flanges, heater coils, gasket, thermometers, hydrometers, test coupons, spares, lab facilities for chemicals and safety accessories for operation personnel shall be made available at site prior to alkali boil out. Refer section 8.0 for pre-checklist.

5.0 ALKALI BOIL OUT PROCEDURE

Alkali boil out shall be carried out with 0.5 wt %. Tri sodium phosphate (Na_3PO_4) + 0.30 wt % Caustic soda (NaOH), under actual firing condition of the boiler at half the working pressure for about 24 hours.

(a) Filling of the boiler with D.M. Water upto the bottom of the drum.

(b) Addition of alkali solution into the boiler drums from top manhole.

(c) Filling of boiler up to normal operating level.

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(d) Fire the boiler and raise the pressures gradually to half the working pressure.

(e) Alkali solution of specified concentration should be held at this pressure for about 24 hours with hourly blow down from all individual valves intermittently for 1-2 minutes to remove accumulated sludge & deposits etc. The normal level in the drum is to be maintained with makeup water.

(f) Boiler water samples to be taken every two hours for analysis of pH, alkalinity, phosphate, oil, conductivity and silica.

(g) After alkali boil-out, boiler is to be cooled down to 80^{o}C and drain the alkali solution. Flushing and rinsing with D.M. water till pH of inlet & outlet is same.

Note:

1. In case, the firing of boiler is not possible, the above procedure shall be followed by circulation method.

6.0 PRESERVATION

After draining the rinsed water, the system can be taken into circuit or should be completely filled up with Ammoniated hydrazine solution containing 200-300 ppm of Hydrazine at pH 9.5 (with addition of ammonia) for short duration.

7.0 REQUIREMENT OF CHEMICALS

Approximate chemicals required for 1 M3 hold up of system

- Tri sodium Phosphate 6 kg
- Caustic Soda 6 kg

The holdup may be taken as hold-up of steam drums, condensers, interconnecting piping and min. liquid level of 300 mm from bottom of the tank.

8.0 PRE-CHECKLIST

1) The stainless steel internal from steam drum shall be removed and kept outside during alkali boil out. Alkali boil out is not good for stainless steel.

2) Ensure mechanically remove as much oil and grease as possible and boiler is completely flushed with fresh water from drums and headers before alkaline boiling out.

3) Check all drum internals for tightness of bolted parts.

4) Ensure there is no loose materials, nuts, bolts, washers, etc. should be left inside the drum and All boiler instruments, leads and sampling line should be isolated except drum sampling and direct reading level gauge glass (better use temporary gauge glass) in drum.

5) Ensure secondary Steam Separators (Scrubbers) can be kept outside the drum as chemicals can stick inside the corrugated surfaces which would be very difficult to

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clean afterwards. These parts can be mechanically cleaned before fitting into the drum after Alkali Boil Out.

6) Ensure all instrument impulse pipes connected to drum except those minimum required during Boiler Pressure-raising should be isolated during the boil-out.

7) Ensure hydro test of boiler is completed before alkali.

8) Ensure that all temporary anchors made in the boiler during erection has been removed and boiler is free to expand.

9) Ensure all expansion reading indicator are erected properly.

10) Before introducing chemical to the boiler, particular care should be taken to eliminate possible leaks in the pressure parts and adequate precautions should be taken to protect personnel in the event leaks occur.

9.0 NEUTRALIZATION AND DISPOSAL

Contractor shall finalize the disposal scheme in consultation with OWNER/PMC before start of the chemical cleaning activity and shall comply to all the necessary OWNER's requirements. The contractor shall make necessary arrangement for complete neutralization of all effluents like acids & alkalis. The effluents shall be analyzed before discharging and if necessary, additional chemicals shall be added for neutralization so that discharged mixtures shall have pH ~7.0.

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JOB SPECIFICATION FOR EXTERNAL CHEMICAL CLEANING AND PASSIVATION OF SS WELDS AND FITTINGS OF TANKS AND PIPES (SMMS)

PROJECT : **MPMC AND PMC/EPCM SERVICES FOR ETHYLENE CRACKER UNIT AND UTILITIES & OFFSITES RELATED TO BINA PETCHEM & REFINERY EXPANSION PROJECT (BPREP)**

OWNER : **M/s BHARAT PETROLEUM COOPERATION LIMITED**

EPCM : **ENGINEERS INDIA LIMITED**

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2.0 PICKLING PROCEDURE

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RECOMMENDED PROCEDURE FOR EXTERNAL CHEMICAL CLEANING AND PASSIVATION OF WELD JOINTS OF SS TANKS AND PIPES

1.0 SEQUENCE OF OPERATION

The sequence of operation shall be as follows:

1.1 Wash with D.M. water

1.2 Applying the acid pickling paste.

1.3 Final wash with DM water

2.0 PICKLING & PASSIVATION PROCEDURE

2.1 Wash the girth weld joints, tees elbows of SS with DM water.

2.2 Prepare a paste with 15% concentration Nitric acid (on 100% purity basis), 0.1% hydrofluoric acid (on 100% purity basis) and with required quantity of Silica insulation fine grog of 0-0.5mm size with minimum 85% SiO_2. Apply the paste on SS welds joints, and fittings which needs to be cleaned, with a uniform thickness. Allow the paste to be on the surfaces for about 30 minutes.

2.3 Remove the acid paste and wash with DM water thoroughly without any traces of paste.

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JOB SPECIFICATION FOR EXTERNAL COATING OF BURIED PIPING, VALVES, FLANGES AND FITTINGS

PROJECT: MPMC AND PMC/EPCM SERVICES FOR ETHYLENE CRACKER UNIT AND UTILITIES & OFFSITES RELATED TO BINA PETCHEM & REFINERY EXPANSION PROJECT (BPREP)

OWNER : M/s BHARAT PETROLEUM CORPORATION LIMITED

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ABBREVIATIONS:

API: American Petroleum Institute
DIN: Deutsches Institut für Normung
3LPE: 3 Layer Polyethylene
FJC: Field Joint Coating
HSS: Heat Shrinkable Sleeves

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1.0 SCOPE

This specification specifies the minimum technical requirements for pipes externally coated with extruded / sintered 3-layer polyethylene (3LPE) in shop or field and the fittings / flanges / valves / strainer body externally coated with liquid epoxy in the shop or field. These externally coated pipes and fittings are intended for the usage in the buried conditions. The list of items to be coated given in this specification is not exhaustive. This specification is applicable for all items which are in buried condition.

This specification does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this specification to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2.0 REFERENCES

BS EN ISO 21809-1: External coatings for buried or submerged pipelines –Polyolefin coatings
DIN 30670: Polyethylene coatings on steel pipes and fittings – Requirements and testing
DIN EN 10289: Steel tubes and fittings for onshore and offshore pipelines
BS EN ISO 21809-3: External coatings for buried or submerged pipelines -Field joint coatings

3.0 MATERIALS

3.1 Coating materials shall be suitable for the service conditions and the pipe sizes involved in the project. The 3LPE coating system for pipes shall comprise of a powder epoxy primer, polymeric adhesive and a medium or high-density polyethylene top coat. The coating materials i.e. epoxy powder; adhesive and polyethylene compound shall have proven compatibility. The compatibility of all the three components shall be ensured by manufacturer / applicator.

3.2 Fittings shall be coated with liquid applied epoxy coating material

3.3 Buried field joints of 3LPE pipe shall be coated with heat shrinkable sleeves / Cold applied tapes defined as per clause 4.3 of this specification.

4.0 FUNCTIONAL REQUIREMENTS AND PROPERTIES OF COATING

4.1 3LPE coated pipes

4.1.1 General requirements

The 3LPE coating shall preferably be applied by side extrusion method as per BS EN ISO 21809-1 for piping which are having a design temperature up to 80°C. However, for design temperature up to 70°C, 3LPE coating by sintering method is also acceptable and shall conform to DIN 30670 (Type S) and table-1 of this specification. Total thickness of the coating shall conform to thickness class ‘n’ as per table-3 of DIN 30670.

Cut back provision for pipes and fittings shall be as follows:

For pipes smaller than DN 600 the length of the cutback shall be no greater than 150 mm, for larger pipes the cutback shall be (150 ± 20) mm. For three-layer coatings, the epoxy resin and adhesive layers at the pipe ends shall be removed to at least 80 mm

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from the welding bevel. A not less than 20 mm strip of epoxy resin or epoxy resin and adhesive should extend from the cutback of the polyethylene coating. For coating thicknesses up to 2.2 mm the bevel angle shall be no greater than 45°, for greater coating thicknesses the bevel angle shall be no greater than 30°.

Table-1: Properties of 3 LPE Coatings

PROPERTY	REQUIREMENT	TESTING AS PER DIN 30670	NOTES
Cathodic disbondment (CD test)	23 °C/28 d or 60 °C/2 d max. 7 mm	Annex C	-
Peel strength	70 N/cm (23 °C) 30 N/cm (70 °C)	Annex D	For system testing single values shall beno more than 25 % lower than the required average value.
Continuity (holiday detection)	No discharges	Annex E	25 kV test
Elongation at break(23 °C ± 2 °C)	min. 300 %	Annex F	-
Impact resistance(23 °C ± 2 °C)	≥ 7 J/mm	Annex H	25 kV test No discharges
Low temperature impact resistance	≥ 7 J/mm (−40 °C ± 2 °C)	Annex H	25 kV test No discharges
Indentation resistance	max. 0,2 mm (23 °C) max. 0,4 mm (70 °C)	Annex I	-
Specific electrical coating resistance (23 °C ± 2 °C)	≥ 10^8 Ωm²	Annex J	-
UV resistance	⊿MFR ± 35 %	Annex K	-
Thermal ageing resistance	⊿MFR ± 35 %	Annex L	-

4.2 Epoxy coated fittings, flanges and valves

Fittings shall be coated with liquid epoxy conforming to DIN EN 10289 (Class C and type 3) and table-2 of this specification. Thickness of the coating shall be minimum 1500 microns. Wherever epoxy coated fittings are to be welded with 3LPE coated pipes or fittings, it is the responsibility of the supplier/coating applicator to ensure a proper cut

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back in such a way that the coating is not damaged during welding. Specific written approval of EIL to be obtained in case there is difficulty in complying with this requirement, supplier to submit justification for the same. The joints between two epoxy coated fittings shall be coated with liquid epoxy as per DIN EN 10289, Class C and type 3.

Table-2: Properties of Liquid Epoxy Coatings

PROPERTIES	REQUIREMENTS		TESTING AS PER DIN EN 10289
Hardness Shore "D"	Specified by the manufacturer		Clause 7.3
Appearance and continuity	Uniform colour, smooth appearance and free from defects		Clause 7.4
Cut back	(150 ± 20) mm		Clause 7.5
Holiday detection	Free from holiday		Clause 7.6
Impact resistance	(23 ± 2) °C	(- 5 ± 3) °C	Clause 7.7
	5 J X k X mm (mm of coating thickness)	3 J X k X mm (mm of coating thickness)	
Adhesion test Resistance to removal	(23 ± 2) °C	maximum service temperature ± 2 °C	Clause 7.8
	min. rating 2	Results for information	
Cathodic disbondment	Average	Maximum	Clause 7.10
	<=6 mm	<= 8 mm	
Specific electrical insulation resistance	Minimum Rs after set number of days at constant temperature		Clause 7.11
Indentation resistance	(23 ± 2) °C	maximum service temperature ± 2 °C	Clause 7.13
	max 0.2 mm	<=30 % of initial measured thickness	

4.3 Field joint coating

The joint between 3LPE coated pipe and epoxy coated fitting shall be protected by heat shrinkable sleeves / cold applied tapes conforming to codes 14-B / 19-E respectively as per BS EN ISO 21809-3.The FJC shall meet the requirements as mentioned in table-3 & 4 of this specification.

Note: Liquid epoxy coating conforming to DIN EN 10289, Class C and type 3 can also be applied as field joint coating where there is practical difficulty in applying HSS / Cold applied tapes subject to approval by the OWNER / PMC. A certificate for compatibility of liquid epoxy with 3LPE coated pipes shall be obtained from liquid epoxy coating manufacturer and submitted to OWNER / PMC for approval. Epoxy coating shall comply to the Table-2 of this specification.

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Table-3: Properties of Heat Shrinkable sleeves

PROPERTY	TEST TEMP.	UNIT	REQUIREMENTS	TEST METHOD AS PER BS EN ISO 21809-3
Thickness – Sleeve Layers	-	-	>= specified min. value	Annex B
Holiday detection at 5 kV/ mm + 5 kV	-	-	No holiday	Annex C
Impact resistance (holiday detection at 5 kV/mm + 5 kV)	23 °C	J/mm	≥7	Annex D
Indentation resistance: Pressure	T_{max}	N/mm2	10,0	Annex E
Residual thickness		mm	≥0,6	
Amount of penetration		mm	—	
Cathodic disbondment at 28 days	23 °C	mm	≤5,0	Annex G
	T_{max} limited to 95 °C	mm	≤10	
Peel strength at 10 mm/min to pipe surface and to poly- olefin plant coating	23 °C	N/mm	≥5,0	H.1
	T_{max}	N/mm	≥0,30	
Peel strength at 10 mm/min to pipe surface and to poly- olefin plant coating after 100- day hot-water immersion test at T max limited as per Annex I	23 °C	P100/P0	≥0,75	Annex I and Annex H
Lap shear strength at 10 mm/ min	23 °C	N/mm2	≥3,0	Annex J
	T_{max}	N/mm2	≥0,20	
Elongation at break E100/ E70)	23 °C	—	≥0,75	Annex M
Peel strength to pipe surface (P100/P70)		—	≥0,75	

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Table-4: Properties of Cold applied tapes

PROPERTY	TEST TEMPERATURE	UNIT	VALUE	TEST METHOD AS PER BS EN ISO 21809-3
Holiday detection at 10 kV/mm, max. 25 kV	—	—	No holiday	Annex C
Peel strength	23 °C	N/mm	>15	Annex H
	T_{max}	N/mm	>4,0	Annex H
Adhesion to pipe surface and plant coating after 28-day hot-water immersion test at T_{max} limited as per Annex I	23 °C	—	>10 N/mm	Annex I plus Annex H
Cathodic disbondment at 28 days	23 °C	mm	≤7	Annex G
	T_{max}	mm	≤10	Annex G
Impact resistance	23 °C	J/mm	5 × α × β	Annex D
Indentation resistance at a pressure of 10 N/mm2	T_{max}	mm	≤1,0	Annex E

5.0 INSPECTION AND TESTING

The contractor shall establish and maintain a proven quality assurance system to ensure that supplied pipes & fittings comply in all respects with the requirements of this specification. The minimum inspection and testing to be performed shall be as per relevant clauses of DIN 30670, BS EN ISO 21809-1 & 3 and DIN EN 10289. Prior to starting the coating job, the contractor /supplier/coating applicator shall prepare coating application procedure and ITP based on the above mentioned standards in consultation with OWNER/PMC and submit for their approval. Coating Job shall start only after approval of the same.

6.0 HANDLING, TRANSPORTATION AND STORAGE

6.1 The vendor shall load, unload, transport and stockpile the coated pipes, flanges, valves and fittings within the coating plant using approved suitable means and in a manner to avoid damage to the coating.

6.2 Coated pipes, flanges, valves and fittings may be handled by means of slings and belts of proper width (minimum 60 mm) made of non- abrasive/non-metallic materials. In this case, pipes, flanges, valves and fittings to be stacked shall be separated row by row to avoid damages by rubbing the coated surface in the process of taking off the slings. Use of round sectional slings is prohibited. Forklifts may be used provided that the arms of the forklift are covered with suitable pads, preferably rubber/PVC/Teflon.

6.3 Coated pipes, flanges, valves and fittings at all times shall be stacked completely clear from the ground, at least 300 mm, so that the bottom row of pipes remains free from any stagnant surface water. The pipes and fittings shall be stacked at a slope so that driving rain does not collect inside the pipe. Coated pipes and fittings may be stacked by placing them on ridges of sand free from stones and covered with a plastic film or on wooden supports provided with suitable cover. Flanges and valves shall be provided with covers/wrapping to ensure that there is no water stagnation/accumulation to protect the coating. This cover can be of dry, germ free straw covered with plastic film, otherwise

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foam rubber may be used. The supports shall be spaced in such a manner as to avoid permanent bending of the pipes. Stacks shall consist of limited number of layers such that the pressure exercised by the pipe's own weight does not cause damages to the coating. Each pipe section shall be separated by means of spacers suitably spaced for this purpose. Stacks shall be suitably secured against falling down and shall consist of pipe sections having the same diameter and wall thickness. The weld seam of pipes shall be positioned always in a manner so as not to touch the adjacent pipes. The ends of the pipes and fittings during handling and stacking shall always be protected with bevel protectors.

6.4 The trucks used for transportation shall be equipped with adequate pipe supports having as many round hollow beds as there are pipes to be placed on the bottom of the lorry bed. Total width of the supports shall be at least 5% of the pipe length and min. 2 no. support shall be provided. These supports shall be lined with a rubber protection and shall be spaced in a manner as to support equal load from the pipes. The rubber protection must be free from all nails and staples where pipes are in contact. The second layer and all following layers shall be separated from the other with adequate number of separating layers of protective material such as straw in plastic covers or mineral wool strips or equivalent, to avoid direct touch between the coated pipes.

All stanchions of Lorries used for transportation shall be covered by non-abrasive material like rubber belts or equivalent. Care shall be exercised to properly cover the top of the stanchions and other positions such as reinforcement of the truck body, rivets, etc. to prevent damage to the coated surface. Slings or non-metallic straps shall be used for securing loads during transportation. They shall be suitably padded at the contact points with the pipe.

6.5 In case of any marine transportation of coated pipes, flanges, valves and fittings involved, the same shall be carried out in compliance with API RP 5LW.

7.0 MARKING

Vendor shall place marking on the outside surface of the coating at one end of the coated pipe and marking shall be as per the requirements of DIN 30670, BS EN ISO 21809-1 & 3 and DIN EN 10289.

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TECHNICAL SPECIFICATION FOR COATING OF UNDERGROUND STAINLESS STEEL/ ALLOY STEEL PIPING

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
0	16-05-2025	Issued as job specification	JATIN	SAHIL	SRIDHAR

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1.0 SCOPE

This Specification outlines minimum requirements for external painting of underground SS and Alloy Steel plant piping. This specification covers surface preparation, details about coating system, application methods & pre-qualification testing requirements etc.

2.0 REFERENCE CODES & STANDARDS

The latest editions and revisions of the following Standards shall be used to supplement and define the intentions and requirements of this Specification.

Swedish Standard
SIS 05 59 00 Pictorial Surface Preparation Standards for Painting Steel Surfaces.

American Steel Structures Painting Council Standards
SSPC - PA2 Measurement of Dry Paint Thickness with Magnetic Gauges
SSPC- SP16 Brush-off Blast for SS, galvanized steel and non-ferrous metals

International Standards
ISO 12944-1 Paints and varnishes -- Corrosion protection of steel structures by protective paint systems -- Part 1: General introduction
ISO 12944-3 Paints and varnishes -- Corrosion protection of steel structures by protective paint systems -- Part 3: Design considerations
ISO 12944-4 Paints and varnishes -- Corrosion protection of steel structures by protective paint systems -- Part 4: Types of surfaces and surface preparation
ISO 12944-5 Paints and varnishes -- Corrosion protection of steel structures by protective paint systems -- Part 5: Protective paint systems
ISO 12944-6 Paints and varnishes -- Corrosion protection of steel structures by protective paint systems -- Part 6: Laboratory performance test methods.
ISO 12944-8 Paints and varnishes -- Corrosion protection of steel structures by
ISO 8501-1 Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness. Part 1: Rust grades and preparation grades of uncoated steel substrates and steel substrates after overall removal of previous coatings
ISO 8504-2 Preparation of steel substrates before application of paints and related products — Surface preparation methods — Part 2, Abrasive blast-cleaning
ISO 2808 Paints and Varnishes - Determination of film thickness

3.0 EQUIPMENT

All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipments, scaffolding materials, shot & grit blasting equipments & air compressors etc. required to be used shall be suitable for the work and all in good condition and shall be arranged by the contractor at site and in sufficient quantity.
Mechanical mixer shall be used for paint mixing operations in case of two pack systems except that the Engineer-In-Charge may allow the hand mixing of small quantities at his discretion in case of specific requirement for touch up work only.

4.0 GENERAL SEQUENCE FOR SURFACE PREPARATION & PAINTING

4.1 Pre-blasting prior to removal for weld splatters.

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4.2 Emulsifying cleaning.
4.3 DM water washing, to remove contaminants
4.4 Shot & Grit blasting
4.5 Dust and grit removal
4.6 Paint application
4.7 Inspection

5.0 PROCEDURE FOR PRE-BLASTING PREPARATION & SURFACE PREPARATION

Pre-blasting

All Sharp edges (if any) shall be rounded by using grinder or disc sander to get minimum 2mm radius (R = 2mm). This can be obtained by way of three passes with the grinding tool on the sharp edges. Weld slag, spatters & weld beads shall be thoroughly removed by chipping and grinding. Under cuts and surface indentations depth exceeding 0.8mm and a width less than its depth should be rectified by welding and grinding (including weld blow holes). Rough weld seam (if any) shall be smoothening by grinding. Overlap weld beads with the sharp notches are to be repaired by welding and grinding.

In case of any localized oil contamination to the surface, same shall be removed by solvent, alkaline detergent or emulsifying agent cleaning as per SSPC-SP-1.

Removal of oil and grease is followed by fresh water washing, to remove contaminants, (soluble salt and welding flux, dirt).

Note: To remove the soluble salt, dirt, and dust, high pressure water cleaning up to a pressure of minimum 250 Bar is required.

Surface preparation

Surfaces to be coated shall be blast cleaned in accordance with SSPC-SP-16. The surfaces shall be blast cleaned using abrasives like Al_2O_3/garnet or non-metallic abrasives at pressure of 7kg/cm^2 at an appropriate distance and angle depending of nozzle size maintaining constant velocity and pressure. The quality of abrasives shall be free from contaminants and impurities and shall meet the requirements of SSPC AB1. Compressed air shall be free from moisture and oil. The blasting nozzles should be venturi style with tungsten carbide or boron carbide as the materials for liners. Nozzles orifice may vary from 3/16" to ¾". Blast cleaning shall not be done outdoors in bad weather without adequate protection or when there is dew on the metal, which is to be cleaned. Surface profile shall be uniform to provide good key to the paint adhesion. If possible vacuum collector shall be installed for collecting the abrasives and recycling.
Blast cleaning shall not be performed where dust can contaminate surfaces or during humid weather conditions having humidity exceed 85%

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6.0 COATING SYSTEM

Table-1

Sl. No.	Surface Preparation	Coating System			DFT (µm)
		Primer	Intermediate	Finish coat	
1.1	**For Stainless Steel piping**				
1.1.1	SSPC-SP-16 Min. 50 microns profile	1 coat of Novolac Epoxy phenolic coating (F-17) @300 microns	-	1 coat of Novolac Epoxy phenolic coating (F-17) @300 microns	600 µ min.
1.2	**For Alloy Steel piping**				
1.2.1	SSPC-SP-16 Min. 50 microns profile	1 coat of glass flake epoxy composite coating @ 150 microns	-	1 coat of glass flake epoxy composite coating @ 150 microns	300 µ min.

7.0 GENERIC PRODUCTS' DESCRIPTION

7.1 Novolac Epoxy coating

Generic name: Novolac epoxy phenolic coating cured with Polyamine adduct hardener.
Properties of the coating shall conform to code F-17 specified in table-2 of B957-000-06-42-PLS-01.

7.2 Glass Flake Epoxy Composite coating

Generic name: Two component glass flake reinforced epoxy composite coating having volume solids of min. 70±2 %. This coating shall be suitable for heat resistance up to 250 Deg. C in buried condition.
Mixing and thinning shall be as per manufacturer's recommendation.

8.0 COATING APPLICATION

Primer/first coat of paint shall be applied within 3-4 hours of surface preparation.
All coating shall be applied by airless spray excepting at the following special cases where application can be carried out by brush

- Spot repair
- Stripe coating on edges
- Small bore parts not suitable for spray application.

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Irregular surfaces such as sharp edges, welds, small brackets, and interstices may stripe coated to ensure specified DFT is achieved. Paint manufacturer recommendation should be followed before deciding for brush application.

9.0 QUALITY CONTROL, INSPECTION AND TESTING

The painting work shall be subject to inspection by Engineer-In-Charge at all times. In particular, following stage-wise inspection will be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows

(a) Surface preparation
(b) Primer application
(c) Each coat of paint

a. Test for presence of oil/grease and contamination

The steel substrate after degreasing as per SSPC-SP-1 shall be tested as per following procedure to validate absence of oil and grease contamination:

- Visual inspection - continue degreasing until all visible signs of contamination are removed.

- Conduct a solvent evaporation test by applying several drops or a small splash of residue-free tri-chloromethane on the suspect area especially pitting, crevice corrosion areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination. Continue degreasing and inspection till test is passed.

b. **Tests for surface finish of blasted surface** shall be done by visual inspection using SSPC-VIS1. Clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on blasted surface. Checks shall be done on each component at least once per 200 m^2 of blasted surface and a minimum of 3 checks per shift.

c. **Test for presence of soluble salts** as per method ISO 8502-9. Maximum allowable salt content shall be considered 20 mg/m2.Checks shall be done on each component at least once per 200 m2 of blasted surface and minimum of 3 checks per shift. In case salt exceeds specified limit, the contaminated surface shall be cleaned by method as per Annexure-C of ISO 12944-4 (water cleaning). After cleaning, surface shall be retested for salt after drying.

d. **Blast Profile Measurement**: (In-Process testing during actual production before application coating). The angular profile depth measurement shall be done by profile tape as per method ASTM D 4417 method B (Profile depth gauge micrometer)/ calibrated Digital gauge meter. Spot measurement shall be carried out every 15m^2 of blasted surface. At each spot three measurements shall be taken over an area of 10

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m^2 and average of measurements to be recorded and reported. If profile is less than specified range, blasting shall continue till greater specified depth profile is achieved.

e. **Tests for blasting media:** Blasting Media (For every fresh batch of media and one random test during blasting)**.** Blasting Media shall be visually inspected for absence of contamination and debris using 10 X magnification.

- Inspection for the absence of oil contamination shall be conducted using following procedure:
  - Fill a small clean 200 ml bottle half full of abrasive.
  - Fill the bottle with potable water, cap and shake the bottle.
  - Inspect water for oil film/slick. If present, the blasting media is not to be used.

- Soluble salt contamination if suspected shall be verified by method ASTM D 4940. If present, media to be replaced.

- Clean blasting equipment, especially pot and hoses, and then replace blasting media and retest.

f. **Test for Blasting Air** (Once Daily before start of blasting and once at random during Blasting). The air for blasting shall be free from moisture and oil. The compressor air shall be checked for oil and water contamination per ASTM D 4285.

In addition to above, record should include type of shop primer already applied on equipment e.g. zinc silicate or zinc rich epoxy or zinc phosphate. Any defect noticed during the various stages of inspection shall be rectified by the CONTRACTOR to the entire satisfaction of Engineer-In-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, CONTRACTOR shall be responsible for rectifying any defects found during final inspection/guarantee period/defect liability period as defined in general conditions of the contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to OWNER, the extra coat should have prior approval of Engineer-in-charge.

9.1 Primer Application

After surface preparation, the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-In-Charge.

9.2 The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring.

Surface profile gauge for checking of surface profile, Dry film thickness (of each coat), Holiday detectors / pinhole detector and protector whenever required for checking

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9.3 At the discretion of Engineer-In-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations. The contractor is responsible to arrange the same.

9.4 Final inspection of finished coating shall consist of measurement of:

- **Coating DFT & WFT check:** DFT measurement shall be as per ISO 2808. Type-II electronic gauge shall be used as described in ASTM D7091. DFT gauge calibration, adjustment of gauge coating thickness, frequency and number of coating thickness measurement shall be as per ASTM D7091 and SSPC-PA2. Measured DFT shall have a tolerance as per SSPC-PA-2 level-3 of the dry film thickness, specified in this specification. Once in every layer of coating application, spot checks of WFT shall be carried out during the coating application according to ISO 2808, Method No. 1A- comb gauge. This is to ensure that film thickness is being achieved as per the specification. The frequency of WFT check shall be one per 10 m^2.

- **Adhesion testing:** Adhesion of the primer to the steel substrate and inter-coat adhesion of the subsequent coat(s) after curing for at least a week after application of the topcoat shall be examined by a knife test in accordance with ASTM D6677. For the knife test, if the rating is better than 8, the adhesion is considered acceptable. The adhesion is destructive and tested areas shall be repaired afterward using the spot repair procedure. Alternatively, the applicator may perform the adhesion test on a steel panel coated using the same surface preparation and coating application procedure as the work piece. Adhesion testing shall be carried out for each component at least once per 200 m^2 of coated surface.

- **Holiday detection check:** Holiday testing of non-conductive coatings shall be carried out in accordance with NACE SP0188. For immersion, buried & under insulation services, 100% of coated area shall be inspected for holidays. For atmospheric exposure, 10% of coated area which must include weld seams, corners and edges to be holiday tested. Voltage at which test is to be carried out will depend upon DFT of coating being tested and shall be as per NACE SP0188. Any holiday is unacceptable and should be marked and repaired immediately**.**

- The CONTRACTOR shall arrange for spot checking of paint materials for specific gravity, glow time (ford cup) and spreading rate.

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10.0 Pre Qualification of the coating materials

For Novolac epoxy phenolic coating, the paint manufacturer engaged by the mechanical contractor shall carry out the tests in NABL accredited government laboratories or in suggested list of laboratories below, as a part of qualification. Paint manufacturer shall provide the paint samples to laboratory for testing of the parameters mentioned in Table-2 of B957-000-06-42-PLS-01 (typical characteristics of F-17) and Table-2 of this specification. The testing laboratory will confirm the compliance of the paint material with respect to the acceptance criteria mentioned in the respective tables.
For Glass Flake Epoxy Composite coating, the paint manufacturer engaged by the mechanical contractor shall carry out the tests as per Table-2 and properties mentioned in product datasheet in any NABL accredited laboratories or in suggested list of laboratories below, as a part of qualification. The test certificates shall be certified by a NACE/AMPP Level-3 certified inspector of a qualified TPI agency.

Colored photographs of coated test panels should be taken before and after the test and should be enclosed along with test report. Contractor shall furnish these test certificates along with all necessary supporting documents/information to EIL-SMMS for approval/ acceptance. The paint manufacturer will be qualified and approved by EIL-SMMS for supply of paints after review/assessment of the submissions made by the contractor. Test certificates which are more than 3 years old will not be considered. Paint manufacturers are advised to carryout pre-qualification testing accordingly for paints supply to EIL projects.

List of suggested laboratories:

1. National Test house – Kolkata
2. National Test house-Mumbai
3. HBTU- Kanpur
4. GIRDA (Gujarat Industrial Research & Development Agency)- Vadodara
5. Indian institute of chemical technology – Hyderabad
6. RITES – Kolkata
7. ICT- Mumbai

Table-2

S. No.	TEST	DURATION	ACCEPTANCE CRITERIA
1.	Chemical Resistance Test (ASTM D543)		
1a.	10% & 40% NaOH	1000 hrs	Shall pass. No cracking, discoloration, blistering,
1b.	5% H2SO4	168 hrs	

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1c.	Xylene	4 weeks	peeling or softening of film shall be observed.
1d.	Acetone	4 weeks	
1e.	Ethanol	4 weeks	
1f.	Kerosene	4 weeks	
1g.	Sea water	2000 hrs	
2	Cathodic Disbondment Test (ASTM G95) for 28 days	28 days	Disbondment radius shall be max. 12mm
3	Flexibility 180^0 bend over 3-inch mandrel (ASTM D522)	-	No cracking or delamination
4	Impact Resistance (ASTM G14)	-	Average 8.4 Nm min. for 5 Samples
5	Water Absorption (ASTM D570)	-	Max 2%
6	Thermal Shock Resistance Test (For epoxy composite coating); 5 cycles @ 30 minutes in furnace at 250 º C and 15 minutes in water after quenching in water for each cycle. (ASTM D2485 method B)	-	Shall pass

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(Unit : 300 - 304)

Marked up for amine service

Marked up for alkali boil out.

Marked up for chemical cleaning and passivation of compressors circuits.

Marked up for chemical cleaning of steam generators

Marked up for chemical cleaning of cooling water pipelines.

Marked up for chemical cleaning of VHP/HP steam (turbine service)

28.01.26
D. BEHERA
SMMS

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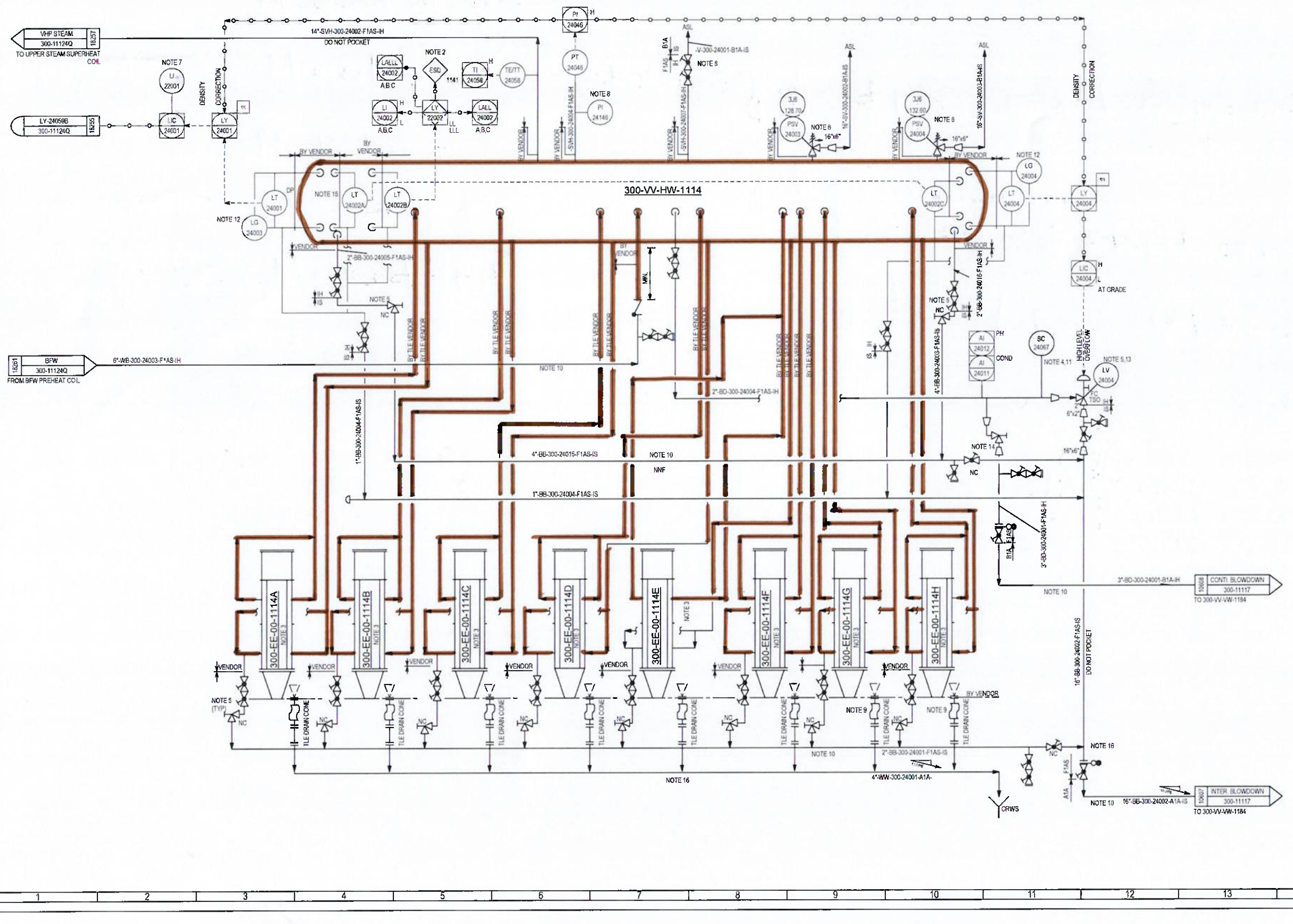
300-VV-HW-1114
VHP STEAM DRUM FOR 300-FF-00-1114

DP 128.7 kg/cm^2g
DT 350 °C
Inside Diam x Len (T/T) BY VENDOR

300-EE-00-1114A/B/C/D/E/F/G/H
TRANSFER LINE EXCHANGER FOR 300-FF-00-1114

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014. ALL INSTRUMENT TAG NUMBERS LOCATED ON THIS DRAWING SHALL HAVE THE PREFIX 300
2. TWO OUT OF THREE LOW LOW LEVEL TRIP SIGNALS WILL CAUSE HEATER SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM OTHERS WILL ALARM.
3. FOR TLE PROCESS SIDE SEE DWG. 300-11124F,G,H
4. ELEVATION SHOULD BE CHECKED AGAINST COOLING WATER PRESSURE TO ENSURE ADEQUATE FLOW.
5. OVERFLOW LEVEL CONTROL VALVES AND INTERMITTENT BLOWDOWN VALVES TO BE YARWAY TYPE OR GESTRA TYPE OR EQUAL.
6. RELIEF VALVES MOUNTED ON THE DRUM WITH RTJ FLANGED CONNECTION.
7. PROVIDE LOCAL READOUT OF STEAM DRUM LI-24001 READABLE FROM HV-24009 AND FV-24057.
8. PRESSURE GAUGE TO BE READABLE FROM VENT VALVES.
9. TWO DRAIN CONES AND TWO FLEX HOSES REQUIRED FOR TLE HYDROJETTING. DRAIN CONES TO BE SUPPLIED BY TLE VENDOR. FLEX HOSES TO BE SUPPLIED BY OWNER.
10. TWO PHASE FLOW ANCHOR SECURELY.
11. SAMPLE COOLER WITH COOLING WATER CONNECTION AND CONNECTING TUBING DETAIL BY DEC.
12. ONE (1) GLASS-TYPE OR BICOLOR LEVEL GAUGE AND ONE (1) CONDUCTIVITY-PROBE SYSTEM VISUAL LEVEL GAUGE/HYDRASTEP OR EQUIVALENT.
13. TO PREVENT EROSION ISSUE DUE TO FLASHING EFFECT, SUITABLE VALVE SHALL BE SELECTED.
14. SPECIAL CALIBRATED CONTINUOUS BLOWDOWN VALVE GESTRA MODEL BA-211 OR YARWAY FIGURE 5617 OR EQUAL.
15. ONE (1) CONDUCTIVITY TYPE LEVE TRANSMITTER WHILE OTHER TWO (2) TO BE DP TYPE
16. PIPING TO BE ROUTED TO CRWS. SUITABLE COKE CATCHING MECHANISM TO BE DEVELOPED BY DEC



BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT
SRT VI HEAVY FEED CRACKING HEATER
300-FF-00-1114
VHP STEAM DRUM

SCALE: | DWG No. 363136-300-11124R | REV 0

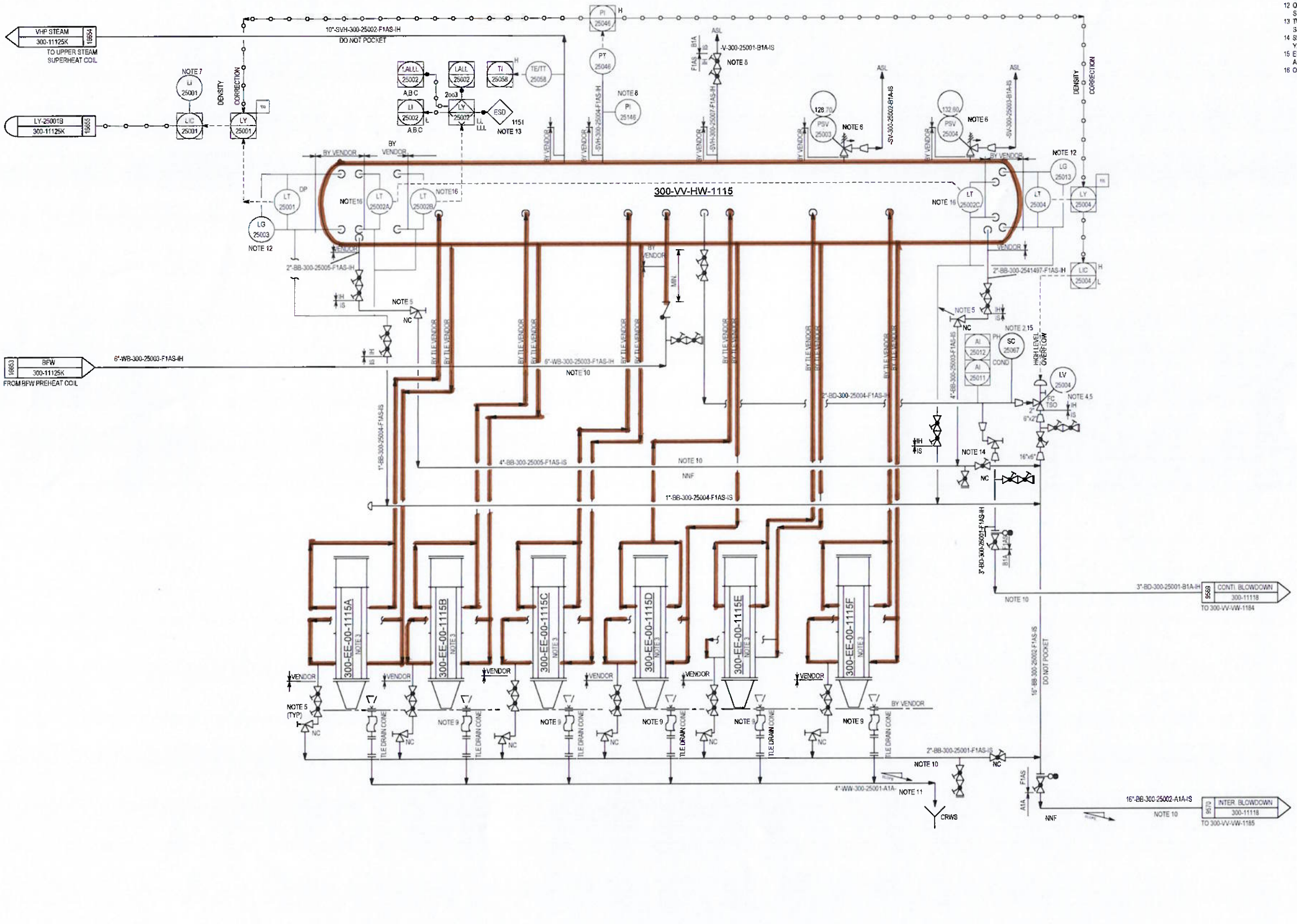
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300-VV-HW-1115
VHP STEAM DRUM FOR 300-FF-00-1115
DP 128.7kg/cm^2g
DT 350 °C
Inside Diam x Len (T/T) x BY VENDOR

300-EE-00-1115A/B/C/D/E/F
TRANSFER LINE EXCHANGER FOR 300-FF-00-1115
DP (S/T) 128.7-L HA 20kg/cm^2g
DT (S/T) 350°C/ 500/525°C
Rated Duty 6.238MMKCAL/HR

NOTES:

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2. SAMPLE COOLER WITH COOLING WATER CONNECTION AND CONNECTING TUBING DETAIL BY DEC.
3. FOR TLE PROCESS SIDE SEE DWG. 300-11125F.G.H.
4. TO PREVENT EROSION ISSUE DUE TO FLASHING EFFECT, SUITABLE VALVE SHALL BE SELECTED.
5. OVERFLOW LEVEL CONTROL VALVES AND INTERMITTENT BLOWDOWN VALVES TO BE YARWAY TYPE OR GESTRA TYPE OR EQUAL.
6. RELIEF VALVES MOUNTED ON THE DRUM WITH R.F.U FLANGED CONNECTION.
7. PROVIDE LOCAL READOUT OF STEAM DRUM LI-25001 READABLE FROM HV-25009 AND FV-25057.
8. PRESSURE GAUGE TO BE READABLE FROM VENT VALVES.
9. TWO DRAIN CONES AND TWO FLEX HOSES REQUIRED FOR TLE HYDROJETTING. DRAIN CONES TO BE SUPPLIED BY TLE VENDOR. FLEX HOSES TO BE SUPPLIED BY OWNER.
10. TWO PHASE FLOW ANCHOR SECURELY.
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16. ONE (1) CONDUCTIVITY TYPE LEVE TRANSMITTER WHILE OTHER TWO (2) TO BE DP TYPE



BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
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BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT
SRT VI LIGHT FEED CRACKING HEATER
300-FF-00-1115
VHP STEAM DRUM

SCALE: | DWG No. 363136-300-11125L | REV. 0

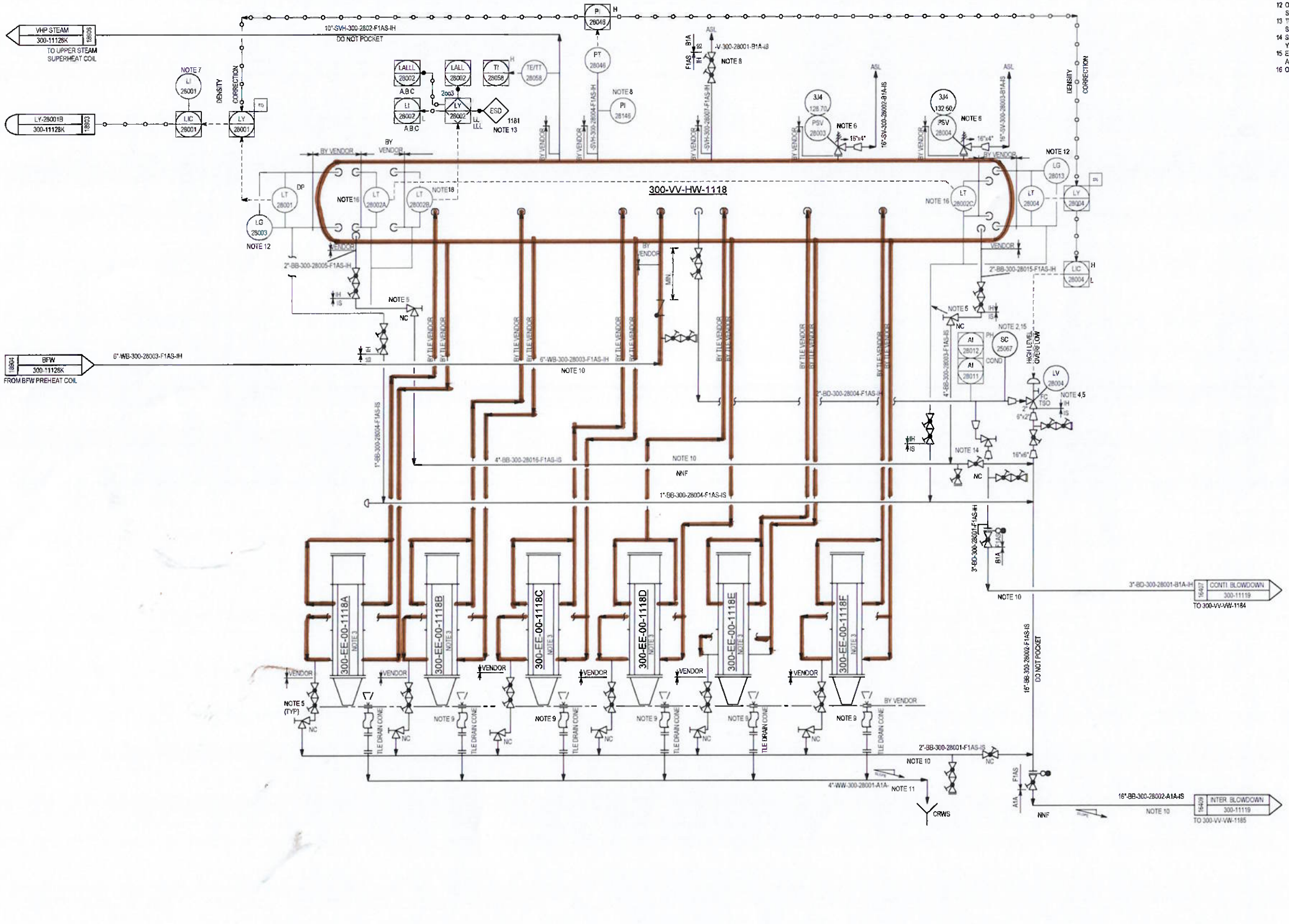
Page 1932 of 4391 : B957-TENDER_DOC-B957-300-16-43-MR-T-3001 : Rev. A

300-VV-HW-1118
VHP STEAM DRUM FOR 300-FF-00-1118
DP 128.7kg/cm^2g
DT 350 °C
Inside Diam. x Len (T/T) x BY VENDOR

300-EE-00-1118A/B/C/D/E/F
TRANSFER LINE EXCHANGER FOR 300-FF-00-1118
DP (S/T) 128.7+L H/I 20kg/cm^2g
DT (S/T) 350°C/ 900/525°C
Rated Duty 6.238MMKCAL/HR

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG NO 363136-000-11011 THRU 363136-000-11014 ALL INSTRUMENT TAG NUMBERS LOCATED ON THIS DRAWING SHALL HAVE THE PREFIX 300
2. SAMPLE COOLER WITH COOLING WATER CONNECTION AND CONNECTING TUBING DETAIL BY DEC
3. FOR TLE PROCESS SIDE SEE DWG 300-11126F G H
4. TO PREVENT EROSION ISSUE DUE TO FLASHING EFFECT, SUITABLE VALVE SHALL BE SELECTED
5. OVERFLOW LEVEL CONTROL VALVES AND INTERMITTENT BLOWDOWN VALVES TO BE YARWAY TYPE OR GESTRA TYPE OR EQUAL
6. RELIEF VALVES MOUNTED ON THE DRUM WITH RTJ FLANGED CONNECTION
7. PROVIDE LOCAL READOUT OF STEAM DRUM LI-28001 READABLE FROM HV-28009 AND FV-28057
8. PRESSURE GAUGE TO BE READABLE FROM VENT VALVES
9. TWO DRAIN CONES AND TWO FLEX HOSES REQUIRED FOR TLE HYDROJETTING. DRAIN CONES TO BE SUPPLIED BY TLE VENDOR. FLEX HOSES TO BE SUPPLIED BY OWNER
10. TWO PHASE FLOW ANCHOR SECURELY
11. PIPING TO BE ROUTED TO CRWS. SUITABLE COKE CATCHING MECHANISM TO BE DEVELOPED BY DEC SYSTEM VISUAL LEVEL GAUGE/HYDRASTEP OR EQUIVALENT
12. ONE (1) GLASS-TYPE OR BI-COLOR LEVEL GAUGE AND ONE (1) CONDUCTIVITY-PROBE SYSTEM VISUAL LEVEL GAUGE/HYDRASTEP OR EQUIVALENT
13. TWO OUT OF THREE LOW LOW AND LOW LOW LOW LEVEL TRIP SIGNALS WILL CAUSE HEATER SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM OTHERS WILL ALARM.
14. SPECIAL CALIBRATED CONTINUOUS BLOWDOWN VALVE GESTRA MODEL BA-211 OR YARWAY FIGURE 5817 OR EQUAL
15. ELEVATION SHOULD BE CHECKED AGAINST COOLING WATER PRESSURE TO ENSURE ADEQUATE FLOW
16. ONE (1) CONDUCTIVITY TYPE LEVE TRANSMITTER WHILE OTHER TWO (2) TO BE DP TYPE



BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	DATE	DESCRIPTION	CAD	PROCESS	LPE	PDM	PM	CLIENT
0	01/13/2025	FOR BEP	NAI	PPP	SC	SK/GVK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT
SRT VI LIGHT FEED CRACKING HEATER
300-FF-00-1118
VHP STEAM DRUM

SCALE: | DWG NO: 363136-300-11128L | REV: 0

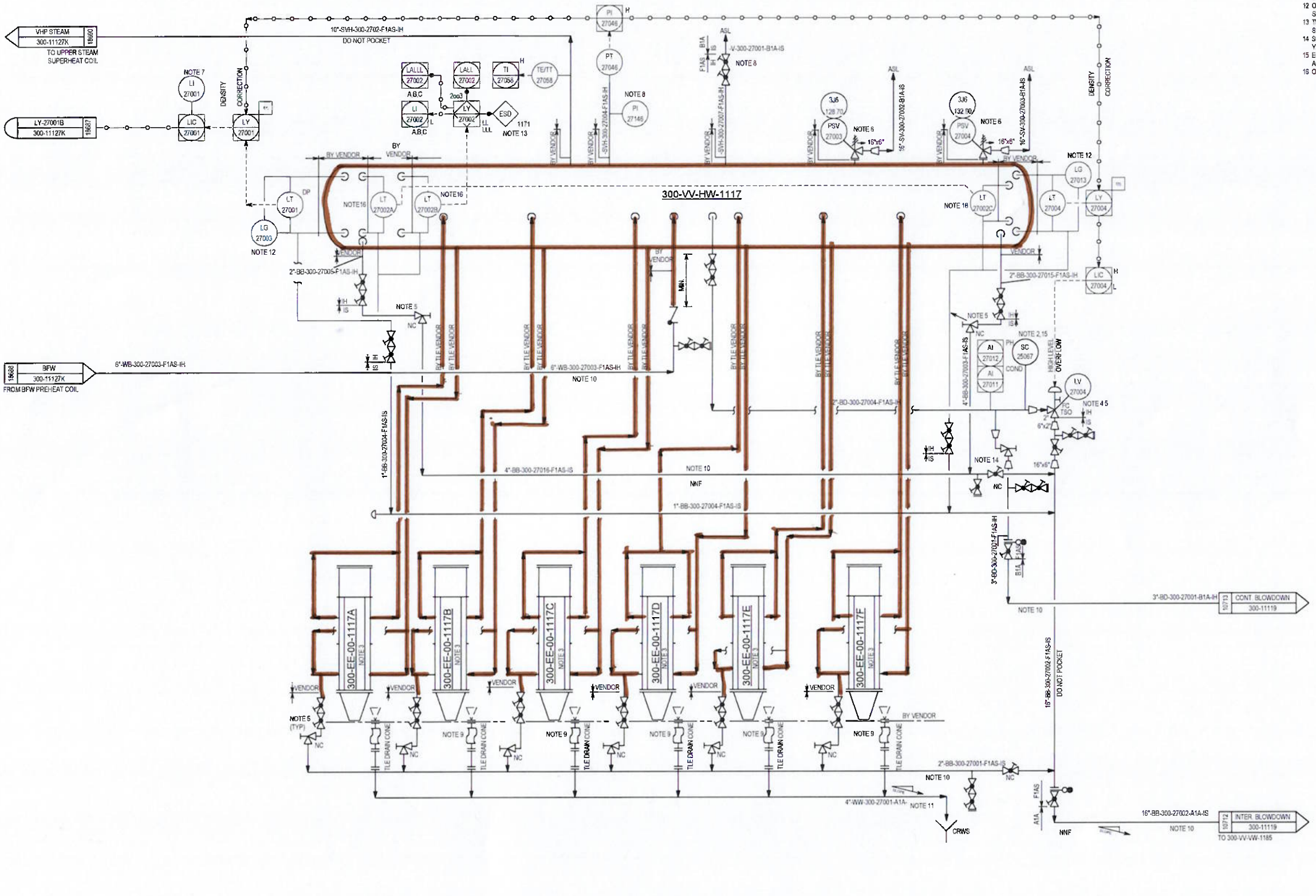
Page 1933 of 4391 : B957-TENDER_DOC-B957-300-16-43-MR-T-3001 : Rev. A

300-VV-HW-1117
VHP STEAM DRUM FOR 300-FF-00-1117
DP 128.7kg/cm^2g
DT 350 °C
Inside Diam 'x Len (T/T) x BY VENDOR

300-EE-00-1117A/B/C/D/E/F
TRANSFER LINE EXCHANGER FOR 300-FF-00-1117
DP (S/T) 128.7 /L IN/ 20kg/cm^2g
DT (S/T) 350°C/ 900/525°C
Rated Duty 6 298MMKCAL/HR

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG NO 363136-000-11011 THRU 363136-000-11014 ALL INSTRUMENT TAG NUMBERS LOCATED ON THIS DRAWING SHALL HAVE THE PREFIX 300
2. SAMPLE COOLER WITH COOLING WATER CONNECTION AND CONNECTING TUBING DETAIL BY DEC
3. FOR TLE PROCESS SIDE SEE DWG 300-11126F G H
4. TO PREVENT EROSION ISSUE DUE TO FLASHING EFFECT, SUITABLE VALVE SHALL BE SELECTED
5. OVERFLOW LEVEL CONTROL VALVES AND INTERMITTENT BLOWDOWN VALVES TO BE YARWAY TYPE OR GESTRA TYPE OR EQUAL
6. RELIEF VALVES MOUNTED ON THE DRUM WITH RTJ FLANGED CONNECTION
7. PROVIDE LOCAL READOUT OF STEAM DRUM LG27001 READABLE FROM HV-27008 AND HV-27057
8. PRESSURE GAUGE TO BE READABLE FROM VENT VALVES
9. TWO DRAIN CONES AND TWO FLEX HOSES REQUIRED FOR TLE HYDROJETTING. DRAIN CONES TO BE SUPPLIED BY TLE VENDOR. FLEX HOSES TO BE SUPPLIED BY OWNER
10. TWO PHASE FLOW ANCHOR SECURELY
11. PIPING TO BE ROUTED TO CRWS. SUITABLE COKE CATCHING MECHANISM TO BE DEVELOPED BY DEC SYSTEM VISUAL LEVEL GAUGE/HYDRASTEP OR EQUIVALENT
12. ONE (1) CLASS-I TYPE OR BH-27 LOR LEVEL GAUGE AND ONE (1) CONDUCTIVITY-PROBE SYSTEM VISUAL LEVEL GAUGE/HYDRASTEP OR EQUIVALENT
13. TWO OUT OF THREE LOW LOW AND LOW LOW LOW LEVEL TRIP SIGNALS WILL CAUSE HEATER SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM OTHERS WILL ALARM.
14. SPECIAL CALIBRATED CONTINUOUS BLOWDOWN VALVE GESTRA MODEL BA-211 OR YARWAY FIGURE 5817 OR EQUAL
15. ELEVATION SHOULD BE CHECKED AGAINST COOLING WATER PRESSURE TO ENSURE ADEQUATE FLOW
16. ONE (1) CONDUCTIVITY TYPE LEVE TRANSMITTER WHILE OTHER TWO (2) TO BE DP TYPE



BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
	01/13/2026	FOR BEP	NAN	PPP	SC	GKG / VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT
SRT VI LIGHT FEED CRACKING HEATER
300-FF-00-1117
VHP STEAM DRUM

SCALE | DWG NO 363136-300-11127L | REV 0

Page 1934 of 4391 ; B957-TENDER_DOC-B957-300-16-43-MR-T-3001 ; Rev. A

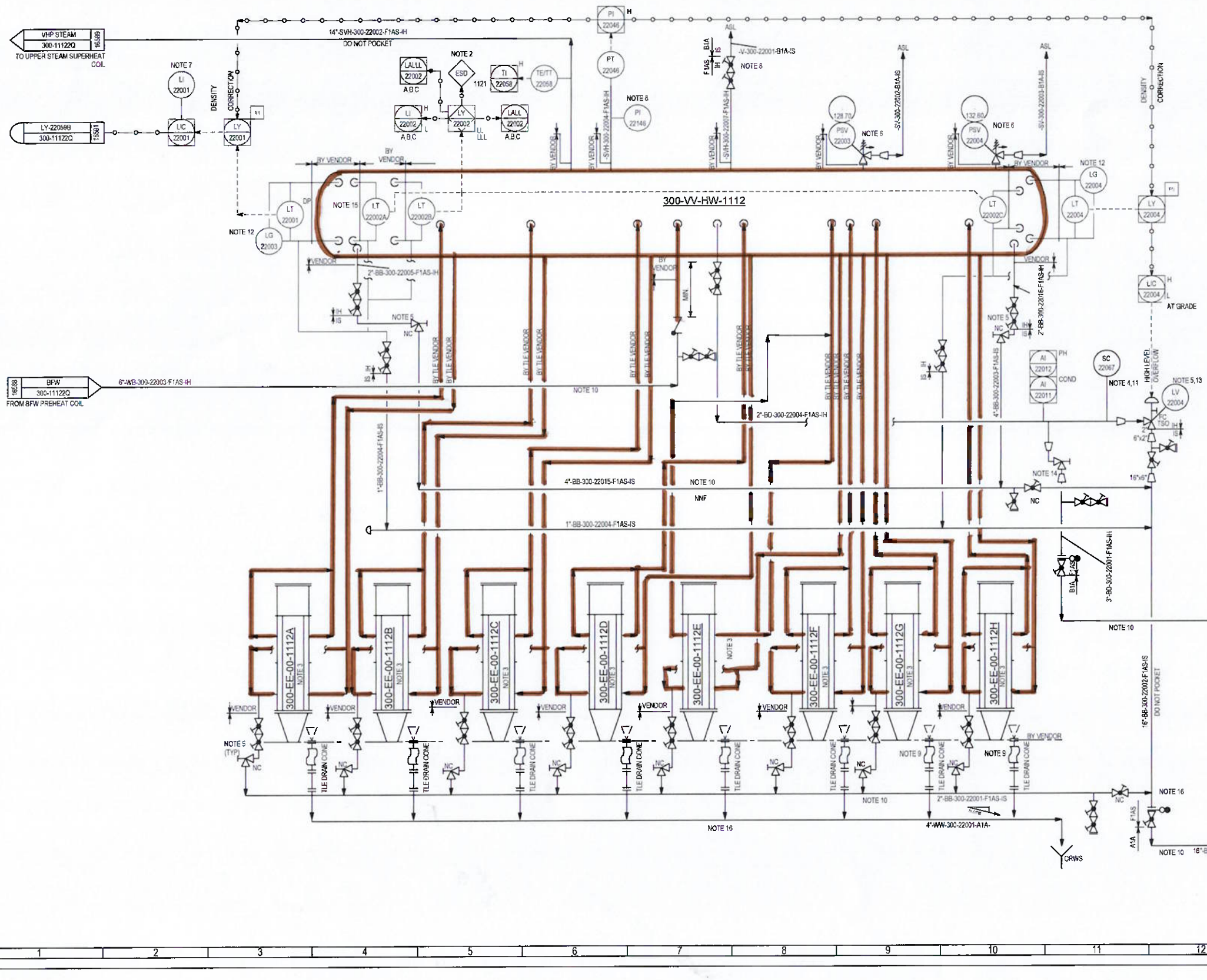
300-VV-HW-1112
VHP STEAM DRUM FOR 300-FF-00-1112

DP 128.7 kg/cm^2g
DT 350 °C
Inside Diam x Len (T/T) BY VENDOR

300-EE-00-1112A/B/C/D/E/F/G/H
TRANSFER LINE EXCHANGER FOR 300-FF-00-1112

NOTES:

1 FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG NO 363136-000-11011 THRU 363136-000-11014
ALL INSTRUMENT TAG NUMBERS LOCATED ON THIS DRAWING SHALL HAVE THE PREFIX 300
2 TWO OUT OF THREE LOW LOW LEVEL TRIP SIGNALS WILL CAUSE HEATER SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM OTHERS WILL ALARM
3 FOR TLE PROCESS SIDE SEE DWG 300-11122F G H
4 ELEVATION SHOULD BE CHECKED AGAINST COOLING WATER PRESSURE TO ENSURE ADEQUATE FLOW
5 OVERFLOW LEVEL CONTROL VALVES AND INTERMITTENT BLOWDOWN VALVES TO BE YARWAY TYPE OR GESTRA TYPE OR EQUAL
6 RELIEF VALVES MOUNTED ON THE DRUM WITH RTJ FLANGED CONNECTION
7 PROVIDE LOCAL READOUT OF STEAM DRUM LI-22001 READABLE FROM HV-22008 AND FV-22057
8 PRESSURE GAUGE TO BE READABLE FROM VENT VALVES.
9 TWO DRAIN CONES AND TWO FLEX HOSES REQUIRED FOR TLE HYDROJETTING. DRAIN CONES TO BE SUPPLIED BY TLE VENDOR. FLEX HOSES TO BE SUPPLIED BY OWNER.
10 TWO PHASE FLOW ANCHOR SECURELY
11 SAMPLE COOLER WITH COOLING WATER CONNECTION AND CONNECTING TUBING DETAIL BY DEC
12 ONE (1) GLASS-TYPE OR BI-COLOR LEVEL GAUGE AND ONE (1) CONDUCTIVITY-PROBE SYSTEM VISUAL LEVEL GAUGE/HYDRASTEP OR EQUIVALENT
13 TO PREVENT EROSION ISSUE DUE TO FLASHING EFFECT, SUITABLE VALVE SHALL BE SELECTED
14 SPECIAL CALIBRATED CONTINUOUS BLOWDOWN VALVE GESTRA MODEL BA-211 OR YARWAY FIGURE 5817 OR EQUAL
15 ONE (1) CONDUCTIVITY TYPE LEVE TRANSMITTER WHILE OTHER TWO (2) TO BE DP TYPE
16 PIPING TO BE ROUTED TO CRWS SUITABLE COKE CATCHING MECHANISM TO BE DEVELOPED BY DEC



BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
1	01/13/2025	FOR BEP	NAh	PPP	SC	SKG/VK	SA	
0	10/21/2024	PRELIMINARY	NAh	PPP	SC	SKG/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT
SRT VI HEAVY FEED CRACKING HEATER
300-FF-00-1112
VHP STEAM DRUM

SCALE: DWG NO 363136-300-11122R REV 0

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300-VV-HW-1116

VHP STEAM DRUM FOR 300-FF-00-1116

DP 128.7kg/cm^2g
DT 350 °C
Inside Diam x Len (T/T). x BY VENDOR

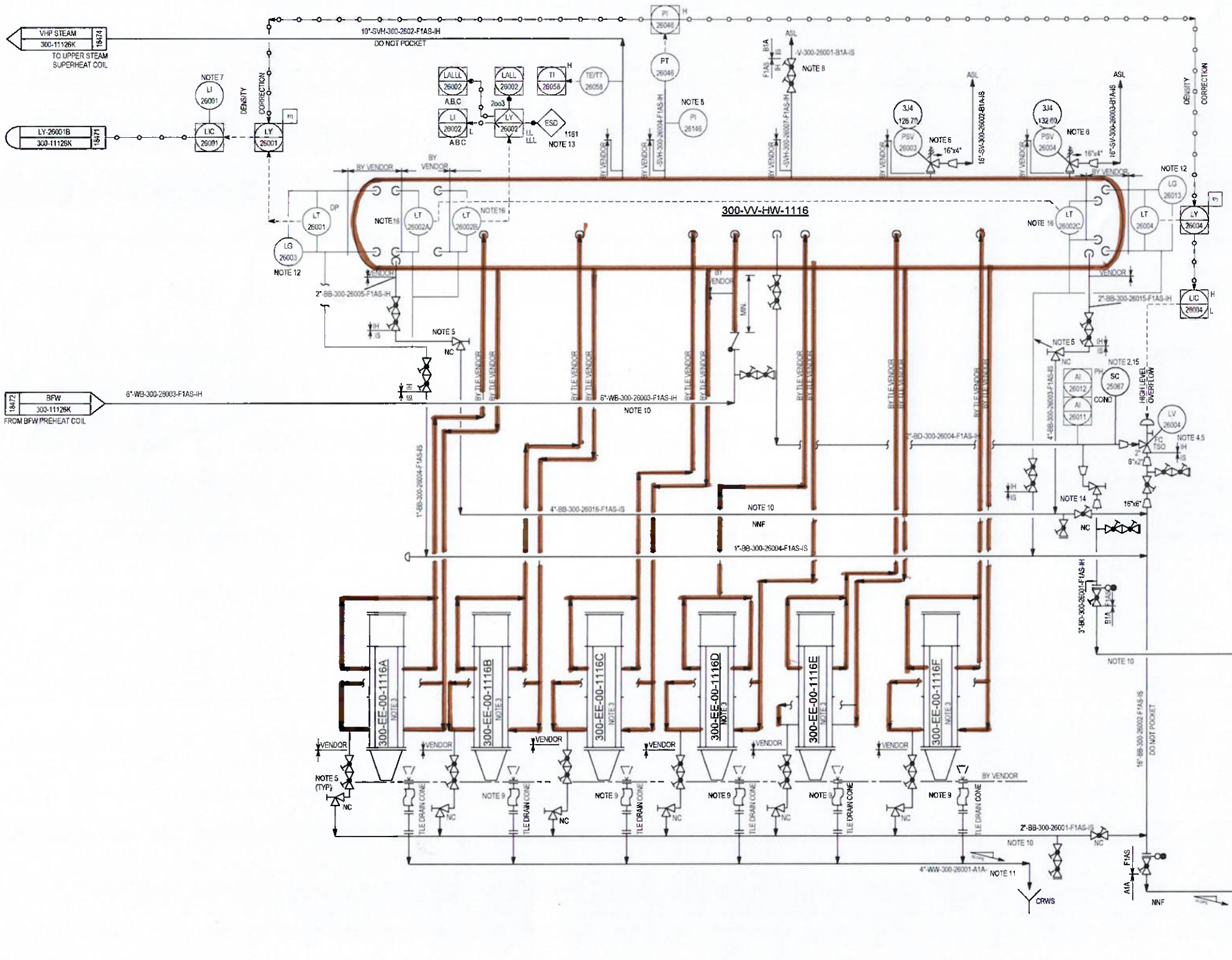
300-EE-00-1116A/B/C/D/E/F

TRANSFER LINE EXCHANGER FOR 300-FF-00-1116

DP (S/T) 128.7+L HA 20kg/cm^2g
DT (S/T) 350°C/ 300/525°C
Rated Duty 8.238MMKCAL/HR

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG NO 363136-000-11011 THRU 363136-000-11014 ALL INSTRUMENT TAG NUMBERS LOCATED ON THIS DRAWING SHALL HAVE THE PREFIX 300
2. SAMPLE COOLER WITH COOLING WATER CONNECTION AND CONNECTING TUBING DETAIL BY DEC
3. FOR TLE PROCESS SIDE SEE DWG 300-11126F,G,H
4. TO PREVENT EROSION ISSUE DUE TO FLASHING EFFECT, SUITABLE VALVE SHALL BE SELECTED
5. OVERFLOW LEVEL CONTROL VALVES AND INTERMITTENT BLOWDOWN VALVES TO BE YARWAY TYPE OR GESTRA TYPE OR EQUAL
6. RELIEF VALVES MOUNTED ON THE DRUM WITH RTJ FLANGED CONNECTION
7. PROVIDE LOCAL READOUT OF STEAM DRUM LI-26001 READABLE FROM HV-26009 AND FV-26057
8. PRESSURE GAUGE TO BE READABLE FROM VENT VALVES
9. TWO DRAIN CONES AND TWO FLEX HOSES REQUIRED FOR TLE HYDROJETTING DRAIN CONES TO BE SUPPLIED BY TLE VENDOR. FLEX HOSES TO BE SUPPLIED BY OWNER
10. TWO PHASE FLOW ANCHOR SECURELY
11. PIPING TO BE ROUTED TO CRWS. SUITABLE COKE CATCHING MECHANISM TO BE DEVELOPED BY DEC SYSTEM VISUAL LEVEL GAUGE/HYDRASTEP OR EQUIVALENT
12. ONE (1) GLASS-TYPE OR BI-COLOR LEVEL GAUGE AND ONE (1) CONDUCTIVITY-PROBE SYSTEM VISUAL LEVEL GAUGE/HYDRASTEP OR EQUIVALENT
13. TWO OUT OF THREE LOW LOW AND LOW LOW LOW LEVEL TRIP SIGNALS WILL CAUSE HEATER SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM OTHERS WILL ALARM
14. SPECIAL CALIBRATED CONTINUOUS BLOWDOWN VALVE GESTRA MODEL BA-211 OR YARWAY FIGURE 58-17 OR EQUAL
15. ELEVATION SHOULD BE CHECKED AGAINST COOLING WATER PRESSURE TO ENSURE ADEQUATE FLOW
16. ONE (1) CONDUCTIVITY TYPE LEVE TRANSMITTER WHILE OTHER TWO (2) TO BE DP TYPE



BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	UPE	PDM	PM		CLIENT
0	01/13/2025	FOR BEP	NAN	PPP	SC	SK/VK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT
SRT VI LIGHT FEED CRACKING HEATER
300-FF-00-1116
VHP STEAM DRUM

SCALE: | DWG NO 363136-300-11126L | REV 0

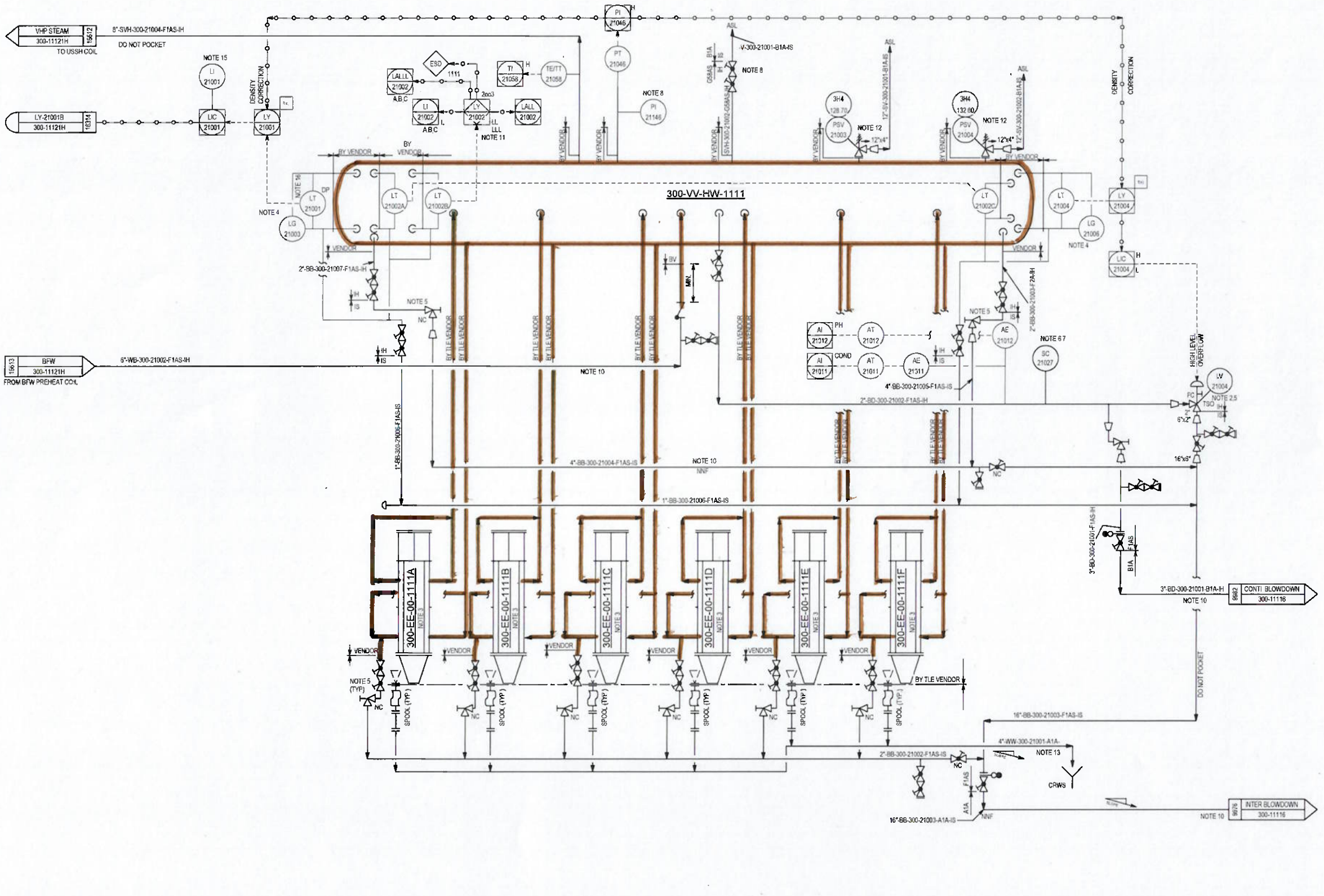
Page 1936 of 4391 : B957-TENDER_DOC-B957-300-16-43-MR-T-3001 : Rev. A

300-VV-HW-1111
VHP STEAM DRUM FOR 300-FF-00-1111
DP 128.70 kg/cm^2g
DT 350 °C
Inside Diam x Len (T/T) x BY VENDOR

300-EE-00-1111A/B/C/D/E/F
TRANSFER LINE EXCHANGER FOR 300-FF-00-1111
DP (S/T) 128.7-L, HM 2 kg/cm^2g
DT (S/T) 350 °C/ (9900425°C)
Rated Duty 3 400 MMKCAL/HR
TEMA Type

NOTES:

1. FOR LEGEND SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG NO 363136-000-11101 THRU 363136-000-11014. ALL INSTRUMENT TAG NUMBERS LOCATED ON THIS DRAWING SHALL HAVE THE PREFIX 300
2. TO PREVENT EROSION ISSUE DUE TO FLASHING EFFECT, SUITABLE VALVE SHALL BE SELECTED
3. FOR TLE PROCESS SIDE SEE DWG 300-11121D,E,F
4. ONE (1) GLASS-TYPE OR BICOLOR LEVEL GAUGE AND ONE (1) CONDUCTIVITY-PROBE SYSTEM VIRTUAL LEVEL GAUGE/HYDRASTEP OR EQUIVALENT
5. OVERFLOW LEVEL CONTROL VALVES AND INTERMITTENT BLOWDOWN VALVES TO BE YARWAY TYPE OR GESTRA TYPE OR EQUAL
6. ELEVATION SHOULD BE CHECKED AGAINST COOLING WATER PRESSURE TO ENSURE ADEQUATE FLOW
7. SAMPLE COOLER WITH COOLING WATER CONNECTION AND CONNECTING TUBING DETAIL BY DEC
8. PRESSURE GAUGE TO BE READABLE FROM VENT VALVES
9. TWO DRAIN CONES AND TWO FLEX HOSES REQUIRED FOR TLE HYDROJETTING. DRAIN CONES TO BE SUPPLIED BY TLE VENDOR. FLEX HOSES TO BE SUPPLIED BY OWNER
10. TWO PHASE FLOW CAN OCCUR ANCHOR SECURELY
11. TWO OUT OF THREE LOW LOW AND LOW LOW LOW LEVEL TRIP SIGNALS WILL CAUSE HEATER SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM OTHERS WILL ALARM
12. RELIEF VALVES MOUNTED ON THE DRUM WITH RTJ FLANGED CONNECTION
13. PIPING TO BE ROUTED TO CRWS. SUITABLE COKE CATCHING MECHANISM TO BE DEVELOPED BY DEC
14. SPECIAL CALIBRATED CONTINUOUS BLOWDOWN VALVE GESTRA MODEL BA-211 OR YARWAY FIGURE 5817 OR EQUAL
15. PROVIDE LOCAL READOUT OF STEAM DRUM LI-21001 READABLE FROM HV-21009 AND FV-21057
16. ONE (1) CONDUCTIVITY TYPE LEVE TRANSMITTER WHILE OTHER TWO (2) TO BE DP TYPE



BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	DATE	DESCRIPTION	CAD	PROC	LPE	PDM	PM	CLIENT
2	01/13/2025	FOR BEP	NAh	PPP	SC	SKG AVK	SA	
1	10/21/2024	PRELIMINARY	NAh	PPP	SC	SKG AVK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT
SRT VI GAS CRACKING HEATER
VHP STEAM DRUM

SCALE: | DWG No: 363136-300-11121I | REV: 0

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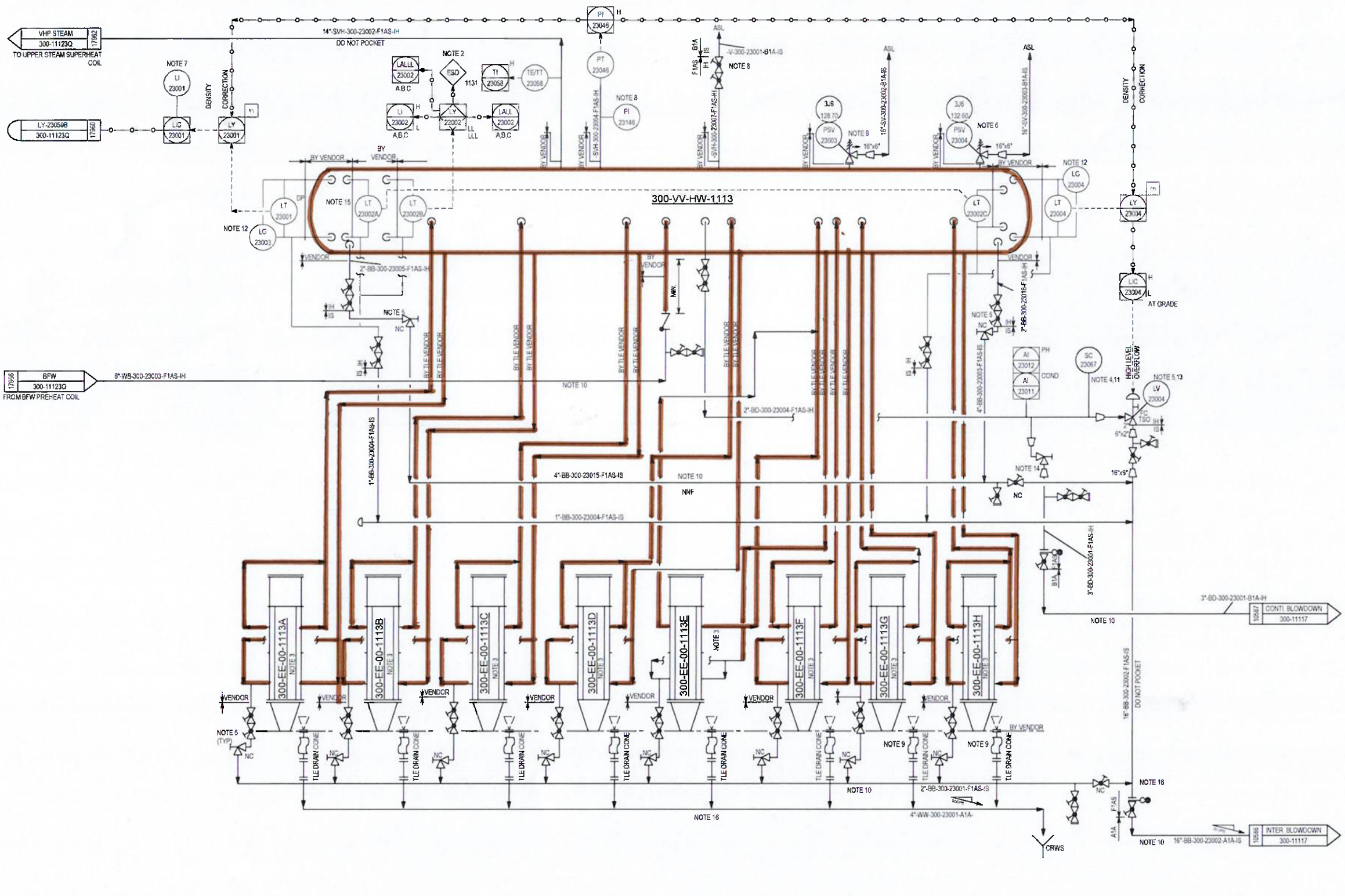
300-VV-HW-1113
VHP STEAM DRUM FOR 300-FF-00-1113

DP 128.7 kg/cm^2g
DT 350 °C
Inside Diam. x Len (T/T) BY VENDOR

300-EE-00-1113A/B/C/D/E/F/G/H
TRANSFER LINE EXCHANGER FOR 300-FF-00-1113

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG NO. 363136-000-11011 THRU 363136-000-11014
   ALL INSTRUMENT TAG NUMBERS LOCATED ON THIS DRAWING SHALL HAVE THE PREFIX 300
2. TWO OUT OF THREE LOW LOW LEVEL TRIP SIGNALS WILL CAUSE HEATER SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM OTHERS WILL ALARM
3. FOR TLE PROCESS SIDE SEE DWG. 300-11123F,G,H
4. ELEVATION SHOULD BE CHECKED AGAINST COOLING WATER PRESSURE TO ENSURE ADEQUATE FLOW.
5. OVERFLOW LEVEL CONTROL VALVES AND INTERMITTENT BLOWDOWN VALVES TO BE YARWAY TYPE OR GESTRA TYPE OR EQUAL
6. RELIEF VALVES MOUNTED ON THE DRUM WITH RTJ FLANGED CONNECTION
7. PROVIDE LOCAL READOUT OF STEAM DRUM LI-23001 READABLE FROM HV-23009 AND PV-23057
8. PRESSURE GAUGE TO BE READABLE FROM VENT VALVES
9. TWO DRAIN CONES AND TWO FLEX HOSES REQUIRED FOR TLE HYDROJETTING. DRAIN CONES TO BE SUPPLIED BY TLE VENDOR. FLEX HOSES TO BE SUPPLIED BY OWNER
10. TWO PHASE FLOW ANCHOR SECURELY
11. SAMPLE COOLER WITH COOLING WATER CONNECTION AND CONNECTING TUBING DETAIL BY DEC
12. ONE (1) GLASS-TYPE OR BICOLOR LEVEL GAUGE AND ONE (1) CONDUCTIVITY-PROBE SYSTEM VISUAL LEVEL GAUGE/HYDRASTEP OR EQUIVALENT
13. TO PREVENT EROSION ISSUE DUE TO FLASHING EFFECT, SUITABLE VALVE SHALL BE SELECTED
14. SPECIAL CALIBRATED CONTINUOUS BLOWDOWN VALVE. GESTRA MODEL BA-211 OR YARWAY FIGURE 5817 OR EQUAL
15. ONE (1) CONDUCTIVITY TYPE LEVE TRANSMITTER WHILE OTHER TWO (2) TO BE DP TYPE
16. PIPING TO BE ROUTED TO CRWS. SUITABLE COKE CATCHING MECHANISM TO BE DEVELOPED BY DEC



BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	UTE	PDM	PM	CLIENT
0	01/13/2025	FOR BEP	NAN	PPP	SC	SKG/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT
SRT VI HEAVY FEED CRACKING HEATER
300-FF-00-1113
VHP STEAM DRUM

SCALE: | DWG NO: 363136-300-11123R | REV: 0

302-VV-VI-2702
PGH RECYCLE COMPRESSOR SUCTION DRUM
DP : 37.0 kg/cm²g
DT : 185 °C
Inside Diam. x Len.(T/T):1200 mm x 4200 mm

NOTES:
1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-01011 THRU B957-79-41-000-11014.
ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "302" UNLESS OTHERWISE SPECIFIED.
2. TWO OUT OF THREE HIGH HIGH LEVEL TRIP SIGNALS WILL CAUSE 302-KA-CF-2701 SHUTDOWN AND ANY ONE WILL CAUSE ALARM.DEVIATION OF ANY ONE SIGNAL FROM ANY OTHERS WILL CAUSE ALARM.
3. TWO PHASE FLOW.ANCHOR SECURELY.
4. COMPRESSOR SUCTION TO BE PICKLED AND PASSIVATED.
5. LG SHOULD BE READABLE FROM GLOBE VALVE.
6. FOR SAMPLE CONNECTION DETAILS REFER P&ID NO. B957-79-41-300-11878.
7. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER P&ID NO. B957-79-41-300-11874.
8. A PRESSURE RELIEF VALVE MAY NOT PROVIDE SUFFICIENT PROTECTION FOR AN UNWETTED WALL VESSEL (UNWETTED VESSEL ARE THOSE ON WHICH THE INTERNAL WALLS ARE EXPOSED TO A GAS, VAPOR OR SUPERCRITICAL FLUID), AND VESSEL RUPTURE COULD OCCUR BEFORE OR TOO SOON AFTER INITIAL RELIEF. ADDITIONAL PROTECTION MEASURE OF FIRE PROOFING & FIRE WATER SPRINKLER SYSTEM TO BE PROVIDED.

10"-HG-302-22601-B52A(B1E)- NOTE 4 → 10354 PGH RECYCLE GAS 302-11227 TO 302-KA-CF-2701
-WFL-302-22602-A11A(A1D)- → 11725 WET FLARE 300-11861-07
-WFL-302-22601-A11A(A1D)-
-WFL-302-22603-A11A(A1D)-
2"-WFL-302-22603-A11A(A1D)-
PSV 22601A, PSV 22601B (NOTE-8, PROC. A11A, 37.00)
-P-302-22603-B52A(B1E)- FREE DRAINING -P-302-22604-B52A(B1E)-
2"-P-302-22605-B52A(B1E)- B52A A11A
TE/TT 22601, TI 22601
PT 22602, PI 22602
302-VV-VI-2702
10511 H2 RICH GAS 302-11217 FROM 302-VV-VW-2603 — 2"-P-302-21701-B52A(B1E)-
10726 HP OFF GAS 302-11230 FROM 302-VV-VW-2701 — 10"-P-302-23002-B52A(B1E)- DO NOT POCKET
MIN. 10"-P-302-23002-B52A(B1E)- 12"x10"
PI 22801
10771 HYDROGEN 302-11213 FROM 300-LZ-00-3002 — 2"-HG-302-21302-B52A(B1E)-
FIC 22601, FE/FT 22601, FV 22601, FC 1", 2"x1", SEE DETAIL "A", XV 22601, FC TSO
2"-HG-302-21302-B52A(B1E)-
ESD 2613
LI 22603 H A,B,C
LY 22603 HH NOTE 2 2oo3
LAHH 22603
LT 22603 A,B,C
UC 2"
MH 24"
LG 22602 NOTE 5
LT 22601
UC 22901 H
3000(MIN) MIN FOR PIPING
2"-P-302-22601-B52A(B1E)-
2"-P-302-22602-B52A(B1E)-
2"-PGD-302-22601-A9A(A1D)- NOTE 5 A9A B52A 2" OWS
10771 PGD DRAIN 300-11868
LV 22601 B52A A9A 2"x1" FC 1" 1" NNF 2"-P-302-22602-A9A(A1D)- NOTE 3
10536 KNOCK OUT LIQUID (300-11146) TO 300-CC-00-1301
SC 22601 NOTE 6

DETAIL "A"
ESD 2613, S, AI, ZLL 226, ZLH 226, ZSL 226, ZSH 226, XV 22601, TSO FC
ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS XV TAG NUMBER

REV.	DATE	REVISION	DRN	BY	CHKD	APPD
3	26.09.25	ISSUED FOR HAZOP	RS	GS	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AN	GS	KK	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	302	11226	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	POM	PM		CLIENT
3	03/07/2025	REVISED FOR BEP	NAh	AS	SC	SKG VK	SA		
2	01/13/2025	FOR BEP	NAh	AS	SC	SKG VK	SA		
1	10/21/2024	PRELIMINARY	NAh	AS	SC	SKG VK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
PGH UNIT
RECYCLE COMPRESSOR SUCTION DRUM

SCALE: | DWG. No: 363136-302-11226 | REV. 1

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "302" UNLESS OTHERWISE SPECIFIED.
2. TWO PHASE FLOW ANCHOR SECURELY.
3. LOCATE CONTROL VALVE WITH SUFFICIENT STATIC HEAD TO PREVENT FLASHING AT CONTROL VALVE INLET.
4. LOCATE LEVEL GAUGE READABLE FROM GLOBE VALVE.

302-VV-VW-2603
PGH FIRST STAGE HP FLASH DRUM
DP : 33 kg/cm^2g
DT : 230 °C
Inside Diam. x Len.(T/T):1600 mm x 8000 mm

H2 RICH GAS 302-11226 10011 TO 302-VV-VI-2702
2"-P-302-21701-B1E-
FV 21701
FIC 21701
FE/FT 21701
FC 1"
2"x1"
1"
4"x2"
4"-P-302-21701-B1E-
PT 21701
PI 21701
2"
PROC. A1D
1D2 33.00 PSV 21701A
PSV 21701B
3"x2"
LO
3"-WFL-302-21701-A1D-
3"-WFL-302-21702-A1D-
10006 WET FLARE
LC
2"-P-302-21704-B1E-
2"-P-302-21705-B1E-
FREE DRAINING
2"-WFL-302-21704-A1D-
2"-WFL-302-21703-A1D-
HIC 21701
2"-P-302-21706-B1E-
B1E A1D
HV 21701
2"-P-302-21703-B1E-
TSO VI
10612 1ST STAGE EFF. 302-11213 FROM 302-EE-00-2603
3"-P-302-21303-B1D-
NOTE 2
10618 1ST STAGE EFF. 302-11214 FROM 302-EE-00-2601
6"-P-302-21406-B1D-
302-VV-VW-2603
LG 21702
LT 21701
LIC 21701
NOTE 4
24" MH
UC 2"
2200 HAM NOTE 3
2"-P-302-21706-B1D-
OWS
B1D A1D
8"-P-302-21702-B1D-
LV 21701
8"x6"
6" FC NOTE 3
6" B1D A1D
8"-P-302-21702-A1D-
10501 1ST STAGE EFF. 302-11218 TO 302-VV-VW-2605
2"-PGD-302-21701-A1D-
10613 PGD DRAIN

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM		CLIENT
3	03/07/2025	REVISED FOR BEP	NAH	AS	SC	SKG/AK	SA		
2	01/13/2025	FOR BEP	NAH	AS	SC	SKG/AK	SA		
1	10/21/2024	PRELIMINARY	NAH	AS	SC	SKG/AK	SA		

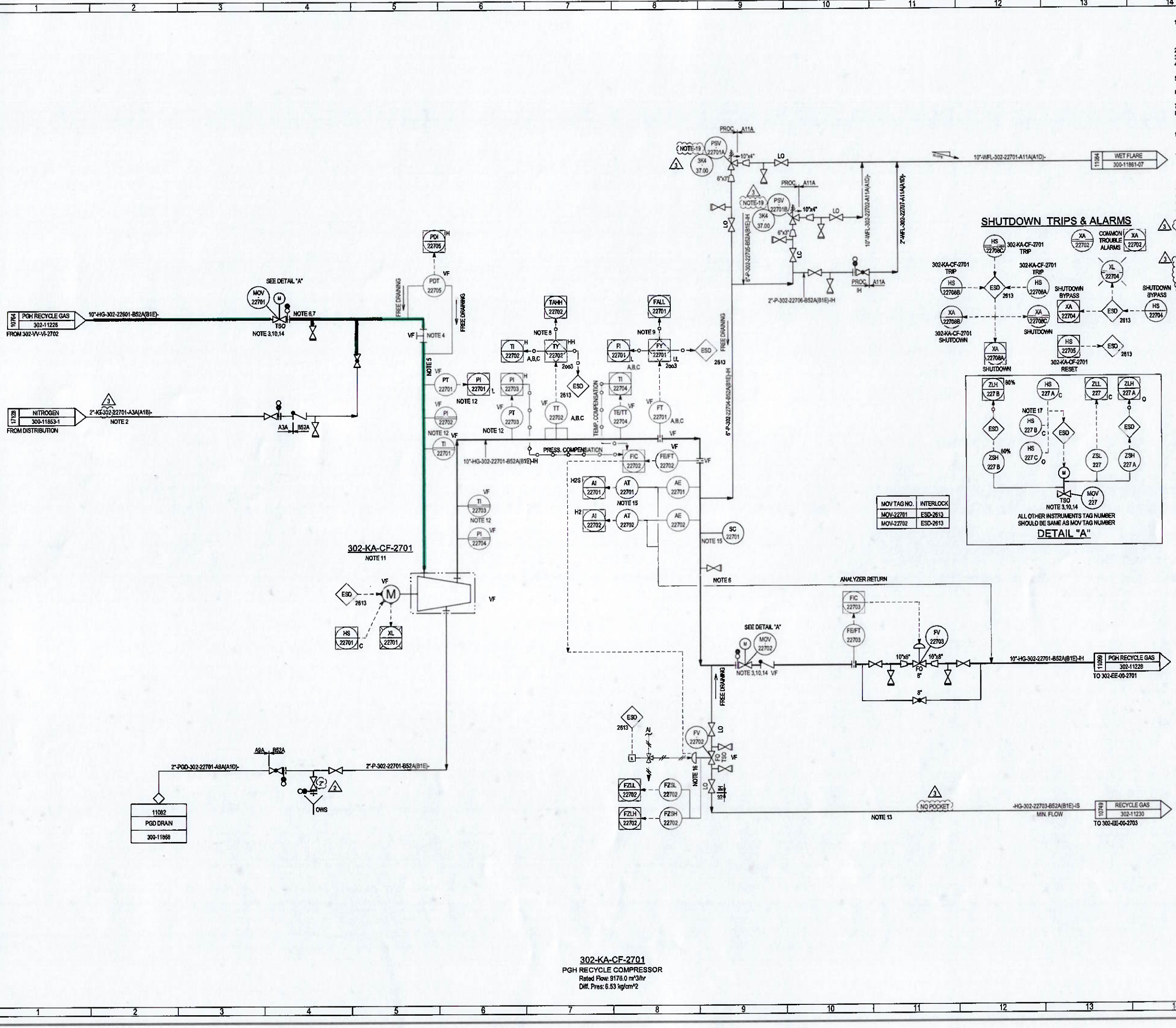
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PIPING AND INSTRUMENTATION DIAGRAM
PGH UNIT
PGH FIRST STAGE HP FLASH DRUM

SCALE: | DWG. No: 363136-302-11217 | REV: 1

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NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-0009 1011 THRU B957-79-41-0009 1014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "302" UNLESS OTHERWISE SPECIFIED.
2. PROVIDE NITROGEN HOSE STATION.
3. LOCATE MOTOR OPERATED VALVE AS CLOSE TO 302-KA-CF-2701 AS POSSIBLE.
4. LOCATE SUCTION STRAINER IN HORIZONTAL RUN AT MINIMUM STRAIGHT RUN DISTANCE FROM COMPRESSOR.
5. STRAIGHT RUN OF PIPE REQUIRED AT COMPRESSOR SUCTION NOZZLES TO BE DETERMINED WITH COMPRESSOR VENDOR DURING DETAIL DESIGN.
6. LOCATE ADJACENT DRAIN VALES AND NITROGEN PURGE CONNECTION AS CLOSE TO THE COMPRESSOR ISOLATION MOVS AS POSSIBLE.
7. COMPRESSOR SUCTION LINE TO BE PICKLED AND PASSIVATED.
8. TWO OUT OF THREE HIGH HIGH TEMPERATURE TRIP SIGNALS WILL CAUSE 302-KA-CF-2701 SHUTDOWN AND ANY ONE WILL CAUSE ALARM. DEVIATION OF ANY ONE SIGNAL FROM ANY OTHER WILL CAUSE ALARM.
9. TWO OUT OF THREE LOW LOW FLOW TRIP SIGNAL WILL CAUSE302-KA-CF-2701 SHUT DOWN AND ANY ONE WILL CAUSE ALARM. DEVIATION OF ANY ONE SIGNAL FROM ANY OTHERS WILL CAUSE ALARM.
10. COMPRESSOR (302-KA-CF-2701) SUCTION/DISCHARGE ISOLATION VALVES SHALL EACH HAVE JOG OPEN/CLOSE PUSH BUTTONS AND OPEN/CLOSE INDICATION INTEGRAL TO THE VALVE MOUNTED ACTUATORS. IF THE VALVE IS LOCATED IN THE FIRE ZONE, IT SHALL BE FIRE SAFE WITH FIRE PROOFED ACTUATOR POWER AND CONTROL CABLES IN A FIRE ZONE SHALL BE FIRE PROOFED.
11. COMPRESSOR DETAILS TO BE CONFIRMED BY VENDOR.
12. LOCATE INSTRUMENT TAPS CLOSE TO COMPRESSOR 302-KA-CF-2701 FLANGES.
13. MINIMUM FLOW LINE SIZE TO BE DETERMINED BY DEC.
14. COMPRESSOR TO SHUTDOWN AUTOMATICALLY WHEN VALVE IS 20% OR MORE CLOSED. COMPRESSOR IS PERMITTED TO START UP ONLY WHEN VALVE IS FULLY OPEN
15. FOR SAMPLE CONNECTION DETAILS REFER P&ID NO. B957-79-41-300-11876.
16. FINAL VALVE TYPE SELECTION BY VENDOR. FINAL VALVE SIZING WILL BE BASED ON SURGE FLOW INFORMATION FROM COMPRESSOR CURVES BY VENDOR. VALVE TO BE SUPPLIED BY COMPRESSOR VENDOR.
17. LOCATE PUSH BUTTON 15 METERS FROM COMPRESSOR AT SAFE LOCATION.
18. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER P&ID NO. B957-79-41-300-11874.
19. FLUID PROPERTIES AT RELIEF CONDITIONS ARE SUPERCRITICAL. A PRESSURE RELIEF VALVE MAY NOT PROVIDE SUFFICIENT PROTECTION FOR AN UNWETTED WALL VESSEL (UNWETTED VESSEL ARE THOSE ON WHICH THE INTERNAL WALLS ARE EXPOSED TO A GAS, VAPOR OR SUPERCRITICAL FLUID), AND VESSEL RUPTURE COULD OCCUR BEFORE OR TOO SOON AFTER INITIAL RELIEF. ADDITIONAL PROTECTION MEASURE OF FIRE PROOFING & FIRE WATER SPRINKLER SYSTEM TO BE PROVIDED.

VF: VENDOR FURNISHED

302-KA-CF-2701
PGH RECYCLE COMPRESSOR
Rated Flow: 9176.0 m^3/hr
Diff. Pres: 6.53 kg/cm^2

REV	DATE	REVISION	DRN	BY	CHKD	APPD.
3	26.09.25	ISSUED FOR HAZOP	RS	GS	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AN	GS	KK	MS

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

अनुमाप SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG. No.	पीढ़ी REV.
S	B957	79	41	302	11227	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
4	03/07/2025	REVISED FOR BEP	NAN	AS	SC	SKG/VK	SA	
3	01/13/2025	FOR BEP	NAN	AS	SC	SKG/VK	SA	
2	10/21/2024	PRELIMINARY	NAN	AS	SC	SKG/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
PGH UNIT
RECYCLE COMPRESSOR

SCALE: | DWG. No: 363136-302-11227 | REV. 1

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302-EE-00-2703
PGH SECOND STAGE REACTOR EFFLUENT CONDENSER
DP (S/T) : 37/28.5 kg/cm^2g
DT (S/T) : 185 °C/ 95 °C
Rated Duty: 4.888 MMKCAL/HR
TEMA Type: HELIX-AEM

302-VV-VW-2701
PGH SECOND STAGE HP FLASH DRUM
DP : 37.0 kg/cm^2g
DT : 185 °C
Inside Diam. x Len.(T/T):1700 mm x 8100 mm

Note: Tube Side of exchanger (EE-00-2703) shall be included in chemical cleaning and passivation markup.

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-0001-1011 THRU B957-79-41-0001-1014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "302" UNLESS OTHERWISE SPECIFIED.
2. TWO PHASE FLOW ANCHOR SECURELY.
3. ELEVATION IS BASED ON PRELIMINARY PUMP NPSH REQUIREMENT.
4. FOR SAMPLE CONNECTION DETAILS REFER P&ID NO. B957-79-41-300-11878.
5. MINIMUM FLOW LINE SIZE TO BE DETERMINED BY DEC.
6. LOCATE PUSH BUTTON 15 METERS FROM PUMP AT SAFE LOCATION.
7. PUSH BUTTON IN THE FIELD OR DCS ACTIVATES INTERLOCK WHICH CLOSES ISOLATION VALVE AND SHUTS DOWN ALL ASSOCIATED PUMPS. VALVE LOCATED IN THE FIRE ZONE SHALL BE FIRE SAFE WITH FIRE PROOF ACTUATOR. POWER AND CONTROL CABLES IN FIREZONE SHALL BE FIREPROOFED.
8. MOTOR OF PUMP SHALL BE AUTOMATICALLY STOPPED WHEN MOV IS LESS THAN 80% OPEN AND CANNOT BE RESTARTED UNTIL THE MOV IS FULLY OPENED.
9. LOCATE CONTROL VALVE WITH SUFFICIENT STATIC HEAD TO PREVENT FLASHING AT CONTROL VALVE INLET.
10. THE LIQUID RECYCLE PUMPS 302-PA-CF-2705A/B IS USED ONLY FOR FLEXIBILITY P/E<0.55
11. LG TO BE READABLE FROM GLOBE VALVE.
12. GLOBE VALBE TO BE CONSIDERED WITH POSITION LOCK ARRENGENMENT AND TO BE LOCATED AT GRADE.
13. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER P&ID NO: B957-79-41-300-11874.
14. FLUID PROPERTIES AT RELIEF CONDITIONS ARE SUPERCRITICAL. A PRESSURE RELIEF VALVE MAY NOT PROVIDE SUFFICIENT PROTECTION FOR AN UNWETTED WALL VESSEL (UNWETTED VESSEL ARE THOSE ON WHICH THE INTERNAL WALLS ARE EXPOSED TO A GAS, VAPOR OR SUPERCRITICAL FLUID), AND VESSEL RUPTURE COULD OCCUR BEFORE OR TOO SOON AFTER INITIAL RELIEF. ADDITIONAL PROTECTION MEASURE OF FIRE PROOFING & FIRE WATER SPRINKLER SYSTEM TO BE PROVIDED.

ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS MOV TAG NUMBER

DETAIL "A"

DETAIL 'B'
1INJECTION QUILL DETAILS BY DETAIL ENGINEERING CONTRACTOR
1INJECTION QUILL TO BE REMOVABLE THRUGH NOZZEL

REV.	DATE	REVISION	ORN	BY	CHKD	APPD.
3	26.09.25	ISSUED FOR HAZOP	RS	GS	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AN	GS	KK	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	302	11230	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAO	PROC ENG	LPE	POM	FM	CLIENT
A	03/07/2025	REVISED FOR BEP	NAh	AS	SC	SK/GK/VK	SA	
B	01/13/2025	FOR BEP	NAh	AS	SC	SK/GK/VK	SA	
A	10/21/2024	PRELIMINARY	NAh	AS	SC	SK/GK/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
PGH UNIT
PGH SECOND STAGE HP FLASH DRUM

SCALE: | DWG. No: 363136-302-11230 | REV. 1

302-PA-CF-2705A/B
PGH SECOND STAGE REACTOR RECYCLE PUMPS
Rated Flow: 74.0 m^3/hr
Diff. Pres: 10.70 kg/cm^2
DP: 53.0 kg/cm^2g
DT : 70 °C
NOTE 10

300-EE-00-2101
SPENT CAUSTIC
WASH GASOLINE COOLER
DP (S/T) 21.5/17.0 kg/cm**2g
DT (S/T) 120 °C/ 65 °C
Rated Duty: 0.185 MMKCAL/HR
TEMA Type: HAIRPIN

300-JS-00-2101
SPEND CAUSTIC/WASH
GASOLINE MIXER
DP 10.5kg/cm**2g
DT 65 °C
Rated Flow 8719 kg/hr

300-VV-HI-2101
SPENT CAUSTIC
COALESCER
DP 10.5 kg/cm**2g
DT 65 °C
Inside Diam. x Len.(T/T) 2000 mm x 6000 mm

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 8957-79-41-000-11011 THRU 8957-79-41-000-11014.
   ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. WASH WATER PURGE.
3. CONNECTION TO THE TOP OF PIPE.
4. LOCATE 300-JS-00-2101 IN VERTICAL POSITION BELOW BOTTOM OF 300-VV-HI-2101.
5. REFER P&ID NO. 8957-79-41-300-11878 FOR SAMPLE CONNECTION DETAILS.
6. REFER P&ID NO. 8957-79-41-300-11877 FOR FLUTE DETAILS.
7. REFER P&ID NO. 8957-79-41-300-11874 FOR CONTROL VALVE VENT AND DRAIN DETAILS.

REV	DATE	REVISION	DRN	BY	CHKD	APPD.
3	30.09.25	REVISED AS MARKED & ISSUED FOR HAZOP	SS	GS	PD/NS	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AK	GS	PD/NS	MS

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अनुभाग SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG. No.	संशो. REV.
	B957	79	41	300	11243	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

Bharat Petroleum
BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
3	03/07/2025	REVISED FOR BEP	NAh	HN	SC	SK/G /VK	SA	
2	01/13/2025	FOR BEP	NAh	HN	SC	SK/G /VK	SA	
1	10/21/2024	PRELIMINARY	NAh	HN	SC	SK/G /VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
SPENT CAUSTIC COALESCER

SCALE	DWG. No.	REV
	363136-300-11243	1

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NOTES:

1. FOR NOTES REFER P&ID NO.B957-79-41-300-1151-I (SHEET 1 OF 2)
2. FOR DETAILS REFER VENDOR P & ID NO.B957-79-4*-300-PID-1151B

300-KA-CF-5001
COMPRESSOR
LP CASING

300-KA-CF-5001
COMPRESSOR
HP CASING

COMPRESSOR CONTROL SYSTEM NOTE 24

B.V NOTE 9,23 (MAIN TURBINE)

PIC-51404 300-11514 (1 OF 2)

SI 51102 VF
SI 51103 VF
SIC 51101 SP VF
ESD 5001

36"-SM-300-51101-B2A(B1A)-IH → 14745 MP STEAM 300-11557 TO HEADER

-CL-300-51101-A9A(A1D)-IH → 20360 VACU. CONDENSATE

24"-SVH-300-51101-G2G(G5BAS)-IH → 14749 VHP STEAM 300-11555 FROM DISTRIBUTION

TY-51103 300-11511 (SHEET 1 OF 2) 20365

PY-51107 300-11511 (SHEET 1 OF 2) 20364

2"-IG-300-51103-A3A(A1B)- → NITROGEN 300-11511 (SHEET 1 OF 2) 20366

1ST 2ND 2ND 1ST 3RD 4TH

62.5d 44.5d 44.5d 62.5d 54d5 42.5d 66.5d

TI 51104 H A B C
NOTE 15
TY 51104 HH 2oo3 TAHH 51104
ESD 5001
TE/TT 51104 A B C
PI 51118 NOTE 17
TI 51110 NOTE 17
PI 51108 NOTE-5,26
TE/TT 51103
PT 51107
TI 51103 NOTE 17
PI 51107 NOTE 17
TI 51121
PI 51151
TETT 51123
PT 51151
PI 51152

-PR-300-51106-D41K(D2)L-HC
-PR-300-51107-D41K(D2)L-HC
-PR-300-51105-D41K(D2)L-HC
-PR-300-51109-D41K(D2)L-HC

54"-PR-300-51151-B9A(B1D)-HC
90.5d
42"-PR-300-51152-B40A(B2A)-HC
78.5d62
56.5d47

66"-PR-300-51101-B9A( )-HC → 20363 4TH STAGE DIS. 300-11511 (SHEET 1 OF 2)

42"-PR-300-51201-B9A(B1D)-HC → 20354 4TH STAGE SUCT. 300-11511 (SHEET 1 OF 2)

30"-PR-300-51151-B9A(B1D)-HC → 20365 C3R 300-11511 (SHEET 1 OF 2)

ESD 0091 0092 ESD 5001

SHUTDOWN & ALARMS

HS 51107C 300-KA-CF-5001 TRIP
HS 51107B 300-KA-CF-5001 TRIP
HS 51107A 300-KA-CF-5001 TRIP
ESD 5001
XA 51107B 300-KA-CF-5001 SHUTDOWN
XA 51107C 300-KA-CF-5001 SHUTDOWN
XA 51107A 300-KA-CF-5001 SHUTDOWN

RESET

300-KA-CF-5001 RESET
HS 51108
ESD 5001

COMMON TROUBLE ALARMS

XA 51110
XA 51111

300-KA-CF-5001

PROPYLENE REFRIGERANT COMPRESSOR
DES. TEMP:
DES. PRESS:

CASING DRAIN 300-11613 TO 300-VV-HW-5007 (1)245
2"-LD-300-51101-D41K(D2)LH-S DO NOT POCKET
NOTE-28
IS IC

IST STAGE SUCT. 300-11511 (SHEET 1 OF 2) 20367
78"-PR-300-51401-B40A(B2A)-HC

2ND STAGE SUCT. 300-11511 (SHEET 1 OF 2) 20366
56"-PR-300-51501-B40A(B2A)-HC

REV.	DATE	REVISIONS	DRN	BY	CHKD	APPD.
3	14.11.25	ISSUED FOR HAZOP	AK	KM	KK	MS

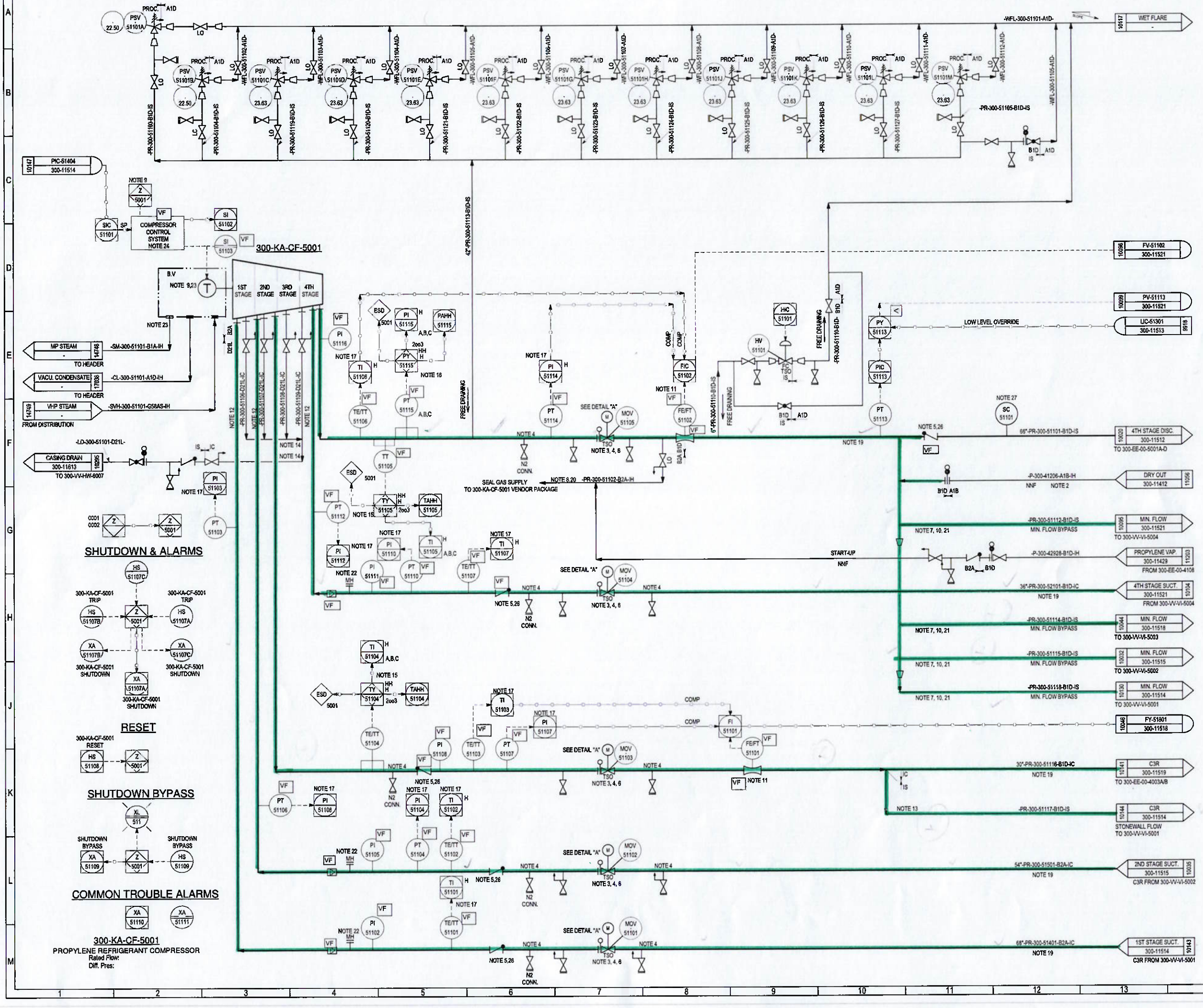
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भारत पैट्रोलियम कॉर्पोरेशन लिमिटेड
BHARAT PETROLEUM CORPORATION LTD.
BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)

पाइपिंग एण्ड इंस्ट्रूमेन्टेशन डायाग्राम
PIPING AND INSTRUMENTATION DIAGRAM
PROPYLENE REFRIGERATION SYSTEM- (SHEET NO.2 OF 2)
PROPYLENE REFRIGERANT COMPRESSOR

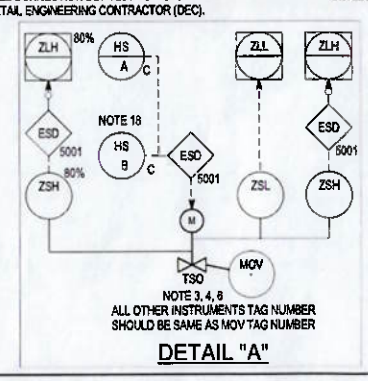
अनुमाप SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG No.	संशो REV.
NTS	B957	79	41	300	11511-2	3

Page 1944 of 4391 ; B957-TENDER_DOC-B957-300-16-43-MR-T-3001 ; Rev. A



NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014.
   ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. FINAL CONFIGURATION OF DRY OUT SYSTEM TO BE CONFIRMED BY DEC.
3. ISOLATION VALVE SHALL HAVE JOG OPEN/CLOSE PUSH BUTTONS AND OPEN/CLOSE INDICATORS INTEGRAL TO VALVE MOUNTED MOTOR ACTUATOR IF THE VALVE IS LOCATED IN A FIRE ZONE. IT SHALL BE FIRE SAFE WITH FIRE PROOFED ACTUATOR, POWER AND CONTROL CABLES IN A FIRE ZONE SHALL BE FIRE PROOFED.
4. LOCATE MOV AS CLOSE TO COMPRESSOR AS POSSIBLE. LOCATE ADJACENT DRAIN VALVES AND NITROGEN PURGE CONNECTIONS AS CLOSE TO THE MOTOR OPERATED VALVES AS POSSIBLE.
5. ACCEPTABLE CHECK VALVES FOR PROPYLENE SERVICE ARE:
   A: MCKVELD AXIAL CHECK VALVE.
   B: GOODWIN AXIAL CHECK VALVE.
   C: CRANE AXIAL CHECK VALVE.
6. COMPRESSOR TO SHUTDOWN AUTOMAITICALLY WHEN MOV IS 20% OR MORE CLOSED.COMPRESSOR IS PERMITTED TO START-UP ONLY WHEN VALVE IS FULLY OPEN.
7. DO NOT POCKET FEED LINE TO MINIMUM FLOW BYPASS CONTROL VALVE.
8. COMPRESSOR SEAL GAS INJECTION SYSTEM SHALL BE DEVELOPED DURING DETAIL ENGINEERING.
9. COMPRESSOR INTERLOCK SHALL TRIP TURBINE AND CLOSE TRIP THROTTLE VALVE AND GOVERNOR VALVE. GLOBAL UTILITY FAILURE SHALL CLOSE AN ADDITIONAL SHP STEAM SUPPLY VALVE.
10. MINIMUM FLOW CONTROL SYSTEM FOR 300-KA-CF-5001 TO BE REVIEWED WITH COMPRESSOR VENDOR.
11. FLOWMETER TO BE TEMPERATURE AND PRESSURE COMPENSATED.
12. STRAIGHT RUN OF PIPE REQUIRED AT COMPRESSOR SUCTION NOZZLES TO BE CONFIRMED WITH COMPRESSOR VENDOR DURING DETAIL DESIGN.
13. LINE SIZE BY DEC BASED ON 300-KA-CF-5001 VENDOR INPUT.
14. CASING DRAIN TO BE PROVIDED FOR EACH STAGE TO BE CONFIRMED WITH VENDOR.
15. TWO OUT OF THREE HIGH TEMPERATURE TRIP SIGNALS WILL CAUSE 300-KA-CF-5001 SHUT DOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM ALL OTHER WILL ALARM.
16. TWO OUT OF THREE HIGH PRESSURE TRIP SIGNALS WILL CAUSE 300-KA-CF-5001 SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM ALL OTHER WILL ALARM.
17. LOCATE INSTRUMENT TAP CLOSE TO COMPRESSOR FLANGES.
18. LOCATE PUSH BUTTON 15 METERS FROM COMPRESSOR AT SAFE LOCATION.
19. DURING DETAIL ENGINEERING COMPRESSOR AND PIPING TO BE CHECKED IF NOISE INSULATION IS REQUIRED.
20. SEAL GAS IS AS FOLLOWS:
    INNER SEAL:
    PROPYLENE VAPOR FROM PROPYLENE START-UP VAPORIZER (300-EE-00-4108) AT STARTUP BEFORE COMPRESSOR OPERATION AND FROM COMPRESSOR DISCHARGE FOR ALL OTHER OPERATIONS. OUTER SEAL:
    NITROGEN FOR ALL OPERATIONS.
21. MIN. FLOW LINE SIZE TO BE CONFIRMED BY DEC.
22. FOR ALL COMPRESSOR SUCTION LINE 30" AND GREATER, 24" MANHOLES SHALL BE PROVIDED IF NECESSARY TO FACILITATE CLEANING AND INSPECTION.
23. PROPYLENE REFRIGERANT COMPRESSOR TURBINE DETAILS BY DEC.
24. PRC CONTROL INSTRUMENTATION INCLUDING MINIMUM SURGE CONTROL SYSTEM AND SHUTDOWN/TRIP LOOPS. TO BE CONFIRMED WHEN VENDOR DESIGN IS REVIEWED AND AGREED, DURING DETAIL ENGINEERING.
25. MULTIPLE RELIEF VALVES ARE STAGGERED BETWEEN 22.5 KG/CM2(G) TO 23.63KG/CM2(G).PRELIMINARY ESTIMATED NUMBER OF PSVS ARE X+1 SPARE. FINAL NUMBER OF PSVS TO BE DETERMINED BY DETAIL ENGINEERING CONTRACTOR.
26. LOW PRESSURE DROP NON SLAMING CHECK VALVE.
27. SAMPLE CONNECTION DETAILS AND RETURN LINE DESTINATION TO BE DEVELOPED BY DETAIL ENGINEERING CONTRACTOR (DEC).



DETAIL "A"

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	POM	PM	CLIENT
A	10/21/2024	PRELIMINARY	NAh	OJK	SC	SKG /VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM-
PROPYLENE REFRIGERANT COMPRESSOR

SCALE: | DWG. No: 363136-300-11511 | REV: A

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NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-71-41-0004-1101 THRU B957-71-41-0004-1114.
   ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. FINAL CONFIGURATION OF DRY OUT SYSTEM TO BE CONFIRMED BY DEC.
3. ISOLATION VALVE SHALL HAVE JOG OPEN/CLOSE PUSH BUTTONS AND OPEN/CLOSE INDICATORS INTEGRAL TO VALVE ETC MOUNTED MOTOR ACTUATOR. IF THE VALVE IS LOCATED IN A FIRE ZONE, IT SHALL BE FIRE SAFE WITH FIRE PROOFED ACTUATOR, POWER AND CONTROL CABLES IN A FIRE ZONE SHALL BE FIRE PROOFED.
4. LOCATE MOV AS CLOSE TO COMPRESSOR AS POSSIBLE. LOCATE ADJACENT DRAIN VALVES AND NITROGEN PURGE CONNECTIONS AS CLOSE TO THE MOTOR OPERATED VALVES AS POSSIBLE.
5. ACCEPTABLE CHECK VALVES FOR PROPYLENE SERVICE ARE:
   A. MOR/WELD AXIAL CHECK VALVE.
   B. GO/DOWN AXIAL CHECK VALVE.
   C. CRANE AXIAL CHECK VALVE.
6. COMPRESSOR TO SHUTDOWN AUTOMATICALLY WHEN MOV IS 20% OR MORE CLOSED. COMPRESSOR IS PERMITTED TO START-UP ONLY WHEN VALVE IS FULLY OPEN.
7. DO NOT POCKET FEED LINE TO MINIMUM FLOW BYPASS CONTROL VALVE.
8. COMPRESSOR SEAL GAS INJECTION SYSTEM SHALL BE DEVELOPED DURING DETAIL ENGINEERING.
9. COMPRESSOR INTERLOCK SHALL TRIP TURBINE AND CLOSE TRIP THROTTLE VALVE AND GOVERNOR VALVE. GLOBAL UTILITY FAILURE SHALL CLOSE AN ADDITIONAL HP STEAM SUPPLY VALVE.
10. MINIMUM FLOW CONTROL SYSTEM FOR 300-KA-CF-5001 TO BE REVIEWED WITH COMPRESSOR VENDOR.
11. FLOWMETER TO BE TEMPERATURE AND PRESSURE COMPENSATED.
12. STRAIGHT RUN OF PIPE REQUIRED AT COMPRESSOR SUCTION NOZZLES TO BE CONFIRMED WITH COMPRESSOR VENDOR DURING DETAIL DESIGN.
13. LINE SIZE BY DEC BASED ON 300-KA-CF-5001 VENDOR INPUT.
14. CASING DRAIN TO BE PROVIDED FOR EACH STAGE TO BE CONFIRMED WITH VENDOR.
15. TWO OUT OF THREE HIGH TEMPERATURE TRIP SIGNALS WILL CAUSE 300-KA-CF-5001 SHUT DOWN AND ANY ONE WILL ALARM, DEVIATION OF ONE SIGNAL FROM ALL - OTHER WILL ALARM.
16. TWO OUT OF THREE HIGH PRESSURE TRIP SIGNALS WILL CAUSE 300-KA-CF-5001 SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM ALL OTHER WILL ALARM.
17. LOCATE INSTRUMENT TAP CLOSE TO COMPRESSOR FLANGES.
18. LOCATE PUSH BUTTON 15 METERS FROM COMPRESSOR AT SAFE LOCATION.
19. DURING DETAIL ENGINEERING COMPRESSOR VENDOR AND PIPING TO BE CHECKED IF NOISE INSULATION IS REQUIRED.
20. SEAL GAS IS AS FOLLOWS
    INNER SEAL
    PROPYLENE VAPOR FROM PROPYLENE START-UP VAPORIZER (300-EE-00-41006) AT STARTUP BEFORE COMPRESSOR OPERATION AND FROM COMPRESSOR DISCHARGE FOR ALL OTHER OPERATIONS.
    OUTER SEAL
    NITROGEN FOR ALL OPERATIONS.
21. MIN. FLOW LINE SIZE TO BE CONFIRMED BASED ON COMPRESSOR VENDOR INPUT.
22. FOR ALL COMPRESSOR SUCTION LINE 20" AND GREATER, 2 x 1/2" DRAIN HOLES SHALL BE PROVIDED IF NECESSARY TO FACILITATE CLEANING AND INSPECTION.
23. PROPYLENE REFRIGERANT COMPRESSOR TURBINE DETAILS BY DEC.
24. PRC CONTROL INSTRUMENTATION INCLUDING MINIMUM SURGE CONTROL SYSTEM AND SHUTDOWN TRIP LOOPS, TO BE CONFIRMED WHEN VENDOR DESIGN IS REVIEWED AND AGREED DURING DETAIL ENGINEERING.
25. MULTIPLE RELIEF VALVES ARE STAGGERED BETWEEN 25 KG/CM2(G) TO 23.63KG/CM2(G). PRELIMINARY ESTIMATED NUMBER OF PSVS ARE 10+2 SPARE. FINAL NUMBER OF PSVS TO BE DETERMINED BY DETAIL ENGINEERING CONTRACTOR.
26. LOW PRESSURE DROP NON SLAMMING CHECK VALVE.
27. FOR SAMPLE CONNECTION DETAILS REFER P&ID NO. B957-7-41-0-300-11974.
28. ONE TEFLON PORT FOR CASING HAVING MANIFOLD DRAIN, FOR EACH CASINGS SHALL BE PROVIDED BY VENDOR AT COMPRESSOR BASES PLATE FURTHER, ROUTING OF THE SAME SHALL BE IN PURCHASER'S SCOPE. (TYPICAL COMMENT FOR ALL THREE STAGE OF PRC.
29. FOR CONTROL VALVE VENT AND DRAIN REFER P&ID NO. B957-7-41-0-300-11974.

REV.	DATE	REVISION	DRN	CHK'D	APPD.
3	14.11.25	ISSUED FOR HAZOP.	AK	KM	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AK	KM	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

JOB NO.	PROJECT	SEQUENCE NO.	DOCUMENT NO.	REV.
B957	79	41	300 11511	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

Bharat Petroleum

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV.	DATE	DESCRIPTION	BY	CHK'D	APPD.	CLIENT
3	03.07.25	REVISED FOR BEP	NAH	OJK	SC	SNG
2	01.11.24	FOR BEP	NAH	OJK	SC	SNG
1	30.05.24	PRELIMINARY	NAH	OJK	SC	SNG

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM-
PROPYLENE REFRIGERANT COMPRESSOR

SCALE | DWG. NO. 363136-300-11511 | REV. 1 | (SHEET 1 OF 2)

DETAIL "A"

NOTE 3, 4, 5
ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS MOV TAG NUMBER

MOV TAG NO.	INTERLOCK
MOV-51101	ESD-5001
MOV-51102	
MOV-51103	
MOV-51104	
MOV-51105	

LOW LEVEL OVERRIDE

SEAL GAS SUPPLY TO 300-KA-CF-5001 VENDOR PACKAGE

FREE DRAINING

SEE DETAIL "A"

START-UP

COMP

COLD LIQUID DRAIN 20177 300-11829-1

4TH STAGE DISC. 300-11511-2
4TH STAGE SUCTION 300-11511-2
C3R 300-11511-2
2ND STAGE SUCTION 300-11511-2
1ST STAGE SUCTION 300-11511-2
TY-51103 300-11511-2 (SHEET 2 OF 2)
PY-51107 300-11511-2 (SHEET 2 OF 2)
NITROGEN 300-11511-2 (SHEET 2 OF 2)
COLD LIQUID DRAIN 20176 300-11829-1

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-11011 THRU B957-79-41-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. ON TRIP, THE CONTROLLER IS AUTOMATICALLY SET TO MANUAL MODE AND THE VALVE IS DRIVEN CLOSED.
3. LOCATED IN 300-KA-CF-5001 COMPRESSOR CONTROL SYSTEM.
4. LOOP MINIMUM FLOW LINE AND STONEWALL LINE AN ELEVATION HIGHER THAN BOTH THE LIQUID QUENCH INJECTION POINT AND VESSEL NOZZLE TO PREVENT BACK FLOW.
5. LIQUID QUENCH LINE SHALL CONNECT TO THE MINIMUM FLOW LINE DOWNSTREAM OF HIGH POINT OF LOOP.
6. INSTRUMENTATION TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.
7. LIQUID QUENCH TV-51402 TO BE LOCATED TO PREVENT FLASHING AT TV-51402 INLET.
8. DIMENSION AND NUMBER OF HOLES TO BE CONFIRMED BY DETAIL ENGINEERING CONTRACTOR TO ENSURE PROPER MIXING OF QUENCH LIQUID TO MIN. FLOW LINE.
9. TWO PHASE FLOW. ANCHOR SECURELY.
10. TWO OUT OF THREE HIGH HIGH LEVEL TRIP SIGNALS WILL CAUSE 300-KA-CF-5001 SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM OTHERS WILL ALARM.
11. FLOWMETER TO BE TEMPERATURE AND PRESSURE COMPENSATED.
12. ELEVATION BASED ON PRELIMINARY 300-PA-CF-5001 NPSH REQUIREMENT.
13. DRAIN LIQUID WHEN PUMP NOT IN USE.
14. DURING DETAIL ENGINEERING PIPING TO BE CHECKED IF NOISE INSULATION IS REQUIRED.
15. LINE SIZE BY DEC BASED ON 300-KA-CF-5001 VENDOR INPUT.
16. FLOW ONLY DURING PUMP START-UP OR SWITCH-OVER. LINE SIZE IS TO BE DETERMINED BY DEC. BASED ON START-UP FLOW REQUIREMENT DURING DETAIL ENGINEERING.
17. MIN. FLOW LINE SIZE TO BE DETERMINED BY DEC, AND QUENCH LIQUID LINE SIZE TO BE CONFIRMED BY DEC.
18. PUSH BUTTON IN THE FIELD OR DCS ACTIVATES INTERLOCK WHICH CLOSES ISOLATION VALVE AND SHUTS DOWN ALL ASSOCIATED PUMPS. VALVE LOCATED IN THE FIRE ZONE SHALL BE FIRE SAFE WITH FIRE PROOF ACTUATOR. POWER AND CONTROL CABLES IN FIREZONE SHALL BE FIREPROOFED.
19. MOTOR OF PUMP SHALL BE AUTOMATICALLY STOPPED WHEN MOV IS LESS THAN 80% OPEN AND CONNOT BE RESTARTED UNTIL THE MOV IS FULLY OPENED.
20. LOCATE PUSH BUTTON 15 METERS FROM PUMP AT SAFE LOCATION.
21. TRANSMITTERS TO HAVE INDIVIDUAL TAPPINGS.
22. PSV SIZING AND SET PRESSURE TO BE CONFIRMED BY DEC.
23. PUMP VENT LINE SIZE BASED ON PUMP VENDOR INPUT.
24. CHILL DOWN FLOW ONLY DURING PUMP START-UP OR SWITCH-OVER. LINE SIZE IS TO BE DETERMINED BASED ON START-UP FLOW REQUIRMENT BASED ON PUMP VENDOR INPUT.
25. LOCATE THE CONTROL VALVE AT HIGH POINT.
26. DO NOT POCKET FEED LINE TO MINIMUM FLOW BYPASS CONTROL VALVE.
27. HANDWHEEL TO BE DISENGAGED DURING SIS OPERATION.
28. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER PSJO NO. B957-79-41-303-11874.

300-VV-VI-5001
PROPYLENE REFRIGERANT COMPRESSOR
1ST STAGE SUCTION DRUM
DP : 18.0 kg/cm^2g
DT : -45°C/100°C
Inside Diam. x Len.(T/T):7200 mm x 9400 mm

DETAIL "A"

DETAIL "B"

300-PA-CF-5001
PROPYLENE REFRIGERANT PUMPOUT PUMP
Rated Flow: 100.0 m^3/hr
Diff. Pres: 22.68 kg/cm^2
DP: 51 kg/cm^2g
DT : -45°C/65°C

3	06.10.25	ISSUED FOR HAZOP.	SS	KM	KK	MS		
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AK	KM	KK	MS		
REV	DATE	REVISION	DRN	BY	CHKD	APPD.		

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	300	11514	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
3	03/07/2025	REVISED FOR BEP	NAH	OJK	SC	SKG/VK	SA	
2	01/13/2025	FOR BEP	NAH	OJK	SC	SKG/VK	SA	
1	10/21/2024	PRELIMINARY	NAH	OJK	SC	SKG/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM
-PRC 1ST STAGE SUCTION DRUM

SCALE: | DWG. No. 363136-300-11514 | REV. 1

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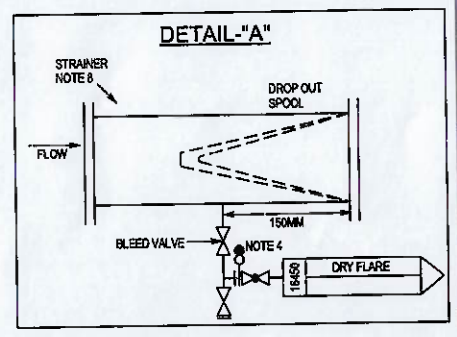
300-VV-VI-5004
PROPYLENE REFRIGERANT COMPRESSOR
4TH STAGE SUCTION DRUM
DP 18.0 kg/cm^2g
DT : -29/100°
Inside Diam. x Len.(T/T):6500 mm x 19600 mm

300-LZ-00-3001-EP-00-18
OFFGAS EXCHANGER NO.6
(PART OF 300-LZ-00-3001)
(NOTE 15)

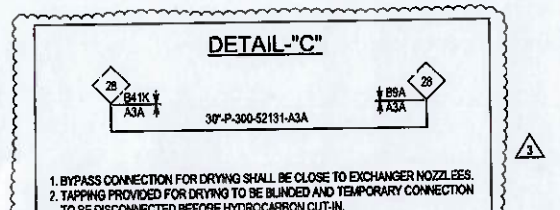
NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-11011 THRU B957-79-41-000-11014
   ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. DO NOT POCKET FEED LINE TO MINIMUM FLOW BYPASS CONTROL VALVE.
3. LOOP MINIMUM FLOW LINE TO AN ELEVATION HIGHER THAN BOTH THE LIQUID QUENCH INJECTION POINT AND VESSEL NOZZLE TO PREVENT BACK FLOW.
4. VENTED GATE VALVES REQUIRED AS PER SERVICE.
5. VENDOR TO ENSURE MECHANICAL STRENGTH REQUIREMENT FOR STRAINER ELEMENT WITH SUITABLE DIFFERENTIAL DESIGN PRESSURE.
6. STRAINERS ARE TO BE LOCATED AS CLOSE AS POSSIBLE TO THE CORE EXCHANGER NOZZLE.
7. ALL PIPING DOWNSTREAM OF STRAINERS SHALL BE STAINLESS STEEL.
8. INLET STRAINERS TO BRAZED ALUMINUM EXCHANGER TO HAVE MESH SIZE BASED ON VENDOR RECOMMENDATION AND SHALL HAVE MAXIMUM PRESSURE DROP OF 100MM H20 AT MAXIMUM FLOW.
9. ELEVATION IS CONFIRMED TO AVOID FLASHING AT INLET OF 300-LZ-00-3001-EP-00-18
10. DROP OUT SPOOLS FOR BYPASSING EXCHANGER AND FIT UP TO PIPING. (REFER DETAIL C.)
11. TWO PHASE FLOW, ANCHOR SECURELY.
12. TWO OUT OF THREE HIGH HIGH LEVEL TRIP SIGNALS WILL CAUSE 300-KA-CF-5001 SHUTDOWN AND ANYONE WILL ALARM DEVIATION OF ONE SIGNAL FROM AL OTHERS WILL ALARM.
13. INSTALL DISSIMILAR METAL FLANGES INSULATING KITS AT CORE EXCHANGER NOZZLE CONNECTION.
14. DURING DETAIL ENGINEERING PIPING TO BE CHECKED IF NOISE INSULATION IS REQUIRED.
15. FOR DUTY OF INDIVIDUAL PASSES SEE RESPECTIVE DATA SHEETS.
16. MIN. FLOW LINE SIZE TO BE DETERMINED BY DEC, AND QUENCH LIQUID LINE SIZE TO BE CONIRMED BY DEC.
17. ADMINISTRATIVE PROCEDURES MUST BE USED TO ENSURE THAT COLD BOX INLET STRAINERS AND PIPING ARE PROPERLY DRAINED AND VENTED WHEN THEY ARE ISOLATED AND OUT OF SERVICE.
18. TRANSMITTERS TO HAVE INDIVIDUAL TAPPINGS.
19. INSTRUMENTATION TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE THE TAPPING POINT.
20. PT INDICATION TO BE READABLE FROM THE GLOBE VALVE.
21. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER P&ID NO. B957-79-41-300-11974

DETAIL-"A"



DETAIL-"C"



1. BYPASS CONNECTION FOR DRYING SHALL BE CLOSE TO EXCHANGER NOZZLEES.
2. TAPPING PROVIDED FOR DRYING TO BE BLINDED AND TEMPORARY CONNECTION TO BE DISCONNECTED BEFORE HYDROCARBON CUT-IN.

REV	DATE	REVISION	DRN	BY	CHKD	APPD.
3	06.10.25	ISSUED FOR HAZOP.	SS	KM	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	RS	KM	KK	MS

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	300	11521	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAO	PROC ENG	L/E	PDM	FM	CLIENT
3	03/07/2025	REVISED FOR BEP	NAh	O.K	SC	SK/G /VK	SA	
2	01/13/2025	FOR BEP	NAh	O.K	SC	SK/G /VK	SA	
1	10/21/2024	PRELIMINARY	NAh	O.K	SC	SK/G /VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM-PRC
4TH STAGE SUCTION DRUM

SCALE	DWG. No.	REV.
	363136-300-11521	1

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302-EE-00-2609
RERUN TOWER VENT CONDENSER
DP (S/T) 18.0/3.5/FV kg/cm^2g
DT (S/T) : -29/160°C/ 65 °C
Rated Duty: 0.188 MMKCAL/HR
TEMA Type: BEM

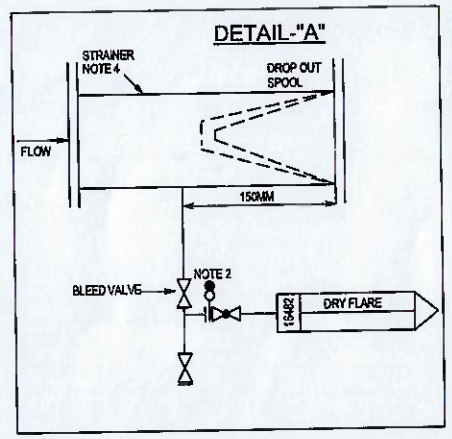
305-LZ-00-5701-EP-00-11
ROG COLD BOX
EXCHANGER NO. 1
(PART OF 305-LZ-00-5701)
(NOTE 13)

305-VV-VI-5713
LIQUID PROPYLENE ACCUMULATOR
FOR 305-LZ-00-5701-EP-00-11
DP : 18.0 kg/cm^2g
DT : -29/100°C
Inside Diam. x Len.(T/T):1100 mm x 3700 mm

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-11011 THRU B957-79-41-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. VENTED GATE VALVES REQUIRED AS PER SERVICE.
3. ALL PIPING DOWNSTREAM OF STRAINER SHALL BE STAINLESS STEEL.
4. INLET STRAINERS TO BRAZED ALUMINUM EXCHANGERS TO HAVE A MESH SIZE BASED ON VENDOR RECOMMENDATION SHALL HAVE A MAXIMUM PRESSURE DROP OF 100MM H2O AT MAXIMUM FLOW.
5. DRY OUT SPOOLS FOR BYPASSING EXCHANGER AND FIT UP TO PROCESS PIPING BY DEC.
6. INSTALL DISSIMILAR METAL FLANGES INSULATING KITS AT CORE EXCHANGER NOZZLE CONNECTION.
7. STRAINERS ARE TO BE LOCATED AS CLOSE AS POSSIBLE TO THE CORE EXCHANGER NOZZLE.
8. DRUM TO BE ELEVATED ABOVE CORE EXCHANGER INLET NOZZEL.DETAIL ENGINEERING CONTRACTOR TO PROPERLY LOCATED THIS VESSEL TO ENSURE PROPER THERMOSIPHON CIRCULATION THROUGH THE CORE 305-LZ-00-5701-EP-00-11.
9. TOP ENTRY.
10. LOCATE FV-52501, LV-52504 TO PREVENT FLASHING AT INLET OF FV-52501, LV-52504 AND MINIMUM DISTANCE FROM 302-EE-00-2609,305-VV-VI-5713 RESPECTIVELY.
11. TWO PHASE FLOW,ANCHOR SECURELY.
12. ADMINISTRATIVE PROCEDURES MUST BE USED TO ENSURE THAT COLD BOX INLET STRAINERS AND PIPING ARE PROPERLY DRAINED AND VENTED WHEN THEY ARE ISOLATED AND OUT OF SERVICE.
13. FOR DUTY OF INDIVIDUAL PASSES SEE RESPECTIVE DATA SHEETS.
14. VENDOR TO ENSURE MECHANICAL STRENGTH REQUIREMENT FOR STRAINER ELEMENT WITH SUITABLE DIFFERENTIAL DESIGN PRESSURE.
15. INSTRUMENTATION TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC SERVICE.LOCATION OF TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.
16. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER P&ID NO. B957-79-41-300-11874.

DETAIL-"A"



REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
3	29.09.25	ISSUED FOR HAZOP	PP	KM	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	RS	KM	KK	MS

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

अनुमान SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG. No.	संशो. REV.
	B957	79	41	300	11525	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

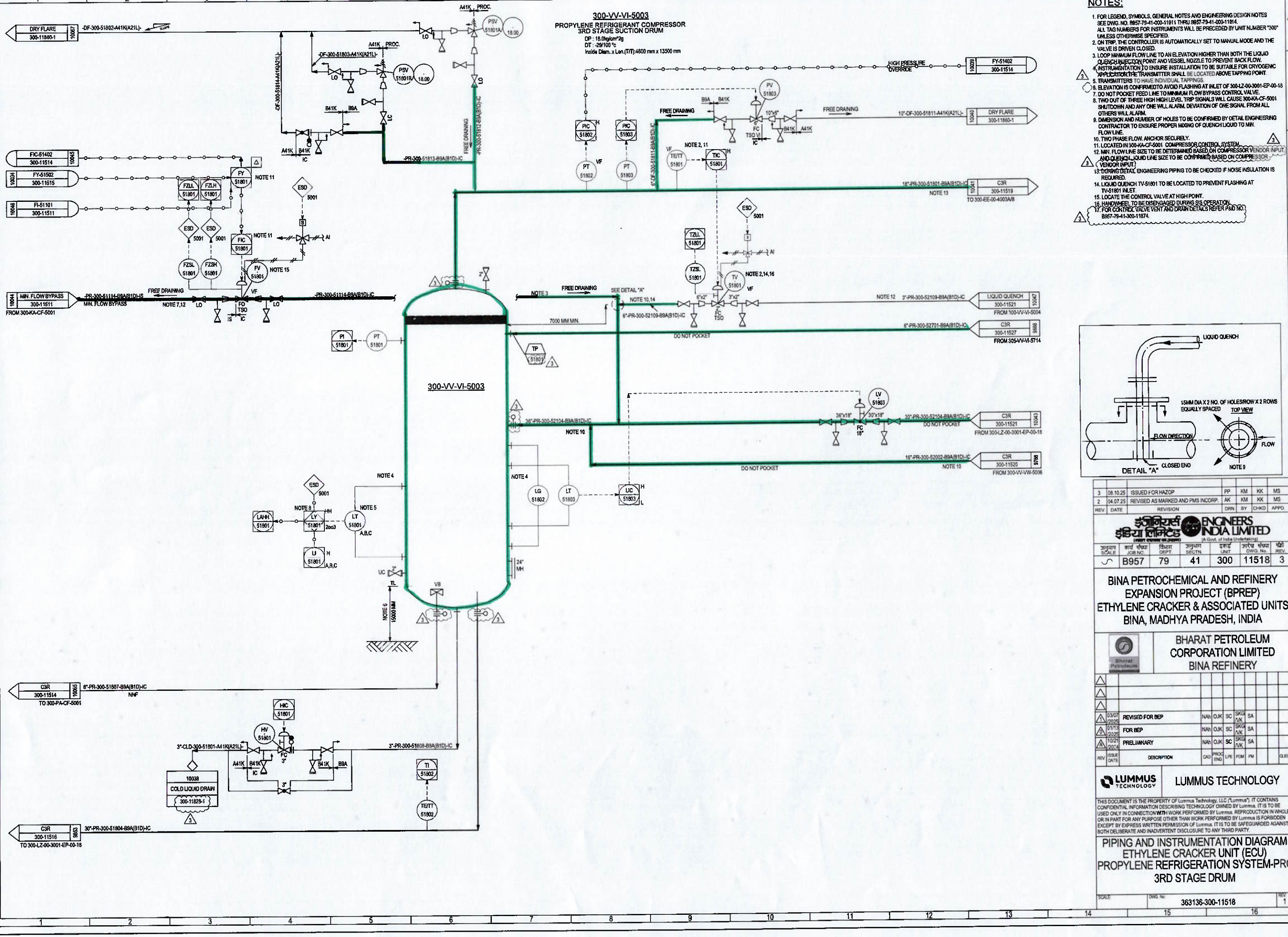
REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM		CLIENT
3	03/07/2025	REVISED FOR BEP	NAh	OJK	SC	SKG/MK	SA		
2	01/13/2025	FOR BEP	NAh	OJK	SC	SKG/MK	SA		
1	10/21/2024	PRELIMINARY	NAh	OJK	SC	SKG/MK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM
(2 OF 5)

SCALE	DWG. No.	REV.
	363136-300-11525	1



NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-11011 THRU B957-79-41-000-11014.
2. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
3. ON TRIP, THE CONTROLLER IS AUTOMATICALLY SET TO MANUAL MODE AND THE VALVE IS DRIVEN CLOSED.
4. LOOP MINIMUM FLOW LINE TO AN ELEVATION HIGHER THAN BOTH THE LIQUID QUENCH INJECTION POINT AND VESSEL NOZZLE TO PREVENT BACK FLOW.
5. INSTRUMENTATION TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.
6. TRANSMITTERS TO HAVE INDIVIDUAL TAPPINGS.
7. ELEVATION IS CONFIRMED TO AVOID FLASHING AT INLET OF 300-LZ-00-3001-EP-00-18
8. DO NOT POCKET FEED LINE TO MINIMUM FLOW BYPASS CONTROL VALVE.
9. TWO OUT OF THREE HIGH HIGH LEVEL TRIP SIGNALS WILL CAUSE 300-KA-CF-5001 SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM ALL OTHERS WILL ALARM.
10. DIMENSION AND NUMBER OF HOLES TO BE CONFIRMED BY DETAIL ENGINEERING CONTRACTOR TO ENSURE PROPER MIXING OF QUENCH LIQUID TO MIN. FLOW LINE.
11. TWO PHASE FLOW. ANCHOR SECURELY.
12. LOCATED IN 300-KA-CF-5001 COMPRESSOR CONTROL SYSTEM.
13. MIN. FLOW LINE SIZE TO BE DETERMINED BASED ON COMPRESSOR VENDOR INPUT AND QUENCH LIQUID LINE SIZE TO BE CONFIRMED BASED ON COMPRESSOR VENDOR INPUT.
14. DURING DETAIL ENGINEERING PIPING TO BE CHECKED IF NOISE INSULATION IS REQUIRED.
15. LIQUID QUENCH TV-51801 TO BE LOCATED TO PREVENT FLASHING AT TV-51801 INLET.
16. LOCATE THE CONTROL VALVE AT HIGH POINT.
17. HANDWHEEL TO BE DISENGAGED DURING SIS OPERATION.
18. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER P&ID NO. B957-79-41-300-11874.

REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
3	08.10.25	ISSUED FOR HAZOP	PP	KM	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AK	KM	KK	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	300	11518	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CKD	PROC-ENG	LPE	PDM	PM		CLIENT
3	03/07/2025	REVISED FOR BEP	NAh	OJK	SC	SKG/VK	SA		
2	01/13/2025	FOR BEP	NAh	OJK	SC	SKG/VK	SA		
1	10/21/2024	PRELIMINARY	NAh	OJK	SC	SKG/VK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM-PRC
3RD STAGE DRUM

SCALE: | DWG. No: 363136-300-11518 | REV. 1

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. TOP ENTRY.
3. TWO-PHASE FLOW, ANCHOR SECURELY.
4. LOCATE LV-52601,FV-52601 TO PREVENT FLASHINING AT INLET OF LV-52601,FV-52601 AND MINIMUM DISTANCE FROM 305-EE-0-5707,301-EE-00-1603 RESPECTIVELY.
5. DEC TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.

305-EE-00-5707
ROG DRYER/TREATER EFFLUENT CHILLER
DP (S/T) : 18.0/12.5 kg/cm^2g
DT (S/T) : -29/160 °C/ 50 °C
Rated Duty: 1.207 MM/KCAL/HR
TEMA Type: BKM

301-EE-00-1603
C4 HP FLASH VENT CONDENSER
DP (S/T) : 18.0/37.0 kg/cm^2g
DT (S/T) : -29/100 °C/ 135 °C
Rated Duty: 0.133 MM/KCAL/HR
TEMA Type: BEL

C3R 300-11525 9617 — TO 300-VV-VI-5504
12"-PR-300-52705-B1D-IC — NO POCKETS
NOTE 2
TP
NOTE 2
12"x10"
10"-PR-300-52705-B1D-IC
C3R 300-11527 16349 — FROM 305-EE-00-5713 / 305-EE-000-5702/300-EE-00-2402
2"-PR-300-52604-B1D-IC — DO NOT POCKET
C4 VENT
FOR TUBE SIDE SEE DWG. 301-11114
301-EE-00-1603
NOTE 5
LT 52603
LG 52604
LIC 52603
NNF
2"-PR-300-52603-B1D-IC — DO NOT POCKET

305-EE-00-5707

ROG
FOR TUBE SIDE SEE DWG. 305-11528
NOTE 5
LT 52601
LG 52602
LIC 52601 H L
4"-PR-300-52602-B1D-IC — NOTE 3 — DO NOT POCKET
NOTE 4
LV 52601
4"x2" 4"x2" 4" FC
4"-PR-300-52602-B1D-IC — NNF
2"-PR-300-52601-B1D-IC — DO NOT POCKET — NOTE 3
FIC 52601
FY 52601
HIGH LEVEL OVERRIDE
NOTE 4
FE/FT 52601
FV 52601
FC
2"-PR-300-52601-B1D-IC
TP
9623 C3R 300-11525 — FROM 300-LZ-00-3001-EP-00-18
8"-PR-300-52404-B1D-IC
8"-PR-300-52404-B1D-IC
16556 C3R 300-11527 — TO 300-EE-00-2402/ 305-EE-00-5702/305-EE-00-5713

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	L/PE	PDM	PM		CLIENT
3	01/13/2025	FOR BEP	NAN	OJK	SC	SKG /VK	SA		
2	10/21/2024	PRELIMINARY	NAN	OJK	SC	SKG /VK	SA		
1									
0									

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM
(3 OF 5)

SCALE: | DWG. No: 363136-300-11526 | REV: 0

Page 1951 of 4391 : B957-TENDER_DOC-B957-300-16-43-MR-T-3001 : Rev. A

300-EE-00-4106
PROPYLENE FRACTIONATOR VENT CONDENSER
DP (S/T) : 18.0/24.5 kg/cm^2g
DT (S/T) : -29/65°/ -29/100 °C
Rated Duty: 0.330 MMKCAL/HR
TEMA Type: BKU

300-LZ-00-3001-EP-00-18
OFFGAS EXCHANGER NO.6
(PART OF 300-LZ-00-3001)
NOTE 13

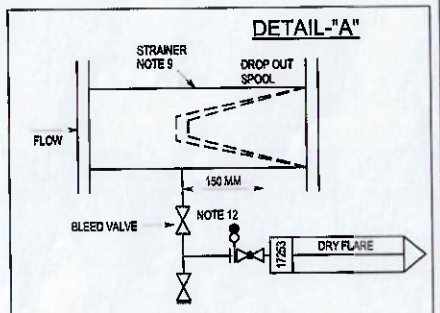
300-EE-00-2004
CHARGE GAS COMPRESSOR 3RD
STAGE AFTER COOLER NO.2
DP (S/T) : 18.0/31.5 kg/cm^2g
DT (S/T) : -29/100°/ 150 °C
Rated Duty: 11.473 MMKCAL/HR
TEMA Type: BKM

300-EE-00-2006A/B
CAUSTIC TOWER EFFLUENT COOLER
DP (S/T) : 18.0 /18.0 kg/cm^2g
DT (S/T) : -29/100°/ 100 °C
Rated Duty: 13.439 MMKCAL/HR
TEMA Type: BKM

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED
2. TOP ENTRY.
3. CHECK VALVE TO BE MINIMUM 600MM UP STREAM OF PROCESS TIE-IN.
4. ADMINISTRATIVE PROCEDURES MUST BE USED TO ENSURE THAT COLD BOX INLET STRAINERS AND PIPING ARE PROPERLY DRAINED AND VENTED WHEN THEY ARE ISOLATED AND OUT OF SERVICE.
5. LOCATE TV-23203,FV-52401,TV-23001 TO PREVENT FLASHING AT INLET OF TV-23203,FV-52401,TV-23001 AND MINIMUM DISTANCE FROM THE DOWNSTREAM 300-EE-00-2004,300-EE-00-4106,300-EE-00-2006A RESPECTIVELY.
6. TWO PHASE FLOW,ANCHOR SECURELY.
7. STRAINERS ARE TO BE LOCATED AS CLOSE AS POSSIBLE TO THE CORE EXCHANGER NOZZLE.
8. DRY OUT SPOOLS FOR BYPASSING EXCHANGER AND FIT UP TO PIPING.
9. INLET STRAINERS TO BRAZED ALUMINUM EXCHANGERS TO HAVE A MESH SIZE BASED ON EXCHANGER VENDOR RECOMMENDATION SHALL HAVE A MAXIMUM PRESSURE DROP OF 100MM H2O AT MAXIMUM FLOW.
10. INSTALL DISSIMILAR METAL FLANGES INSULATING KITS AT CORE EXCHANGER NOZZLE CONNECTION.
11. ALL PIPING DOWNSTREAM OF STRAINER SHALL BE STAINLESS STEEL.
12. VENTED GATE VALVES REQUIRED AS PER SERVICE.
13. FOR DUTY OF INDAVIDUAL PASSES SEE RESPECTIVE DATA SHEETS.
14. SYMMETRICAL PIPING.
15. DETAIL ENGINEERING CONTRACTOR TO ENSURE MECHANICAL STRENGTH REQUIREMENT FOR STRAINER ELEMENT WITH SUITABLE DIFFERENTIAL DESIGN PRESSURE.
16. FOR CAD VALVE
17. DEC TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.

DETAIL-"A"



BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
2	01/12/2025	FOR BEP	NAh	OJK	SC	SKG /VK	SA	
1	10/21/2024	PRELIMINARY	NAh	OJK	SC	SKG /VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM
(1 OF 5)

SCALE	DWG No.	REV
	363136-300-11524	0

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305-LZ-00-5701-EP-00-11
ROG COLD BOX EXCHANGER NO. 1 (PART OF 305-LZ-00-5701)
(NOTE 13)

305-VV-VI-5714
LIQUID PROPYLENE ACCUMULATOR FOR 305-LZ-00-5701-EP-00-11
DP : 18.0 kg/cm^2g
DT : -29/100°C
Inside Diam. x Len.(T/T):1000 mm x 3400 mm

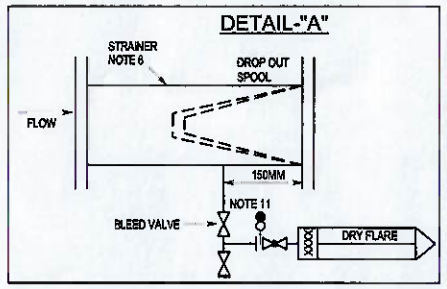
305-EE-00-5702
ROG DRYER/TREATER FEED CHILLER
DP (S/T) : 18.0/12.5 kg/cm^2g
DT (S/T) : -29/100°C/ 65 °C
Rated Duty: 0.983 MMKCAL/HR
TEMA Type: BKM

300-EE-00-2402
DCU OFF GAS DRYER /TREATER FEED CHILLER
DP (S/T) : 15.0/14.0 kg/cm^2g
DT (S/T) : -29/100°C/ 100 °C
Rated Duty: 0.284 MMKCAL/HR
TEMA Type: BKM

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. ADMINISTRATIVE PROCEDURES MUST BE USED TO ENSURE THAT COLD BOX INLET STRAINERS AND PIPING ARE PROPERLY DRAINED AND VENTED WHEN THEY ARE ISOLATED AND OUT OF SERVICE.
3. LOCATE LV-52701 , TV-26001 AND TV-51801 TO PREVENT FLASHING AT INLET OF LV-52701,TV-26001 TV-51801 AND MINIMUM DISTANCE FROM 305-VV-VI-5714, 300-EE-00-2402 AND 305-EE-00-5702 RESPECTIVELY.
4. TWO PHASE FLOW,ANCHOR SECURELY.
5. ALL PIPING DOWNSTREAM OF STRAINER SHALL BE STAINLESS STEEL.
6. INLET STRAINERS TO BRAZED ALUMINUM EXCHANGERS TO HAVE A MESH SIZE BASED ON VENDOR RECOMMENDATION AND SHALL HAVE A MAXIMUM PRESSURE DROP OF 100MM H2O AT MAXIMUM FLOW.
7. DRY OUT SPOOLS FOR BYPASSING EXCHANGER AND FIT UP TO PROCESS PIPING.
8. STRAINERS ARE TO BE LOCATED AS CLOSE AS POSSIBLE TO THE CORE EXCHANGER NOZZLE.
9. INSTALL DISSIMILAR METAL FLANGES INSULATING KITS AT CORE EXCHANGER NOZZLE CONNECTION.
10. DRUM TO BE ELEVATED ABOVE CORE EXCHANGER INLET NOZZLE. DETAIL ENGINEERING CONTRACTORTO PROPERLY LOCATE THIS VESSEL TO ENSURE PROPER THERMOSIPHON CIRCULATION THROUGH THE CORE 305-LZ-00-5701-EP-00-11.
11. VENTED GATE VALVES REQUIRED AS PER SERVICE.
12. TOP ENTRY.
13. FOR DUTY OF INDIVIDUAL PASSES SEE RESPECTIVE DATA SHEETS.
14. CHECK VALVE TO BE MINIMUM 600MM UP STREAM OF PROCESS TIE-IN.
15. DETAIL ENGINEERING CONTRACTOR TO ENSURE MECHANICAL STRENGTH REQUIREMENT FOR STRAINER ELEMENT WITH SUITABLE DIFFERENTIAL DESIGN PRESSURE.
16. DEC TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.

DETAIL-"A"



BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
1	01/13/2025	FOR BEP	NAN	O.JK	SC	SK/O /VK	SA	
A	10/21/2024	PRELIMINARY	NAN	O.JK	SC	SK/O /VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM
(4 OF 5)

SCALE: | DWG. No: 363136-300-11527 | REV: 0

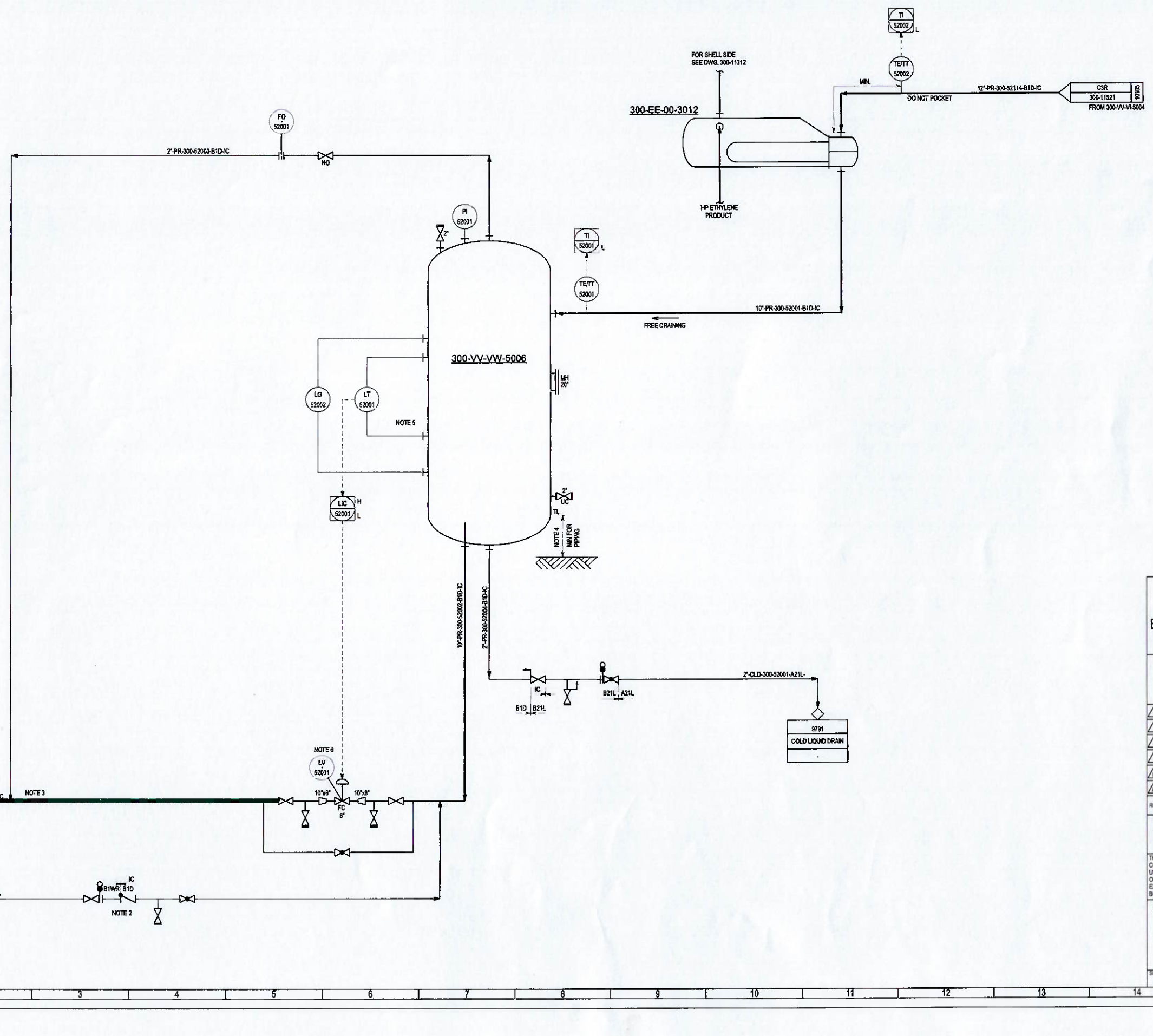
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300-VV-VW-5006
LIQUID PROPYLENE ACCUMULATOR
FOR 300-EE-00-3012
DP : 18.0kg/cm^2g
DT : -45/100 °C
Inside Diam. x Len.(T/T):1000 mm x 1900 mm

300-EE-00-3012
ETHYLENE PRODUCT VAPORIZER
DP (S/T) : 48.0/18.0 kg/cm^2g
DT (S/T) : -45/65°C/-45/ 100 °C
Rated Duty: 6.546 MMKCAL/HR
TEMA Type: BKU

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. CHECK VALVE TO BE 500 MM UPSTREAM OF PROCESS TIE-IN.
3. TWO PHASE FLOW, ANCHOR SECURELY.
4. ELEVATION TO BE DETERMINDED BY DEC.
5. DEC TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.
6. LV-52001 TO BE LOCATED BELOW 300-VV-VW-5006TO PREVENT TWO PHASE FLOW AT CONTROL VALVE INLET.



BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM		CLIENT
1	01/12/2024	FOR BEP	NAN	OJK	SC	SKG/JVK	SA		
0	10/21/2024	PRELIMINARY	NAN	OJK	SC	SKG/JVK	SA		

LUMMUS TECHNOLOGY

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM-
ETHYLENE PRODUCT VAPORIZER

SCALE: | DWG. No. 363136-300-11520 | REV. 0

Page 1954 of 4391 ; B957-TENDER DOC-B957-300-16-43-MR-T-3001 ; Rev. A

Page 1955 of 4391 ; B957-TENDER_DOC-B957-300-16-43-MR-T-3001 ; Rev. A

BINA PETROCHEMICAL AND REFINERY
EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM
CORPORATION LIMITED
BINA REFINERY

PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM
(40C USER 1/2)

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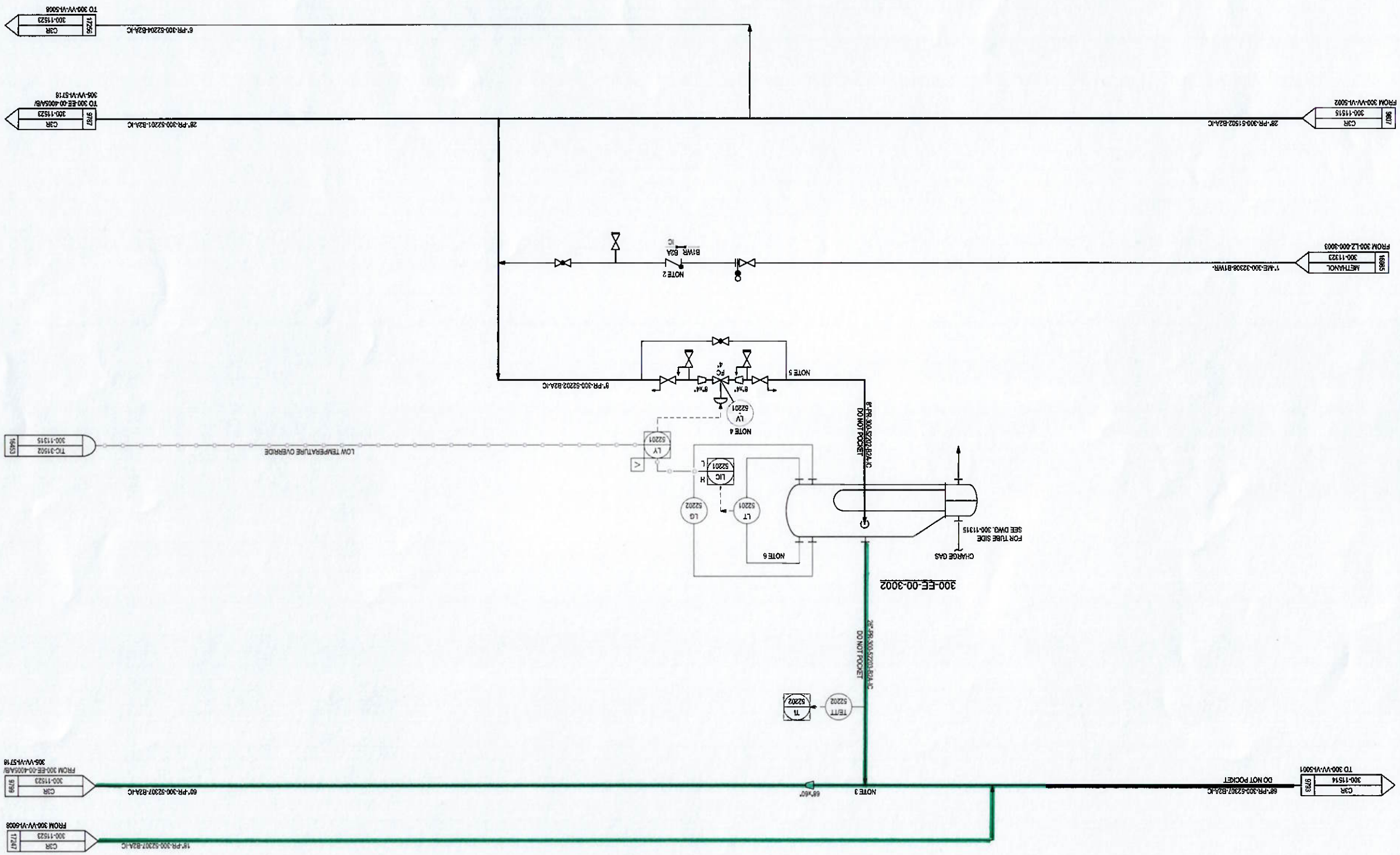
REV	ISSUE DATE	DESCRIPTION	CHD	PROJ ENG	LPE	PDM	PM	
0	01/13/2024	FOR BEP	NAH	OJK	SO	SMG AK	SA	
1	10/21/2024	PRELIMINARY	NAH	OJK	SO	SMG AK	SA	

CLIENT

SCALE	DWG No.	REV
	363136-300-11522	0

NOTES:
1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11001 THRU 363136-000-11016.
ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PREFIXED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. CHECK VALVE TO BE 600MM UPSTREAM OF PROCESS TIE-IN.
3. TOP ENTRY.
4. LOCATE LV-52201 TO PREVENT FLASHING AT INLET OF LV-52201 AND MINIMUM DISTANCE FROM THE 300-EE-00-3002.
5. TWO-PHASE FLOW, ANCHOR SECURELY.
6. DEC TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT

300-EE-00-3002
DEMETHANIZER FEED CHILLER
DP (S/T) : 18.0/3.5 kg/cm^2g
DT (S/T) : -45/100°C/ -45/85°C
Relief Duty: 5.430 MMKCAL/HR
TEMA Type: BKM



300-EE-00-4005A/B
ETHYLENE FRACTIONATOR CONDENSER
DP (S/T) : 18.0/19.5 kg/cm^2g
DT (S/T) : -45/100°C/ -45/65°C
Rated Duty: 64.612 MM#CAL/HR
TEMA Type: BKM)

300-LZ-00-3001-EP-00-17
OFFGAS EXCHANGER NO.5
(PART OF 300-LZ-00-3001)
(NOTE 12)

300-VV-VI-5008
LIQUID PROPYLENE ACCUMULATOR
FOR 300-LZ-00-3001-EP-00-17
DP : 18.0 kg/cm^2g
DT : -45/100° C
Inside Diam. x Len.(T/T):1900 mm x 4100 mm

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 9957-79-41-000-11011 THRU 9957-79-41-000-11014.
   ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. CHECK VALVE TO BE MINIMUM 600MM UP STREAM OF PROCESS TIE-IN.
3. SYMMETRICAL PIPING.
4. LOCATE PV-41403A/B, LV-52302 TO PREVENT FLASHING AT INLET OF PV-41403A/B, LV-52302 AND MINIMUM DISTANCE FROM THE DOWNSTREAM 300-EE-00-4005A/B, 300-VV-VI-5008 RESPECTIVELY.
5. TWO PHASE FLOW.ANCHOR SECURELY.
6. INLET STRAINERS TO BRAZED ALUMINUM EXCHANGERS TO HAVE A MESH SIZE BASED ON VENDOR RECOMMENDATION SHALL HAVE A MAXIMUM PRESSURE DROP OF 100MM H2O AT MAXIMUM FLOW.
7. ALL PIPING DOWNSTREAM OF STRAINER SHALL BE STAINLESS STEEL.
8. DRY OUT SPOOLS FOR BYPASSING EXCHANGER AND FIT UP TO PROCESS PIPING (REFER DETAIL - C).
9. STRAINERS ARE TO BE LOCATED AS CLOSE AS POSSIBLE TO THE CORE EXCHANGER NOZZLE.
10. INSTALL DISSIMILAR METAL FLANGES INSULATING KITS AT CORE EXCHANGER NOZZLE CONNECTION.
11. DRUM TO BE ELEVATED ABOVE CORE EXCHANGER INLET NOZZLE. VENDOR TO PROPERLY LOCATE THIS VESSEL TO ENSURE PROPER THERMOSIPHON CIRCULATION THROUGH THE CORE 300-LZ-00-3001-EP-00-17. ELEVATION IS BASED ON VENDOR INPUT.
12. FOR DUTY OF INDIVIDUAL PASSES SEE RESPECTIVE DATA SHEETS.
13. ADMINISTRATIVE PROCEDURES MUST BE USED TO ENSURE THAT COLD BOX INLET STRAINERS AND PIPING ARE PROPERLY DRAINED AND VENTED WHEN THEY ARE ISOLATED AND OUT OF SERVICE.
14. VENTED GATE VALVES REQUIRED AS PER SERVICE.
15. INSTRUMENTATION TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.
16. INDIVIDUAL HIC CONTROL FOR PROPYLENE REFRIGERANT TO ETHYLENE FRACTIONATOR CONDENSER NEEDS TO BE SET INITIALLY WITH THE HELP OF INDIVIDUAL BIAS(BY DEC) TO COUNTER UNBALANCED HYDRAULICS OF THE SYSTEM BASED ON THE LEVELS OF 300-EE-00-4005A/B. LIC CONTROL OUTPUT WILL BE APPLICABLE ON ALL CONDENSERS SIMULTANEOUSLY AND AS PER INDIVIDUAL BIAS CONTROL.
17. VENDOR TO ENSURE MECHANICAL STRENGTH REQUIREMENT FOR STRAINER ELEMENT WITH SUITABLE DIFFERENTIAL DESIGN PRESSURE.
18. FOR CONTROL VALVE VENT AND DRAIN REFER P&ID NO. B957-79-41-300-11847

DETAIL-"C"

DETAIL-"A"

REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
3	08.10.25	ISSUED FOR HAZOP.	SS	KM	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	RS	KM	KK	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
NTS	B957	79	41	300	11523	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
3	03/07/2025	REVISED FOR BEP	NAH	OJK	SC	SKG/VK	SA	
2	31/13/2025	FOR BEP	NAH	OJK	SC	SKG/VK	SA	
1	10/21/2024	PRELIMINARY	NAH	OJK	SC	SKG/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM
(-40C USER 2/2)

SCALE: | DWG. No: 363136-300-11523 | REV. 1

305-LZ-00-5701-EP-00-11
ROG COLD BOX EXCHANGER NO. 1 (NOTE 11)
(PART OF 305-LZ-00-5701)

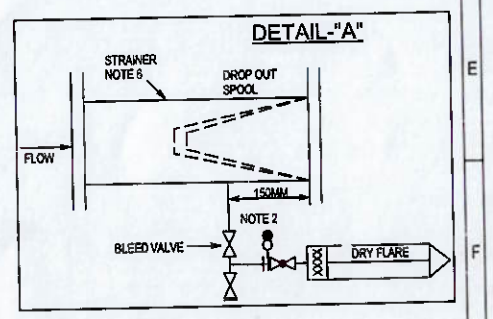
305-VV-VI-5716
LIQUID PROPYLENE ACCUMULATOR FOR 305-LZ-00-5701-EP-00-11
DP : 18.0 kg/cm^2g
DT : -45/100°C
Inside Diam. x t.en.(T/T):1000 mm x 3300 mm

305-EE-00-5713
RFCC C3 CHILLER
DP (S/T) : 24.5/28.0 kg/cm^2g
DT (S/T) : -29/100°C/ -29/120°C
Rated Duty: 0.122 MMKCAL/HR
TEMA Type: BKU

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-11011 THRU B957-79-41-000-11015. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. VENTED GATE VALVES REQUIRED AS PER SERVICE.
3. LOCATE LV-52801, TV-53903 TO PREVENT FLASHING AT INLET OF LV-52801, TV-53903 AND MINIMUM DISTANCE FROM 305-VV-VI-5716,305-EE-00-5713 RESPECTIVELY.
4. TWO PHASE FLOW,ANCHOR SECURELY.
5. ALL PIPING DOWNSTREAM OF STRAINER SHALL BE STAINLESS STEEL.
6. INLET STRAINERS TO BRAZED ALUMINUM EXCHANGERS TO HAVE A MESH SIZE BASED ON VENDOR RECOMMENDATION AND SHALL HAVE A MAXIMUM PRESSURE DROP OF 100MM H2O AT MAXIMUM FLOW.
7. DRY OUT SPOOLS FOR BYPASSING EXCHANGER AND FIT UP TO PROCESS PIPING.
8. STRAINERS ARE TO BE LOCATED AS CLOSE AS POSSIBLE TO THE CORE EXCHANGER NOZZLE.
9. INSTALL DISSIMILAR METAL FLANGES INSULATING KITS AT CORE EXCHANGER NOZZLE CONNECTION.
10. DRUM TO BE ELEVATED ABOVE CORE EXCHANGER INLET NOZZLE. DETAIL ENGINEERING CONTRACTOR TO PROPERLY LOCATE THIS VESSEL. TO ENSURE PROPER THERMOSIPHON CIRCULATION THROUGH THE CORE 305-LZ-00-5701-EP-00-11.
11. FOR DUTY OF INDIVIDUAL PASSES SEE RESPECTIVE DATA SHEETS.
12. CHECK VALVE TO BE MINIMUM 600MM UP STREAM OF PROCESS TIE-IN.
13. DEC TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT..
14. ADMINISTRATIVE PROCEDURES MUST BE USED TO ENSURE THAT COLD BOX INLET STRAINERS AND PIPING ARE PROPERLY DRAINED AND VENTED WHEN THEY ARE ISOLATED AND OUT OF SERVICE.
15. DETAIL ENGINEERING CONTRACTOR TO ENSURE MECHANICAL STRENGTH REQUIREMENT FOR STRAINER ELEMENT WITH SUITABLE DIFFERENTIAL DESIGN PRESSURE.

DETAIL-"A"



REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	RS	KM	KK	MS

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	300	11528	2

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAO	PROJ ENG	LPE	POM	PM		CLIENT
3	03/07/2025	REVISED FOR BEP	NAh	OJK	SC	SKG/AK	SA		
1	01/13/2025	FOR BEP	NAh	OJK	SC	SKG/AK	SA		
0	10/21/2024	PRELIMINARY	NAh	OJK	SC	SKG/AK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM
(5 OF 5)

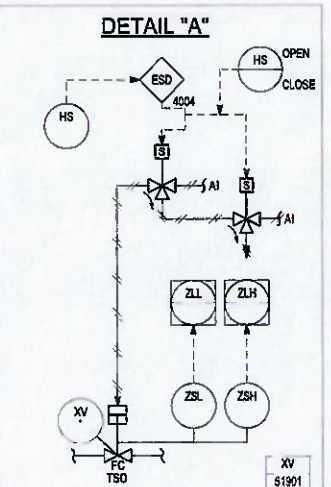
SCALE: | DWG. No: 363136-300-11528 | REV. 1

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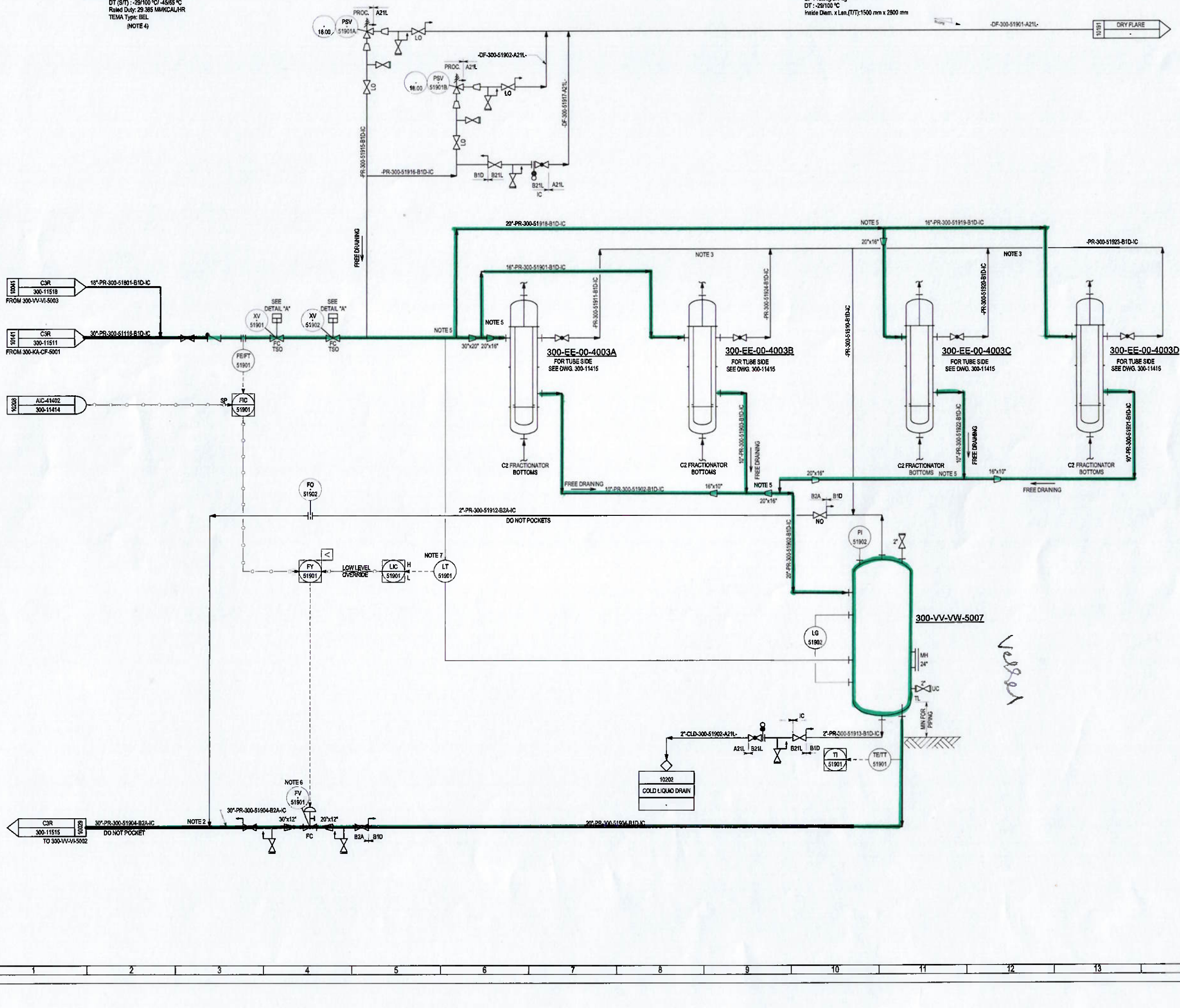
300-EE-00-4003A/B/C/D
ETHYLENE FRACTIONATOR REBOILER
(NOTE 4) DP (S/T) : 18.0/21.5 kg/cm^2g
DT (S/T) : -29/100 °C/ -45/65 °C
Rated Duty: 29.385 MMKCAL/HR
TEMA Type: BEL
(NOTE 4)

300-VV-VW-5007
LIQUID PROPYLENE ACCUMULATOR
FOR 300-EE-4003A/B/C/D
DP : 18.0kg/cm^2g
DT : -29/100 °C
Inside Diam. x Len.(T/T):1500 mm x 2900 mm

NOTES:
1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. TWO PHASE FLOW. ANCHOR SECURELY.
3. LINE TO VENT OUT NON CONDENSABLES.
4. ALL OPERATING IN NORMAL OPERATION.
5. SYMMETRICAL PIPING.
6. FV-51901 TO BE LOCATED BELOW 300-VV-VW-5007 TO PREVENT TWO PHASE FLOW AT CONTROL VALVE INLET.
7. DEC TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.

DETAIL "A"


XV 51901 51902
ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS XV TAG NUMBER



Verified

01/13/2025	FOR BEP	NAN	OJK	SC	SKG/VK	SA				
10/21/2024	PRELIMINARY	NAN	OJK	SC	SKG/VK	SA				
REV / ISSUE DATE	DESCRIPTION	CAD	PROCESSING	LPE	PDM	PM				CLIENT

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM-
ETHYLENE FRACTIONATOR REBOILER

SCALE: | DWG. No. 363136-300-11519 | REV. 0

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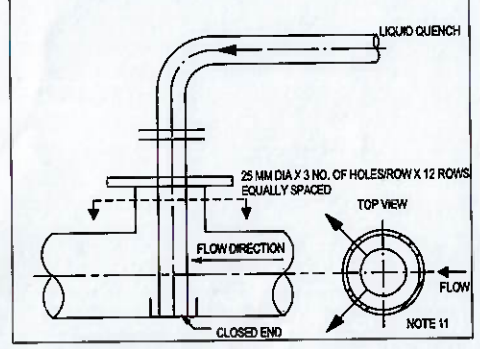
300-VV-VI-5002

PROPYLENE REFRIGERANT COMPRESSOR
2ND STAGE SUCTION DRUM
DP : 18.0 kg/cm^2g
DT : -45/100 °C
Inside Diam. x Len.(T/T):6200 mm x 11200 mm

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-11011 THRU B957-79-41-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. TWO PHASE FLOW. ANCHOR SECURELY.
3. LOCATED IN COMPRESSOR CONTROL SYSTEM.
4. LOOP MINIMUM FLOW LINE TO AN ELEVATION HIGHER THAN BOTH THE LIQUID QUENCH INJECTION POINT AND VESSEL NOZZLE TO PREVENT BACK FLOW.
5. LIQUID QUENCH LINE SHALL CONNECT TO THE MINIMUM FLOW LINE DOWNSTREAM OF HIGH POINT OF LOOP.
6. TRANSMITTERS TO HAVE INDIVIDUAL TAPPINGS.
7. LOCATE THE CONTROL VALVE AT HIGH POINT.
8. MIN. FLOW LINE SIZE TO BE DETERMINED BY DEC, AND QUENCH LIQUID LINE SIZE TO BE CONFIRMED BY DEC
9. LIQUID QUENCH TV-51501 TO BE LOCATED TO PREVENT FLASHING AT TV-51501 INLET.
10. PRELIMINARY ELEVATION TO BE CONFIRMED BASED ON 300-PA-CF-5001 NPSH REQUIREMENT AND TO AVOID FLASHING AT INLET OF CONTROL VALVES PV-41403A/B AND LV- 52201, LV-52302, LV-52601, WHICHEVER IS HIGHER. ELEVATION TO BE CONFIRMED BY DEC.
11. DIMENSION AND NUMBER OF HOLES TO BE COFIRMED BY DETAIL ENGINEERING CONTRACTOR TO ENSURE PROPER MIXING OF QUENCH LIQUID TO MIN. FLOW LINE.
12. DURING DETAIL ENGINEERING PIPING TO BE CHECKED IF NOISE INSULATION IS REQUIRED.
13. ON TRIP, THE CONTROLLER IS AUTOMATICALLY SET TO MANUAL MODE AND THE VALVE IS DRIVEN CLOSED.
14. TWO OUT OF THREE TRIP HIGH HIGH LEVEL SIGNALS WILL CAUSE 300-KA-CF-5001 SHUTDOWN AND ANY ONE WILL ALARM . DEVIATION OF ONE SIGNAL FROM OTHERS WILL ALARM.
15. FLOW METER TO BE TEMPERATURE AND PRESSURE COMPENSATED.
16. INSTRUMENTATION TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION.THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.
17. DO NOT POCKET FEED LINE MINIMUM FLOW BYPASS CONTROL VALVE.
18. HANDWHEEL TO BE DISENGAGED DURING SIS OPERATION.
19. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER P&ID NO. B957-79-41-300-11874.

DETAIL "A"



REV	DATE	REVISION	DRN	BY	CHKD	APPD.
3	03.10.25	ISSUED FOR HAZOP	PP	KM	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AK	KM	KK	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
B957	79	41	300	11515	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM		CLIENT
3	03/07/2025	REVISED FOR BEP	NAh	OJK	SC	SKG/VK	SA		
2	01/13/2025	FOR BEP	NAh	OJK	SC	SKG/VK	SA		
1	10/21/2024	PRELIMINARY	NAh	OJK	SC	SKG/VK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM
-PRC 2ND STAGE SUCTION DRUM

SCALE: | DWG. No: 363136-300-11515 | REV. 1

Page 1959 of 4391 : B957-TENDER DOC-B957-300-16-43-MR-T-3001 : Rev. A

Markup upto → Nearest Isolation

300-EE-00-2203
HP DEPROPANIZER CONDENSER
DP (S/T) : 18.0/31.5 kg/cm²2g
DT (S/T) : -45/100 °C/ -45/65 °C
Rated Duty: 14.092 MMKCAL/HR
TEMA Type: BKU

300-EE-00-2205
LP DEPROPANIZER CONDENSER
DP (S/T) : 18.0/6.5 kg/cm²2g
DT (S/T) : -45/100 °C/ -45/100 °C
Rated Duty: 8.328 MMKCAL/HR
TEMA Type: BKU

300-LZ-00-3001-EP-00-18
OFFGAS EXCHANGER NO.6
(PART OF 300-LZ-00-3001)
(NOTE 3)

300-EE-00-4004
ETHYLENE FRACTIONATOR SIDE REBOILER NO.1
DP (S/T) : 21.0/18.0 kg/cm²2g
DT (S/T) : -45/65 °C/ -29/100 °C
Rated Duty: 5.621 MMKCAL/HR
TEMA Type: BKM

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014
   ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. CHECK VALVE TO BE 600MM UPSTREAM OF PROCESS TIE-IN.
3. FOR DUTY OF INDIVIDUAL PASSES SEE RESPECTIVE DATA SHEETS.
4. LOCATE LV-25201,PV-25301 TO PREVENT FLASHING AT INLET OF LV-25201,PV-25301 AND MINIMUM DISTANCE FROM THE DOWNSTREAM 300-EE-00-2203,300-EE-00-2205 RESPECTIVELY.
5. TWO-PHASE FLOW ANCHOR SECURELY.
6. INLET STRAINER TO BRAZED ALUMINUM EXCHANGERS TO HAVE MESH SIZE BASED ON VENDOR RECOMMENDATION AND SHALL HAVE MAXIMUM PRESSURE DROP OF 100MM H2O AT MAXIMUM FLOW.
7. ALL PIPING DOWNSTREAM OF STRAINERS SHALL BE STAINLESS STEEL.
8. DRY-OUT SPOOL FOR BYPASSING EXCHANGER AND FIT UP TO PIPING.
9. STRAINERS ARE TO LOCATED AS CLOSE AS POSSIBLE TO CORE EXCHANGER NOZZLE.
10. INSTALL DISSIMILAR METAL FLANGES INSULATING KITS AT CORE EXCHANGER NOZZLE CONNECTION.
11. ADMINISTRATIVE PROCEDURES MUST BE USED TO ENSURE THAT COLD BOX INLET STRAINERS AND PIPING ARE PROPERLY DRAINED AND VENTED WHEN THEY ARE ISOLATED AND OUT OF SERVICE.
12. VENTED GATE VALVES REQUIRED AS PER SERVICE.
13. DEC TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.
15. DETAIL ENGINEERING CONTRACTOR TO ENSURE MECHANICAL STRENGTH REQUIREMENT FOR STRAINER ELEMENT WITH SUITABLE DIFFERENTIAL DESIGN PRESSURE.
18. REFER TO THE ECU COLD BOX PACKAGE PROCESS SPECIFICATION SECTION 4.18 FOR RELATIVE ELEVATION OF 300-VV-VI-5003 AND COLD BOX NOZZLE.

30"-PR-300-52901-B2A-IC → C3R 300-11529 17260 FROM 300-VV-VI-5009
28"-PR-300-51701-B2A-IC → C3R 300-11517 17251 FROM 300-EE-00-4002A/B
20"-PR-300-52905-B2A-IC → C3R 300-11517 9835 FROM 305-VV-VI-5715/ 305-EE-00-5710
48"-PR-300-52905-B2A-IC → C3R 300-11515 9834 TO 300-VV-VI-5002
32"-PR-300-51603-B2A-IC
TP
48"x42" NOTE 14 42"x34" NOTE 14
NOTE 14 NOTE 14
DO NOT POCKET
34"x12"
12"-PR-300-51606-B2A-IC
TE/TT 51603 TI 51603
TI 51602

300-EE-00-2203
HP DEPROPANIZER OVERHEAD
FOR TUBE SIDE SEE DWG. 300-11252
NOTE 13
LT 51601 LG 51602 LIC 51601 H L
16"-PR-300-51602-B2A-IC
DO NOT POCKET
HIGH LEVEL OVERRIDE
LIC-25201 9957 300-11252
LY 25201 NOTE 4 LV 25201
18"x6" 12"x8" FC 6"
NOTE 5
12"-PR-300-51602-B1D-IC
B2A B1D
METHANOL 9842 300-11323 FROM 300-LZ-3003
1"-ME-300-32304-B1WR-
NOTE 2 B1WR B1D IC

300-EE-00-2205
LP DEPROPANIZER OVERHEAD
FOR TUBE SIDE SEE DWG. 300-11254
NOTE 13
LT 51603 LG 51604 LIC 51603 H L
HIGH LEVEL OVERRIDE
PY 25301
PIC-25301 300-11253 15620
6"-PR-300-51604-B1D-IC
DO NOT POCKET
NOTE 5
PV 25301 NOTE 4
4"x2" 6"x2" FC 2"
4"-PR-300-51604-B1D-IC
B1D B2A
NOTE 2 B1D B1WR IC
1"-ME-300-32337-B1WR-
METHANOL 9847 300-11323 FROM 300-LZ-00-3003

DETAIL-"A"
STRAINER NOTE 8
DROP OUT SPOOL
FLOW
150MM
NOTE 12
BLEED VALVE
XXXX DRY FLARE

TI 51601
TE/TT 51601
FOR PROCESS STREAMS SEE DWG. 300-11312
FOR BR STREAMS SEE DWG.300-11612
PDI 51601 H
PDT 51601
30"-PR-300-51804-B21L-IC
30"-PR-300-51609-B1D-IC
RS
NOTES 8, 10
NOTES 8, 10
300-LZ-00-3001-EP-00-18
SEE DETAIL "A"
NOTES 6, 7, 9,11,15
NOTES 6, 7, 9,11,15
5"XD Bd/L
FOR SHELL SIDE SEE DWG. 300-11416
300-EE-00-4004
ETHYLENE FRACTIONATOR SIDE DRAW
15"-PR-300-51610-B1D-IC
30"x24"
TP
30"-PR-300-51804-B1D-IC → C3R 300-11518 9853 FRDM 300-VV-VI-5003
NOTE 2 B1D B1WR IC
1"-ME-300-32327-B1WR-
METHANOL 11573 300-11323 FROM 300-LZ-00-3003
10"-PR-300-51611-B1D-IC → C3R 300-11517 17258 TO 305-EE-00-5710/ 305-VV-VI-5715
24"-PR-300-51606-B1D-IC → C3R 300-11515 9845 TO 300-VV-VI-5002
16"-PR-300-51607-B1D-IC → C3R 300-11517 16480 TO 300-EE-00-4002A/B/ 300-VV-VI-5009

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROCESS	LPE	PDM	PM	CLIENT
1	01/13/2025	FOR BEP	NAN	OJK	SC	SKG/VK	SA	
0	10/21/2024	PRELIMINARY	NAN	OJK	SC	SKG/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM ETHYLENE CRACKER UNIT (ECU) PROPYLENE REFRIGERATION SYSTEM- (-28C USER 1/2)

SCALE: | DWG. No: 363136-300-11516 | REV: 0

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300-EE-00-4002A/B
DEETHANIZER CONDENSER
DP (S/T) : 18.0/23.5 kg/cm^2g
DT (S/T) : -45/100 °C/ -45/70 °C
Rated Duty: 10.252 MMKCAL/HR
TEMA Type: BKM

305-EE-00-5710
ROG DEPROPANIZER CONDENSER
DP (S/T) : 18.0/21.5 kg/cm^2g
DT (S/T) : -45/100°C/ -45/120°C
Rated Duty: 2.728 MMKCAL/HR
TEMA Type: BKU

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. CHECK VALVE TO BE 600MM UPSTREAM OF PROCESS TIE-IN.
3. TWO-PHASE FLOW. ANCHOR SECURELY.
4. LOCATE LV-41201,PV-53701A TO PREVENT FLASHING AT INLET OF LV-41201,PV-53701A AND MINIMUM DISTANCE FROM 300-EE-00-4002A/B,305-EE-00-5710 RESPECTIVELY.
5. DEC TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.
6. TOP ENTRY.
7. SYMMETRICAL PIPING.

C3R 300-11518 17251 TO 300-VV-VI-5002
20"-PR-300-52905-B2A-IC
DO NOT POCKET
NOTE 6
20"x10"
10"-PR-300-52905-B2A-IC
C3R 300-11529 9866 FROM 305-VV-VI-5715

C3R 300-11518 9835 TO 300-VV-VI-5002
28"-PR-300-51701-B2A-IC
DO NOT POCKET
NOTE 6
28"-PR-300-51701-B2A-IC
20"-PR-300-51701-B2A-IC
28"x20"
NOTE 7
28"x20"
20"-PR-300-51706-B2A-IC
TE/TT 51701
TI 51701
TE/TT 51704
TI 51704

14"-PR-300-51705-B2A-IC
DO NOT POCKET
TE/TT 51702
TI 51702

300-EE-00-4002A
DEC2 OVHD
FOR TUBE SIDE SEE DWG. 300-11412
NOTE 5
LT 51701
LG 51702
LIC 51701 H L

DEC2 OVHD
FOR TUBE SIDE SEE DWG. 300-11412
300-EE-00-4002B
NOTE 5
LT 51707
LG 51708
LIC 51707 H L

ROG DEPROPANIZER CONDENSER
FOR TUBE SIDE SEE DWG. 305-11538
305-EE-00-5710
NOTE5
LT 51703
LG 51704
LIC 51703 H L

NOTE 7
12"-PR-300-51707-B2A-IC
16"x12"
HIGH LEVEL OVERRIDE
NOTE 3
15"-PR-300-51706-B2A-IC
9869 LIC-41201 300-11412
LY 41201
HIGH LEVEL OVERRIDE

DO NOT POCKET
NOTE 4
LV 41201
16"x16"
12"x6"
PC
12"-PR-300-51708-B1D-IC
B2A B1D

8"-PR-300-51704-B2A-IC
NOTE 3
DO NOT POCKET
HIGH LEVEL OVERRIDE
PY 53701A
PIC-53701A 305-11537 12676

NOTE 4
PV 53701A
6"x3"
6"x3"
PC
3"
B1D B2A
6"-PR-300-51704-B1D-IC

1457 METHANOL 300-11323 FROM 300-LZ-00-3003
1"-ME-300-32306-B1WR-
NOTE 2
B1WR B1D IC

1458 METHANOL 300-11323 FROM 300-LZ-00-3003
1"-ME-300-32303-B1WR-
NOTE 2
B1WR B1D IC
12"-PR-300-51708-B1D-IC

16460 C3R 300-11515 FROM 300-EE-00-4004
16"-PR-300-51607-B1D-IC
16"x12"
12"-PR-300-51607-B1D-IC
16461 C3R 300-11529 TO 300-VV-VI-5009

17248 C3R 300-11516 FROM 300-EE-00-4004
10"-PR-300-51611-B1D-IC
10"x4"
4"-PR-300-51611-B1D-IC
17251 C3R 300-11529 TO 300-VV-VI-5715

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM		CLIENT
2	01/13/2025	FOR BEP	NAH	OJK	SC	SKG /VK	SA		
1	10/21/2024	PRELIMINARY	NAH	OJK	SC	SKG /VK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
PROPYLENE REFRIGERATION SYSTEM-
(-28C USER 2/2)

SCALE: | DWG. No: 363136-300-11517 | REV: 0

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300-LZ-00-3001-EP-00-18
OFFGAS EXCHANGER NO.6
(PART OF 300-LZ-00-3001)
(NOTE 13)

300-VV-VI-5009
LIQUID PROPYLENE ACCUMULATOR
FOR 300-LZ-00-3001-EP-00-18
Inside Diam. x Len.(T/T): x

305-LZ-00-5701-EP-00-11
ROG COLD BOX
EXCHANGER NO. 1
(PART OF 305-LZ-00-5701)
(NOTE 13)

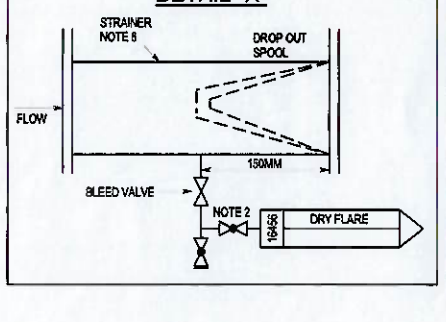
305-VV-VI-5715
LIQUID PROPYLENE ACCUMULATOR
FOR 305-LZ-00-5701-EP-00-11
Inside Diam. x Len.(T/T): x

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. VENTED GATE VALVES REQUIRED AS PER SERVICE.
3. ADMINISTRATIVE PROCEDURES MUST BE USED TO ENSURE THAT COLD BOX INLET STRAINERS AND PIPING ARE PROPERLY DRAINED AND VENTED WHEN THEY ARE ISOLATED AND OUT OF SERVICE.
4. LOCATE CONTROL VALVE TO PREVENT FLASHING AT INLET OF CONTROL VALVE AND MINIMUM DISTANCE FROM THE DOWNSTREAM EQUIPMENT.
5. TWO PHASE FLOW,ANCHOR SECURELY.
6. INLET STRAINERS TO BRAZED ALUMINUM EXCHANGERS TO HAVE A MESH SIZE BASED ON VENDOR RECOMMENDATION AND SHALL HAVE A MAXIMUM PRESSURE DROP OF 100MM H2O AT MAXIMUM FLOW.
7. ALL PIPING DOWNSTREAM OF STRAINER SHALL BE STAINLESS STEEL.
8. DRY OUT SPOOLS FOR BYPASSING EXCHANGER AND FIT UP TO PROCESS PIPING.
9. STRAINERS ARE TO BE LOCATED AS CLOSE AS POSSIBLE TO THE CORE EXCHANGER NOZZLE.
10. INSTALL DISSIMILAR METAL FLANGES INSULATING KITS AT CORE EXCHANGER NOZZLE CONNECTION.
11. DRUM 300-VV-VI-5009 AND 305-VV-VI-5715 TO BE ELEVATED ABOVE CORE EXCHANGER INLET NOZZLE. DETAIL ENGINEERING CONTRACTOR TO PROPERLY LOCATE THIS VESSEL TO ENSURE PROPER THERMOSIPHON CIRCULATION THROUGH THE CORE 300-LZ-00-3001-EP-00-18 AND 305-LZ-00-5701-EP-00-11 RESPECTIVELY.
12. HEAT TRACING OF LEVEL INSTRUMENT IN COLD SERVICE IS RECOMMENDED IF A DP CELL WITHOUT DIAPHRAGM IS USED.
13. FOR DUTY OF INDIVIDUAL PASSES SEE RESPECTIVE DATA SHEETS.
14. CHECK VALVE TO BE MINIMUM 600MM UP STREAM OF PROCESS TIE-IN.
15. DETAIL ENGINEERING CONTRACTOR TO ENSURE MECHANICAL STRENGTH REQUIREMENT FOR STRAINER ELEMENT WITH SUITABLE DIFFERENTIAL DESIGN PRESSURE.
16. TOP ENTRY.

10"-PR-300-53005-B2A-IC
C3R 300-11517 9856 TO 300-VV-VI-5002
30"-PR-300-53001-B2A-IC
TP
NOTE 16
DO NOT POCKET
PI 53004
PI 53003
2"
12"-PR-300-53003-B2A-IC
NOTE 5
10"-PR-300-53007-B2A-IC
NOTE 5
FOR PROCESS STREAMS SEE DWG.300-11312 FOR OTHER C3R STREAMS SEE DWG.300-11324/11321/11316
FOR PROCESS STREAMS SEE DWG. 305-11534 FOR OTHER C3R STREAMS SEE DWG. 300-11527/11528/11525
300-LZ-00-3001-EP-00-18
305-LZ-00-5701-EP-00-11
NOTE 8,10
300-VV-VI-5009
305-VV-VI-5715
NOTE 12
LG 53001
LT 53002
LG 53003
LT 53004
LIC 53002
LIC 53004
MH 20"
MH 24"
2" UC
TL
NOTE 11
MM
6"-PR-300-53002-B2A-IC
2"-PR-300-53008-B2A-IC
6"-PR-300-53006-B2A-IC
2"-PR-300-53009-B2A-IC
IC
B2A B21L
2"-CLD-300-53001-A21L-
2"-CLD-300-53002-A21L-
B21L A21L
9838 COLD LIQUID DRAIN
SEE DETAIL "A"
NOTE 3,6,7,9,15
PDI 53001
PDT 53001
PDI 53002
PDT 53002
14"-PR-300-51607-B2A-IC DO NOT POCKET
6"-PR-300-53004-B2A-IC DO NOT POCKET
6"-PR-300-53002-B21L-IC
6"-PR-300-53006-B21L-IC
NOTE 4
LV 53002
LV 53004
FC
NOTE 5
B1D B2A
16461 C3R 300-11517 FROM 300-EE-00-4004
14"x12"
14"-PR-300-51607-B1D-IC
4"-PR-300-53004-B1D-IC
NOTE 14
B1D IC B1WR
11675 METHANOL 300-11323 FROM 300-LZ-00-3003
1"-ME-300-32345-B1WR-
9844 METHANOL 300-11323 FROM 300-LZ-00-3003
1"-ME-300-32329-B1WR-

DETAIL-"A"



BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM		CLIENT
A	10/21/2024	PRELIMINARY	NAN	O.K	SC	SR/G /VK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNITS
LIQUID PROPYLENE ACCUMULATOR

SCALE: | DWG No: 363136-300-11529 | REV A

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300-EE-00-2101
SPENT CAUSTIC
WASH GASOLINE COOLER
DP (S-T) : 21.5 17.0 kg/cm^2g
DT (ST) : 120 °C, 65 °C
Rated Duty : 0.185 MMKCAL/HR
TEMA Type: HAIRPIN

300-JS-00-2101
SPEND CAUSTIC/WASH
GASOLINE MIXER
DP : 10.5kg.cm^2g
DT : 65 °C
Rated Flow: 8719 kg/hr

300-VV-HI-2101
SPENT CAUSTIC
COALESCER
DP : 10.5 kg.cm^2g
DT : 65 °C
Inside Diam. x Len.(T-T) 2900 mm x 6000 mm

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-11011 THRU B957-79-41-000-11014.
2. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
3. WASH WATER PURGE.
4. CONNECTION TO THE TOP OF PIPE.
5. LOCATE 300-JS-00-2101 IN VERTICAL POSITION BELOW BOTTOM OF 300-VV-HI-2101.
6. SAMPLE CONNECTION DETAILS AND RETURN LINE DESTINATION TO BE DEVELOPED BY DETAIL ENGINEERING CONTRACTOR (DEC).
7. TIE-IN POINT FOR FUTURE ROG UNIT.

REV	DATE	REVISION	DRN	BY	CHKD	APPD.
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AK	GS	PD:NS	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	300	11243	2

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

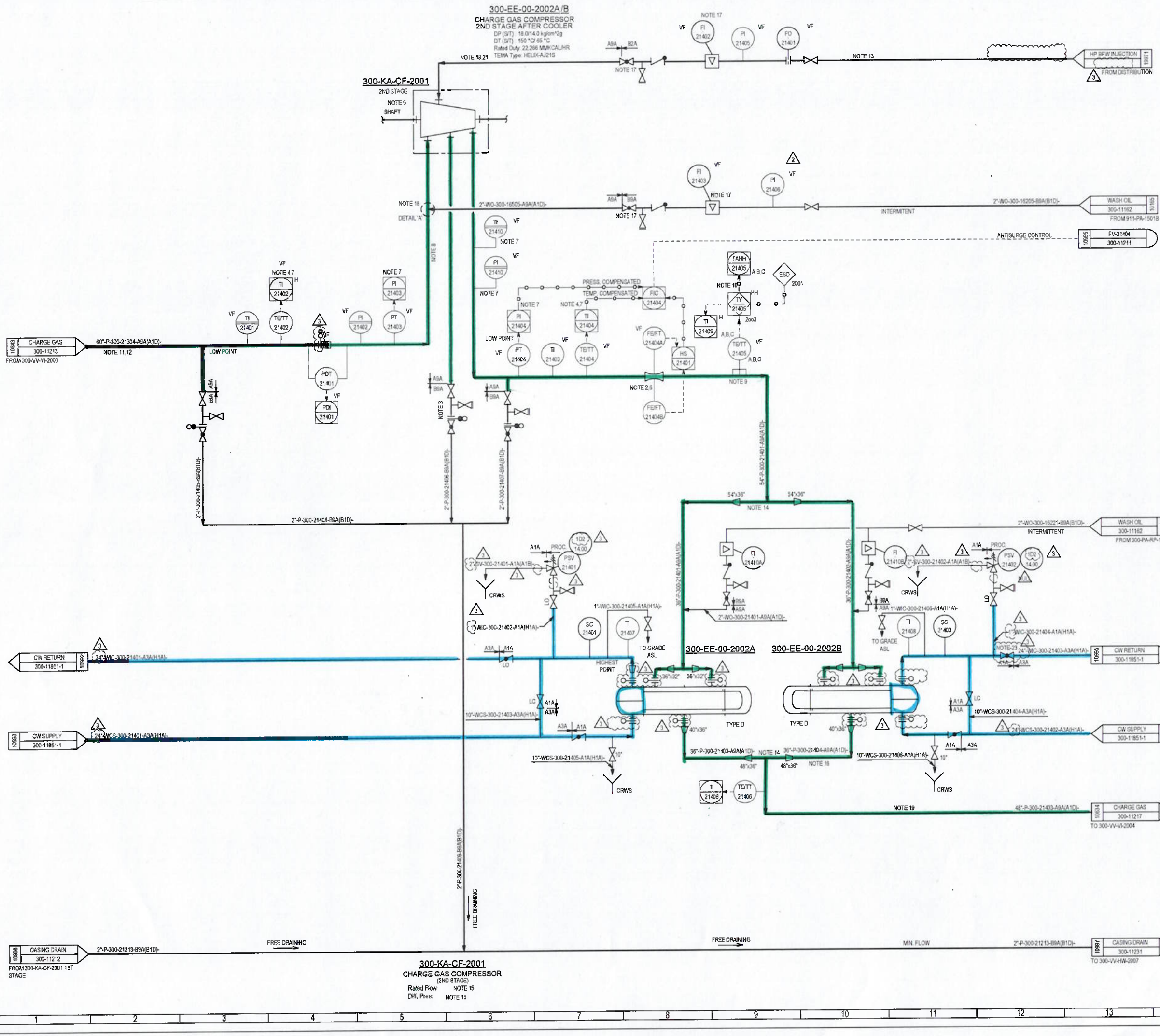
REV	ISSUE DATE	DESCRIPTION	CAD	PROJ ENG	I.P.E	PDM	PM	CLIENT
3	03/07/2025	REVISED FOR BEP	NAH	HN	SC	SKG VK	SA	
2	01/13/2025	FOR BEP	NAH	HN	SC	SKG VK	SA	
1	10/21/2024	PRELIMINARY	NAH	HN	SC	SKG VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
SPENT CAUSTIC COALESCER

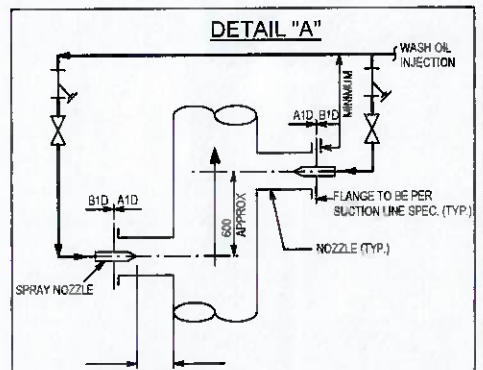
SCALE | DWG. No. 363136-300-11243 | REV. 1



NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-11011 THRU B957-79-41-000-11014.
2. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
3. SCAN TIME FOR ANTI SURGE CONTROL SHALL NOT EXCEED 0.1 SECONDS. TO BE CONFIRMED BY COMPRESSOR VENDOR.
4. COMPRESSOR CASING DRAIN VALVES TO BE ACCESSIBLE FROM OPERATING PLATFORM (TYPICAL).
5. LOCATE TEMPERATURE TRANSMITTER WITH DIGITAL READOUT ON LOCAL GAUGE BOARD.
6. SHUT DOWN TRIPS AND ALARMS FOR 300-KA-CF-2001
7. FLOW METER TO BE PRESSURE AND TEMPERATURE COMPENSATED.
8. LOCATE INSTRUMENT TAPS CLOSE TO COMPRESSOR 300-KA-CF-2001 FLANGES.
9. PIPING STRAIGHT RUN REQUIREMENT TO BE CONFIRMED WITH COMPRESSOR VENDOR DURING DETAILED DESIGN.
10. TRANSMITTERS TO HAVE INDIVIDUAL TAPPINGS.
11. TWO OUT OF THREE HIGH TEMPERATURE SIGNALS WILL CAUSE 300-KA-CF-2001 SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM THE OTHERS WILL ALARM.
12. FOR ALL COMPRESSOR SUCTION LINE 30" AND GREATER, 24" MANHOLES SHALL BE PROVIDED TO FACILITATE CLEANING AND INSPECTION.
13. NO POCKETS PERMITTED ON COMPRESSOR SUCTION LINE EXCEPT AT 300-KA-CF-2001 INLET.
14. PHOSPHATE FREE BFW.
15. SYMMETRICAL PIPING.
16. REFER 300-KA-CF-2001 PROCESS SPECIFICATION FOR RATED FLOW AND DIFFERENTIAL PRESSURE OF EACH STAGE.
17. THE OUTLET FROM THE EXCHANGER TO BE COLLECTED IN A COMMON HEADER BELOW THE EXCHANGERS BEFORE GOING TO A HIGH ELEVATION.
18. FI TO BE READABLE FROM GLOBE VALVE.
19. CONNECTIONS SHOWN FOR WASH OIL AND BFW ARE TYPICAL. TO BE CONFIRMED WITH COMPRESSOR VENDOR DURING DETAILED ENGINEERING.
20. TWO PHASE FLOW, ANCHOR SECURELY.
21. "VF" STANDS FOR VENDOR FURNISHED.
22. A SINGLE BFW LINE SHALL BE PROVIDED AT THE B/L OF VENDOR INTERNAL DISTRIBUTION TO VARIOUS LOCATION IS IN COMPRESSOR VENDOR SCOPE.
23. FOR VENDOR PO REFER DOCUMENT NO. 363136-300-11213.
24. GLOBE VALVE TO BE CONSIDERED WITH POSITION LOCK ARRANGMENT.

DETAIL "A"



REV	DATE	REVISION				
3	26.09.25	REVISED AS MARKED & ISSUED FOR HAZOP	SP	GS	PD/NS	MS
2	23.06.25	REVISED AS MARKED	MD	GS	PD/NS	MS
1			GRN	BY	CHKD	APPD

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

जनुमान SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG. No.	संशो REV.
NTS	B957	79	41	300	11214	2

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	POM	PM		CLIENT
3	03/07/2025	REVISED FOR BEP	NAh	PKJ	SC	SKG/VK	SA		
2	01/13/2025	FOR BEP	NAh	PKJ	SC	SKG/VK	SA		
1	10/21/2024	PRELIMINARY	NAh	PKJ	SC	SKG/VK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
CHARGE GAS COMPRESSOR
2ND STAGE

SCALE: | DWG. No. 363136-300-11214 | REV. 1

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300-KA-CF-6001
BINARY REFRIGERANT COMPRESSOR

RATED FLOW
DIFF. PRES.

NOTES:

1. FOR NOTES REFER P&ID B957-79-41-309 11611 (SHEET 1 OF 2)
2. FOR DETAILS REFER VENDOR P&ID NO B957-79-41-103/1611 B).

20381 | 8R | 300-11611-1 | SHEET 1 OF 2

8"-BR-300-61118-D40A(D2A)-IS

TO SEAL SYSTEM

ESD 6001 — VF — SI 61102 / SI 61103 — COMPRESSOR CONTROL SYSTEM (NOTE 25) — VF — SIC 61101 (NOTE 25) — PIC-61502 | 300-11615 | 10250

SHUTDOWN & ALARMS

ESD 0001 0002 — ESD 6001

HS 61106C — 300-KA-CF-6001 TRIP
HS 61106B — 300-KA-CF-6001 TRIP
HS 61106A — 300-KA-CF-6001 TRIP
ESD 6001
XA 61106B — 300-KA-CF-6001 SHUTDOWN
XA 61106C — 300-KA-CF-6001 SHUTDOWN
XA 61107A — 300-KA-CF-6001 SHUTDOWN

RESET

300-KA-CF-6001 RESET — HS 61107 — ESD 6001

COMMON TROUBLE ALARMS

XA 61110
XA 61109

300-KA-CF-6001 LP CASING

300-KA-CF-6001 HP CASING

M — GEAR MOTOR

1ST — 2ND — 3RD

36x30" — 24x20" — 20x16" — 28x24" — 42x16"

NOTE 4 — NOTE 8 — NOTE 13 — NOTE 5,14 — NOTE 6 — NOTE 6,7,16

PI 61103 — PT 61103 — VF
PT 61121 — PI 61121 — TE 61121 — TT 61121 — TI 61121
PI 61105 — PT 61105 — TI 61111 — PI 61113
PDI 61103 — PDT 61103
PI 61108
TI 61104 — TE/TT 61104
PI 61111 — PT 61111
MOV 61103 — SEE DETAIL 'A'

2"-BR-300-61115-D41K(B21L)-HC
2"-BR-300-61111A-D41K-B21L-HC
2"-BR-300-61116-D41K(B21L)-HC
2"-BR-300-61102-B41K(B21L)-HC
26"-BR-300-61131-B41K(B21L)-HC
28"-BR-300-61702-B41K(B21K)-HC
42"-BR-300-61101-D40A(D2A)-IS
2"-IG-300-61103-B41K(B21K)-

BR DRAIN | 300-11613 | TO 300-VV-HV-6007 — DO NOT POCKET NOTE-2 — 2"-BR-300-61117-D41K(D21K)-HS

20344 | 1ST STAGE SUCTION | 300-11611-1 | SHEET 1 OF 2 — 36"-BR-300-61501-B41K(B21L)-HC

20345 | 2ND STAGE SUCTION | 300-11611-1 | SHEET 1 OF 2 — 24"-BR-300-61502-B41K(B21L)-HC

20347 | BR | 300-11611-1 | SHEET 1 OF 2

20344 | NITROGEN | 300-11611-1 | SHEET 1 OF 2

20345 | 3RD STAGE SUCTION | 300-11611-1 | SHEET 1 OF 2

REV.	DATE	REVISIONS	DRN	BY	CHKD	APPD.
3	17.11.25	ISSUED FOR HAZOP	AK	KM	KK	MS

इंजीनियर्स इंडिया लिमिटेड (भारत सरकार का उपक्रम) — ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

भारत पैट्रोलियम कॉर्पोरेशन लिमिटेड
BHARAT PETROLEUM CORPORATION LTD.
BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)

पाइपिंग एण्ड इंस्ट्रूमेन्टेशन डायाग्राम
PIPING AND INSTRUMENTATION DIAGRAM
BINARY REFRIGERATION SYSTEM
-BINARY REFRIGERANT COMPRESSOR (SHEET NO.2 OF 2)

अनुमाप SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG No	संशो REV.
NTS	B957	79	41	300	11611-2	3

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300-JS-00-6003
BR 3RD STAGE SUCTION DRUM STATIC MIXER
RATED FLOW:

300-VV-VI-6003
BINARY REFRIGERANT COMPRESSOR 3RD STAGE SUCTION DRUM
Inside Diam. x Len.(T/T): x

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. ON TRIP, THE CONTROLLER IS AUTOMATICALLY SET TO MANUAL MODE AND THE VALVE IS DRIVEN CLOSED.
3. LOCATED IN 300-KA-CF-6001 COMPRESSOR CONTROL SYSTEM.
4. HEAT TRACING OF LEVEL INSTRUMENT IN COLD SERVICE IS RECOMMENDED IF A DP CELL WITHOUT DIAPHRAGM IS USED.
5. ELEVATION IS TO BE DETERMINED BY THE DEC BASED ON DRAINING OF LIQUID TO BINARY REFRIGERANT COMPRESSOR SUCTION DRUM 300-VV-VI-6001.
6. TWO OUT OF THREE HIGH HIGH LEVEL TRIP SIGNALS WILL CAUSE 300-KA-CF-6001 SHUTDOWN AND ANY ONE WILL ALARM.DEVIATION OF ONE SIGNAL FROM ALL OTHERS WILL ALARM.
7. TWO PHASE FLOW ANCHOR SECURELY.
8. MIXER TO BE LOCATED DOWNSTREAM THE HIGH POINT OF THE MINIMUM FLOW LOOP.
9. LOCATE QUENCH VALVE TO AVOID FLASHING AT INLET OF CONTROL VALVE AND MINIMUM DISTANCE TO MIXER 300-JS-00-6003.
10. LOOP MINIMUM FLOW LINE TO AN ELEVATION HIGHER THAN BOTH THE LIQUID QUENCH INJECTION POINT AND VESSEL NOZZLE TO AVOID BACK FLOW OF LIQUID INTO LINE.
11. LOCATE 10 DIAMETERS MINIMUM DISTANCE FROM DRUM NOZZLE.
12. THERMOWELL FOR TEMPERATURE SENSOR TO BE LOCATED ON THE BOTTOM OF THE LINE TO DETECT IF LIQUID REACHES THIS POINT.
13. QUENCH TEMPERATURE SHALL BE ADJUSTED FOR COMPOSITION AND PRESSURE.
14. DURING DETAIL ENGINEERING PIPING TO BE CHECKED IF NOISE INSULATION IS REQUIRED.
15. MIN. FLOW AND QUENCH LIQUID LINE SIZE TO BE CONFIRMED BY DEC.
16. TRANSMITTERS TO HAVE INDIVIDUAL TAPPINGS.
17. BR MINIMUM FLOW MIXERS TO BE ORIENTED IN THE VERTICAL, WITH VAPOR DOWN FLOW.

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROCTNG	LPE	PDM	PM	CLIENT
A	10/21/2024	PRELIMINARY	NAh	OJK	SC	SKG/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
BINARY REFRIGERATION SYSTEM -BR
3RD STAGE SUCTION DRUM

SCALE: | DWG. No: 363136-300-11617 | REV: A

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300-JS-00-6001
BR 1ST STAGE SUCTION DRUM STATIC MIXER
Rated Flow: 98228 kg/hr

300-VV-VI-6001
BINARY REFRIGERANT COMPRESSOR 1ST STAGE SUCTION DRUM
DP : 33.0 kg/cm^2g
DT : -115/100 °C
Inside Diam. x Len.(T/T):3100 mm x 5000 mm

300-VV-HW-6005
BINARY REFRIGERANT COMPRESSOR SUCTION DRUM BLOWCASE
DP : 58.0 kg/cm^2g
DT : -115/100 °C
Inside Diam. x Len.(T/T):1900 mm x 7600 mm

Note: Mark up shall be considered upto nearest isolation (valve)

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-300-11011 THRU B957-79-41-300-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. ON TRIP, THE CONTROLLER IS AUTOMATICALLY SET TO MANUAL MODE AND THE VALVE IS DRIVEN CLOSED.
3. PROVIDE DISSIMILAR TYPE CHECK VALVES.
4. LOOP MINIMUM FLOW LINE TO AN ELEVATION HIGHER THAN BOTH THE LIQUID QUENCH INJECTION POINT AND VESSEL NOZZLE TO AVOID BACK FLOW OF LIQUID INTO LINE.
5. MIXER TO BE LOCATED DOWNSTREAM THE HIGH POINT OF THE MINIMUM FLOW LOOP.
6. ELEVATION TO BE DETERMINED BY DEC TO ENSURE GRAVITY FLOW OF LIQUID DRAIN INTO 300-VV-HW-6005.
7. FLOW METER TO BE TEMPERATURE AND PRESSURE COMPENSATED.
8. MIN. FLOW LINE SIZE TO BE DETERMINED BY BASED ON COMPRESSOR VENDOR INPUT AND QUENCH LIQUID LINE SIZE TO BE CONFIRMED BY DEC.
9. LOCATE QUENCH VALVE TO AVOID FLASHING AT INLET OF CONTROL VALVE AND MINIMUM DISTANCE TO MIXER 300-JS-00-6001.
10. TWO OUT OF THREE HIGH HIGH LEVEL TRIP SIGNALS WILL CAUSE 300-KA-CF-6001 SHUTDOWN AND ANY ONE WILL ALARM.DEVIATION OF ONE SIGNAL FROM ALL OTHERS WILL ALARM.
11. BR MINIMUM FLOW MIXERS TO BE ORIENTED IN THE VERTICAL WITH VAPOR DOWN FLOW.
12. TWO PHASE FLOW, ANCHOR SECURELY.
13. PRESSURE GAUGE AND LEVEL INDICATOR TO BE READABLE FROM PRESSURING VALVE.
14. LOCATE 10 DIAMETERS MINIMUM DISTANCE FROM DRUM NOZZLE.
15. THERMOWELL FOR TEMPERATURE SENSOR TO BE LOCATED ON THE BOTTOM OF THE LINE TO DETECT IF LIQUID REACHES THIS POINT.
16. QUENCH TEMPERATURE SHALL BE ADJUSTED FOR COMPOSITION AND PRESSURE.
17. LOCATED IN 300-KA-CF-6001 COMPRESSOR CONTROL SYSTEM.
18. ELEVATION OF 300-VV-HW-6005 IS TO BE DETERMINED BY DEC BASED ON GRAVITY FEED FROM 300-VV-VI-6001.
19. DURING DETAIL ENGINEERING PIPING TO BE CHECKED IF NOISE INSULATION IS REQUIRED.
20. INSTRUMENTATION TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.
21. TRANSMITTERS TO HAVE INDIVIDUAL TAPPINGS.
22. TWO OUT OF THREE LOW LOW TEMPERATURE TRIP SINAL WILL CAUSE 300-KA-CF-6001 SHUTDOWN AND ANYONE WILL ALARAM. DEVIATION OF ONE SIGNAL FROM ALL OTHERS WILL ALARM.
23. HANDWHEEL TO BE DISENGAGED DURING SIS OPERATION.
24. PRESSURE RELIEF MAY NOT PROVIDE SUFFICIENT PROTECTION FOR AN UNWETTED WALL VESSEL (UNWETTED WALL VESSEL ARE THOSE ON WHICH THE INTERNAL WALLS ARE EXPOSED TO A GAS/VAPOR OR SUPERCRITICAL FLUID), AND VESSEL RUPTURE COULD OCCUR BEFORE OR TOO SOON AFTER INITIAL RELIEF ADDITIONAL PROTECTION MEASURE OF FIRE PROOFING AND FIRE WATER SPRINKLER TO BE PROVIDED.
25. FOR CONTROL VALVE VENT AND DRAIN REFER B957-79-41-300-11874

REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
3	13.10.25	ISSUED FOR HAZOP	SS	KM	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	MD	KM	KK	MS

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अनुमाप SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	दस्तावेज़ UNIT	प्रारूप संख्या DWG. No.	संशोधन REV.
	B957	79	41	300	11615	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM		CLIENT
3	03/07/2025	REVISED FOR BEP	NAN	OJK	SC	SKG/VK	SA		
2	01/13/2025	FOR BEP	NAN	OJK	SC	SKG/VK	SA		
1	10/21/2024	PRELIMINARY	NAN	OJK	SC	SKG/VK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNITS
BINARY REFRIGERATION SYSTEM -BR
1ST STAGE SUCTION DRUM

SCALE: | DWG. No. 363136-300-11615 | REV. 1

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300-EE-00-6001
BINARY REFRIGERANT COOLER
DP (S/T) SR 0.50,5 kg/cm2g
DT (S/T) -45/160°C EE C
Rated Duty 7,8,05 MMKCAL/HR
TEMA Type AXL

DETAIL "A"
ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS MOV TAG NUMBER

DETAIL "B"
ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS XV TAG NUMBER

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-300-11011 THRU B957-79-41-300-11014.
   ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. SEAL GAS IS AS FOLLOWS:
   INNER SEAL
   -COMPRESSOR DISCHARE DURING NORMAL OPERATION
   -BACKUP ETHYLENE VAPOR FROM HP ETHYLENE VAPOR PRODUCT HEADER DURING NORMAL OPERATION OR FROM OSBL ETHYLENE START-UP VAPORIZER AT START-UP BEFORE COMPRESSOR IN OPERATION. OUTER SEAL
   -NITROGEN FOR ALL OPERATIONS.
3. COMPRESSOR SEAL GAS INJECTION SYSTEM SHALL BE DEVELOPED DURING DETAIL ENGINEERING
4. STRAIGHT RUN OF PIPE REQUIRED AT COMPRESSOR SUCTION NOZZLES TO BE CONFIRMED WITH COMPRESSOR VENDOR DURING DETAIL DESIGN.
5. ACCEPTABLE CHECK VALVES FOR BR SERVICE ARE:
   A. MOKVELD AXIAL CHECK VALVE. B. GOODVAN AXIAL CHECK VALVE.
   C. CRANE AXIAL CHECK VALVE.
6. LOCATE ADJACENT DRAIN VALVES AND NITROGEN PURGE CONNECTION AS CLOSE TO THE MOTOR OPERATED VALVES AS POSSIBLE. LOCATE MOTOR OPERATED VALVES AS CLOSE TO COMPRESSOR AS POSSIBLE.
7. COMPRESSOR TO SHUTDOWN AUTOMATICALLY WHEN MOV IS 20% OR MORE CLOSED. COMPRESSOR IS PERMITTED TO START-UP ONLY WHEN VALVE IS FULLY OPEN.
8. CASING DRAIN TO BE PROVIDED FOR EACH STAGE TO BE CONFIRMED WITH VENDOR.
9. FOR SAMPLE CONNECTION DETAILS REFER P&ID NO. B957-79-41-300-11878.
10. TWO OUT OF THREE HIGH HIGH PRESSURE TRIP SIGNAL WILL CAUSE 300-KA-CF-6001 SHUTDOWN AND ANYONE WILL ALARM.DEVIATION OF ONE SIGNAL FROM ALL OTHERS WILL ALARM.
11. TWO OUT OF THREE HIGH HIGH TEMPERATURE TRIP SIGNAL WILL CAUSE 300-KA-CF-6001 SHUTDOWN AND ANYONE WILL ALARM.DEVIATION OF ONE SIGNAL FROM ALL OTHERS WILL ALARM.
12. FINAL CONFIGURATION OF DRYOUT SYSTEM TO BE CONFIRMED BY DEC
13. LOCATE INSTRUMENT TAP CLOSE TO COMPRESSOR FLANGES.
14. LOW PRESSURE DROP NON SLAMMING CHECK VALVE.
15. FOR ALL COMPRESSOR SUCTION LINE 30" AND GREATER. 24" MANHOLES SHALL BE PROVIDED IF NECESSARY TO FACILITATE CLEANING AND INSPECTION.
16. ISOLATION VALVES SHALL HAVE LOCAL OPEN/CLOSE PUSH BUTTONS AND OPEN/CLOSE INDICATORS INTEGRAL TO VALVE MOUNTED MOTOR ACTUATOR IF THE VALVE IS LOCATED IN A FIRE ZONE, IT SHALL BE FIRE SAFE WITH FIREPROOFED ACTUATOR POWER AND CONTROL CABLES IN A FIRE ZONE SHALL BE FIREPROOFED.
17. DURING DETAIL ENGINEERING COMPRESSOR AND PIPING TO BE CHECKED IF NOISE INSULATION IS REQUIRED.
18. MIN. FLOW LINE SIZE TO BE CONFIRMED AFTER RECEIPT OF VENDOR DATA.
19. BRC CONTROL INSTRUMENTATION INCLUDING MINIMUM SURGE CONTROL SYSTEM AND SHUTDOWN/TRIP LOOPS, TO BE CONFIRMED WHEN VENDOR DESIGN IS REVIEWED AND AGREED, DURING DETAIL ENGINEERING.
20. ANALYZER SAMPLE RETURN TO 300-VV-VI-2002 INLET VIA COMMON HEADER BASED ON ANALYZER HOUSE LOCATION. TO BE DEVELOPED BY DEC.
21. FLOWMETER TO BE TEMPERATURE AND PRESSURE COMPENSATED.
22. MINIMUM FLOW CONTROL SYSTEM FOR 300-KA-CF-6001 TO BE REVIEWED AFTER VENDOR SELECTION.
23. LOCATE PUSH BUTTON 15 METERS FROM COMPRESSOR AT SAFE LOCATION.
24. DO NOT POCKET FEED LINE TO MINIMUM FLOW BYPASS CONTROL VALVE.
25. THE SPEED CONTROLLER REGULATES THE MOTOR SPEED USING VFD. SPEED CONTROLLER MAY RESIDE IN THE COMPRESSOR CONTROL SYSTEM.
26. DELETED.
27. GLOBE VALVE TO BE CONSIDERED WITH POSITION LOCK ARRANGEMENT.
28. ONE TIE-IN POINT FOR CASING DRAIN (HAVING MANIFOLD DRAIN) FOR EACH CASING SHALL BE PROVIDED BY VENDOR AT COMPRESSOR BASES PLATE FURTHER, ROUTING OF THE SAME SHALL BE IN PURCHASERS SCOPE(TYPICAL NOTES FOR ALL THREE STAGES OF BRL).

MOV TAG NO.	INTERLOCK
MOV-61101	ESD-6001
MOV-61103	
MOV-61104	
MOV-61105	

REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
3	07.10.25	ISSUED FOR HAZOP.	AN	KM	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	MD	KM	KK	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	UNIT	DWG. No.	REV.
	B957	79	41	300	11611	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	DATE	DESCRIPTION						
3	03/07/25	REVISED FOR BEP	NAh	OJK	SC	SKG/VK	SA	
2	01/13/25	FOR BEP	NAh	OJK	SC	SKG/VK	SA	
1	10/21/24	PRELIMINARY	NAh	OJK	SC	SKG/VK	SA	
REV	ISSUE DATE	DESCRIPTION	CAD	PROJ ENG	LPE	PDM	PM	CLIENT

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNITS
BINARY REFRIGERATION SYSTEM
-BINARY REFRIGERANT COMPRESSOR

SCALE	DWG. No.	REV.
	363136-300-11611	1

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BINA PETROCHEMICAL AND REFINERY
EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM
CORPORATION LIMITED
BINA REFINERY

LUMMUS TECHNOLOGY

PIPING AND INSTRUMENTATION DIAGRAM
BINARY REFRIGERATION SYSTEM
-BINARY REFRIGERANT ACCUMULATOR

363136-300-11612

REV	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
A	10/21/2024 PRELIMINARY	Nkh	OJK	SO	SKG AK	SA	

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NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014.
ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300"
2. INSTALL DISSIMILAR METAL FLANGES INSULATING KITS AT CORE EXCHANGER CONNECTIONS AS REQUIRED.
3. ALL PIPING DOWNSTREAM OF STRAINER SHALL BE STAINLESS STEEL.
4. FOR DUTY OF INDIVIDUAL PASSES SEE RESPECTIVE DATA SHEETS.
5. DRYOUT SPOOLS FOR BYPASSING EXCHANGER AND FIT UP PROCESS PIPING ON VENDOR RECOMMENDATION AND SHALL HAVE A MAXIMUM PRESSURE DROP OF 100 MM H2O AT MAXIMUM FLOW.
6. INLET STRAINER TO BRAZED ALUMINUM EXCHANGER TO HAVE MESH SIZE BASED ON VENDOR RECOMMENDATION AND SHALL HAVE A MAXIMUM PRESSURE DROP OF 100 MM H2O AT MAXIMUM FLOW.
7. VENTED GATE VALVES REQUIRED AS PER SERVICE.
8. STRAINER ARE TO BE LOCATED AS CLOSE AS POSSIBLE TO THE CORE EXCHANGER.
9. ALL VENDOR SUPPLIED INSTRUMENTS INSIDE COLD BOX MUST BE WIRED TO A TERMINAL BOX UNLESS OTHERWISE SPECIFIED.
10. QUENCH LIQUID LINE SIZE TO BE CONFIRMED BY DEC.
11. ADMINISTRATIVE PROCEDURES MUST BE USED TO ENSURE THAT COLD BOX INLET STRAINERS AND PIPING ARE PROPERLY DRAINED AND VENTED WHEN THEY ARE ISOLATED AND OUT OF SERVICE.
12. LOCATE PUSH BUTTON 15 METERS FROM COMPRESSOR AT SAFE LOCATION.
13. TRACING OF LEVEL INSTRUMENTS IN COLD SERVICE IS RECOMMENDED IF A DP CELL WITHOUT DIAPHRAM IS USED.
14. DEC TO ENSURE BOTTOM OF 300-VV-HW-6004 IS NOT MORE THAN 5 METERS ABOVE TOP OF 300-VV-HW-6005.
15. TWO PHASE FLOW, ANCHOR SECURELY.
16. DETAIL ENGINEERING CONTRACTOR TO ENSURE MECHANICAL STRENGTH REQUIREMENT FOR STRAINER ELEMENT WITH SUITABLE DIFFERENTIAL DESIGN PRESSURE.
17. DEC TO ENSURE THAT TOP OF 300-VV-HW-6004 DOES NOT EXCEED LOWEST ELEVATION OF 300-LZ-00-3001-EP-00-17 OUTLET PASS "C" NOZZLE OR 300-LZ-00-3001-EP-00-15 INLET PASS "C" NOZZLE

DETAIL "A"

DETAIL "B"

300-VV-HW-6004
BINARY REFRIGERANT ACCUMULATOR
Inside Diam. x Len.(T/T): x

300-LZ-00-3001-EP-00-15
OFFGAS EXCHANGER NO.3 (PART OF 300-LZ-00-3001)
NOTE 4

300-LZ-00-3001-EP-00-17
OFFGAS EXCHANGER NO.5
(PART OF 300-LZ-00-3001)
NOTE 4

300-LZ-00-3001-EP-00-18
OFFGAS EXCHANGER NO.6
(PART OF 300-LZ-00-3001)
NOTE 4

300-VV-HW-6007
BR COMPRESSOR CASING DRAIN POT (NOTE 10)
Inside Diam. x Len.,(T/T): x

(NOTE 9) 300-EP-00-4007
ETHYLENE RUNDOWN CHILLER
Rated Duty:

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011THRU 363136-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. INSTALL DISSIMILAR METAL FLANGES INSULATING KITS AT CORE EXCHANGER CONNECTIONS AS REQUIRED.
3. BYPASS GLOBE VALVE TO BE SIZED BASED ON MAXIMUM RUNDOWN.
4. DRY OUT SPOOLS FOR BYPASSING EXCHANGER AND FITUP PROCESS PIPING.
5. STRAINERS ARE TO BE LOCATED AS CLOSE AS POSSIBLE TO THE CORE EXCHANGER.
6. INLET STRAINER TO BRAZED ALUMINUM EXCHANGER TO HAVE MESH SIZE BASED ON VENDOR RECOMMENDATION AND SHALL HAVE A MAXIMUM PRESSURE DROP OF 100MM H2O AT MAXIMUM FLOW.
7. ALL PIPING DOWNSTREAM OF STRAINER SHALL BE STAINLESS STEEL.
8. TWO PHASE FLOW ANCHOR SECURELY.
9. FOR DUTY OF INDIVIDUAL PASSES SEE RESPECTIVE DATA SHEETS.
10. DRUM SHARED WITH 300-KA-CF-5001.
11. PRESSURE GAUGE AND LEVEL INDICATOR TO BE READABLE FROM VALVE.
12. VENTED GATE VALVE REQUIRED AS PER SERVICE.
13. ADMINISTRATIVE PROCEDURES MUST BE USED TO ENSURE THAT COLD BOX INLET STRAINERS AND PIPING ARE PROPERLY DRAINED AND VENTED WHEN THEY ARE ISOLATED AND OUT OF SERVICE.
14. DETAIL ENGINEERING CONTRACTOR TO ENSURE MECHANICAL STRENGTH REQUIREMENT FOR STRAINER ELEMENT WITH SUITABLE DIFFERENTIAL DESIGN PRESSURE.

300-EP-00-4007

DWG. 300-11416 — ETHYLENE RUNDOWN — DWG. 300-11416

8"-BR-300-61301-D21L-IC

6"-BR-300-61203-D21L-IC

TIC-41601 / 300-11415

6"-BR-300-61203-B21L-IC

8"-BR-300-61301-B21L-IC

6"-BR-300-61304-B21K-IC

18"-BR-300-61302-B21K-IC

10"-BR-300-61203-D21K-IC — BR 300-11612 — FROM 300-VV-HW-6004

10"-BR-300-61305-D21K-IC — DO NOT POCKET — BR 305-11534 — TO 305-LZ-00-5701-EP-00-12

6"-BR-300-61304-B21K-IC — BR 300-11617 — 300-VV-VI-6003

18"-BR-300-61302-B21K-IC — BR 300-11616 — 300-VV-VI-6002

10"-BR-300-53406-B21K-IC — BR 305-11534 — FROM 305-LZ-00-5701-EP-00-12

300-KA-CF-5001 — 300-VV-HW-6007 NOTE 10

DRY FLARE — -DF-300-61301-A21L-

-DF-300-61302-A21L-

-DF-300-61303-A21L- — DRY FLARE

-P-300-61303-D21L-IS

-P-300-61304-A21L-

-P-300-61301-D21L-

-P-300-61302-D21L-IS

FREE DRAINING

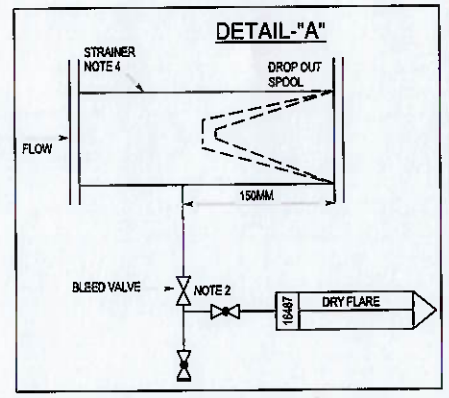
2"-BR-300-61117-D21L-IS — BR DRAIN 300-11611 — FROM 300-KA-CF-6001

-LD-300-51101-D21L-IS — C3R CASING DRAIN 300-11511 — FROM 300-KA-CF-5001

NITROGEN — 2"-IG-300-61301-A1B-

300-VV-HW-6007

DETAIL-"A"



BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM		CLIENT
A	10/21/2024	PRELIMINARY	NAN	OJK	SC	SKG/VK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
BINARY REFRIGERATION SYSTEM
-ETHYLENE RUNDOWN CHILLER

SCALE: | DWG. No: 363136-300-11613 | REV: A

Page 1970 of 4391. : B957-TENDER_DOC-B957-300-16-43-MR-T-3001. : Rev. A

300-JS-00-6002
BR 2ND STAGE SUCTION DRUM STATIC MIXER
Rated Flow: 76093 kg/hr

300-VV-VI-6002
BINARY REFRIGERANT COMPRESSOR 2ND STAGE SUCTION DRUM
DP : 33.0kg/cm^2g
DT : -90/100°C
Inside Diam. x Len.(T/T):2500 mm x 5000 mm

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-300-11011 THRU B957-79-41-300-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. ON TRIP, THE CONTROLLER IS AUTOMATICALLY SET TO MANUAL MODE AND THE VALVE IS DRIVEN CLOSED.
3. LOCATED IN 300-KA-CF-6001 COMPRESSOR CONTROL SYSTEM.
4. QUENCH TEMPERATURE SHALL BE ADJUSTED FOR COMPOSITION AND PRESSURE.
5. MIN. FLOW LINE SIZE TO BE DETERMINED BY BASED ON COMPRESSOR VENDOR INPUT AND QUENCH LIQUID LINE SIZE TO BE CONFIRMED BY DEC.
6. TWO OUT OF THREE HIGH HIGH LEVEL TRIP SIGNALS WILL CAUSE 300-KA-CF-6001 SHUTDOWN AND ANY ONE WILL ALARM.DEVIATION OF ONE SIGNAL FROM ALL OTHERS WILL ALARM.
7. TWO PHASE FLOW ANCHOR SECURELY.
8. MIXER TO BE LOCATED DOWNSTREAM THE HIGH POINT OF THE MINIMUM FLOW LOOP.
9. DEC TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION. THE TRANSMITTER SHELL BE LOCATED ABOVE TAPPING POINT.
10. LOOP MINIMUM FLOW LINE TO AN ELEVATION HIGHER THAN BOTH THE LIQUID QUENCH INJECTION POINT AND VESSEL NOZZLE TO AVOID BACK FLOW OF LIQUID INTO LINE.
11. LOCATE 10 DIAMETERS MINIMUM DISTANCE FROM DRUM NOZZLE.
12. THERMOWELL FOR TEMPERATURE SENSOR TO BE LOCATED ON THE BOTTOM OF THE LINE TO DETECT IF LIQUID REACHES THIS POINT.
13. FLOW METER TO BE TEMPERATURE AND PRESSURE COMPENSATED.
14. DURING DETAIL ENGINEERING PIPING TO BE CHECKED IF NOISE INSULATION IS REQUIRED.
15. BR MINIMUM FLOW MIXERS TO BE ORIENTED IN THE VERTICAL WITH VAPOR DOWN FLOW.
16. ELEVATION IS TO BE DETERMINED BY THE DEC BASED ON DRAINING OF LIQUID TO BINARY REFRIGERANT COMPRESSOR SUCTION DRUM 300-/V-VI-6001.
17. LOCATE QUENCH VALVE TO AVOID FLASHING AT INLET OF CONTROL VALVE AND MINIMUM DISTANCE TO MIXER 300-JS-00-6002.
18. TRANSMITTERS TO HAVE INDIVIDUAL TAPPINGS.
19. SHOWN ONLY TO BE CONSIDERED DURING LIS OPERATION.
20. PRESSURE RELIEF MAY NOT PROVIDE SUFFICIENT PROTECTION FOR AN UNWETTED WALL VESSEL (UNWETTED WALL VESSEL ARE THOSE ON WHICH THE INTERNAL WALLS ARE EXPOSED TO A GAS,VAPOR OR SUPERCRITICAL FLUID) AND VESSEL RUPTURE COULD OCCUR BEFORE OR TOO SOON AFTER INITIAL RELIEF. ADDITIONAL PROTECTION MEASURE OF FIRE PROOFING AND FIRE WATER SPRINKLER TO BE PROVIDED.
21. FOR CONTROL VALVE VENT AND DRAIN REFER B957-79-41-300-11874

REV	DATE	REVISION	DRN.	CHKD	APPD.
3	13.10.25	ISSUED FOR HAZOP	SS	KM	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	MD	KM	KK	MS

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	300	11616	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	FDM	PM	CLIENT
3	03/07/2026	REVISED FOR BEP	NAH	OJK	SC	SKG VK	SA	
2	01/12/2025	FOR BEP	NAH	OJK	SC	SKG VK	SA	
1	10/21/2024	PRELIMINARY	NAH	OJK	SC	SKG VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNITS
BINARY REFRIGERATION SYSTEM -BR
2ND STAGE SUCTION DRUM

SCALE: | DWG. No: 363136-300-11616 | REV. 1

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Page 1972 of 4391 ; B957-TENDER_DOC-B957-300-16-43-MR-T-3001 ; Rev. A

BINA PETROCHEMICAL AND REFINERY
EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

LUMMUS TECHNOLOGY

PIPING AND INSTRUMENTATION DIAGRAM
REFINERY OFF GAS UNIT
ROG COLD BOX EXCHANGER

363136-305-1534

NOTES:

1 FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PREFIXED BY UNIT NUMBER '305' SEE DWG NO. 363136-000-1101 THRU 363136-000-1104
2 DEC TO CONSIDER ADDING POSITIVE ISOLATION BETWEEN REFINERY OFF GAS UNIT AND METHANOL UNIT
3 DRY OUT SPOOLS FOR BYPASSING EXCHANGER AND FT UP TO PROCESS PIPING BY DEC
4 INLET FLTER TO BE FACED ALUMINUM EXCHANGER TO HAVE MESH SIZE BASED ON EXCHANGER VENDOR RECOMMENDATION AND SHALL HAVE A MAX PRESSURE DROP OF 100 MM-HG AT MAXIMUM FLOW
5 STRAINERS ARE TO BE LOCATED AS CLOSE AS POSSIBLE TO THE COLD BOX NOZZLES
6 SAMPLE CONNECTION TO BE PROVIDED AT EACH OPERATING LEVEL. FINAL NUMBER TO BE CONFIRMED BY COLD BOX VENDOR
7 ALL PIPING DOWNSTREAM OF STRAINER SHALL BE STAINLESS STEEL
8 LOCATE TEMPERATURE TRANSMITTER AS CLOSE TO COLD BOX AS POSSIBLE
9 CHECK VALVE ON METHANOL LINE SHALL BE AT LEAST 800 MM FROM PROCESS TIE-IN
10 VENTED GATE VALVES REQUIRED AS PER SERVICE
11 TWO PHASE FLOW ANCHOR RECOMMENDED
12 LINE SPECIFICATION BREAK TO UNKNOWN OF 50 M FROM COLD BOX CONNECTION
13 METHANOL WILL FREEZE AT -98°C. CHECK OPERATING TEMPERATURES BEFORE MEETING METHANOL
14 ADMINISTRATIVE PROCEDURES MUST BE USED TO ENSURE THAT COLD BOX INLET STRAINERS AND PIPING ARE PROPERLY DRAINED AND VENTED WHEN THEY ARE ISOLATED AND OUT OF SERVICE
15 TWO OUT OF THREE LOW-LOW TEMPERATURE TRIP SIGNAL WILL CLOSE XV-5401 AND ANYONE WILL ALARM DEVIATION OF ONE SIGNAL FROM ALL OTHERS WILL CAUSE ALARM
16 SET PRESSURE TO BE PROVIDED BY COLD BOX VENDOR. PSV TO BE PROVIDED BY COLD BOX VENDOR
17 NUTMLL DISMLAR METAL FLANGES INSULATING KITS AT COLD BOX CONNECTIONS AS REQUIRED
18 FOR DUTY OF INDIVIDUAL PASSES SEE RESPECTIVE DATA SHEETS
19 ANALYZER SAMPLE RETURN DETAIL TO BE DEVELOPED DURING DETAILED ENGINEERING
20 DETAILED ENGINEERING CONTRACTOR TO ENSURE MECHANICAL STRENGTH REQUIREMENT FOR STRAINER ELEMENT WITH SUITABLE DIFFERENTIAL DESIGN PRESSURE
21 SAMPLE CONNECTION DETAILS AND RETURN LINE DESTINATION TO BE DEVELOPED BY DEC

REV	DATE	DESCRIPTION	CHD	PROJ ENG	LEAD	PM	AM
2	10/24/2024	PRELIMINARY	NMH	RR	SC	SKG AK	SA
1	01/13/2023	FOR DEP	NMH	RR	SC	SKG AK	SA

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DETAIL "A"

300-EE-00-1205
QUENCH OIL/ LP STEAM GENERATOR

DP (S/T) : 20.0(FV)/26.0 kg/cm^2g
DT (S/T) : 240 °C/ 225 °C
Rated Duty: 13.703 MMKCAL/HR
TEMA Type: BKM

NOTE 4

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014.
   ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. 10MM WEEP HOLE SHALL BE PROVIDED IN LOW POINT DRAIN.
3. TIE-IN POINT FOR FUTURE LP STEAM GENERATOR.
4. EXCHANGER FOR FUTURE DESIGN CASE 3 ONLY.
5. QUENCH OIL SYSTEM SHALL BE DESIGNED WITH MINIMUM NUMBER OF BENDS AND LOW POINT. LOW POINT DRAINS SHALL HAVE MIN. 2" VALVE.
6. TRACING MEDIUM REQUIRED IS MP STEAM.

FUTURE

LP STEAM 15882 — TO DISTRIBUTION
NOTE 3
FI 16801
FE/FT 16801
PI 16801
PT 16801
2"-SL-300-16606-A1A-IH
PSV 16601A — PROC A1B — 20.00 — ASL — -SV-300-16613-A1B-
PSV 16601B — PROC A1B — 20.00 — ASL — -SV-300-16612-A1B-
-SL-300-16610-A1A-IH
-SL-300-16611-A1A-IH
FREE DRAINING

QUENCH OIL 15880 — 300-11135 — TO 300-JS-00-1201
36"-QO-300-16604-B1D-IT — NOTE 6
54"x36"

QUENCH OIL 15340 — 300-11116 — TO QF OF 300-FF-00-1112 THRU 300-FF-00-1114
36"-QO-300-16603-B1D-IT — NOTE 6

TP — NOTE 3
TE/TT 16601
TIC 16801
TI 16602 — TE/TT 16602
TI 16603 — TE/TT 16603
NOTE 6
MIN

FLUX OIL 17902 — 300-11160 — FROM 300-PA-CF-1502A/B
2"-XO-300-16017-B1D-
LO
IT MIN
TP — NOTE 3
54"-QO-300-16602-B1D-IT

300-EE-00-1205
TYPE G

LT 16601 — LIC 16801 H — LG 16602
LT 16603 — LI 16603 H L
HIGH LEVEL OVERRIDE
TY 16601

QUENCH OIL 15879 — 300-11158 — FROM 300-EE-00-1204A-E
54"-QO-300-15801-B1D-IT
MIN
A1D B1D
TP — NOTE 3
TP — NOTE 3
NOTE 6
2"-BB-300-16606-A1A-IH
SC 16610
HS 16601

QUENCH OIL DRAIN 17904 — 300-11158 — TO 300-VV-HW-1201
-QOD-300-16601-A1D-IT

3"-WB-300-16607-A1A-IH
MIN.
TV 16601A — 3"x3" — FC 3" — 3"x3"
A1A B1A
TV 16601B — A1A D1A — 3"x3" — FC 2" — 3"x3"

2"-BB-300-15806-A1A-
TP — NOTE 3
15586 BLOWDOWN — TO WWTP

3"-CM-300-16615-B1A-IH
TP — NOTE 3
15885 MP CONDENSATE — FROM MP CONDENSATE PUMPS

START-UP NNF
3"-WB-300-61120-D1A-IH
TP — NOTE 3
15884 HP BFW 300-11811A — FROM 300-PA-CF-8005A/B

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
3	01/13/2025	FOR BEP	NAN	PKJ	SC	SKG/VK	SA	
2	10/21/2024	PRELIMINARY	NAN	PKJ	SC	SKG/VK	SA	
1								
0								

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PIPING AND INSTRUMENTATION DIAGRAM
MAIN FRACTIONATION
QUENCH OIL/ LP STEAM GENERATOR

SCALE: | DWG No: 363136-300-11166 | REV 0

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300-VV-HW-2007
CHARGE GAS COMPRESSOR CASING DRAIN DRUM

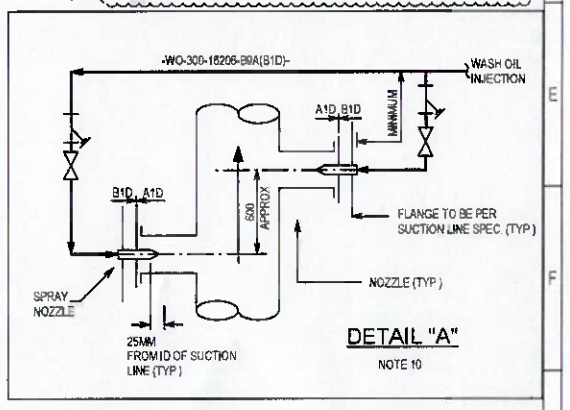
DP : 31.5 kg/cm^2g
DT : 150 °C
Inside Diam. x Len.(T/T) 600 mm x 1000 mm

STAGE	ITEM LOC. PID	CHARGE GAS LINE NUMBER	WASH OIL LINE NO.
1ST STAGE-1	300-11212	64"-P-300-21215-A1D-	2"-WO-300-16204-B1D-
1ST STAGE-2	300-11212	84"-P-300-21204-A1D-	2"-WO-300-16205-B1D-
2ND STAGE	300-11214	56"-P-300-21304-A1D-	2"-WO-300-16205-B1D-
3RD STAGE	300-11231	48"-P-300-23002-A1D-	2"-WO-300-16206-B1D-

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 9957-79-41-300-1001 THRU 9957-79-41-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. SCAN TIME FOR ANTI SURGE CONROL SHALL NOT EXCEED 0.1 SECOND. TO BE CONFIRMED BY COMPRESSOR VENDOR.
3. COMPRESSOR CASING DRAIN VALVES TO BE ACCESSIBLE FROM OPERATING PLATFORM (TYPICAL).
4. FOR ALL COMPRESSOR SUCTION LINE 30" AND GREATER, 24" MANHOLES SHALL BE PROVIDED TO FACILITATE CLEANING AND INSPECTION. ALSO USE THE MANHOLES WITH TEMPORARY SCREENS AS AIR DRYOUT SUCTION. VENDOR TO MAN HOLE FOR DRY OUT CONDITION.
5. LG-23101 TO BE VISIBLE FROM GLOBE VALVE.
6. FLOW METER TO BE PRESSURE AND TEMPERATURE COMPENSATED.
7. LOCATE INSTRUMENT TAPS CLOSE TO COMPRESSOR 300-KA-CF-2001 FLANGES
8. PIPING STRAIGHT RUN REQUIREMENT TO BE CONFIRMED WITH COMPRESSOR VENDOR DURING DETAILED DESIGN.
9. TWO OUT OF THREE HIGH TEMPERATURE SIGNALS WILL CAUSE 300-KA-CF-2001 SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM THE OTHERS WILL ALARM.
10. ATOMIZING NOZZLES SHALL BE INSTALLED IN SUCTION LINE TO 300-KA-CF-2001 AT MINIMUM DISTANCE FROM SUCTION NOZZLE AS SHOWN IN DETAIL "A".
11. NO POCKETS PERMITTED ON COMPRESSOR SUCTION LINE EXCEPT AT 300-KA-CF-2001 INLET.
12. REFER 300-KA-CF-2001 PROCESS SPECIFICATION FOR RATED FLOW AND DIFFERENTIAL PRESSURE OF EACH STAGE.
13. DURING "AIR DRY OUT" LINE TO WET FLARE IS BLINDED AND LINE TO ATMOSPHERE IS OPEN AFTER "AIR DRY OUT" IS COMPLETE LINE TO ATMOSPHERE IS BLINDED AND LINE TO WET FLARE IS OPEN.
14. FI TO BE READABLE FROM GLOBE VALVE.
15. CONNECTIONS SHOWN FOR WASH OIL AND BFW ARE TYPICAL. TO BE CONFIRMED WITH COMPRESSOR VENDOR DURING DETAILED ENGINEERING.
16. TRANSMITTERS TO HAVE INDIVIDUAL TAPPINGS.
17. THROAT AREA OF THE VENTURI METER MUST BE AT LEAST EQUAL TO THE SAFETY VALVE INLET.
18. PSV-23106A/B/C/D/E SIZE AND NUMBER OF PSVS INSTALLED IS PRELIMINARY, TO BE CONFIRMED BY DEC BASED ON COMPRESSOR VENDOR'S RECOMMENDATION.
19. EQUIPMENT, SAMPLING POINT, CONTROL VALVE AND LEVEL INSTRUMENT DRAINS TO BE ROUTED TO THE CLOSED DRAIN SYSTEM IDENTIFIED FOR ASSOCIATED EQUIPMENT AS SHOWN IN THE P&ID.

3 19. REFER P&ID NO. 9957-79-41-300-11874 FOR CONTROL VALVE VENT AND DRAIN DETAILS.



DETAIL "A"
NOTE 10

REV.	DATE	REVISION	DRN	BY	CHKD	APP'D.
3	26.09.25	REVISED AS MARKED & ISSUED FOR HAZOP	SS	GS	PD/NS	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AK	GS	PD/NS	MS

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

जनुमाप SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	प्रारेख संख्या DWG. No.	संशो REV.
NTS	B957	79	41	300	11231	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
3	03/07/2025	REVISED FOR BEP	NA	HN	SC	SKG/VK	SA	
2	01/13/2025	FOR BEP	NA	HN	SC	SKG/VK	SA	
1		PRELIMINARY	NA	HN	SC	SKG/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
CHARGE GAS COMPRESSOR 3RD STAGE

SCALE | DWG No. 363136-300-11231 | REV 1

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300-LZ-00-8001
DEAERATOR PACKAGE
INSIDE DSAM_X LEN (T/T) 49202'0"

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 8957-79-41-000-11011 THRU 8957-79-41-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. ALL INDICATED ELEVATION ARE WITH REFERENCE TO GRADE LEVEL.
3. AUTOSTART STAND BY PUMP ON LOW DISCHARGE PRESSURE, ALARM ON LOW LOW PRESSURE.
4. SAMPLE CONNECTION DETAILS AND RETURN LINES DESTINATION TO BE FINALIZED DURING DETAIL ENGINEERING.
5. ALARM ON HIGH O2 LEVEL SHALL BE PROVIDED.
6. FOR PUMP TURBINE STEAM LINES DETAILS, REFER P&ID 300-11811B.
7. LV-81101B IS TO BE KEPT MIN DISTANCE TO LP CONDENSATE FLASH DRUM.
8. PUMP MINIMUM FLOW LINE SIZE WILL BE FINALISED BASED PUMP VENDOR.
9. ELEVATION CONFIRMED BASED ON NPSH OF THE BFW PUMPS, DEAERATOR VESSEL (300-LZ-00-8001) IS LOCATED ABOVE PLATFORM (ELEVATION 29.5 METER) . BTL ELEVATION BY PIPING ENGINEERING INPUT.
10. ELEVATION OF THE LP CONDENSATE FLASH DRUM (300-VJ-VW-8001) MUST PERMIT THE OVERFLOW FROM DEAERATOR TO FLOW BY GRAVITY THROUGH 300-LV-81103B.
11. 10 MM WEEPHOLE SHALL BE PROVIDED AT LOW POINT AND CONDENSATE TO BE ROUTED TO LOW POINT AT SAFE LOCATION.
12. ONE TURBINE DRIVEN PUMP AND ONE MOTOR DRIVEN PUMP ARE OPERATING SIMULTANEOUSLY, ONE MOTOR DRIVEN PUMP IS SPARE.
13. TWO PHASE FLOW.
14. RATED FLOWRATE AT PUMP SUCTION, FOR ONE PUMP.
15. LIC-81101: POSITION WITH CONTROLLER SETTING.
16. LINE SIZE SHALL BE CONFIRMED AFTER VENDOR INPUT.

OPEN / VALVE POSITION / CLOSED — A VALVE, B VALVE — LEVEL INCREASE

DETAIL "A"

ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS XV TAG NUMBER

300-PA-CF-00-8001A/B/C
VHP BFW PUMPS
Rated Flow: 399.0 m^3/hr
Diff. Pres: 143.00 kg/cm^2 (NOTE 14)
DP: 207.0 kg/cm^2g
DT: 170 °C

300-PT-00-8001A
BFW PUMP TURBINE

REV	DATE	REVISION	DRN	BY	CHKD	APPD.
3	16.10.25	REVISED AS MARKED & ISSUED FOR HAZOP	AN	MV	MK	NS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AK	MK	NS	MS

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

अनुमाप SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG. No.	पोटी REV.
	B957	79	41	300	11811	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROJ. ENG.	LPE	PEM	PM	CLIENT
3	03/07/2025	REVISED FOR BEP	YK	SC	SC	SK/G JVK	SA	
2	01/13/2025	FOR BEP	NAh	SC	SC	SK/G JVK	SA	
1	10/21/2024	PRELIMINARY	NAh	SC	SC	SK/G JVK	SA	

LUMMUS TECHNOLOGY

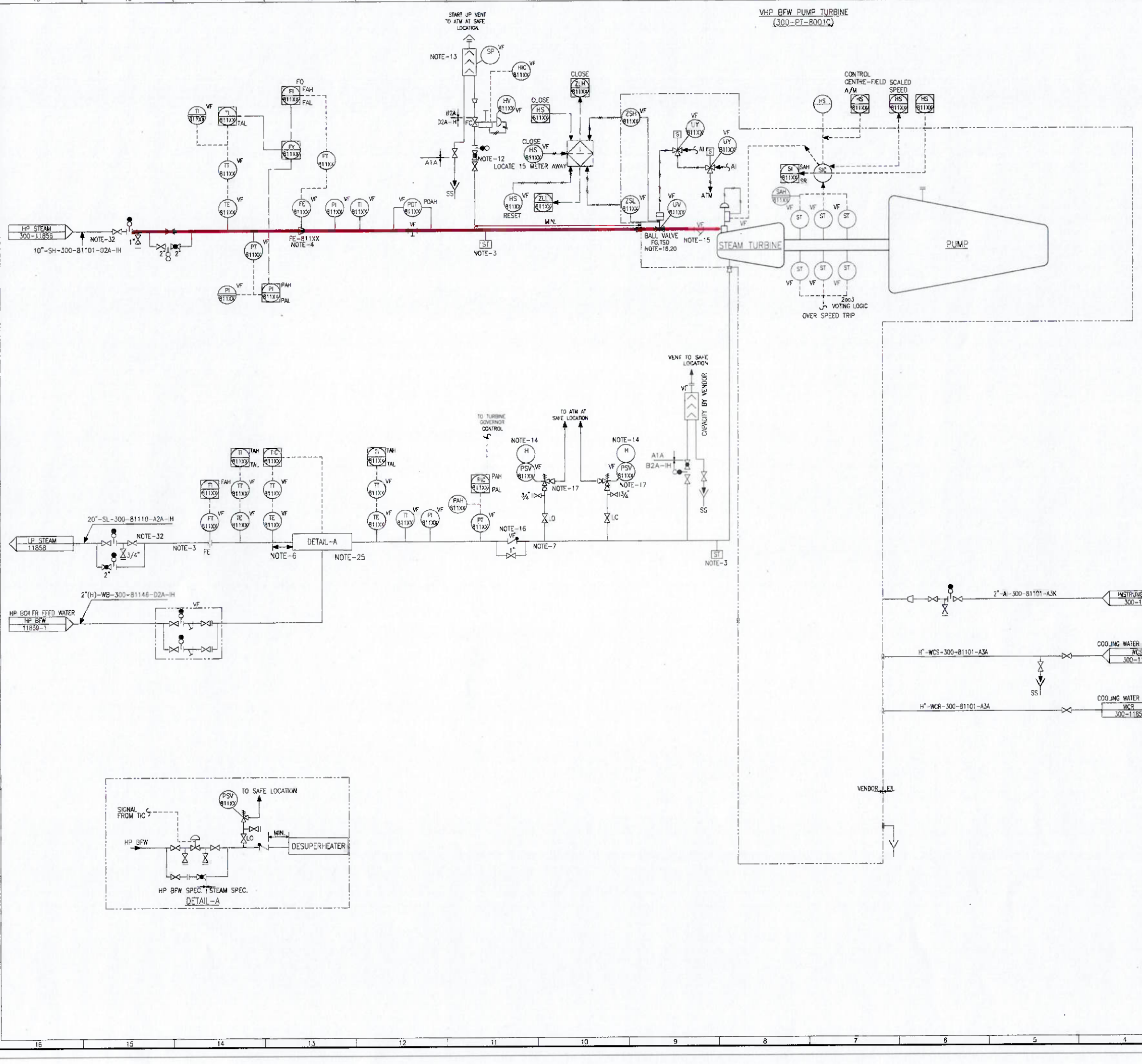
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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT
DEAERATOR AND BFW PUMPS

SCALE — TWG. No. 363136-300-11811 — REV. 1

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NOTES: -

1. FOR GENERAL NOTES, REFER STANDARD P&ID NO. 1191,1192,1193. FOR THE PROJECT.
2. "VF" DENOTES ITEMS UNDER VENDOR SCOPE OF SUPPLY.
3. LINE TRAP TO BE PROVIDED IN THE STEAM LINE. OTHER STEAM TRAPS AS REQUIRED FOR PIPING LOW POINTS TO BE SUITABLY PROVIDED. THE TRAP SHOWN IS LINE STEAM TRAP ONLY.
4. TYPE OF FLOW METER WILL BE ORIFICE, VENTURIMETER OR ANY OTHER TYPE CAN BE CONSIDERED IN CASE OF ANY FEEDBACK FROM ENGINEERING/VENDOR OR AS PER CLIENT'S REQUIREMENT.
5. DETAILS OF DESUPERHEATER TO BE UPDATED DURING DETAIL ENGG. BASED ON CONFIGURATION.
6. DISTANCE OF TEMPERATURE ELEMENT FROM DESUPERHEATER WILL BE A MINIMUM OF 10 PIPE DIA. ACTUAL ARRANGEMENT, STRAIGHT LENGTH AND DIAMETER TO BE CONFIRMED BY VENDOR.
7. PIPING PMS SHALL BE SUITABLE FOR TURBINE EXHAUST CONDITIONS AND NO LOAD CONDITIONS OF TURBINE.
8. DELETED.
9. DELETED
10. IN CASE ANY OTHER STEAM IS REQUIRED AS PER VENDOR FEEDBACK, THE SAME TO BE PROVIDED.
11. DELETED.
12. LINE RATING AND PMS SHALL BE FINALIZED BASED ON EXHAUST STEAM CONDITION AT GLOBE VALVE OUTLET.
13. STEAM SILENCER RATING TO BE DECIDED AS PER DESIGN TEMP CONDITION OF THE FLASHED STEAM.
14. SET PRESSURE OF PSV'S TO BE STAGGERED AND MAXIMUM SET PRESSURE OF PSV SHOULD BE SAME AS DESIGN PRESSURE OF EXHAUST SYSTEM.
15. STRAINER IS PART OF T&T VALVE. T&T VALVE & STRAINER SHALL BE IN VENDOR SCOPE.
16. NRV SHALL BE INSTALLED IN HORIZONTAL LINE AND AS CLOSE AS POSSIBLE FROM STEAM TURBINE. QUICK CLOSING NRV TO BE PROVIDED.
17. PROVIDE 10MM WEEP HOLE AT LOWEST POINT. SPARING OF PSV SHALL BE AS PER BEDB PART-B.
18. TRIP LOGIC REQUIREMENT OF THESE INSTRUMENT TO BE DEFINED BY TURBINE VENDOR.
19. TE SHALL BE MOUNTED AS CLOSE AS POSSIBLE FROM STEAM TURBINE.
20. ON/OFF VALVE SHALL BE BALL TYPE AS PER ENGINEERING DESIGN BASIS.
21. B/L VALVE SHALL BE AT PACKAGE VENDOR B/L.
22. COMMON CWS/CWR FOR LO COOLER, GLAND CONDENSER, BEARING COOLER ETC.
23. PIPING SHALL REVERT WITH THE MINIMUM FEASIBLE DISTANCE AND PROCESS SHALL VERIFY THE SAME.
24. REFER BEDB PART-B FOR COOLING WATER EXCHANGER INSTRUMENTATION.
25. REQUIREMENT OF DESUPERHEATER TO BE DECIDED BY TURBINE VENDOR.
26. DELETED.
27. REQUIREMENT OF DESUPERHEATER SHALL BE CONFIRMED TO MEET THE DESIGN CONDITIONS AS PER PART-B.
28. REQUIREMENT OF EMERGENCY BFW SHALL BE CONFIRMED BASED ON VENDOR INPUTS. SCHEME SHOWN IS PRELIMINARY & SHALL BE DEVELOPED DURING DETAIL ENGINEERING.
29. SEPARATE SPEED PROBES + TRANSMITTERS (MIN. 2 NOs.) SHALL BE PROVIDED FOR GOVERNOR.
30. STEAM TURBINE OVER SPEED TRIP SHALL BE BASED ON 2 OUT OF 3 (2oo3) VOTING LOGIC. SPEED PROBES + TRANSMITTERS (3 NOs.) FOR OVER SPEED TRIP SHALL BE PROVIDED.
31. ONE SEPARATE SPEED PROBE + TRANSMITTER SHALL BE PROVIDED FOR SPEED MONITORING.
32. IBR SERVICE.

No.	DATE	REVISIONS	DRN	CHKD	APPD.
A	12.12.25	ISSUED FOR COMMENTS	SP	MK	NS	NS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

VHPBFW PUMP TURBINE

पाइपिंग एण्ड इंस्ट्रूमेन्टेशन डायाग्राम
PIPING AND INSTRUMENTATION DIAGRAM
STANDARD INSTRUMENTATION FOR STEAM TURBINE HP TO LP (BACK PRESSURE)

SCALE	JOB NO.	DEPT	SECTN.	UNIT	DWG No.	REV.
NTS	B957	79	41	300	11811B	A

EIL-0241-SC2-REV-0-A

DISTRIBUTION CODE

CAD DWG-VHP STEAM TURBINE

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300-VV-VI-2002
CHARGE GAS COMPRESSOR 1ST STAGE SUCTION DRUM

DP 4.2 (Hv) kg/cm2g
DT 150 °C
Inside Diam. x Len.(T/T) 6800 mm x 8200 mm

PROPYLENE VAPOR 300-11427 FROM 300-EE-00-4108 -P-300-42925-D9A(D1D)-IH (START UP) NNF
LP OFF GAS 302-11218 FROM 302-VV-VM-2605 302-VV-HW-2605 &703 6"-P-302-21801-A61A(A1WR)-IH
VENT 305-11511 FROM 305-V-HI-5501 2"-P-305-51105-A61A(A1WR)-IH
RECYCLE 300-11251 FROM 300-VD-00-2201 36"-P-300-25107-B9A(B1D-IH NNF
DEPRESSURIZING 300-11239 FROM DRYER/TREATERS 4"-P-300-23915-A40A(A2A)- NNF
CHARGE GAS 300-11145 FROM 300-CC-00-1301 88"-P-300-14405-A9A(A1D)-IH NOTE 17 DO NOT POCKET
VENT GAS 300-11431 FROM 300-VV-HW-4202 10"-P-300-43108-A9A(A1D)-IH NNF
NITROGEN 300-11853-1 FROM DISTRIBUTION -IG-300-21101-A3A(A1B)-
ETH. VAPOR 300-11419 FROM OSBL VAPORIZER -P-300-41919-D9A(D1D)- STARTUP NNF
STARTUP METHANE 300-11311 FROM 300-LZ-00-3001-EP-00-18 -P-300-31114-A9A(A1D)- NNF (FOR START UP)
CHARGE GAS 300-11218 FROM 300-AE-21801 ANALYZER RETURN
CHARGE GAS FROM 300-AE-22001 ANALYZER RETURN
FIC-21404 300-11214 FROM ANTI-SURGE CONTROL
MIN. FLOW BYPASS 300-11217 FROM 300-VV-VI-2004 -P-300-21708-A9A(A1D)-IH FREE DRAINING DO NOT POCKET
CHARGE GAS 300-11235 FROM 300-AE-23501 ANALYZER RETURN
CHARGE GAS 300-11238 FROM 300-AE-23801 ANALYZER RETURN
WATER & HC 300-11146 TO 300-CC-00-1301 4"-P-300-21105-A9A(A1D)-IS
CBD 300-11866-2 300-VV-HW-2010 2"-CBD-300-21102-A9A(A1D)-

NOTE 17 88"-P-300-21102-A9A(A1D)- CHARGE GAS 300-11212 TO 300-KA-CF-2001 1ST STAGE
TO COMPRESSOR CONTROL SYSTEM
PV-21197 300-11212 TO VENT TO FLARE
-P-300-21101-A9A(A1D)- CHARGE GAS 300-11212 TO 300-PSV-2120*A,B,C
4"-P-300-21319-A9A(A1D)- CONDENSATE 300-11213 FROM 300-VV-VI-2003
TOP/SIDE ENTRY
SEE DETAIL "A"
NOTE 5,9
NOTE 12
NOTE 2 MIN. FLOW
-P-300-21708-A9A(A1D)-IH
-P-300-21107-A9A(A1D)-HS
-P-300-21108-A9A(A1D)-HS
4"-P-300-21105-A9A(A1D)-HS
4"-P-300-21105-A9A(A1D)-IH
6"-P-300-21104-A9A(A1D)-
6"-P-300-21103-A9A(A1D)-
6"-P-300-21102-A9A(A1D)-
3"-CBD-300-21101-A9A(A1D)-
2"-CBD-300-21103-A9A(A1D)-
2"-CBD-300-21102-A9A(A1D)-
NOTE 14
NOTE 19
NOTE 21
NOTE 23
NOTE 10,11
LOCATE VALVE AT HIGH POINT
AUTO START NOTE 15
AUTO START NOTE 12, 15
CRACKED COND 300-11233A FROM 300-AE-23301 ANALYZER RETURN
17157 CBD 300-11866-1

300-PA-CF-2001A
300-PA-CF-2001B

300-PA-CF-2001A/B
CHARGE GAS COMPRESSOR
1ST STAGE SUCTION DRUM PUMPS
Rated Flow 43.8 m^3/hr
Diff. Pres. 3.60 kg/cm^2
DP 9kg/cm^2g
DT 70 C

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-300-11011 THRU B957-79-41-300-11014.
2. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
3. PUMP MIN. FLOW LINE SIZE SHALL BE DETERMINED DURING DETAIL ENGINEERING BASED ON PUMP SELECTION.
4. LOCATE MOTOR OPERATED VALVE AS CLOSE TO 300-VV-VI-2002 AS POSSIBLE. LOCATE AQUASTAT DRAIN VALVE CLOSE TO THE VALVE AS POSSIBLE.
5. TWO OUT OF THREE HIGH-HIGH LEVEL SIGNALS WILL CAUSE 300-KA-CF-2001 SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM OTHERS WILL ALARM.
6. TRANSMITTERS TO HAVE INDIVIDUAL TAPPINGS.
7. ELEVATION IS BASED ON PRELIMINARY PUMP NPSH REQUIREMENT. TO BE CONFIRMED BY DEC.
8. ISOLATION VALVE SHALL HAVE JOG OPEN/CLOSE PUSHBUTTONS AND OPEN CLOSE INDICATORS INTEGRAL TO VALVE MOUNTED MOTOR ACTUATOR IF THE VALVE IS LOCATED IN A FIRE ZONE, IT SHALL BE FIRE SAFE (WITH FIRE PROOFED ACTUATOR,POWER AND CONTROL CABLES IN A FIRE ZONE SHALL BE FIRE PROOFED.
9. SUCTION AND DISCHARGE VALVE ON STAND BY PUMP TO BE LEFT OPEN FOR AUTO START.
10. ROOT VALVES TO BE LOCKED OPEN.
11. VALVE TO BE AUTOMATICALLY TRIPPED OPEN ON SHUTDOWN, REFER TO INTERLOCK LOGIC.
12. FINAL VALVE TYPE SELECTION BY VENDOR.FINAL VALVE SIZING WILL BE BASED ON SURGE FLOW INFORMATION FROM COMPRESSOR CURVES BY VENDOR. VALVE TO BE SUPPLIED BY COMPRESSOR VENDOR.
13. SPARE PUMP AUTOSTART ON HIGH LEVEL.
14. ALL PIPELINES CONNECTED TO INLET TO 300-VV-VI-2002 WILL BE TOP ENTRY.
15. CONTROL VALVE AND PIPING ARE SIZED FOR TWO PUMPS OPERATION DURING STARTUP OR UPSET.
16. AUTO START SPARE PUMP ON LOW DISCHARGE PRESSURE. ALARM ON LOW LOW PRESSURE.
17. LOCATE LOCAL EMERGENCY PUSH BUTTON MINIMUM 15M FROM 1ST STAGE SUCTION DRUM 300-VV-VI-2002.
18. PERMISSIVE TO START 300-KA-CF-2001 REQUIRES 300-MOV-21101 TO BE FULLY OPEN.
19. BYPASS VALVES ON STANDBY PUMP TO BE LEFT OPEN FOR AUTOSTART.
20. TIE-IN POINT FOR FUTURE ROG UNIT.
21. FLOW TO BE ACCONTED FOR ANTI SURGE CALCULATION BY ANTI SURGE CONTROLLER VENDOR.
22. "VF" STANDS FOR VENDOR FURNISHED.
23. ANALYSER RETURNS FROM MULTIPLE USER CAN BE COMBINED INTO SINGLE HEADER BEFORE CONNECTING TO THE CHARGE GAS LINE.

HS 21101A/C, HS 21101B/C, HS 21101C, NOTE 7,16, NOTE 18, ESD 2001, ZLL 21101, ZLH 21101, ZSL 21101, ZSH 21101, MOV 21101, TSO

ALL OTHER INSTRUMENT TAG NUMBER SHOULD BE SAME AS MOV TAG NUMBER

DETAIL "A"

REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
2	23.06.25	REVISED AS MARKED	AK	GS	PD/NS	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	300	11211	2

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

03/07/2025	REVISED FOR BEP	NAh	PKJ	SC	SK/GVK	SA	
01/13/2025	FOR BEP	NAh	PKJ	SC	SK/GVK	SA	
10/21/2024	PRELIMINARY	NAh	PKJ	SC	SK/GVK	SA	
REV.	ISSUE DATE	DESCRIPTION	CAD	PROJ ENG	LPE	PDM	PM	CLIENT

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
CHARGE GAS COMPRESSOR
1ST STAGE SUCTION DRUM

SCALE | DWG. NO. 363136-300-11211 | REV. 1

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NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-1 & 1A THRU B957-79-41-003-1 [1] & 1.
   ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. SEAL GAS (DIOLEFIN FREE) FOR CGC COMPRESSOR AS FOLLOWS
   INNER SEAL
   - NITROGEN FOR STARTUP FOR AIR DRY OUT.
   - ETHYLENE VAPOR FROM OSBL VAPORIZER FOR START-UP BEFORE BENEFICIAL VAPOR ETHYLENE PRODUCTION.
   - DRY CHARGE GAS FROM ACETYLENE CONVERTOR DRYER OUTLET FOR ALL OTHER OPEARATIONS IF APPROVED BY COMPRESSOR VENDOR.
   - ETHYLENE VAPOR FROM VAPOR PRODUCT HEADER MAY BE USED AS AN ALTERNATIVE AS PRIMARY SOURCE OR AS BACK-UP SOURCE.
   OUTER SEAL
   - NITROGEN FOR ALL OPERATIONS
3. COMPRESSOR CASING DRAIN VALVES TO BE ACCESSIBLE FROM OPERATING PLATFORM (TYPICAL).
4. PHOSPHATE FREE BFW.
5. FOR ALL COMPRESSOR SUCTION LINE 30" AND GREATER, 24" MANHOLES SHALL BE PROVIDED TO FACILITATE CLEANING AND INSPECTION. ALSO USE THE MANHOLES WITH TEMPORARY SCREENS AS AIR DRYOUT SUCTION. DEC TO VERIFY SIZE OF MANHOLE FOR DRY OUT CONDITION.
6. CGC TURBINE DETAILS BY DEC.
7. COMPRESSOR SEAL GAS INJECTION SYSTEM SHALL BE DEVELOPED DURING DETAIL ENGINEERING.
8. TWO OUT OF THREE HIGH-HIGH TEMPERATURE SIGNALS WILL CAUSE 300-KA-CF-2001 SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM THE OTHERS WILL ALARM.
9. LOCATE INSTRUMENT TAPS CLOSE TO COMPRESSOR 300-KA-CF-2001 FLANGES.
10. PIPING STRAIGHT RUN REQUIREMENT TO BE CONFIRMED WITH COMPRESSOR VENDOR DURING DETAILED DESIGN.
11. ALL CHARGE GAS COMPRESSOR CONTROL INSTRUMENTATION INCLUDING MINIMUM SURGE CONTROL SYSTEM AND SHUTDOWN/TRIP LOOPS. TO BE CONFIRMED WHEN VENDOR DESIGN IS REVIEWED AND AGREED DURING DETAIL ENGINEERING.
12. NO POCKETS PERMITTED ON COMPRESSOR SUCTION LINE EXCEPT AT 300-KA-CF-2001 INLET.
13. LOCATE PV ABOVE FLARE HEADER.
14. FI TO BE REDABLE FROM GLOBE VALVE.
15. CONNECTIONS SHOWN FOR WASH OIL AND BFW ARE TYPICAL, TO BE CONFIRMED WITH COMPRESSOR VENDOR DURING DETAILED ENGINEERING.
16. REFER TO DETAIL "A" ON DWG. 300-11214.
17. REFER 300-KA-CF-2001 PROCESS SPECIFICATION FOR RATED FLOW AND DIFFERENTIAL PRESSURE OF EACH STAGE.
18. COMPRESSOR INTERLOCK SHALL TRIP TURBINE AND CLOSE THROTTLE VALVE AND VHP STEAM SUPPLY ISOLATION VALVE.
19. PSV-21201A/B/C SIZE AND NUMBER OF PSVS INSTALLED IS PRELIMINARY, TO BE CONFIRMED BY DEC BASED ON COMPRESSOR VENDOR'S RECOMMENDATION CONSIDERING 300-FV-21404 90% VALVE OPENING.
20. REFER INTERLOCK DESCRIPTION FOR DETAILS.
21. "VF" STANDS FOR VENDOR FURNISHED.
22. BFW SHALL BE PROVIDED TO VENDOR AT A SINGLE POINT AT BL.

300-KA-CF-2001
CHARGE GAS COMPRESSOR
(1ST STAGE)
Rated Flow: NOTE 17
Diff. Pres: NOTE 17

SHUTDOWN TRIPS AND ALARMS FOR 300-KA-CF-2001

REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
2	23.06.25	REVISED AS MARKED	MD	GS	PD/NS	MS
1	03/07/2025	REVISED FOR BEP	NAh	PKJ	SC	SKG/VK SA
0	01/13/2025	FOR BEP	NAh	PKJ	SC	SKG/VK SA
0	12/21/2024	PRELIMINARY	NAh	PKJ	SC	SKG/VK SA

REV	ISSUE DATE	DESCRIPTION	CAS	PROJ ENG	LPE	PDM	PM	CLIENT

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

JOB NO.	DIVN.	UNIT	DWG. No.	REV.
B957	79	41	300	11212	2

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

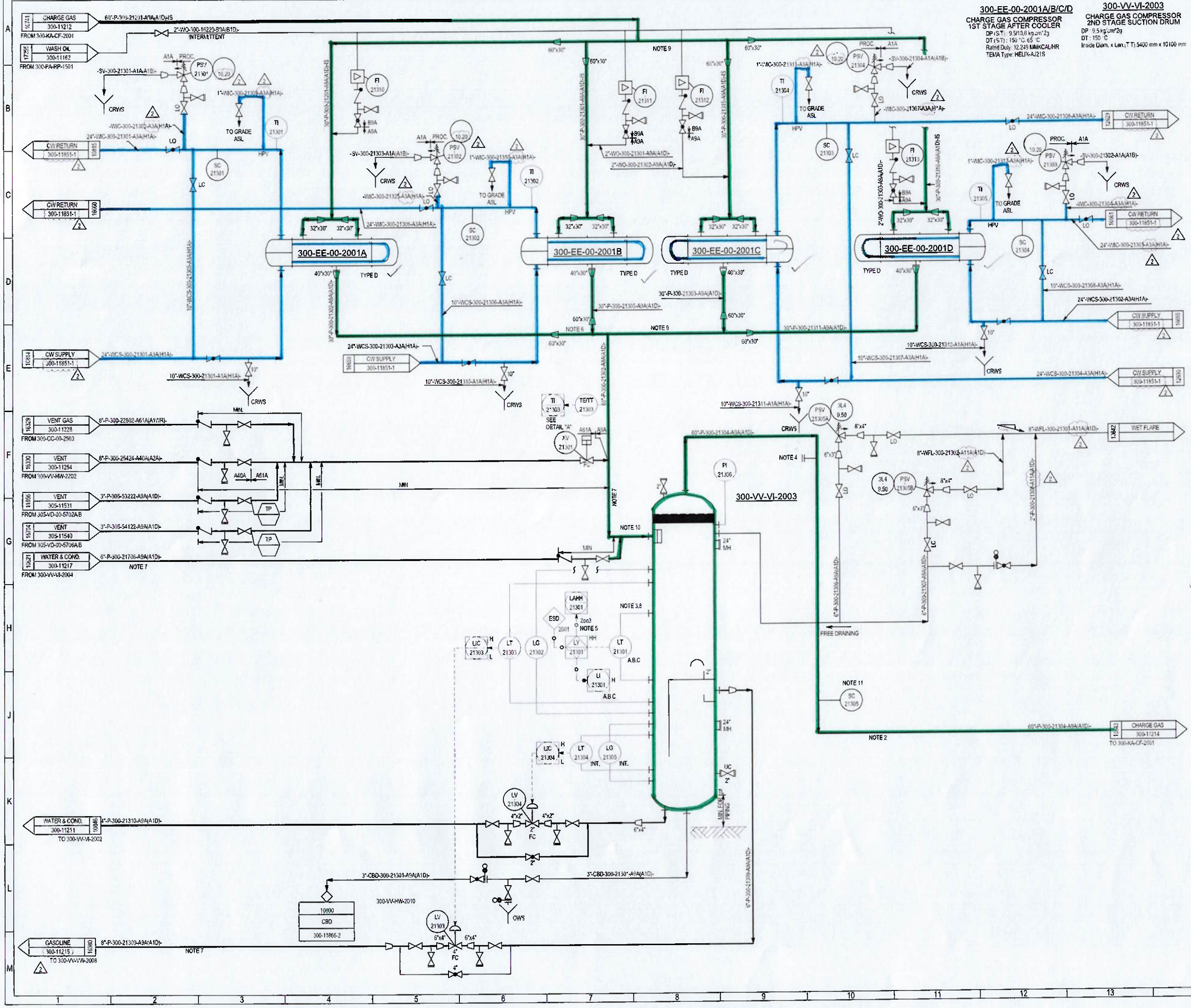
BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
CHARGE GAS COMPRESSOR
1ST STAGE

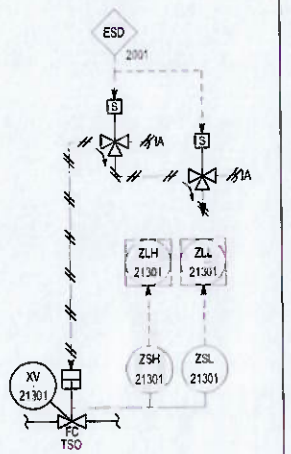
SCALE | DWG. No. 363136-300-11212 | REV. 1



300-EE-00-2001A/B/C/D
CHARGE GAS COMPRESSOR
1ST STAGE AFTER COOLER
DP (S.T) : 9.5/10.6 kg/cm^2g
DT (S.T): 150 °C/ 65 °C
Rated Duty : 12,249 MMKCAL/HR
TEMA Type: HELIX-AJ21S

300-VV-VI-2003
CHARGE GAS COMPRESSOR
2ND STAGE SUCTION DRUM
DP : 9.5 kg/cm^2g
DT : 150 °C
Inside Diam. x Len.(T.T.):5400 mm x 10100 mm

NOTES:
1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-11011 THRU B957-79-41-000-11014.
   ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. NO POCKETS PERMITTED ON COMPRESSOR SUCTION LINE EXCEPT AT 300-KA-CF-2001 COMPRESSOR INLET.
3. ROOT VALVES TO BE LOCKED OPEN.
4. FOR ALL COMPRESSOR SUCTION LINE 30" AND GREATER, 24" MANHOLES SHALL BE PROVIDED TO FACILITATE CLEANING AND INSPECTION.
5. TWO OUT OF THREE HIGH-HIGH LEVEL SIGNALS WILL CAUSE 300-KA-CF-2001 SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM ALL OTHER WILL ALARM.
6. THE OUTLET FROM THE EXCHANGER TO BE COLLECTED IN A COMMON HEADER BELOW THE EXCHANGERS BEFORE GOING TO A HIGH ELEVATION.
7. TWO PHASE FLOW, ANCHOR SECURELY.
8. TRANSMITTERS TO HAVE INDIVIDUAL TAPPINGS.
9. SYMMETRICAL PIPING.
10. ALL PIPELINES CONNECTED TO INLET TO 300-VV-VI-2003 WILL BE TOP ENTRY.
11. SAMPLE CONNECTION DETAILS AND RETURN LINE DESTINATION TO BE DEVELOPED BY DETAIL ENGINEERING CONTRACTOR (DEC).

DETAIL "A"


ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS XV TAG NUMBER

REV.	DATE	REVISION	MD	GS	PD:NS	MS
2	23.06.25	REVISED AS MARKED				

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	300	11213	2

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV.	DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
3	03/07/2025	REVISED FOR BEP	NAH	PKJ	SC	SKG/VK	SA	
2	01/13/2025	FOR BEP	NAH	PKJ	SC	SKG/VK	SA	
1	29-05-2025	PRELIMINARY	RAA	PKJ	SC	SKG/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
CHARGE GAS COMPRESSOR
2ND STAGE SUCTION DRUM

SCALE | DWG. No. 363136-300-11213 | REV. 1

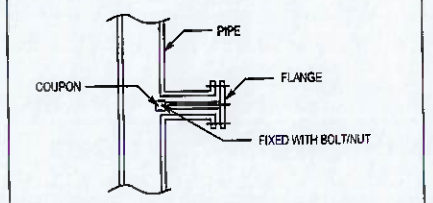
Page 1979 of 4391 ; B957-TENDER_DOC-B957-300-16-43-MR-T-3001 ; Rev. A

300-CC-00-2501
MEA/WATER WASH COLUMN
DP 18.0 kg/cm^2g
DT 100 °C
Inside Diam. x Len.(T/T) 6200 mm x 34200 mm

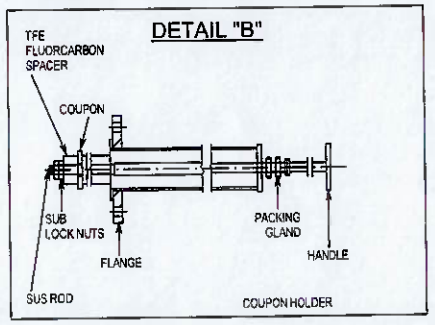
NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO.: B^57-79-41-000- 11011 THRU B^57-79-41-000-11014.
   ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. ULTRASONIC OR TUNING FORK LEVEL SWITCH TO BE LOCATED AT TOP OF STAND PIPE.
3. CORROSION PROBE COUPON, ISOLATION VALVE TO BE FULL BORED.
4. PROVIDE A 2000 MM MINIMUM LOOP IN PIPING TO PREVENT BACK FLOODING OFF GAS FEED LINE.
5. LOCATE LEVEL GAUGE READABLE FROM GLOBE VALVE.
6. TO ISOLATE MEA/WATER WASH COLUMN AND CAUSTIC WASH COLUMN AT STARTUP VALVE WILL BE KEPT OPEN NORMALLY.
7. SAMPLE CONNECTION DETAILS AND RETURN LINE DESTINATION TO BE DEVELOPED BY DETAIL ENGINEERING CONTRACTOR (DEC).
8. SPEC BREAK PROVIDED AT TOP OF LOOP.

DETAIL "A"



DETAIL "B"



REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
3	04.07.25	REVISED AS MARKED AND PMS INCORP.	AK	GS	PD/NS	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

सूचनार्थ SCALE	कार्य संख्या JOB NO.	विभाग DEPT.	अनुभाग SECTN.	इकाई UNIT	आरेख संख्या DWG. NO.	संशो. REV.
	B957	79	41	300	11220	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROJ. ENG	PE	PDM	PM	CLIENT
3	03/06/2025	REVISED FOR BEP	NS	RR	SC	SK/VK	SA	
2	03/03/2025	REVISED FOR BEP	NAh	RR	SC	SK/VK	SA	
1	01/13/2025	FOR BEP	NAh	PKJ	SC	SK/VK	SA	
0	10/21/2024	PRELIMINARY	NAh	PKJ	SC	SK/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
STEAM CRACKER UNIT (SCU)
MEA/WATER WASH COLUMN

SCALE	DWG. NO.	REV.
	363136-300-11220	2

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NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. AUTOSTART SPARE PROCESS WATER STRIPPER BOTTOMS PUMP ON LOW DISCHARGE PRESSURE. ALARM ON LOW LOW PRESSURE.
3. PUMP MIN. FLOW LINE SIZE IS PRELIMINARY AND SHALL BE FINALIZED DURING ENGINEERING BASED ON PUMP SELECTION
4. TWO PHASE FLOW, ANCHOR SECURELY.
5. BY-PASS VALVE SHALL BE LEFT OPEN ON STANDBY PUMP FOR AUTOSTART.
6. TRACING MEDIUM REQUIRED IS MP STEAM.
7. TIE-IN POINT FOR FUTURE ROG UNIT.

300-EE-00-1405
BOILER FEED WATER COOLER
DP (S/T) : 31.528.0 kg/cm^2g
DT (S/T) : 159 °C/ 65 °C
Rated Duty: 1.349 MMKCAL/HR
TEMA Type: BEM

300-EE-00-1201
QUENCH OIL/DILUTION STEAM DRUM FEED PREHEATER
DP (S/T) : 20.0/26.0 kg/cm^2g
DT (S/T) : 175 °C/ 225 °C
Rated Duty: 15.997 MMKCAL/HR
TEMA Type: HELIX-AES

300-PA-CF-1402A/B
PROCESS WATER STRIPPER BOTTOMS PUMPS
Rated Flow: 437.9 m^3/hr
Diff. Pres: 9.37 kg/cm^2

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)	
ETHYLENE CRACKER & ASSOCIATED UNITS	
BINA, MADHYA PRADESH, INDIA	
BHARAT PETROLEUM CORPORATION LIMITED	BINA REFINERY
01/13/2025	FOR BEP
10/21/2024	PRELIMINARY
LUMMUS TECHNOLOGY	
PIPING AND INSTRUMENTATION DIAGRAM ETHYLENE CRACKER UNIT (ECU) PROCESS WATER STRIPPER BOTTOMS PUMP AND PREHEAT EXCHANGER	
SCALE:	DWG. No: 363136-300-11153 REV: 0

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Page 1982 of 4391 : B957-TENDER_DOC-B957-300-16-43-MR-T-3001 : Rev. A

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

BINA PETROCHEMICAL AND REFINERY
EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
CHARGE GAS COMPRESSOR
3RD STAGE DISCHARGE DRUM

363136-300-11232

LUMMUS TECHNOLOGY

REV	DATE	DESCRIPTION	ORG	END	LPE	PEM	PM	CLIENT
4		PRELIMINARY	NAH	PKJ	SC	SNG VK	SA	
3	01'15 2025	FOR BEP	NAH	PKJ	SC	SNG VK	SA	
2	03/07 2025	REVISED FOR BEP	NAH	RR	SC	SNG VK	SA	

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REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AK	GS	PDNS	MS

Engineers India Limited
(A Govt. of India Undertaking)

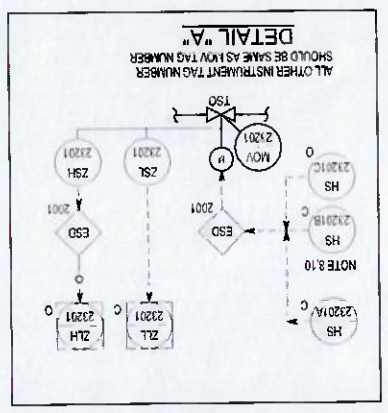
SCALE	JOB NO.	DEPT.	SHEET NO.	UNIT	DWG. NO.	REV.
NONE	B957	79	41	300	11231	2

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-7-41-0001 THRU B957-7-41-0004-11011.
2. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PREFIXED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
3. MINIMUM FLOW CONTROL VALVE TO BE PROTECTED BY APPROPRIATE STRAINERS AND/OR LINE CLEANING.
4. ELEVATIONS BASED ON PREFERRED WAY PUMP NPSH REQUIREMENT. TO BE CONFIRMED BY OEC.
5. TWO PHASE FLOW, ANCHOR SECURELY.
6. VALVE TO AUTOMATICALLY TRIPPED OPEN ON SHUTDOWN. (REFER TO INTERLOCK LOGIC.
7. MINIMUM FLOW LINE SIZE TO BE DETERMINED BY OEC.
8. METHANOL VALL FREEZE AT -36 C. CHECK OPERATING TEMPERATURE. LOWER FREEZING POINT SOLVENT TO BE USED.
9. INJECTING METHANOL BELOW -36 C OPERATING TEMPERATURE. LOWER ISOLATION VALVE SHALL HAVE JOG OPEN/CLOSE PUSHBUTTONS AND OPEN/CLOSE INDICATORS INTEGRAL TO VALVE MOUNTED MOTOR ACTUATOR IF THE VALVE IS LOCATED IN A FIRE ZONE IT SHALL BE FIRE SAFE WITH FIRE PROOFED ACTUATOR/POWER AND CONTROL CABLES IN A FIRE ZONE SHALL BE FIRE PROOFED.
10. LOCATE LOCAL EMERGENCY PUSH BUTTON MINIMUM 15M FROM 3RD STAGE DISCHARGE DRUM 300-VV-VI-2006.
11. SYMMETRICAL PIPING.
12. CHECK VALVE IN METHANOL LINE SHALL BE 600MM FROM PROCESS TIEIN.
13. LOCATE ADJACENT DRAIN VALVES AS CLOSE TO VALVE AS POSSIBLE.
14. EQUIPMENT, SAMPLING POINT, CONTROL VALVE AND LEVEL INSTRUMENT DRAINS TO BE ROUTED TO THE CLOSED DRAIN SYSTEM IDENTIFIED FOR ASSOCIATED EQUIPMENT AS SHOWN IN THE P&ID.

DETAIL "A"

ALL OTHER INSTRUMENT TAG NUMBER SHOULD BE SAME AS LOV TAG NUMBER



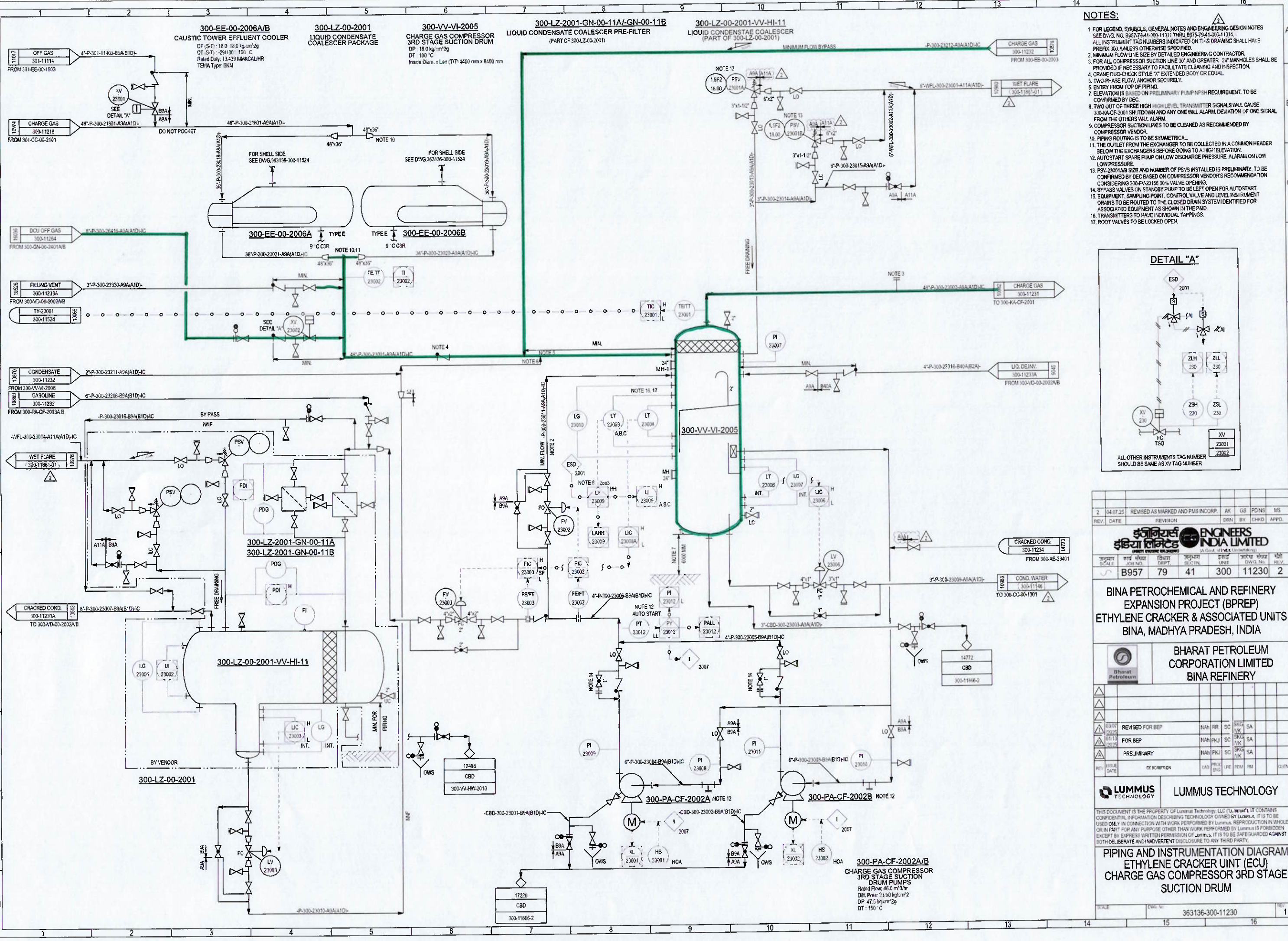
300-PA-CF-2003A/B
CHARGE GAS COMPRESSOR
3RD STAGE DISCHARGE DRUM PUMPS
Rated Flow: 36.1 m³/hr
Diff. Press: 7.83 kg/cm^2
DP: 43.5 kg/cm^2g
DT : 65° C

300-VV-VI-2006
CHARGE GAS COMPRESSOR
3RD STAGE DISCHARGE DRUM
DP: 31.6 kg/cm^2g
DT : 150 °C
Suction Drum: x Len.(T.T) 3502 mm x 7900 mm

300-EE-00-2004
CHARGE GAS COMPRESSOR
STAGE AFTER COOLER NO.2
DP (S/T) : 18.0/15.6 kg/cm^2g
DT (S/T) : 230/100 / 150 °C
Rated Duty : 11,473 MMKCAL/HR
TEMA Type BKM

300-EE-00-2003A/B
CHARGE GAS COMPRESSOR
3RD STAGE AFTER COOLER NO.1
DP (S/T) : 3.5/0.6 kg/cm^2g
DT (S/T) : 150 °C/65 °C
Rated Duty : 12.444 MMKCAL/HR
TEMA Type HEUX-A21S

Bharat Petroleum



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BINA PETROCHEMICAL AND REFINERY
EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM
CORPORATION LIMITED
BINA REFINERY

LUMMUS TECHNOLOGY

PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNITS
DCU OFF GAS DRYER / TREATER B

S	B957	79	41	300	11264	2

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-78-41-300-11011 THRU B957-78-41-300-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. DRYER VALVES TO BE IN HORIZONTAL POSITION WITH STEM VERTICAL.
3. MINIMUM FOR PIPING AND ASSOCIATED LOADING.
4. REQUIRED DURING START UP FOR PRESSURIZING.
5. DRYER VALVES:
   A. MOTOR OPERATORS ARE TO BE INTERLOCKED SUCH THAT THE REFINERY OPERATING AND REGENERATION VALVES CANNOT BE SIMULTANEOUSLY OPEN
   B. PROVIDE OPEN AND CLOSED POSITION SWITCHES FOR INTERLOCK AND POSITION INDICATION IN CONTROL ROOM.
6. TWO OUT OF THREE HIGH HIGH PRESSURE SIGNALS WILL PERMIT OPENING OF REFINERY OFF-GAS VALVES AND TWO OUT OF THREE HIGH PRESSURE SIGNALS WILL PREVENT OPENING OR INITIATE EMERGENCY SHUTDOWN OF REGENERATION GAS VALVES.
7. FOR VALVE DETAILS SEE DWG. 363-B957-300-11263.
8. ADSORBENT DUST NOZZLE.
9. EMERGENCY SHUTDOWN SWITCH CLOSES ALL VALVES ON RESPECTIVE DRYER PIPING ARE PROPERLY DRAINED AND VENTED WHEN THEY ARE ISOLATED AND OUT OF SERVICE.
10. ADMINISTRATIVE PROCEDURES MUST BE USED TO ENSURE THAT FILTERS AND ADSORBENT ARE NOT CHANGED OUT WHEN THE DRYER IS IN REGEN MODE.
11. VALVE DISCHARGING TO FUEL GAS WILL OPEN PRIOR TO THE VALVE DISCHARGING TO FLARE.
12. FOR SAMPLE CONNECTION DETAILS REFER PID NO. B957-78-41-300-11878
13. VENDOR TO ENSURE MECHANICAL STRENGTH REQUIREMENT FOR STRAINER FLEXIBILITY WITH SUITABLE DIFFERENTIAL DESIGN PRESSURE.
14. EACH DRYER SHALL BE PROVIDED WITH A THREE WAY MODE SWITCH. LOGIC SHALL BE PROVIDED TO ALLOW ONLY ONE DRYER IN REGEN MODE AT ANY TIME.
15. PV POSITION WITH CONTROLLER SETTING.
16. FOR CONTROL VALVE VENT AND DRAIN REFER P&ID NO. B957-79-41-300-11874

HV TAG NO.	INTERLOCK
HV-26413	S-2405
HV-26411	S-2405
HV-26412	S-2405

MOV TAG NO.	INTERLOCK
MOV-26401	ESD-2406, S-2405
MOV-26402	ESD-2406, S-2405
MOV-26403	ESD-2406, S-2405
MOV-26404	ESD-2406, S-2405
MOV-26405	ESD-2406, S-2405
MOV-26406	ESD-2406, S-2405
MOV-26407	ESD-2406, S-2405
MOV-26408	ESD-2406, S-2405

DETAIL "A"
ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS MOV TAG NUMBER

DETAIL "B"
ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS HV TAG NUMBER

DETAIL "C"
ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS PV TAG NUMBER

DETAIL "A"

EMERGENCY STOP

CONTROLLER OUTPUT

REV	DATE	DESCRIPTION	CAD	PROC	ENG	LPE	PDM	PM
3	03/07/2025	REVISED FOR BEP	NAK	RR	SC			SA
2	01/13/2025	FOR BEP	NAK	JJ	SC			SA
1	10/21/2024	PRELIMINARY	NAK	JJ	SC			SA

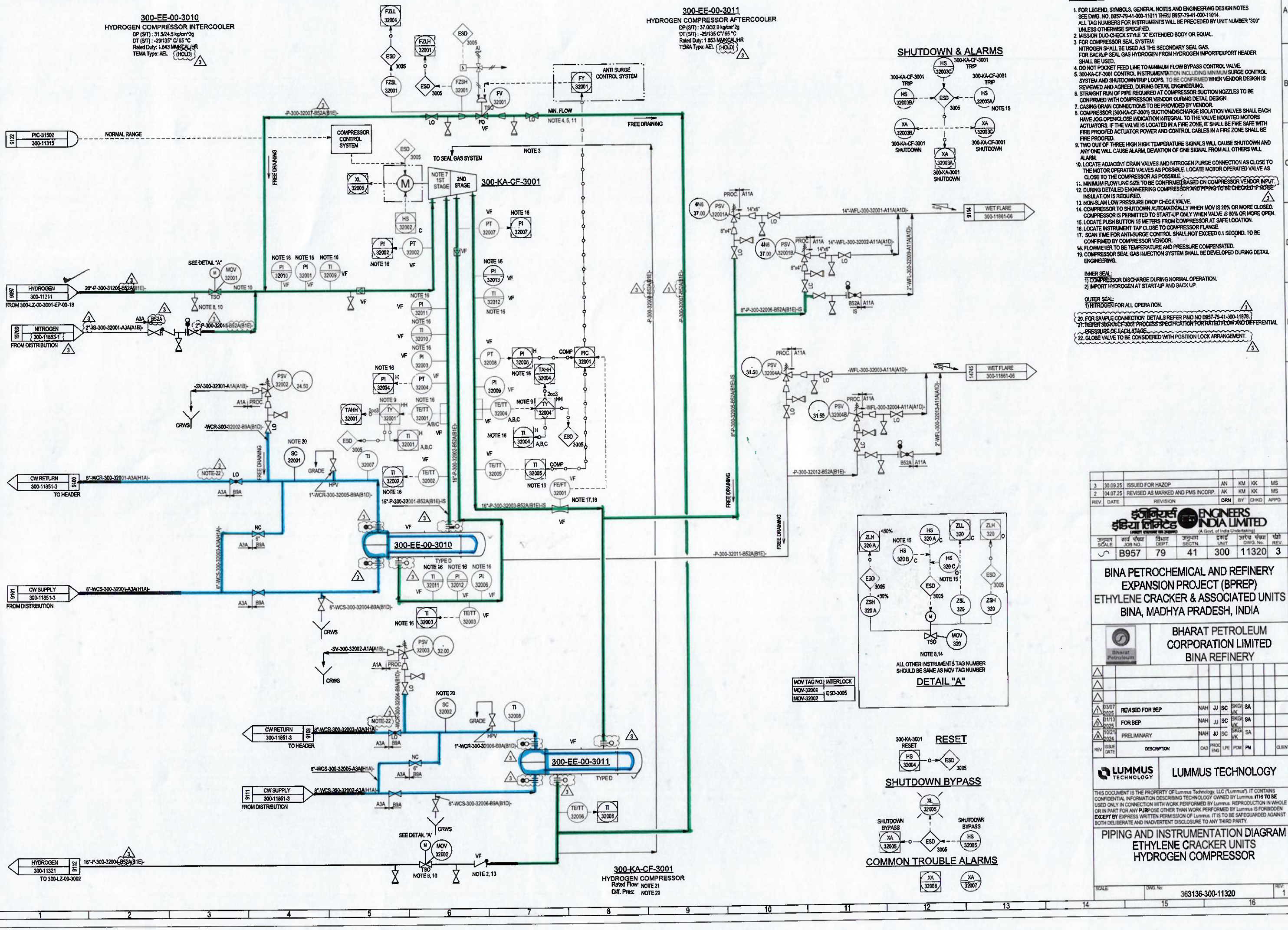
REV	DATE	REVISION	DWN	BY	CHKD	APPD
3	29 09 25	REVISED AS MARKED & ISSUED FOR HAZOP	MD	KM	KK	MS
2	04 07 25	REVISED AS MARKED AND PMS NOCRP	MD	KM	KK	MS

SCALE	DWG. No.	REV
	363136-300-11264	1

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300-VD-00-2401B
DCU OFFGAS DRYER / TREATER
Normal: Regeneration
DP: 14.0 kg/cm²g — DP: 7.5 kg/cm²g
DT: 65 °C — DT: 205 °C
Inside Diam. x Len.(T/T): 2600 mm x 13400 mm

300-GN-00-2401A/B
DCU OFFGAS DRYER / TREATER EFFLUENT FILTER
DP: 14.0 kg/cm²g
DT: 65 °C
Rated Flow: 13438 kg/hr
TYPE: TRUNCATED CONE



NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-11011 THRU B957-79-41-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. MISSION DUO-CHECK STYLE "X" EXTENDED BODY OR EQUAL.
3. FOR COMPRESSOR SEAL SYSTEM: NITROGEN SHALL BE USED AS THE SECONDARY SEAL GAS. FOR BACK-UP SEAL GAS HYDROGEN FROM HYDROGEN IMPORT/EXPORT HEADER SHALL BE USED.
4. DO NOT POCKET FEED LINE TO MINIMUM FLOW BYPASS CONTROL VALVE.
5. 300-KA-CF-3001 CONTROL INSTRUMENTATION INCLUDING MINIMUM SURGE CONTROL SYSTEM AND SHUTDOWN/TRIP LOOPS, TO BE CONFIRMED WHEN VENDOR DESIGN IS REVIEWED AND AGREED, DURING DETAIL ENGINEERING.
6. STRAIGHT RUN OF PIPE REQUIRED AT COMPRESSOR SUCTION NOZZLES TO BE CONFIRMED WITH COMPRESSOR VENDOR DURING DETAIL DESIGN.
7. CASING DRAIN CONNECTIONS TO BE PROVIDED BY VENDOR.
8. COMPRESSOR (300-KA-CF-3001) SUCTION/DISCHARGE ISOLATION VALVES SHALL EACH HAVE JOG OPEN/CLOSE INDICATION INTEGRAL TO THE VALVE MOUNTED MOTORS ACTUATORS. IF THE VALVE IS LOCATED IN A FIRE ZONE, IT SHALL BE FIRE SAFE WITH FIRE PROOFED ACTUATOR POWER AND CONTROL CABLES IN A FIRE ZONE SHALL BE FIRE PROOFED.
9. TWO OUT OF THREE HIGH HIGH TEMPERATURE SIGNALS WILL CAUSE SHUTDOWN AND ANY ONE WILL CAUSE ALARM, DEVIATION OF ONE SIGNAL FROM ALL OTHERS WILL ALARM.
10. LOCATE ADJACENT DRAIN VALVES AND NITROGEN PURGE CONNECTION AS CLOSE TO THE MOTOR OPERATED VALVES AS POSSIBLE. LOCATE MOTOR OPERATED VALVE AS CLOSE TO THE COMPRESSOR AS POSSIBLE.
11. MINIMUM FLOW LINE SIZE TO BE CONFIRMED BASED ON COMPRESSOR VENDOR INPUT.
12. DURING DETAILED ENGINEERING COMPRESSOR AND PIPING TO BE CHECKED IF NOISE INSULATION IS REQUIRED.
13. NON-SLAM LOW PRESSURE DROP CHECK VALVE.
14. COMPRESSOR TO SHUTDOWN AUTOMATICALLY WHEN MOV IS 20% OR MORE CLOSED. COMPRESSOR IS PERMITTED TO START-UP ONLY WHEN VALVE IS 80% OR MORE OPEN.
15. LOCATE PUSH BUTTON 15 METERS FROM COMPRESSOR AT SAFE LOCATION.
16. LOCATE INSTRUMENT TAP CLOSE TO COMPRESSOR FLANGE.
17. SCAN TIME FOR ANTI-SURGE CONTROL SHALL NOT EXCEED 0.1 SECOND. TO BE CONFIRMED BY COMPRESSOR VENDOR.
18. FLOWMETER TO BE TEMPERATURE AND PRESSURE COMPENSATED.
19. COMPRESSOR SEAL GAS INJECTION SYSTEM SHALL BE DEVELOPED DURING DETAIL ENGINEERING.

INNER SEAL:
1) COMPRESSOR DISCHARGE DURING NORMAL OPERATION.
2) IMPORT HYDROGEN AT START-UP AND BACK UP

OUTER SEAL:
1) NITROGEN FOR ALL OPERATION.

20. FOR SAMPLE CONNECTION DETAILS REFER P&ID NO B957-79-41-300-11878.
21. REFER 300-KA-CF-3001 PROCESS SPECIFICATION FOR RATED FLOW AND DIFFERENTIAL PRESSURE OF EACH STAGE.
22. GLOBE VALVE TO BE CONSIDERED WITH POSITION LOCK ARRANGEMENT.

REV	DATE	REVISION	ORN	BY	CHKD	APPD.
3	30.09.25	ISSUED FOR HAZOP	AN	KM	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AK	KM	KK	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SEC/TN	UNIT	DWG. No.	REV.
	B957	79	41	300	11320	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	POM	PM	CLIENT
3	03/07 2025	REVISED FOR BEP	NAH	JJ	SC	SKG/VK	SA	
2	01/13 2025	FOR BEP	NAH	JJ	SC	SKG/VK	SA	
1	10/21 2024	PRELIMINARY	NAH	JJ	SC	SKG/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNITS
HYDROGEN COMPRESSOR

SCALE: | DWG. No: 363136-300-11320 | REV. 1

Page 1985 of 4391 : B957-TENDER_DOC-B957-300-16-43-MR-T-3001 : Rev. A

300-EE-00-3012
ETHYLENE PRODUCT VAPORIZER
DP (S/T) : 48.0/18.0 kg/cm^2g
DT (S/T) : -45/65°C/-45/ 100 °C
Rated Duty: 8.546 MMKCAL/HR
TEMA Type: BKU

300-LZ-00-3001-EP-00-18
OFFGAS EXCHANGER NO.6
(PART OF 300-LZ-00-3001)
NOTE 10

300-LZ-00-3001-EP-00-17
OFFGAS EXCHANGER NO.5
(PART OF 300-LZ-00-3001)
NOTE 10

300-LZ-00-3001
SCU COLD BOX PACKAGE

300-LZ-00-3001
300-LZ-00-3001-EP-00-17
300-LZ-00-3001-EP-00-18

RAW HYDROGEN 300-11311 9433 — 20"-P-309-31205-B41K(B21L)-
TO 300-KA-CF-3001

METHANE OFFGAS 300-11311 9452 — 24"-P-300-31208-A41K(A21L)-
TO REGENERATION/OFF GAS SYSTEM

ETHYLENE PRODUCT 300-11311 9461 — 18"-P-300-31204-D40A(D2A)-
PRODUCT VAPOR TO OSBL

ETHANE RECYCLE 300-11311 9461 — 14"-P-300-31203-A40A(A2A)-H
TO 300-EE-00-1001

DRY FLARE 300-11880-2 9625 — 28"(H)-DF-300-31201-A41K(A21L)-

DEC1 BOTTOMS 300-11319 9416 — FROM 300-PA-CF-3001A/B

DEC2 UPPER FEED 300-11411 9628 — 8"-P-300-31202-B40A(B2A)-HC — NOTE 12 — TO 300-CC-00-4001

DEC2 LOWER FEED 300-11411 9627 — 16"-P-300-31201-B40A(B2A)-HC — NOTE 12 — TO 300-CC-00-4001

ETHYLENE PRODUCT 300-11420 10945 — 10"-P-300-42002-D40A(D2A)-HC — FROM 300-PA-CF-4004A/B

ETHANE RECYCLE 300-11414 9634 — 14"-P-300-41412-B41K(B21K)-HC — NOTE 12 — TO 300-CC-00-4002

LIC-41702 300-11417 16252

LIC-31601 300-11316 9704

PIC-31104 300-11311 47703

300-EE-00-3012

DWG. 300-11313
DWG. 300-11313
DWG. 300-11612
DWG. 300-11612
DWG. 300-11523
DWG. 300-11523
DWG. 300-11612
DWG. 300-11612
DWG. 300-11524
DWG. 300-11521
DWG. 300-11516
DWG. 300-11529

300-VV-HV-5005
300-VV-VI-5004
300-VV-VI-5003
300-VV-VI-5009
300-VV-VI-5008

43°C C3R
9°C C3R
-3°C C3R
-27°C C3R
-40°C C3R
9°C C3R INLET

DEC1 BOTTOMS
HP ETHYLENE
ETHANE RECYCLE
C1H
BR

TE/TT 31212
TE/TT 31211
TE/TT 31210
TE/TT 31213
TE/TT 31209
TE/TT 31208
TE/TT 31203 A,B,C
TE/TT 31202
TE/TT 31204
TE/TT 31206
TE/TT 31205
TE/TT 31201
TI 31212
TI 31211
TI 31210
TI 31205
TI 31213
TI 31208
TI 31203
TI 31202
TI 31204
TI 31206
TI 31205
TI 31201
PDI 31205
PDT 31205
PDI 31204
PDT 31204
PDI 31202
PDT 31202
PDI 31203
PDT 31203
PDI 31201
PDT 31201
FIC 31201
FV 31201
FE/FT 31201
PV 31201
FFC 31201
FIC 31202
FV 31202
FE/FT 31202
FIC 31203
FE/FT 31203
PI 31208
PT 31208
PI 31207
PT 31207
PI 31206
PT 31206
FY 31203
LIC 31202
LT 31202
LG 31201
LG 31202
TALL 31203
TY 31203
ESD 3002
XV 31201
FC TSO
ZLL 31201
ZLH 31201
ZSL 31201
ZSH 31201

PSV 31201A
PSV 31201B
48.00
A41K PROC.

NOTE 2,9
NOTE 5,8
NOTE 4,6,7,14,18
SEE DETAIL "A"
SEE DETAIL "B"
NOTE 11
NOTE 12
NOTE 13
NOTE 15
NOTE 17
NOTE-3
FOR TUBE SIDE SEE DWG. 300-11520
HIGH LEVEL OVERRIDE
FREE DRAINING
10"-P-300-31207-D40A(D2A)-HC
14"-P-300-31208-D40A(D2A)-HC
8"-P-300-31202-B41K(B21L)-HC
16"-P-300-31201-B41K(B21L)-HC
10"-P-300-31210-D40A(D2A)-HC
12"-P-300-31901-B41K(B21L)-HC
8"-P-300-31901-B41K(B21L)-HC
10"-P-300-31212-B41K(B21L)-HC
14"x10"
10"x8"
8"x6"
150MM

NOTES:
1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 8957-79-41-000 -11011 THRU 8957-79-41-000 -11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. DRY OUT SPOOLS FOR BYPASSING EXCHANGER AND FIT UP TO PROCESS PIPING (REFER DETAIL-C).
3. LOCATE TEMPERATURE AND PRESSUER INSTRUMENT AS CLOSE TO COLD BOX NOZZEL AS POSSIBLE.
4. STRAINERS ARE TO BE LOCATED AS CLOSE AS POSSIBLE TO THE COLD BOX NOZZLES.
5. ALL TEMPERATURE ELEMENTS INSIDE THE COLD BOX WILL BE WIRED TO A TERMINAL BOX.
6. INLET STRAINERS TO BRAZED ALUMINUM EXCHANGERS TO HAVE A MESH SIZE BASED ON EXCHANGER VENDOR RECOMMENDATION SHALL HAVE A MAXIMUM PRESSURE DROP OF 100MM H2O AT MAXIMUM FLOW.
7. ALL PIPING DOWNSTREAM OF STRAINER SHALL BE STAINLESS STEEL.
8. ALL TEMPERATURE ELEMENTS INSIDE THE COLD BOX ARE SKIN TYPE OR EQUIVALENT AND SHALL BE SUPPLIED BY VENDOR.
9. INSTALL DISSIMILAR METAL FLANGES INSULATING KITS AT COLD BOX CONNECTIONS AS REQUIRED.
10. EQUALITY OF WORKMANSHIP PASSES SEE RESPECTIVE DATA SHEETS.
11. INSTRUMENTATION TO ENSURE INSTALLATION TO BE SUITABLE FOR CRYOGENIC APPLICATION THE TRANSMITTER SHALL BE LOCATED ABOVE TAPPING POINT.
12. TWO PHASE FLOW, ANCHOR SECURELY.
13. TWO OUT OF THREE LOW LOW TEMPERATURE SIGNALS WILL CAUSE SHUTDOWN AND ANYONE WILL CAUSE ALARM DEVIATION OF ONE SIGNAL FROM ALL OTHERS WILL ALARM.
14. ADMINISTRATIVE PROCEDURES MUST BE USED TO ENSURE THAT COLD BOX INLET STRAINERS AND PIPING ARE PROPERLY DRAINED AND VENTED WHEN THEY ARE ISOLATED AND OUT OF SERVICE.
15. VENTED GATE VALVES REQUIRED AS PER SERVICE.
16. PSV SIZE BY DEC.
17. LINE SPECIFICATION BREAK SHALL BE MINIMUM OF 50000 MM FROM COLD BOX CONNECTION.
18. VENDOR TO ENSURE MECHANICAL STRENGTH REQUIREMENT FOR STRAINER ELEMENT WITH SUITABLE DIFFERNTIAL DESIGN PRESSURE.
19. FOR CONTROL VALVE VENT AND DRAIN REFER P&ID NO. 8957-79-41-300-11874.

DETAIL "B"
ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS XV TAG NUMBER

DETAIL "A"
STRAINER NOTE 6
DROP OUT SPOOL
FLOW
150MM
BLEED VALVE
NOTE 15
DRY FLARE

"DETAIL-C"
16"-P-30-31221-A3A
8"-P-30-31222-A3A
14"-P-30-31223-A3A
10"-P-30-31224-A3A
18"-P-30-31225-A3A

NOTES:-
1. BYPASS CONNECTION TO ENABLE PLANT DRYING OUT. THE TAPPING SHALL BE CLOSE TO EXCHANGER NOZZLES.
2. TAPPING PROVIDED FOR DRYING TO BE BLINDED AND TEMPORARY CONNECTIONS TO BE DISCONNECTED BEFORE HYDROCARBON OUT-IN.

REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
3	30.09.25	ISSUED FOR HAZOP.	PD	KM	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AN	KM	KK	MS

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	300	11312	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
3	03/07 2025	REVISED FOR BEP	NAN	JJ	SC	SKG VK	SA	
2	01/13 2025	FOR BEP	NAN	JJ	SC	SKG VK	SA	
1	10/21 2024	PRELIMINARY	NAN	JJ	SC	SKG VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNITS
CHARGE GAS CHILLING TRAIN (2 OF 5)

SCALE: | DWG. No: 363136-300-11312 | REV. 1

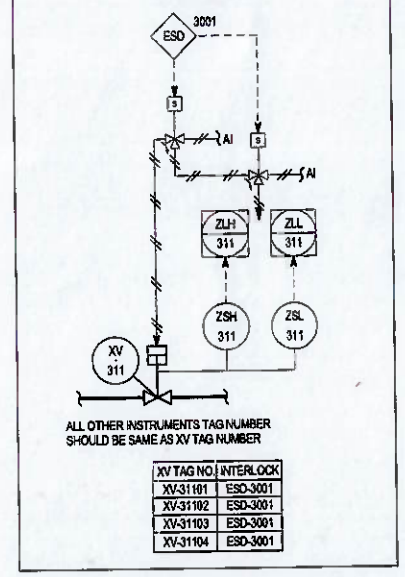
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NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 9957-79-41-000 -11011 THRU 9957-79-41-000 -11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. LOCATE TEMPERATURE ELEMENT AS CLOSE TO COLD BOX AS POSSIBLE.
3. LINE SPECIFICATION BREAK SHALL BE MINIMUM OF 50000 MM FROM COLD BOX CONNECTION.
4. START-UP ETHYLENE WILL BE BACKED IN FROM PIPE LINE.
5. PROVIDE DISSIMILAR TYPE CHECK VALVES.
6. TWO OUT OF THREE LOW LOW TEMPERATURE SIGNALS WILL CAUSE SHUTDOWN AND ANYONE WILL CAUSE ALARM. DEVIATION OF ONE SIGNAL FROM ALL OTHERS WILL ALARM.
7. ANALYZER SAMPLE RETURN TO TO 300-VV-VK-2002 INLET VIA COMMON HEADER BASED ON ANALYZER HOUSE LOCATION TO BE DEVELOPED BY DEC.
8. FOR SAMPLE CONNECTION DETAILS, REFER P&ID NO. 9957-79-41-300-11878.
9. FOR CONTROL VALVE VENT AND DRAIN DETAILS, REFER P&ID NO. B957-79-41-300-11874.

3

DETAIL "A"



ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS XV TAG NUMBER

XV TAG NO.	INTERLOCK
XV-31101	ESD-3001
XV-31102	ESD-3001
XV-31103	ESD-3001
XV-31104	ESD-3001

REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
3	07.10.25	ISSUED FOR HAZOP	RS	KM	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AN	KM	KK	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	300	11311	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM		CLIENT
4	03/07/2025	REVISED FOR BEP	NAI	JJ	SC	SKG VK	SA		
3	01/13/2025	FOR BEP	NAI	JJ	SC	SKG VK	SA		
2	10/21/2024	PRELIMINARY	NAI	JJ	SC	SKG VK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNITS
CHARGE GAS CHILLING TRAIN (1 OF 5)

SCALE:	DWG. No.	REV.
	363136-300-11311	1

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 363136-000-11011 THRU 363136-000-11014.
   ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED.
2. SEAL GAS (DIOLEFIN FREE) FOR CG COMPRESSOR AS FOLLOWS :
   INNER SEAL
   - NITROGEN FOR STARTUP FOR AIR DRY OUT.
   - ETHYLENE VAPOR FROM OSBL VAPORIZER FOR START-UP BEFORE BENEFICIAL VAPOR ETHYLENE PRODUCTION.
   - DRY CHARGE GAS FROM ACETYLENE CONVERTOR DRYER OUTLET FOR ALL OTHER OPEARATIONS, IF APPROVED BY COMPRESSOR VENDOR.
   - ETHYLENE VAPOR FROM VAPOR PRODUCT HEADER MAY BE USED AS AN ALTERNATIVE AS PRIMARY SOURCE OR AS BACKUP SOURCE.
   OUTER SEAL
   - NITROGEN FOR ALL OPERATIONS
3. COMPRESSOR CASING DRAIN VALVES TO BE ACCESSIBLE FROM OPERATING PLATFORM (TYPICAL).
4. PHOSPHATE FREE BFW.
5. FOR ALL COMPRESSOR SUCTION LINE 30" AND GREATER, 24" MANHOLES SHALL BE PROVIDED TO FACILITATE CLEANING AND INSPECTION, ALSO USE THE MANHOLES WITH TEMPORARY SCREENS AS AIR DRYOUT SUCTION. DEC TO VERIFY SIZE OF MANHOLE FOR DRY OUT CONDITION.
6. CGC TURBINE DETAILS BY DEC.
7. COMPRESSOR SEAL GAS INJECTION SYSTEM SHALL BE DEVELOPED DURING DETAIL ENGINEERING.
8. TWO OUT OF THREE HIGH-HIGH TEMPERATURE SIGNALS WILL CAUSE 300-KA-CF-2001 SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION OF ONE SIGNAL FROM THE OTHERS WILL ALARM.
9. LOCATE INSTRUMENT TAPS CLOSE TO COMPRESSOR 300-KA-CF-2001 FLANGES.
10. PIPING STRAIGHT RUN REQUIREMENT TO BE CONFIRMED WITH COMPRESSOR VENDOR DURING DETAILED DESIGN.
11. ALL CHARGE GAS COMPRESSOR CONTROL INSTRUMENTATION INCLUDING MINIMUM SURGE CONTROL SYSTEM AND SHUTDOWN/TRIP LOOPS, TO BE CONFIRMED WHEN VENDOR DESIGN IS REVIEWED AND AGREED DURING DETAIL ENGINEERING.
12. NO POCKETS PERMITTED ON COMPRESSOR SUCTION LINE EXCEPT AT 300-KA-CF-2001 INLET.
13. LOCATE PV ABOVE FLARE HEADER.
14. FI TO BE READABLE FROM GLOBE VALVE.
15. CONNECTIONS SHOWN FOR WASH OIL AND BFW ARE TYPICAL. TO BE CONFIRMED WITH COMPRESSOR VENDOR DURING DETAILED ENGINEERING.
16. REFER TO DETAIL "A" ON DWG. 300-11214.
17. REFER 300-KA-CF-2001 PROCESS SPECIFICATION FOR RATED FLOW AND DIFFERENTIAL PRESSURE OF EACH STAGE.
18. COMPRESSOR INTERLOCK SHALL TRIP TURBINE AND CLOSE THROTTLE VALVE AND VHP STEAM SUPPLY ISOLATION VALVE.
19. PSV-21201A/B/C SIZE AND NUMBER OF PSVS INSTALLED IS PRELIMINARY. TO BE CONFIRMED BY DEC BASED ON COMPRESSOR VENDOR'S RECOMMENDATION CONSIDERING 300-FV-21404 90% VALVE OPENING.

Note: Mark up shall be considered from the nearest isolation (valve)

300-KA-CF-2001
CHARGE GAS COMPRESSOR
(1ST STAGE)
Rated Flow: NOTE 17
Diff. Press: NOTE 17

SHUTDOWN TRIPS AND ALARMS FOR 300-KA-CF-2001

HS 21201C — 300-KA-CF-2001 TRIP
HS 21201B — 300-KA-CF-2001 TRIP
HS 21201A — 300-KA-CF-2001 TRIP
ESD 2001
XA 21201B — 300-KA-CF-2001 SHUTDOWN
XA 21201C — 300-KA-CF-2001 SHUTDOWN
XA 21201A — 300-KA-CF-2001 SHUTDOWN
HS 21202 — 300-KA-CF-2001 RESET
XL 21203
SHUTDOWN BYPASS — XA 21203
SHUTDOWN BYPASS — HS 21203
XA 21204A — COMMON TROUBLE ALARMS — XA 21204B

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	L/E	POM	PM	CLIENT
1	01/13/2025	FOR BEP	NAN	PKJ	SC	SKG /VK	SA	
A	10/21/2024	PRELIMINARY	NAN	PKJ	SC	SKG /VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNIT (ECU)
CHARGE GAS COMPRESSOR
1ST STAGE

SCALE: | DWG. No: 363136-300-11212 | REV: 0

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300-VV-VI-2401
DCU OFF GAS COMPRESSOR SUCTION DRUM

DP 7.0 kg/cm^2g
DT 155 °C
Inside Diam. x Len.(T/T) 1100 mm x 3200 mm

300-KA-CF-2401
DCU OFF GAS COMPRESSOR
Rated Flow 13750.0 m^3/hr
Diff. Pres. 8.37 kg/cm^2

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-300-11011 THRU B957-79-41-300-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED
2. FLOW MEASUREMENT IS TEMPERATURE AND PRESSURE COMPENSATED.
3. ISOLATION VALVE SHALL HAVE JOG OPEN/CLOSE PUSHBUTTONS AND OPEN/CLOSE INDICATORS INTEGRAL TO VALVE MOUNTED MOTOR ACTUATOR. IF THE VALVE IS LOCATED IN A FIRE ZONE IT SHALL BE FIRE SAFE WITH FIRE PROOFED ACTUATOR, POWER AND CONTROL CABLES IN A FIRE ZONE SHALL BE FIRE PROOFED.
4. LOCATE MOV AS CLOSE TO COMPRESSOR AS POSSIBLE. LOCATE ADJACENT DRAIN VALVES AND NITROGEN PURGE CONNECTIONS AS CLOSE TO THE MOTOR OPERATED VALVES AS POSSIBLE.
5. CASING DRAIN CONNECTIONS TO BE PROVIDED BY VENDOR.
6. LOCATE INSTRUMENT TAPS CLOSE TO COMPRESSOR 300-KA-CF-2401 FLANGES.
7. TWO OUT OF THREE HIGH - HIGH LEVEL SIGNALS WILL CAUSE 300-KA-CF-2401 SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION FROM THE OTHERS WILL ALARM.
8. TWO OUT OF THREE HIGH - HIGH TEMPERATURE SIGNALS WILL CAUSE 300-KA-CF-2401 SHUTDOWN AND ANY ONE WILL ALARM, DEVIATION FROM THE OTHERS WILL ALARM.
9. TWO OUT OF THREE HIGH HIGH PRESSURE SIGNALS WILL CAUSE 300-KA-CF-2401 SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION FROM THE OTHERS WILL ALARM.
10. COMPRESSOR TO SHUTDOWN AUTOMATICALLY WHEN MOV IS 20% OR MORE CLOSED. COMPRESSOR IS PERMITTED TO START-UP ONLY WHEN THE MOV IS 80% OR MORE OPEN.
11. STRAIGHT RUN OF PIPE REQUIRED AT COMPRESSOR SUCTION NOZZLE. TO BE SET BY COMPRESSOR VENDOR.
12. LOCAL PUSH BUTTON TO BE LOCATED AT SAFE DISTANCE (15 METER MINIMUM) AWAY FROM COMPRESSOR FOR ACCESS DURING FIRE.
13. DURING DETAILED ENGINEERING COMPRESSOR AND PIPING TO BE CHECKED IF SOUND PROTECTION INSULATION IS REQUIRED.
14. COMPRESSOR CONTROL INSTRUMENTATION INCLUDING MINIMUM SURGE CONTROL SYSTEM AND SHUTDOWN/TRIP LOOPS. TO BE CONFIRMED WHEN VENDOR DESIGN IS REVIEWED AND AGREED, DURING DETAIL ENGINEERING.
15. CASING DRAIN CONNECTIONS TO BE PROVIDED BY VENDOR.
16. SEAL GAS IS AS FOLLOWS
    INNER SEAL
    -COMPRESSOR DISCHARGE DURING NORMAL OPERATION
    -BACK UP ETHYLENE VAPOR FROM HP ETHYLENE VAPOR PRODUCT HEADER DURING NORMAL OPERATION OR FROM OSBL ETHYLENE START-UP VAPORIZER AT START-UP BEFORE COMPRESSOR IN OPERATIONAL
    OUTER SEAL
    -NITROGEN FOR ALL OPERATIONS.
17. SUCTION PRESSURE CONTROL BY INLET GUIDE VANE
18. ALL INSTRUMENTS MARKED AS 'VF' SHALL BE LOOSE SUPPLIED BY COMPRESSOR VENDOR TO BE INSTALLED BY PURCHASER.
19. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER P&ID NO. B957-79-41-300-11874.

SHUTDOWN & ALARMS

RESET

SHUTDOWN BYPASS

COMMON TROUBLE ALARMS

DETAIL "A"

ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS MOV TAG NUMBER

REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
3	29.09.25	ISSUED FOR HAZOP	SS	KM	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AK	KM	KK	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	300	11256	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROJ ENG	LPE	PDM	PM	CLIENT
3	23/07/2025	REVISED FOR BEP	NAh	RR	SC	SKG/VK	SA	
2	01/13/2025	FOR BEP	NAh	JJ	SC	SKG/VK	SA	
1	10/21/2024	PRELIMINARY	NAh	JJ	SC	SKG/VK	SA	

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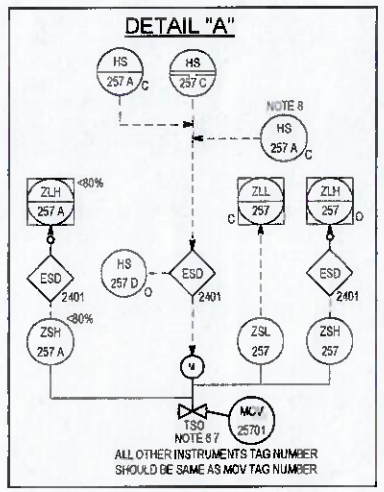
PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNITS
DCU OFFGAS COMPRESSOR & SUCTION DRUM

SCALE | DWG. No. 363136-300-11256 | REV. 1

300-EE-00-2401
DCU OFF GAS COMPRESSOR AFTER COOLER
DP (S/T) 14.0/12.0 kg/cm^2g
DT (S/T) 155 °C/ 85 °C
Rated Duty 0.67 MMKCAL/HR
TEMA Type AES

300-VV-VI-2402
DCU OFF GAS CAUSTIC TOWER FEED KO DRUM
DP 14.0 kg/cm^2g
DT 100 °C
Inside Diam. x Len.(T/T) 1000 mm x 2900 mm

NOTES:
1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG NO B957-79-41-300-11011 THRU B957-79-41-300-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "300" UNLESS OTHERWISE SPECIFIED
2. DISSIMILAR AND NON-SLAM TYPE CHECK VALVE.
3. MINIMUM FLOW LINE SIZE TO BE CONFIRMED BY OEC.
4. DO NOT POCKET FEED LINE TO MINIMUM FLOW BYPASS CONTROL VALVE.
5. 300-KA-CF-2401 CONTROL INSTRUMENTATION INCLUDING MINIMUM SURGE CONTROL SYSTEM AND SHUTDOWN/TRIP LOOPS, TO BE CONFIRMED WHEN VENDOR DESIGN IS RECEIVED AND AGREED DURING DETAIL ENGINEERING.
6. COMPRESSOR TO SHUTDOWN AUTOMATICALLY WHEN MOV IS 20% OR MORE CLOSED, COMPRESSOR IS PERMITTED TO START-UP ONLY WHEN VALVE IS 80% OR MORE OPEN.
7. ISOLATION VALVE SHALL HAVE JOG OPEN/CLOSE PUSH BUTTONS AND OPEN/CLOSE INDICATORS INTEGRAL TO VALVE MOUNTED MOTOR ACTUATOR. IF THE VALVE IS LOCATED IN A FIRE ZONE, IT SHALL BE FIRE SAFE WITH FIRE PROOFED ACTUATOR, POWER AND CONTROL CABLES IN A FIRE ZONE SHALL BE FIRE PROOFED.
8. LOCAL PUSH BUTTON TO BE LOCATED AT SAFE DISTANCE (15 METER MINIMUM) AWAY FROM COMPRESSOR FOR ACCESS DURING FIRE. 3
9. FOR SAMPLE CONNECTION DETAILS REFER P&ID NO B957-79-41-300-11878
10. TWO OUT OF THREE HIGH HIGH TEMPERATURE SIGNALS WILL CAUSE 300-KA-CF-2401 SHUTDOWN AND ANY ONE WILL ALARM. DEVIATION FROM THE OTHERS WILL ALARM.
11. CLOSE VALVE TO BE CONSIDERED WITH POSITION LOCK ARRANGEMENT.
12. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER P&ID NO. B957-79-41-300-11874. 3

DETAIL "A"


REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
3	29.09.25	ISSUED FOR HAZOP.	SS	KM	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	MD	KM	KK	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
NTS	B957	79	41	300	11257	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	UPE	PDM	PM		CLIENT
3	03/07 2026	REVISED FOR BEP	NAN	RR	SC	SKG /VK	SA		
2	31/12 2025	FOR BEP	NAN	JJ	SC	SKG /VK	SA		
1	10/21 2024	PRELIMINARY	NAN	JJ	SC	SKG /VK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
ETHYLENE CRACKER UNITS
DCU OFFGAS COMPRESSOR AFTERCOOLER

SCALE | DWG. No. 363136-300-11257 | REV. 1

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Note: Tube Side of Exchanger (EE-1602) shall be Included in Chemical cleaning and passivation markup.

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-11011 THRU B957-79-41-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "301" UNLESS OTHERWISE SPECIFIED.
2. MINIMUM FLOW AND VENT LINE SIZE BY OEC.
3. TWO PHASE FLOW, ANCHOR SECURELY.
4. MOTOR OF PUMP SHALL BE AUTOMATICALLY STOPPED WHEN MOV IS LESS THAN 80% OPEN AND CANNOT BE RESTARTED UNTIL THE MOV IS FULLY OPENED
5. LOCATE TAKEOFF AT HIGH POINT OF PIPING.
6. LOCATE PUSH BUTTON 15 METERS FROM PUMP AT SAFE LOCATION.
7. CONNECT VAPOR LINE AT TOP OF LIQUID LINE.
8. ELEVATION BASED ON PRELIMINARY NPSH CALCULATION.
9. PUSH BUTTON IN THE FIELD OR CONTROL ROOM ACTIVATES WIRED LOGIC WHICH CLOSES ISOLATION VALVE AND SHUTS DOWN ALL ASSOCIATED PUMPS. VALVE LOCATED IN THE FIRE ZONE SHALL BE FIRE SAFE WITH FIRE PROOF ACTUATOR. POWER AND CONTROL CABLES IN A FIREZONE SHALL BE FIREPROOFED.
10. REACTOR EFFLUENT MIXING POINT TO BE AT SAME ELEVATION AS 301-EE-00-1602.
11. LOCATE TEMPERATURE SENSING POINT AT MINIMUM OF 10 PIPE DIAMETERS DOWNSTREAM OF VAPOUR TIE-IN POINT.
12. 301-EE-00-1602 TO BE ELEVATED ABOVE 301-VV-HW-1602 SUFFICIENTLY TO OVERCOME LINE LOSS AND EXCHANGER PRESSURE DROP TO RETURN LIQUID TO DRUM.
13. PROVIDE MINIMUM MECHANICAL STOP WHICH IS TO BE SET ABOVE THE "LL" FLOW
14. LOCATE FLOW ELEMENT AND CONTROL VALVE WITH SUFFICIENT STATIC HEAD TO PREVENT FLASHING AT FLOW ELEMENT AND CONTROL VALVE INLET.
15. AUTOSTART STAND BY PUMP ON LOW LOW FLOW. PROVIDE ADJUSTABLE TIME DELAY FOR I-1905 ON LOSS OF RECYCLE FLOW TO ALLOW THE RECYCLE FLOW ON SPARE PUMP TO AUTOSTART. IF NOT RECOVERED WITHIN THE SET TIME ESD-1602 WILL ACTIVATE.
16. CHECK VALVE BYPASS VALVE ON STANDBY PUMP TO BE LEFT OPEN FOR AUTOSTART.
17. FOR SAMPLE CONNECTION DETAILS REFER P&ID NO. B957-79-41-300-11878.
18. DISSIMILAR TYPE CHECK VALVE.
19. LG TO BE READABLE FROM THE GLOBE VALVE.
20. PROVIDE N2 HOSE STATION.
21. LOCATE AT HIGH POINT ON LINE.
22. FOR CASE 1/CASE 2/CASE 3, 2 OPERATING AND 1 SPARE PUMP.
23. TIE-IN POINT FOR HEAT RECOVERY.
24. VALVE TO BE LOCATED AT GRADE.
25. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER P&ID NO. B957-79-41-300-11874.
26. FLUID PROPERTIES AT RELIEF CONDITIONS ARE SUPERCRITICAL. A PRESSURE RELIEF VALVE MAY NOT PROVIDE SUFFICIENT PROTECTION FOR AN UNWETTED WALL VESSEL (UNWETTED VESSEL ARE THOSE ON WHICH THE INTERNAL WALLS ARE EXPOSED TO A GAS, VAPOR OR SUPERCRITICAL FLUID), AND VESSEL RUPTURE COULD OCCUR BEFORE OR TOO SOON AFTER INITIAL RELIEF. ADDITIONAL PROTECTION MEASURE OF FIRE PROOFING & FIRE WATER SPRINKLER SYSTEM TO BE PROVIDED.

MOV TAG NO.	INTERLOCK NO.
MOV-11401	ESD-1604
MOV-11402	-
MOV-11403	-
MOV-11404	-

REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
3	26.09.25	ISSUED FOR HAZOP	RS	GS	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AK	GS	KK	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	301	11114	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM		CLIENT
3	03/07/2025	REVISED FOR BEP	NAh	AS	SC	SKG/VK	SA		
2	01/13/2025	FOR BEP	NAh	AS	SC	SKG/VK	SA		
1	10/21/2024	PRELIMINARY	NAh	AS	SC	SKG/VK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
C4 HYDROGENATION UNIT
C4 HP FLASH DRUM SECTION

SCALE | DWG. No: 363136-301-11114 | REV. 1

301-EE-00-1602
C4 REACTOR EFFLUENT CONDENSER
DP (S/T) : 37.0/28.5 kg/cm^2g
DT (S/T) : 200 °C/ 65 °C
Rated Duty: 44.953 MMKCAL/HR
TEMA Type: HEUD-AEL
NOTE 12

301-VV-HW-1602
C4 HP FLASH DRUM
DP : 37.0 kg/cm^2g
DT : 130 °C
Inside Diam. x Len.(T/T):4600 mm x 13800 mm

301-EE-00-1603
C4 HP FLASH VENT CONDENSER
DP (S/T) : 18.0/37.0 kg/cm^2g
DT (S/T) : -29/100 °C/ 130 °C
Rated Duty: 0.133 MMKCAL/HR
TEMA Type: BEL

301-PA-CF-1602A/B/C
C4 HP FLASH RECYCLE PUMPS
NOTE 22
Rated Flow: 1211.3 m^3/hr
Diff. Press: 11.50 kg/cm^2
DP: 49.5 kg/cm^2g
DT : 130 °C

DETAIL "A"
ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS MOV TAG NUMBER

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302-RB-00-2601A
PGH FIRST STAGE REACTOR
Inside Diam. x Len.(T/T):3000 mm x 16600 mm
NOTE 13

302-EE-00-2603
PGH FIRST STAGE REACTOR OFF GAS COOLER
DP (S/T) : 33/26.5 kg/cm²-2g
DT (S/T) : 230 °C/ 65 °C
Relief Duty: 0.252 MMKCAL/HR
TEMA Type: AES

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-11011 THRU B957-79-41-000-11014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "302" UNLESS OTHERWISE SPECIFIED.
2. NITROGEN CONNECTION LOCATED AT HIGH POINT.
3. LOCATE LEVEL GAUGE READABLE FROM GLOBE VALVE.
4. ONE DUPLEX THERMO COUPLE SHALL BE USED AT EACH SENSING POINT WITH THREE SENSING POINT AT EACH ELEVATION MOUNTED IN SINGLE THERMOWELL. ONE ELEMENT OF EACH THERMOCOUPLE SHALL HAVE TEMPERATURE INDICATION, SHUTDOWNS ON HIGH-HIGH TEMPERATURE SHALL BE TWO OUT OF EIGHTEEN.THE OTHER ELEMENT IS UNCONNECTED SPARE. DEVIATION OF ONE SIGNAL FROM THE OTHER AT SAME ELEVATION WILL CAUSE ALARM.

REACTOR TT LOOP NUMERICAL TABLE		
PONT NO.	TE/TT/TI	TE/TT/TI
EL-1	21306A-C	21307A-C
EL-2	21308A-C	21309A-C
EL-3	21310A-C	21311A-C
EL-4	21312A-C	21313A-C
EL-5	21314A-C	21315A-C
EL-6	21316A-C	21317A-C

5. ELEVATION IS BASED ON PUMP NPSH REQUIREMENT AND CATALYST UNLOADING.
6. LOCATE PDI TRANSMITTER ABOVE TOP TAPPING AND ALL IMPULSE LINE TO BE SELF-DRAINING INTO THE VESSEL.
7. REMOVABLE ELBOW FOR REACTOR ENTRY
8. TWO PHASE FLOW, ANCHOR SECURELY.
9. INTERLOCK IS ACTIVE FOR THE REACTOR IN OPERATION MODE AND IS BYPASSED WHEN THE REACTOR IS IN REGENERATION MODE.
10. THERMOWELL SPACED AT 120 DEGREE EQUALLY ALONG THE BED.
11. TEMPERATURE HIGH HIGH ALARM/SHUTDOWN SHALL BE BYPASSED IF REACTOR IS IN REGENERATION MODE.
12. FOR SAMPLE CONNECTION DETAILS REFER P&ID NO. B957-79-41-300-11875.
13. SEE PROCESS DATASHEET FOR DESIGN CASE OPERATION AND DESIGN CONDITIONS.
14. LOCATE PI READABLE FROM GLOBE VALVE.
15. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER P&ID NO. B957-79-41-300-11874.

Note: Tube Side of exchanger (EE-00-2603) shall be induded in chemical cleaning and passivation markup.

3	26.09.25	ISSUED FOR HAZOP		RS	GS	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.		AN	GS	KK	MS
REV.	DATE	REVISION		DRN	BY	CHKD	APPD.

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DRFT.	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	302	11213	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC. ENG	LPE	PDM	PM	CLIENT
3	03/07/2025	REVISED FOR BEP	NAH	AS	SC	SKG/VK	SA	
2	01/13/2025	FOR BEP	NAH	AS	SC	SKG/VK	SA	
1	10/21/2024	PRELIMINARY	NAH	AS	SC	SKG/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
PGH UNIT
PGH FIRST STAGE REACTOR
(SHEET 1 OF 4)

SCALE: | DWG. No: 363136-302-11213 | REV. 1

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302-EE-00-2601
PGH FIRST STAGE REACTOR RECYCLE COOLER
DP (S/T) : 43.0/34.0 kg/cm**2g
DT (S/T) : 230 °C/65 °C
Rated Duty: 12.975 MMKCAL/HR
TEMA Type: HEL0X-AES

302-EE-00-2602
PGH FIRST STAGE REACTOR HEATER
DP (S/T) : 34.0/FV/43.0kg/cm**2g
DT (S/T) : 350 °C/230 °C
Rated Duty: 3.773 MMKCAL/HR
TEMA Type: AES NOTE 3

302-VV-VW-2604
CONDENSATE POT FOR 302-EE-00-2602
DP : 34.0/FV kg/cm**2g
DT : 350 °C
Inside Diam. x Len.(T/T):600 mm x 1000 mm

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. B957-79-41-000-11011 THRU B957-79-41-000-11014
2. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "302" UNLESS OTHERWISE SPECIFIED.
3. LOCATE CONTROL VALVE AT THE GRADE.
4. EXCHANGER ONLY IN OPERATION DURING START-UP/RE-START OF THE REACTOR.
5. TWO PHASE FLOW, ANCHOR SECURELY.
6. HAND SWITCH TO SELECT THE REACTOR IN OPERATION FOR REACTOR LEVEL CONTROL.
7. 10 MM WEEP HOLE SHALL BE PROVIDED AT LOW POINT (WITH HARDPIPE CONNECTION TO SAFE LOCATION.)
8. HAND SWITCH TO SELECT HEATING MODE (START-UP) OR NORMAL OPERATING (COOLING).
9. FOR SAMPLE CONNECTION DETAILS REFER P&ID NO. B957-79-41-300-11678.
10. GLOBE VALVE TO BE CONSIDERED WITH POSITION LOCK ARRANGEMENT AND TO BE LOCATED AT GRADE.
11. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER P&ID NO. B957-79-41-300-11574.

DETAIL "B"

ESD 2602 (S) AI (S) AI
ZLL 214, ZLH 214, ZSL 214, ZSH 214
XV 214 TSO FC

ALL OTHER INSTRUMENTS TAG NUMBER SHOULD BE SAME AS XV TAG NUMBER

XV TAG NO.	INTERLOCK NO.
XV-21401	2602
XV-21402	2602

Note:

Tube Side of exchanger shall be Included in chemical cleaning and passivation markup.

REV.	DATE	REVISION	DRN	BY	CHKD	APPD.
3	26.09.25	ISSUED FOR HAZOP.	RS	GS	KK	MS
2	04.07.25	REVISED AS MARKED AND PMS INCORP.	AN	GS	KK	MS

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO	DEPT	SECTN.	UNIT	DWG. No.	REV.
	B957	79	41	302	11214	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAO	PROC ENG	LPE	PDM	PM		CLIENT
3	03/07/2025	REVISED FOR BEP	NAN	AS	SC	SKG/VK	SA		
2	01/13/2025	FOR BEP	NAN	AS	SC	SKG/VK	SA		
1	10/21/2024	PRELIMINARY	NAN	AS	SC	SKG/VK	SA		

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PIPING AND INSTRUMENTATION DIAGRAM
PGH UNIT
PGH FIRST STAGE REACTOR
(SHEET 2 OF 4)

SCALE: | DWG. No: 363136-302-11214 | REV. 1

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302-EE-00-2605
DEPENTANIZER CONDENSER
DP (S/T) : 5.0/10.6 kg/cm^2g
DT (S/T) : 170 °C/ 65 °C
Rated Duty: 6.237 MMKCAL/HR
TEMA Type: HELIX-AES

302-VV-HW-2606
DEPENTANIZER REFLUX DRUM
DP : 5.0kg/cm^2g
DT : 65 °C
Inside Diam. x Len.(T/T):1600 mm x 4800 mm

NOTES:

1. FOR LEGEND, SYMBOLS, GENERAL NOTES AND ENGINEERING DESIGN NOTES SEE DWG. NO. 9857-79-4-1-000-1011 THRU 9857-79-41-000-1014. ALL TAG NUMBERS FOR INSTRUMENTS WILL BE PRECEDED BY UNIT NUMBER "302" UNLESS OTHERWISE SPECIFIED.
2. DEPENTANIZER CONDENSER TO BE ELEVATED ABOVE REFLUX DRUM.
3. LOCATE PUSH BUTTON 15 METERS FROM PUMP AT SAFE LOCATION.
4. TWO PHASE FLOW ANCHOR SECURELY.
5. LOCATE LEVEL GAUGE READABLE FROM GLOBE VALVE.
6. MINIMUM FLOW LINE.
7. PUSH BUTTON IN THE FIELD OR DCS ACTIVATES INTERLOCK WHICH CLOSES ISOLATION VALVE AND SHUTS DOWN ALL ASSOCIATED PUMPS. VALVE LOCATED IN THE FIRE ZONE SHALL BE FIRE SAFE WITH FIRE PROOF ACTUATOR. POWER AND CONTROL CABLES IN FIREZONE SHALL BE FIREPROOFED.
8. ELEVATION IS BASED ON PRELIMINARY PUMP NPSH REQUIREMENT.
9. MOTOR OF PUMP SHALL BE AUTOMATICALLY STOPPED WHEN MOV IS LESS THAN 90% OPEN AND CANNOT BE RESTARTED UNTIL THE MOV IS FULLY OPENED.
10. FOR SAMPLE CONNECTION DETAILS REFER P&ID NO. 9857-79-41-300-11878.
11. GLOBE VALVE TO BE CONSIDERED WITH POSITION LOCK ARRENGEMENT AND TO BE LOCATED AT GRADE.
12. FOR CONTROL VALVE VENT AND DRAIN DETAILS REFER P&ID NO. 9857-79-41-300-11874.

Note: Tube Side of exchanger (EE-00-2605) shall be Included in chemical cleaning and passivation markup.

DETAIL "A"

302-PA-CF-2603A/B
DEPENTANIZER REFLUX/ PRODUCT PUMPS
Rated Flow: 93.3 m^3/hr
Diff. Pres: 14.88 kg/cm^2
DP: 25kg/cm^2g
DT : 70 °C

REV	DATE	REVISION	DRN	BY	CHKD	APPD.
3	26.09.25	ISSUED FOR HAZOP	RS	GS		
2	04.07.25	REVISED AS MARKED AND P/S INCORP	RS	GS		

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

SCALE	JOB NO.	DEPT.	SECTN.	UNIT	DWG. No.	REV.
S	B957	79	41	302	11219	3

BINA PETROCHEMICAL AND REFINERY EXPANSION PROJECT (BPREP)
ETHYLENE CRACKER & ASSOCIATED UNITS
BINA, MADHYA PRADESH, INDIA

BHARAT PETROLEUM CORPORATION LIMITED
BINA REFINERY

REV	ISSUE DATE	DESCRIPTION	CAD	PROC ENG	LPE	PDM	PM	CLIENT
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2	01/13/2025	FOR BEP	NAH	AS	SC	SKG/VK	SA	
1	10/21/2024	PRELIMINARY	NAH	AS	SC	SKG/VK	SA	

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PIPING AND INSTRUMENTATION DIAGRAM
PGH UNIT
DEPENTANIZER REFLUX DRUM

SCALE: | DWG. No: 363136-302-11219 | REV. 1

Signature Not Verified
Digitally signed by ARITRA DE
Date: 2026.05.18 16:47:42 IST
Location: ePROC
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