PREFEASIBILITY REPORT

FOR

"REVAMP OF DIESEL HYDRO DE – SULPHURISATION UNIT"

BY

CHENNAI PETROLEUM CORPORATION LIMITED

AT

VILLAGE: MANALI

TALUK: AMBATTUR

DISTRICT: THIRVALLUR

STATE: TAMIL NADU

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BS	Bharath Stage
CBR	Cauvery Basin Refinery
CDU	Crude Distillation Unit
CPCL	Chennai Petroleum Corporation Limited
CRU	Catalytic Reforming Unit
DCU	Delayed Coker Unit
DHDS	Diesel Hydro De-Sulphurisation
DHDT	Diesel Hydro Treating
EOR	End of Run
FCCU	Fluidized Catalytic Cracking Unit
HCO	Heavy Cycle Oil
ISOM	Isomerisation Unit
LABFS	Linear Alkyl Benzene Feed Stock
LCO	Light Cycle Oil
LOBS	Heavy Cycle Oil
LPG	Lube Oil Base Stock
LVGO	Liquefied Petroleum Gas
MDEA	Light Vacuum Gas Oil
MEK	Methyl Di-Ethanol Amine
MMT	Methyl Ethyl Ketone
MMTPA	Million Metric Tonnes
MP	Million Metric Tonnes Per Annum
OHCU	Medium Pressure
SOR	Once-through Hydro Cracker Unit
SRGO	Start of Run
SRU	Straight Run Gas Oil
VBU	Sulphur Recovery Unit
VGO	Visbreaker Unit

1. EXECUTIVE SUMMARY

Chennai Petroleum Corporation Limited (CPCL) is the oldest refinery in Southern part of India and the most complex public sector refinery within India in a spread of 800 acres land. Over the last 45 years, Chennai Petroleum Corporation Limited has expanded its capacity from 2.5 MMTPA to 10.5 MMTPA. The CPCL site is located about 4 km away from Thiruvottiyur Town and it is in the express highway connecting Thiruvottiyur and Ponneri.

The existing Diesel Hydro-desulphurisation (DHDS) unit in CPCL is designed for treating the feed consisting of straight run gas oil, light vacuum gas oil, spindle oil and FCCU's and LCO / HCO to produce treated diesel to meet the required specifications. The DHDS unit of CPCL is located at survey numbers 266 / 2, 274, 296, 297, 298 and 299 Manali Village, Ambattur Taluk, Tiruvallur District, Tamil Nadu.

The DHDS unit is proposed to be revamped to meet the new specifications for diesel as outlined in "AUTO FUEL VISION & POLICY 2025" (AFV), submitted in the year 2014. Presently BS-IV specification diesel with sulphur content of 350 ppm wt is being supplied to major cities and BS-III specification diesel with sulphur content of 50 ppm wt is being supplied to rest of the country. As per AFV recommendation, 100% BS-IV specification fuels have to be supplied by 1st April 2017 and 100% BS-V specification fuels by 1st April 2020.

The proposed DHDS revamp is to increase the capacity from 1.80 MMTPA to 2.34 MMTPA and to meet the BS-V standards by producing treated diesel having sulphur content of less than 10 ppm wt. The proposed Revamp is also for treating Straight Run VGO with a capacity of 0.5 MMTPA.

The project cost for the proposed revamp is Rs. 350.33 Crores.

2. INTRODUCTION OF THE PROJECT

2.1 ABOUT THE PROJECT PROPONENT

Chennai Petroleum Corporation Limited (CPCL) (formerly known as Madras Refineries Limited) was formed as a joint venture of the Government of India (GOI), Amoco India Inc., U.S.A. and National Iranian Oil Company (NIOC), Iran with the initial equity contribution in the ratio of 74:13:13. The company was incorporated on 30.12.1965 as a Public Limited Company. Amoco Inc. disinvested its equity holding in favour of GOI in 1985. Later, Govt. of India transferred its equity share of 51.89% to Indian Oil Corporation Limited.

The Manali refinery was originally designed for processing 2.5 MMTPA (Million Metric Tonnes Per Annum) of imported Darius crude from Iran. CPCL's Manali refining capacity was increased from 2.5 MMTPA in 1969 to 10.5 MMTPA in 2011 through addition of new units and debottlenecking existing units. Secondary processing units like FCCU and OHCU were implemented to improve the total distillate yield. Facilities like DHDT, CCR and ISOM were also added to meet stringent Euro-IV quality norms for Diesel and Gasoline.

CPCL's Cauvery Basin Refinery (CBR) was commissioned in Nov 1993 initially with a capacity of 0.5 MMTPA to process Narimanam crude. CPCL completed the CBR capacity expansion to 1.0 MMTPA in 2002 and construction of an Oil Jetty facility for crude in 2003.

2.2 MAJOR PRODUCTS OF CPCL

The main products of the company are LPG, Motor Spirit, Superior Kerosene, Aviation Turbine Fuel, High Speed Diesel, Naphtha, Bitumen, Lube Base Stocks, Paraffin Wax, Fuel Oil and Hexane. In addition, CPCL, as a mother industry, supplies Petrochemical feed stocks like Propylene and Butylenes stream for the manufacture of Propylene Oxide, Propylene Glycol, MEK, Polybutylene and Kerosene stream for the manufacture of Linear Alkyl Benzene.

All Fuel products, Bitumen and Lubes of the Manali Refinery of CPCL and all the products of CBR of CPCL are marketed through Indian Oil Corporation Limited. CPCL does direct marketing of some of its speciality products from Manali Refinery, like Waxes, Propylene, Hexane, LAB feed stock, Petrochemical Feed stocks and Lube Extracts.

A Propylene Plant with a capacity of 17,000 tonnes per annum was commissioned in 1988 to supply petrochemical feedstock to neighboring downstream industries. The unit was revamped to enhance the propylene production capacity to 30,000 tonnes per annum in 2004. CPCL also supplies LABFS to a downstream unit for manufacture of Liner Alkyl Benzene.

The crude throughput for the year 2014-2015 was 10.782 million metric tonnes (MMT). The company's turnover for the year 2014-2015 was Rs. 47, 877.82 Crores and the Profit after Tax was Rs. 38.99 Crores.

2.3 ABOUT THE PROJECT

As per the Auto Fuel Vision and Policy 2025 of Government of India and the directives from MoP&NG, 100% BS – IV quality fuels have to be supplied by the refineries from April 2017 and 100% BS – V / VI quality fuels from April 2020. To comply with this directive, the existing Diesel Hydro De-Sulphurisation unit (DHDS) is proposed to be revamped from 1.80 MMTPA to 2.34 MMTPA to ensure 100% BS – IV production from the Manali Refinery. After the revamp, the DHDS unit will be able to produce hydro treated diesel with less than 10 ppm Sulphur. The proposed Revamp is also for treating Straight Run VGO with a capacity of 0.5 MMTPA. The DHDS revamp is being proposed to comply with the BS – IV and V specifications as given below in **table 1.1** and **table 1.2**:

Table 2.1 BS IV Specifications for Diesel

S. No	Attribute	Unit	BS IV
1	Density @ 15 °C	kg/m^3	820 – 845
2	Distillation: 95 % vol. Recovery @ °C, max	°C	360
3	Sulphur	ppm max	50
4	Cetane number	Min	51
5	Cetane Index	Min	46
6	Flash Point, Abel, min	°C	35
7	KV @ 40 °C	cSt	2.0 – 4.5
8	Carbon residue (Rams bottom) on 10% residue, max (without additive)	% wt max	0.3
9	Water content	mg/kg max	200
10	Lubricity corrected Wear Scar Diameter @ 60 °C, max	Microns	460
11	Ash	% wt max	0.01
12	Cold Filter Plugging Point		
	a) Summer	°C	18
	b) Winter	°C	6
13	Total contamination, max	mg/kg	24
14	Oxidation stability	g/m^3, max	25
15	Polycyclic Aromatic Hydrocarbon (PAH), max	% wt	11
16	Copper strip corrosion for 3 hrs @ 50 °C, max	Rating	Class-1

Table 2.2 BS V Specifications for diesel

S. No	Attribute	Unit	Proposed BS V
1	Density @ 15 °C	kg/m^3	820-845
2	Distillation T_{95}	°C max	360
3	Sulphur	ppm max	10
4	Cetane number	min	51
5	Cetane Index	min	46
6	Flash Point	°C min.	42
7	Viscosity @ 40 °C	cSt	2.0 – 4.5
8	PAH	% wt max	11
9	Total contaminants	mg/kg max	24
10	RCR on 10% Residue	% wt max	0.3
11	Water content	mg/kg max	200
12	Lubricity corrected Wear Scar Diameter @ 60 °C	Microns, max	460
13	Ash	% wt max	0.01
14	Cold Filter Plugging Point		
	a) Summer	°C	18
	b) Winter	°C	6
15	Oxidation stability	g/m^3, max	25
16	Copper strip corrosion for 3 hrs @ 50 °C, max	Rating	Class-1

The expansion project scope mainly involves replacement of an existing reactor with a new reactor and addition of hot separator drum, stabilizer reflux drum, stripper air condenser, feed / effluent exchanger and naphtha recycle / stabilizer reflex pumps. Off-site requirements will be met by existing units which have enough capacity margins to support proposed expansion. The cost estimation is around Rs. 350 Crores and the construction is carried out in phases spread in 10 – 12 months.

The proposed capacity expansion does not require any new process or new raw materials. Since the project is proposed to reduce the sulphur content, there will not be any additional pollutants. The existing effluent treatment plant and other treatment systems have adequate design capabilities to handle the additional pollutant loads from expansion as there are no changes in characteristics.

2.4 PROJECT BENEFITS

The proposed revamp will enhance the quality of the product, to meet the BS IV & V specifications. This DHDS revamp will also help in enhancing the environmental conditions by reducing the emission of Sulphur into the atmosphere.

3. PROJECT DESCRIPTION

3.1 TYPE OF PROJECT

CPCL proposes to expand the capacity of all the existing Diesel Hydro De – Sulphurisation unit to meet the BS IV & V Standards. The project scope mainly involves addition, modification and replacement of condensers, exchangers, pumps, cooler, coalesce, strippers etc. The proposed project falls under the schedule 4 (a), category 'A' as per the EIA notification dated September 14, 2006 and its amendments. There is no interlinked project.

3.2 PROJECT LOCATION

The proposed project is planned within the existing facility of CPCL, located at survey numbers 266 / 2, 274, 296, 297, 298 and 299 Manali Village, Ambattur Taluk, Tiruvallur District, and Tamil Nadu. The site is located about 4 km away from Thiruvottiyur Town and it is in the express highway connecting Thiruvottiyur and Ponneri. The nearest railway station is Thiruvottiyur. The Project site is given in **Figure 3.1.** The 10 Km radius map from the project is given in **Fig 3.2**.

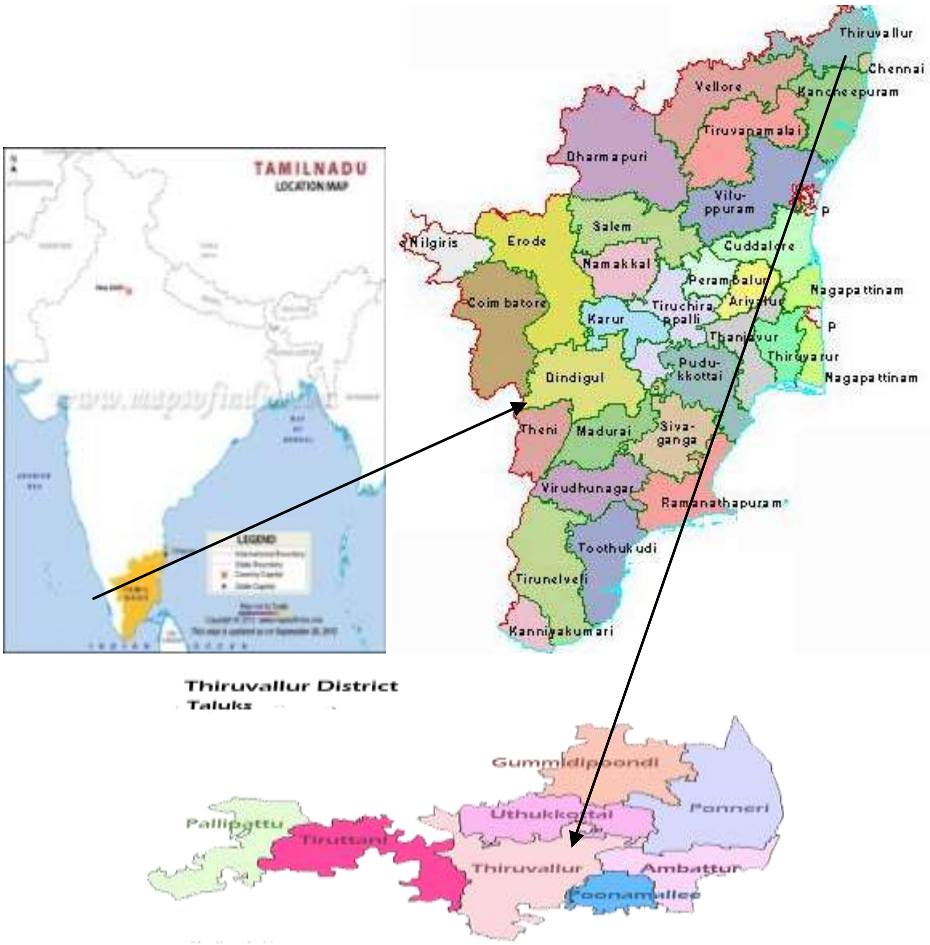

Figure 3.1 Project Site

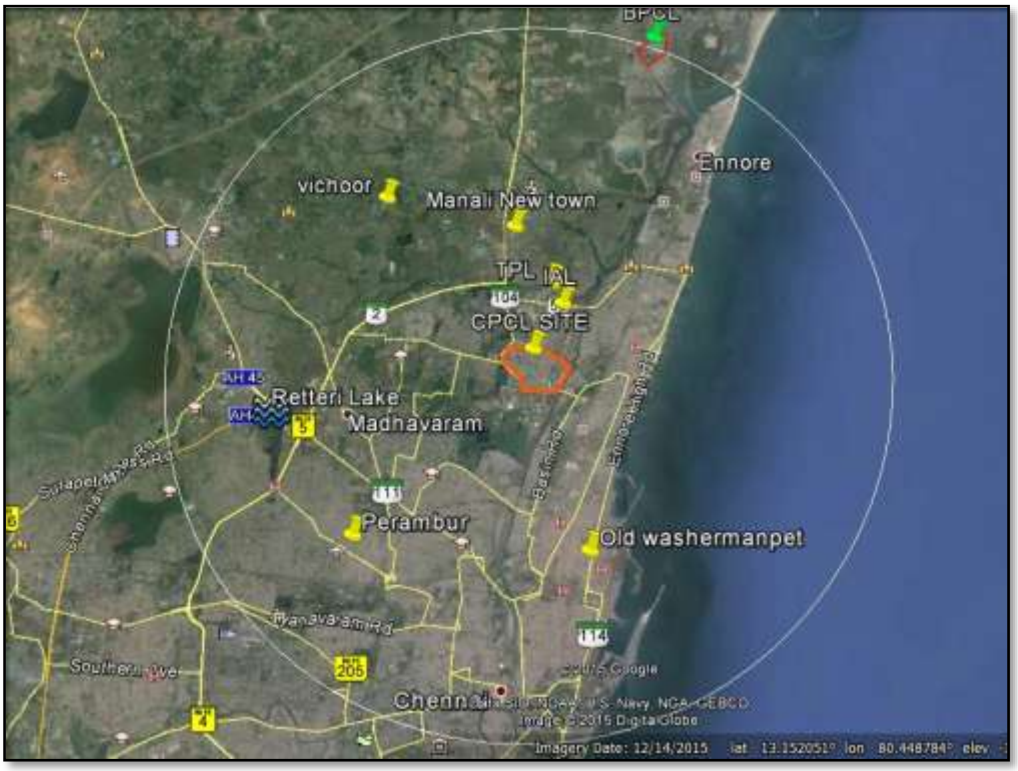

Figure 3.2 10 km Radius around project site

3.3 MAJOR PROJECTS OF CPCL

The details of current major projects are given below:

3.3.1 RESID UPGRADATION PROJECT

To improve the distillate yield of Manali refinery, a Resid Upgradation Project is under implementation with an estimated cost of Rs 3110.36 Crores. This project involves installation of Delayed Coker Unit and Revamping of existing Hydrocracker Unit along with other associated facilities. The Environment clearance for the Project was given in March 2013. The project is under implementation.

3.3.2 MOUNDED BULLET STORAGE

As a risk reduction measure and in order to provide intrinsically passive and safe environment, the Mounded Bullet Project is under implementation for LPG and Petrochemical feed stock storage at an estimated cost of Rs 279 Crores.

3.3.3 NEW 42" CRUDE OIL PIPELINE

A new 42 " Crude Oil Pipeline Project, from Chennai Port to Manali Refinery, with enhanced safety features is planned to ensure reliable faster crude transfer from Port. The estimated cost of the project is Rs. 257.87crore. The Ministry of Environment, Forests & Climate Change (MoEF&CC), Government of India, accorded CRZ clearance for this Project in January 2014.

As part of Resid Upgradation project enabling job, a new reservoir of 4 MG Reservoir was constructed and commissioned. Installation of 2 Crude Oil storage tanks of 10,500 kL each was implemented at an estimated cost of Rs 25 Crore.

The capacities of the major units are as follows:

Table 3.1 Capacity of major units of CPCL

UNIT	DESIGN (Million Metric Tonnes Per Annum)
CDU – I	2.8
CDU – II	3.7
CDU – III	4.0
FCCU	0.83
OHCU	1.85
VBU	1.15
CRU	0.3
ISOM	0.14
DHDT	1.8
DHDS	1.8
LOBS	0.27

3.4 DESCRIPTION OF THE PROJECT

The DHDS unit was commissioned in 2000. The catalyst in the reactors was replaced in the year 2008. The proposed project is the revamp of existing DHDS unit to increase the capacity from 1.80 MMTPA to 2.34 MMTPA. The DHDS unit photographs are given in **Annexure 6.**

As per the Auto Fuel Vision and Policy 2025 of Government of India and the directives from MoP&NG, 100% BS – IV quality fuels have to be supplied by the refineries from April 2017 and 100% BS – V / VI quality fuels from April 2020. To comply with this directive, the existing Diesel Hydro De-Sulphurisation unit (DHDS) is proposed to be revamped from 1.80 MMTPA to 2.34 MMTPA to ensure 100% BS – IV production from the Manali Refinery. After the revamp, the DHDS unit will be able to produce hydro treated diesel with less than 10 ppm Sulphur.

The Revamp is also done for processing of Straight Run VGO with the capacity of 0.5 MMTPA.

3.5 PROJECT NEED

The Diesel Hydro De – Sulphurisation Unit (DHDS - Unit No.77) was installed and commissioned in 2000 with a capacity of 1.80 MMTPA, to produce treated diesel with sulphur content of 2000 wt ppm. A single reactor with catalyst volume of $82m^3$ was installed for treating the feed consisting of Straight Run Gas Oil, Light Vacuum Gas Oil, Spindle Oil and FCCU's LCO / HCO. A new 2nd reactor with catalyst volume of 136 m^3 was added in the year 2002 in series to produce diesel with sulphur content of 500 wt ppm to meet BS-II specifications. The catalysts in the reactors were replaced in 2008. The sulphur content in treated diesel was brought down to 160 wt ppm after the catalyst change in 2008.

After the above proposed revamp, the sulphur content in treated diesel will meet BS-V standards.

Table 3.2 BS Specifications

BS CODE	SULPHUR CONTENT (PPM)
BS – III	<350
BS – IV	<50
BS – V	<10

3.6 MANUFACTURING PROCESS DESCRIPTION

The DHDS Unit (Unit No.77) is proposed to be revamped from the existing 1.80 MMTPA to 2.34 MMTPA. The main objectives of the revamp are as follows:

- To increase the capacity to, additional 30% of existing capacity.
- To include the Delayed Coker Unit (DCU) streams in the Feed basis.
- To produce the treated diesel, meeting BS-V norms (10 wt ppm. Sulphur).

The existing DHDS is designed for treating the feed consisting of Straight Run Gas Oil, Light Vacuum Gas Oil, Spindle Oil and FCCU's LCO / HCO. The revamped DHDS will be capable of processing additional cracked gas oils and naphtha produced from DCU.

3.6.1 REACTION SECTION

The feed to the DHDS unit is a blend of straight run gas oil, light coker gas oil, heavy coker naphtha, heavy naphtha, kerosene, heavy cycle oil, light cycle oil, and spindle oil. The feed is filtered through feed filter package 77-T1 (rerated) and sent to the feed surge drum 77- C1 (retained) under level control. The pressure in the feed surge drum is maintained by split range fuel gas to flare pressure control. The feed is pumped by feed pumps 77-G101 A/B (replaced) under flow control where it mixes with recycle hydrogen, from the recycle compressor 77-K2 (driver modification) discharge, upstream of the Feed / Effluent exchangers, 77-E1 A/B/C/D/E/F (77-E1A/B/C- tube side nozzle size increase). Mixing of recycle hydrogen with the feed ensures an adequate hydrogen partial pressure at the inlet of the reactor train. Anti-fouling agent is injected in the fresh feed at the suction of the feed pump. The hydrogen make-up gas coming from battery limit is routed through chlorine absorbent pot 77- C20 (retained) to the make-up K.O. drum 77-C5 A/B (modified). It is then compressed by the makeup compressors 77-K1 A/B (retained) both operating, in parallel. The make-up gas flow rate to the reaction section is controlled by means of a compressor spillback which is sent back to the K.O. drum 77-C5 A/B (modified) after cooling through spillback water cooler 77-E6 A/B (retained). The make-up gas joins the recycle and quench gas upstream the recycle K.O. drum 77-C13 (retained). The combined make-up and recycle gas stream is routed to the recycle gas compressor 77-K2 (driver modification); a part of the compressed fluid is sent as quench gas to the reactors.

The mixed stream (feed and recycle hydrogen) is first preheated against the reactor effluent in the shell side of the 1st Reactor Feed / Effluent exchangers, 77-E1 A/B/C/D/E/F (77-E1A/B/C- tube side nozzle size increase), in the shell side of second reactor feed / effluent exchangers, 77-E2 A/B (retained), then in the shell side of third reactor feed / effluent exchangers, 77-E160 A/B (replaced), and finally in the reactor heater 77-F1 (retained) to the required reactor inlet temperature. The reactor inlet temperature is controlled by acting on the fuel gas / fuel oil to the heater burners.

Table 3.3 Specifications of Diesel and VGO Case

Heater	Diesel Case		VGO Case	
	SOR	EOR	SOR	EOR
Inlet pressure kg/cm2	55.3	58	49.8	52.3
Outlet pressure kg/cm2	50.3	53	46.3	48.8
Inlet temperature °C	290	321.7	310.8	338.7
Outlet temperature °C	309.2	347.2	347.5	379.8
Inlet vapor flow rate kg/hr	62096	90632	20903	26219
Outlet vapor flow rate kg/hr	83696	130299	24235	32617
Inlet liquid flow rate kg/hr	239802	212967	148402	146579
Outlet liquid flow rate kg/hr	218203	173300	145070	140181
Heat duties MMkcal/hr	5.230	7.410	4.970	5.880

The stream is then sent to the first reactor 77-C102 (new) which includes catalyst installed in three beds. The process flow diagram for Diesel case and VGO Case is given in **Figure 3.4 and Figure 3.5 respectively**.

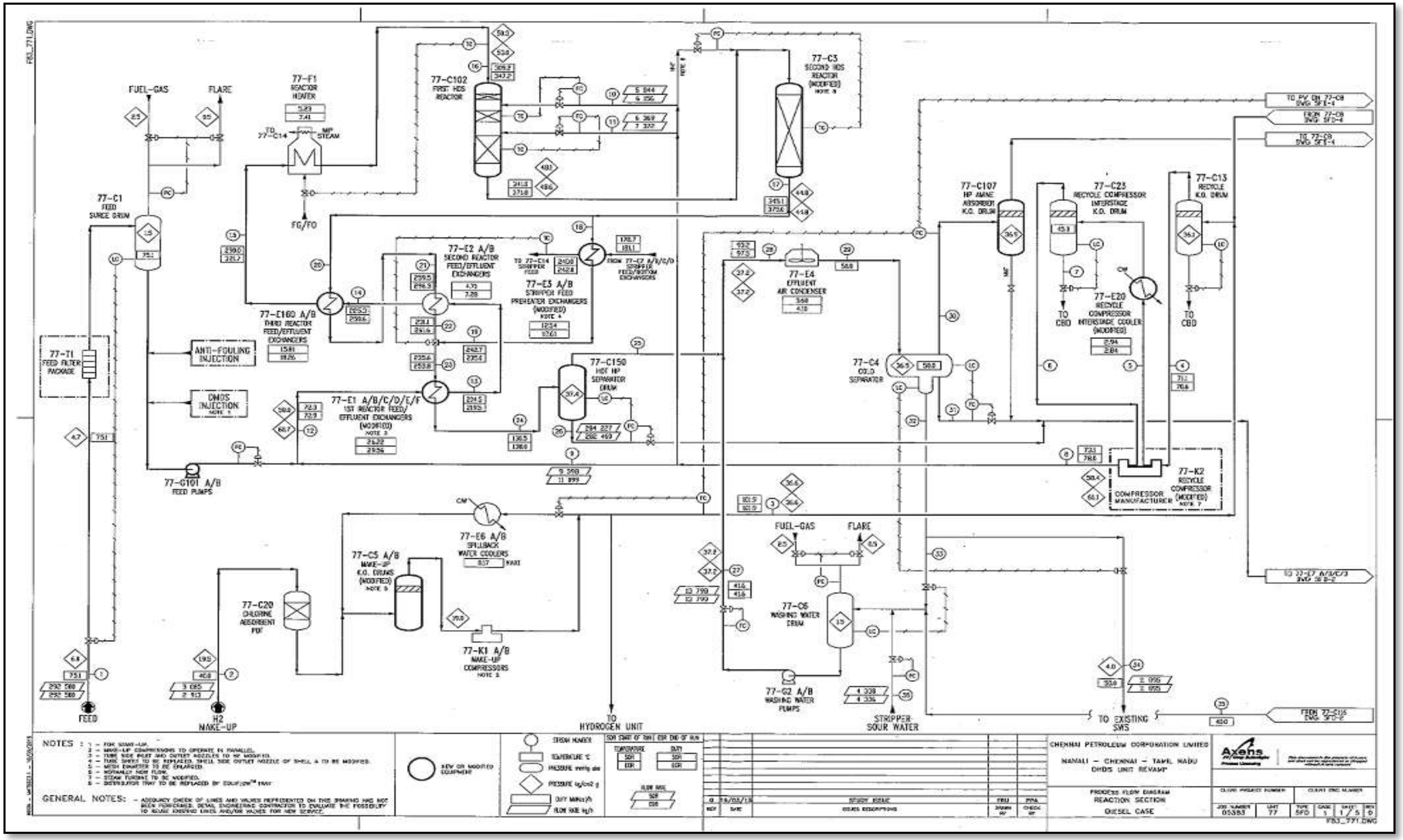

Figure 3.3 Reaction Section for Diesel Case

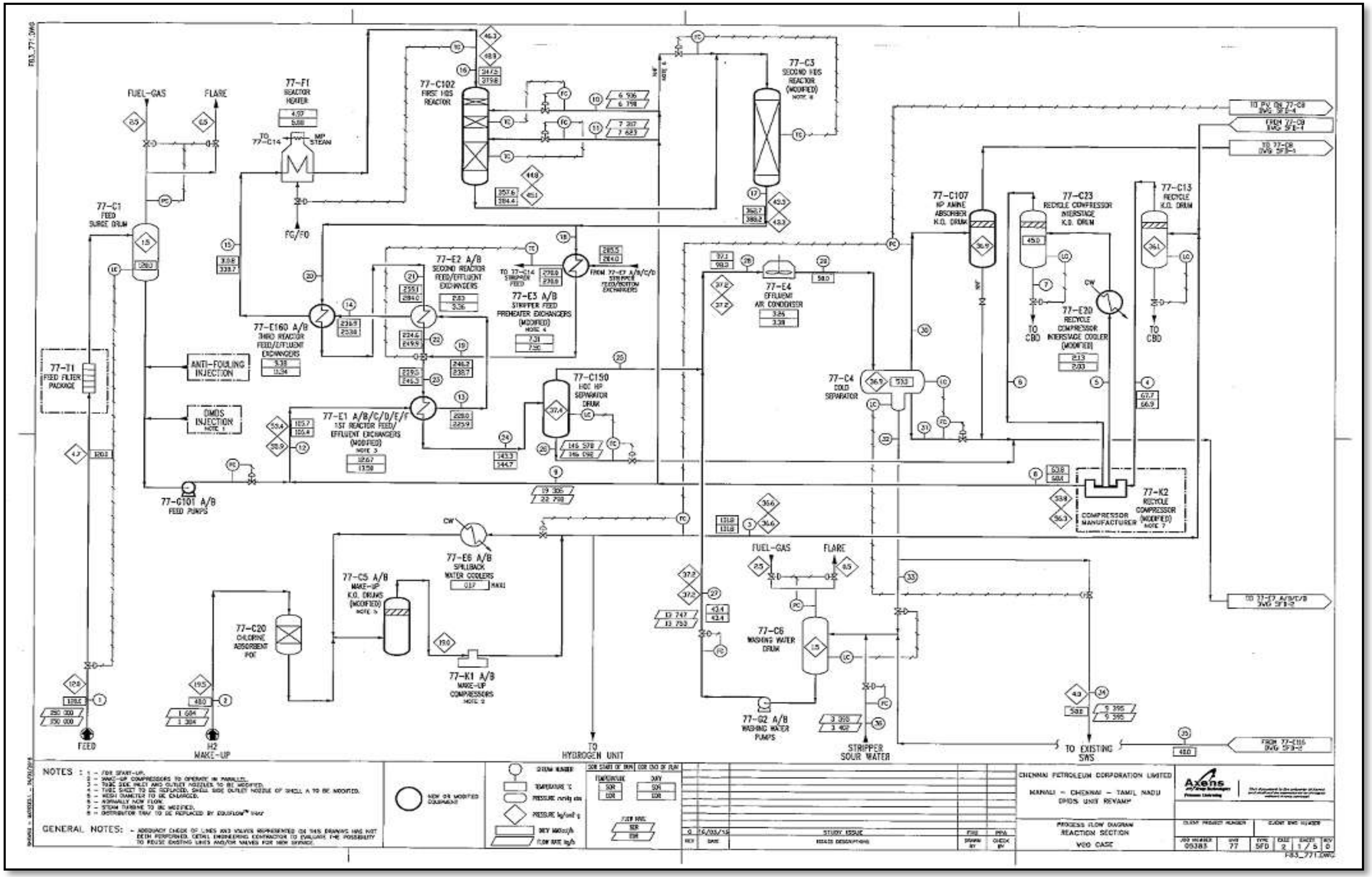

Figure 3.4 Reaction Section for VGO Case

3.6.1.1 FIRST HDS REACTOR 77-C102

The reactor loading is based on the dense loading technique for HR-648. ACT catalysts are sock loaded. The catalyst details are given in **table 3.4**:

Table 3.4 Catalyst Details

77-C102 BED N°	CATALYST TYPE	LOADING DENSITY kg/m3	HEIGHT mm	VOLUME m3	WEIGHT kg
1st Bed	ACT 069	880	150	3.564	3 136
	ACT 077	550	180	4.276	2 352
	ACT 935	525	150	3.564	1871
	ACT 971	570	170	4.039	2302
	HR 648 (1.6 mm)	840	2736	65.003	54602
	1/4" BALLS	1400	150	3.564	4 989
2nd Bed	1/4" BALLS	1400	150	3.564	4 989
	HR 648 (1.6 mm)	840	8800	209.073	175 621
	1/4" BALLS	1400	150	3.564	4 989
3rd Bed	1/4" BALLS	1400	150	3.564	4 989
	HR 648 above TL (1.6 mm)	840	8961	212.898	178 834
	HR 648 below TL (1.6 mm)	840	1230	27.272	22909
	1/4" BALLS below TL	1400	150	2.761	3 865
	3/4" BALLS below TL	1350	963	12.661	17093

3.6.1.2 SECOND HDS REACTOR 77-C3

The reactor loading is based on the dense loading technique for HR-648 and the specifications are given as below:

Table 3.5 Catalyst loading details of Second HDS Reactor

77-C3 BED N°	CATALYST TYPE	LOADING DENSITY kg/m3	HEIGHT mm	VOLUME m3	WEIGHT kg
1st Bed	1/4" BALLS	1400	150	1.980	2 773
	HR 648 above TL (1.6 mm)	840	9 426	124.447	104 536
	HR 648 below TL (1.6 mm)	840	917	11.298	9 490
	1/4" BALLS below TL	1400	150	1.516	2 123
	3/4" BALLS below TL	1350	616	4.779	6 452

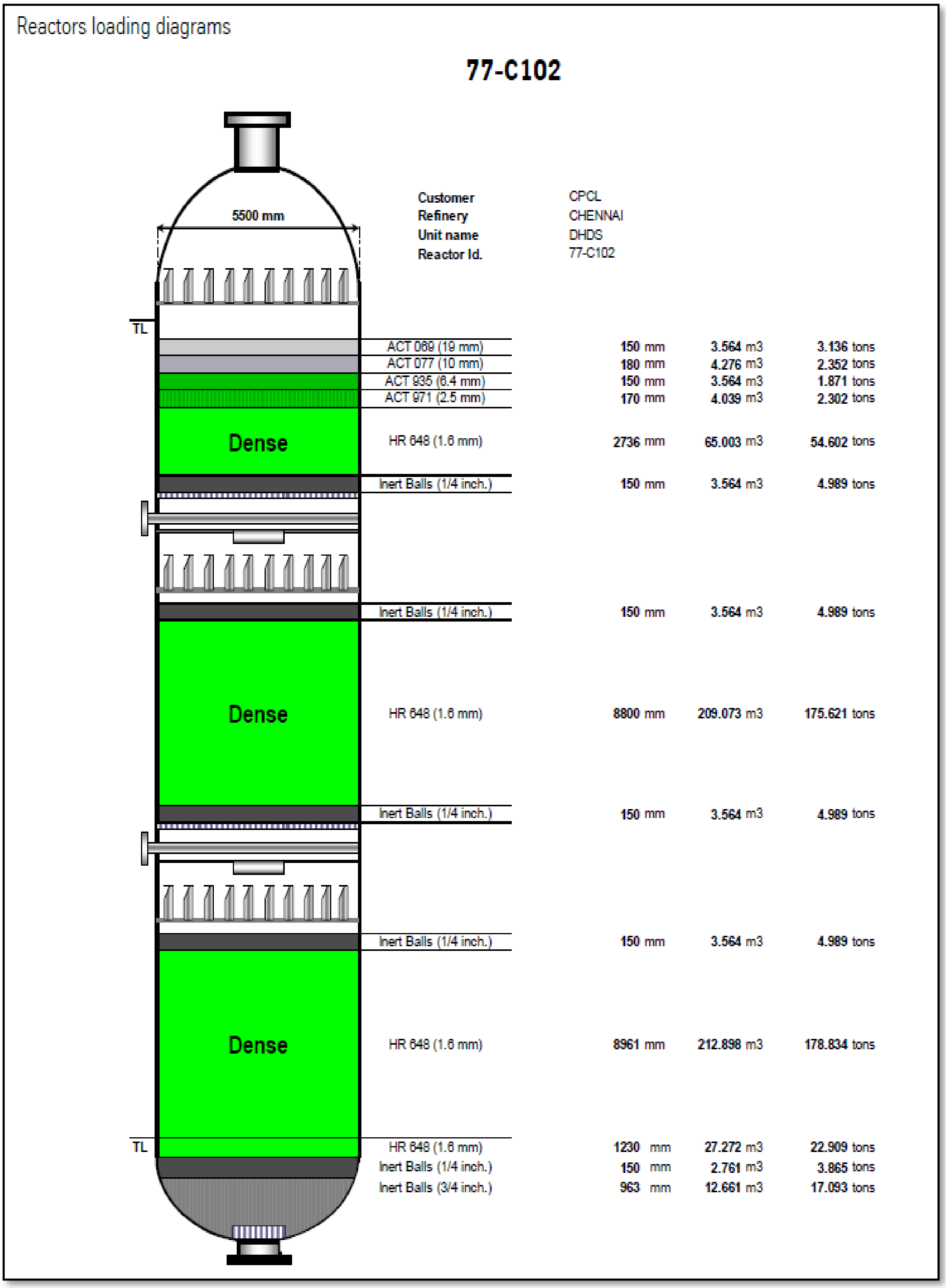

Figure 3.5 Reactor (77 – C102) Loading diagram

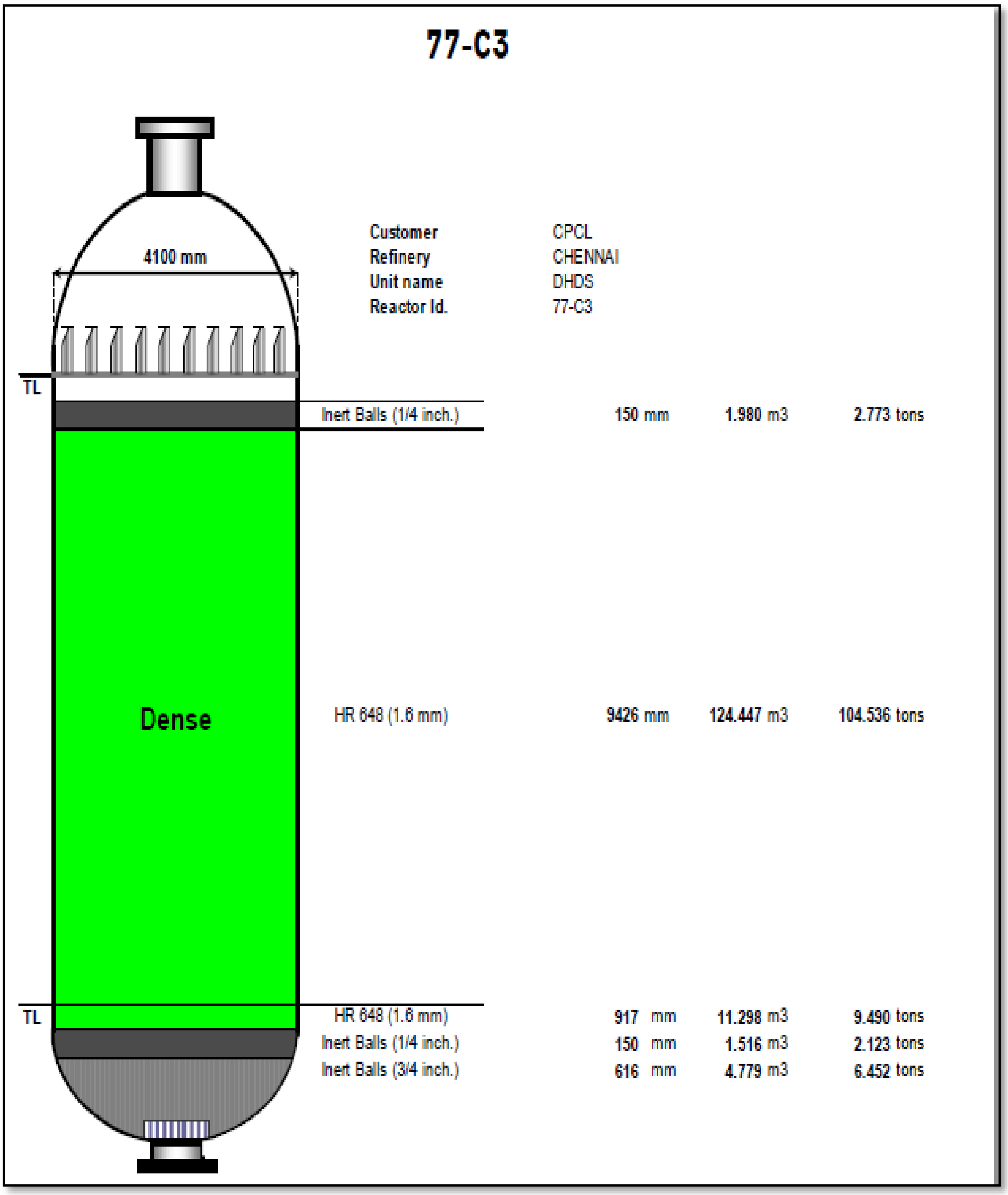

Figure 3.6 Reactor (77 – C3) loading

3.6.2 CATALYST INVENTORY

The following catalyst inventory is considered. The total amount of catalyst is listed in the **table 3.6**.

Table 3.6 Catalyst Inventory details

Ref.	Volume m3	Mass metric tons	Type	Shape	Size (mm)	Loading
ACT 069	3.564	3.136	Inert, scale trap	Penta-ring extr.	19.1	Sock
ACT 077	4.276	2.352	Inert, scale trap	Fluted ring extr.	10.0	Sock
ACT 935	3.564	1.871	Inert, silica trap	Hollow cylindrical extr.	6.4	Sock
ACT 971	4.039	2.302	Inert, silica trap	Trilobe extrudates	2.5	Sock
HR 648	644.991	545. 992	Promoted NiMo	Multilobe extr.	1.6	Dense
Balls 1/4"	20.513	28.717	Inert	Sphere	6.4	Sock
Balls 3/4"	17.440	23.545	Inert	Sphere	19.1	Sock
TOTAL	703.387 (1)	607.956				

Notes:

1. ACT 069, ACT 077, ACT 935, ACT 971 shall be replaced by new fresh loads after each cycle period. HR 648 can be regenerated ex-situ and reused.

Cold quenches of hydrogen coming from recycle compressor are added at the inlet of each new bed under TC/FC cascade to control the bed inlet temperature. The stream goes to a second reactor 77-C3 (modified), at the outlet of the first reactor. The second reactor includes one catalyst bed. The quench between 77-C102 (new) and 77-C3 (modified) is not used in normal operation.

The Second reactor outlet stream is split in two. In order to maximize heat recovery, one part exchanges heat with the stripper feed preheater exchanger 77-E3 A/B (modified) under temperature control of the stripper feed, while the remaining part exchanges heat with the reactor feed in exchanger 77-E160 A/B (new) in series with 77-E2 A/B (retained) . The two streams are mixed together before entering 77-E1 A/B/C/D/E/F (77- E1A/B/C- tube side nozzle size increase).

The vapor and liquid phases of the reactor effluent from 77-E1 A/B/C/D/E/F (77-E1A/B/C- tube side nozzle size increase) are separated in the hot separator drum 77-C150 (new). The liquid phase is routed under flow control reset by hot separator drum level control to the inlet of the stripper feed effluent heat exchanger train (77-E7 A/B/C/D) (retained). Final cooling of the vapor phase of the hot separator is achieved in the effluent air condenser 77-E4 (retained).

To avoid ammonium salt deposits and risk of corrosion, water is injected at the inlet of the effluent air condenser 77-E4 (retained) by washing water pump 77-G2 A/B (retained). This washing water is a mixture of recycled water from the HP cold separator 77-C4 (retained), stripped water from sour water stripper and water recovered at the stripper reflux drum 77-C116 (new). This mixture is collected in the washing water drum 77-C6 (retained) which is maintained under pressure by split range fuel gas to flare pressure control.

The effluent of air condenser 77-E4 (retained) is collected in the cold separator 77-C4 (retained) where three phases are separated:

- The hydrocarbon liquid phase from the cold separator 77-C4 (retained) is mixed with the liquid phase of the hot separator 77-C150 (new) and then routed under flow control reset by cold separator drum level control to the shell side inlet of the stripper feed/bottom exchanger train (77-E7 A/B/C/D) (retained).

- The sour water containing ammonium salts is partly recycled to the washing water drum 77-C6 (retained) under level control of the washing water drum 77-C6 (retained) while a part is sent to the sour water stripper unit under level control of cold separator 77-C4 (retained) boot.
- The gas phase from cold separator goes to the HP amine absorber K.O. drum 77-C107 (new) and then is partly sent to the HP amine absorber 77-C8 (retained) where H2S is removed. The other part by-passes the HP amine absorber and is directly routed to the recycle compressor K.O. drum 77-C13 (retained). This by-pass allows for control of H_2S concentration in the recycle gas.

In the HP amine absorber 77-C8 (retained), the gas is washed by a 40 wt% MDEA solution. The lean MDEA, pumped by MDEA booster pump 77-G3 A/B (retained) from HP amine surge drum 77-C9 (retained), is injected at the top of the absorber under level control. HP amine surge drum 77-C9 (retained) is maintained under pressure by split range fuel gas to flare pressure control. Anti-foaming is injected to the MDEA solution before it is pumped by 77-G3 A/B (retained).

The rich MDEA solution is withdrawn under level control at the bottom of the absorber to be fed to the LP amine absorber 77-C11 (retained). The H2S removed gases from 77-C8 (retained) and the HP absorber bypassed gases are sent to recycle gas drum 77-C13 (retained) where the entrained liquid is removed. A high-level trip will shut-off the recycle compressor to prevent liquid from reaching the recycle compressor. The recycle compressor 77-K2 (drive modification) circulates the recycle gas through the high pressure system.

The compressor is a two stage centrifugal compressor. First stage discharge is cooled in the inter stage cooler 77-E20 (modified) and the entrained liquid in the first stage outlet is removed in the interstage KO drum 77-C23 (retained). A high level in 77- C23 (retained) will shut off the recycle compressor to prevent liquid from reaching the recycle compressor. The hydrogen make up gas coming from battery limit is routed through chlorine adsorbent pot 77-C20 (retained) to the makeup KO drum 77-C5A/B (modified). The high level in 77-C5A/B (modified) trips the makeup gas compressor 77-K01A/B (retained). It is then compressed by the makeup compressor 77-K1A/B (retained). The makeup gas flow rate to the reaction section is controlled by means of a compressor spillback, which is sent back to the makeup KO drum after cooling through spillback water cooler 77-E6 (retained). The makeup gas joins the recycle and quench gas upstream to the recycle KO drum 77-C13 (retained). The combined make up + recycle + quench stream is routed via the recycle gas compressor 77-K2 (drive modification) to reactor 77-C102 (new).

3.6.3 STRIPPING AND STABILIZING SECTION

The liquid hydrocarbon phases of hot separator 77-C150 (new) and cold separator 77-C4 (retained) are the stripper feed. The stripper feed is first preheated by heat exchange against stripper bottom product in the shell side of the stripper feed/bottom exchanger 77-E7 A/B/C/D (retained) and then by heat exchange against the reactor effluent in the stripper feed pre-heater shell side 77-E3 A/B (modified) in order to reach the required stripper inlet temperature.

Medium pressure stripping steam comes from two sources, the reactor heater, 77-F1 (retained), where steam was superheated, and from the MP steam header, before being injected under flow control at the bottom of the stripper 77-C14 (modified) in order to produce a diesel with adjusted flash point and free of H_2S. Light ends and H2S gather at the top of the stripper. Corrosion inhibitor is injected into the stripper overhead line. The overhead of the stripper is first cooled in the new Stripper Air Cooler, 77-E109 (new), and then further cooled in the new Stripper Trim Condenser, 77-E110 (new), before being separated into three phases in the new stripper reflux drum 77-C116 (new): a hydrocarbon liquid distillate (wild naphtha), a free liquid water phase and a vapor phase stream. The process flow chart for Stripping and Stabilisation section in Diesel Case and VGO Case is shown as below:

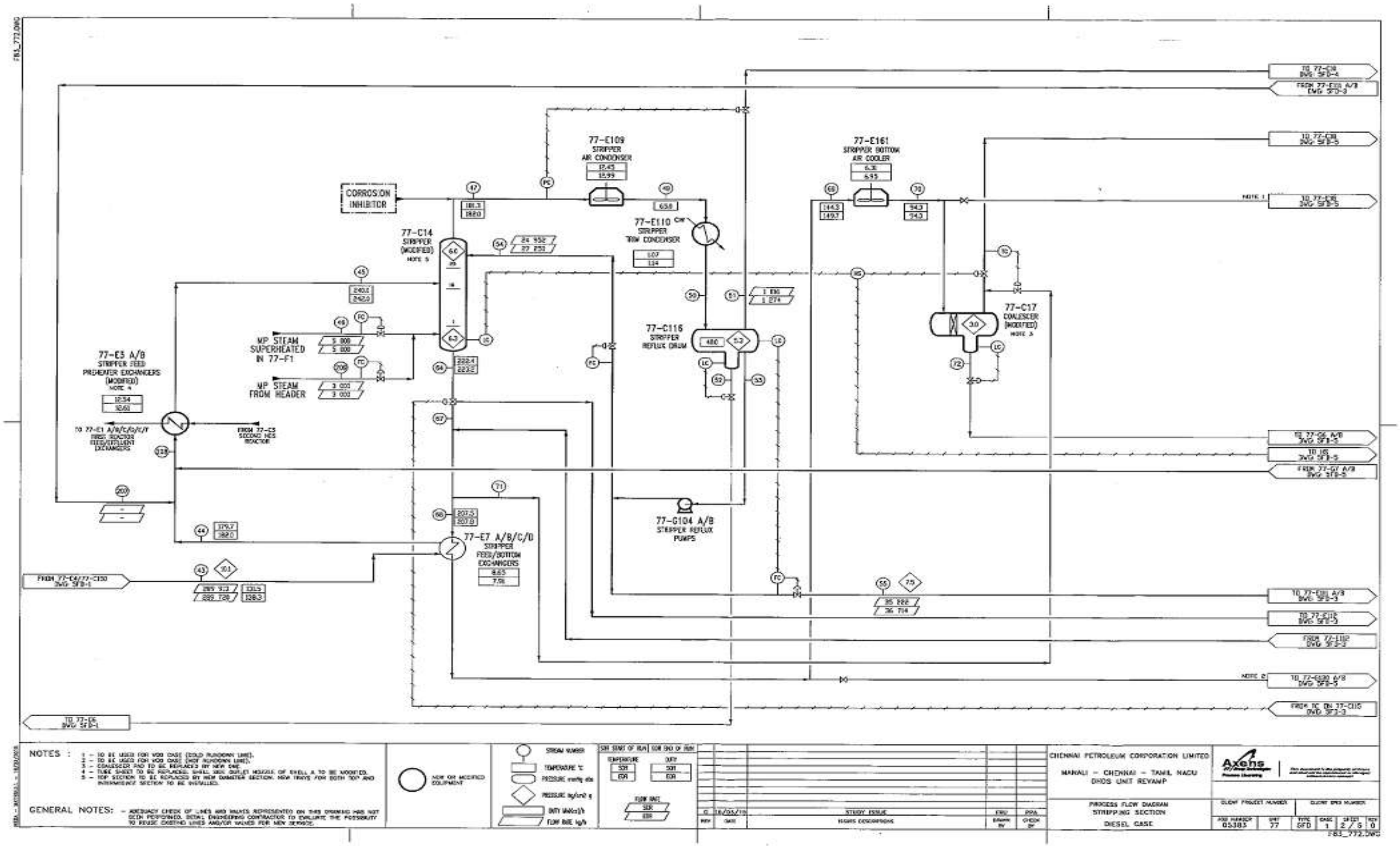

Figure 3.7 Stripping Section Diesel Case

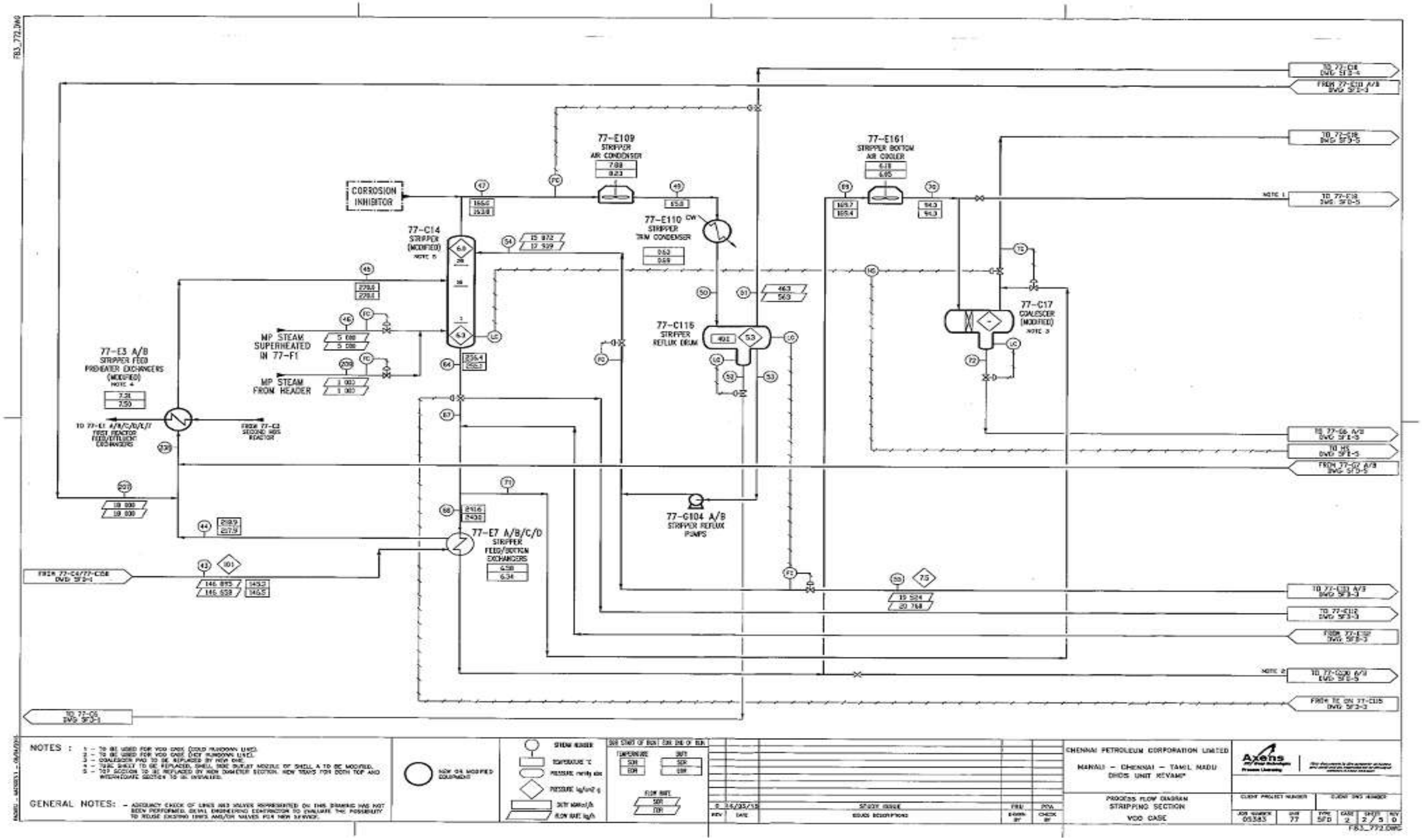

Figure 3.8 Stripping Section VGO Case

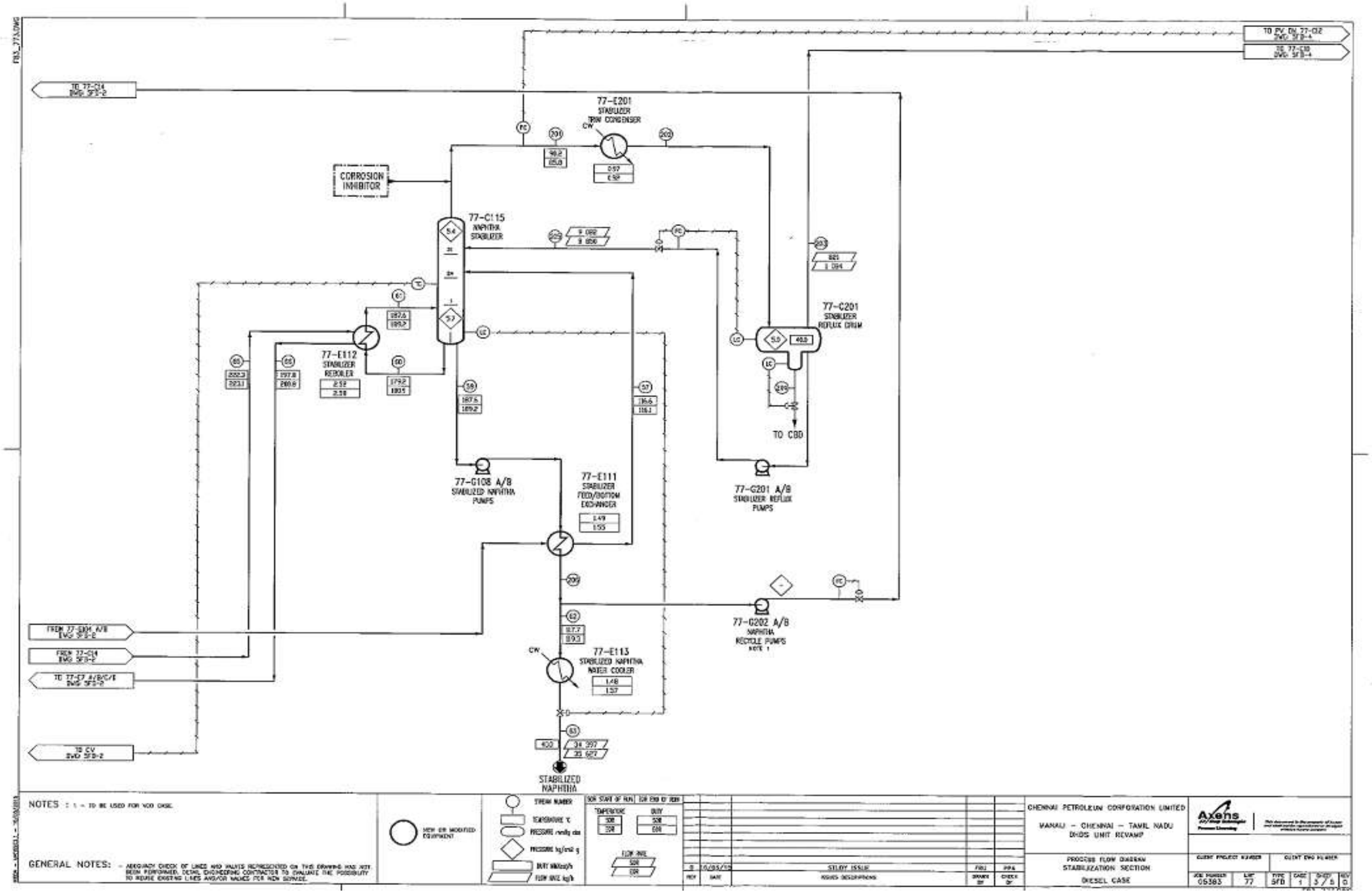

Figure 3.9 Stablilisation Section Diesel Case

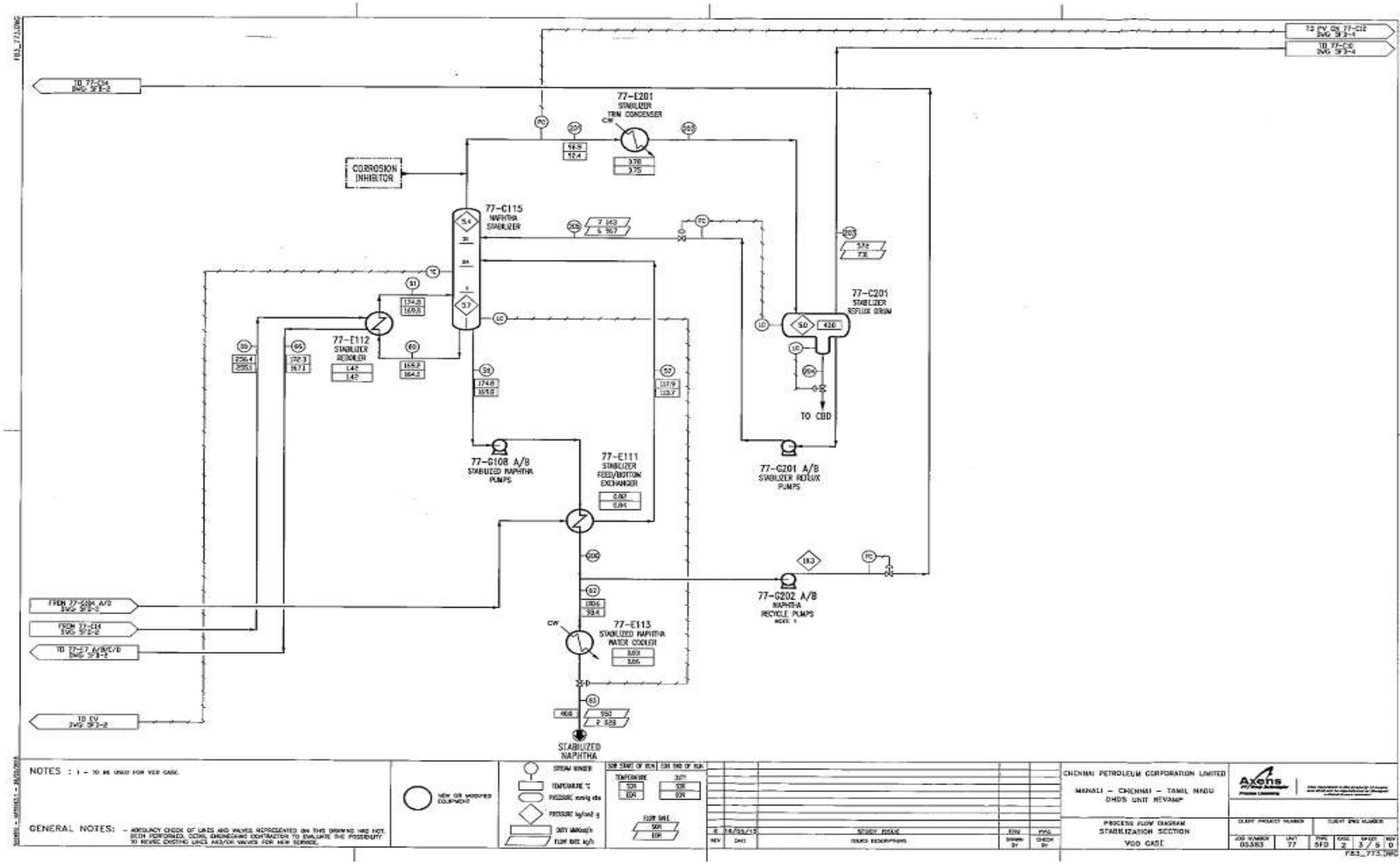

Figure 3.10 Stabilisation Section VGO Case

The mixed vapor streams from 77-C116 (new) and 77-C201 (new) are sent to the LP amine absorber K.O. drum 77-C10 (retained). This stream is then fed to the LP amine absorber 77-C11 (retained) as well as the rich amine stream from bottom of HP amine absorber 77-C8 (retained). The vapor fed to the LP amine absorber is washed by a lean MDEA solution to remove the H2S. The lean MDEA to which anti-foaming is injected is fed at the inlet line of the column which is under flow control. The rich MDEA solution is withdrawn under level control at the bottom of the LP amine absorber 77-C11 (retained) to be sent to the amine regeneration unit. The vapor from LP amine absorber then goes to the stacked LP amine absorber FG K.O. drum 77-C12 (retained) before reaching unit B/L. Pressure of the stabilizer column 77-C115 (new) is controlled directly by the amount of sweet gas sent to B/L as fuel gas.

The decanted water from 77-C116 (new) is sent under boot level control to the washing water surge drum 77-C6 (retained). One part of the hydrocarbon liquid phase is split into reflux, and returned to the stripper under flow control. The other part of liquid distillate (wild naphtha) is routed to the shell side of the new stabilizer feed/bottom exchanger 77-E111 (new), where it is preheated against the stabilizer bottoms stream, under flow control reset by level control on stripper reflux drum 77-C116 (new) and then fed to the new stabilizer 77 C-115 (new). Light ends and H2S gather at the top of the stabilizer. Corrosion inhibitor is injected into the Stabilizer overhead line. The overhead of the stabilizer is cooled in the new Stabilizer Trim Condenser, 77- E201(new), before being separated into three phases in the new Stabilizer reflux drum 77-C201 (new): a hydrocarbon liquid phase (wild naphtha), a free liquid water phase and a vapor phase stream.

The hydrocarbon liquid phase is totally refluxed back to the Stabilizer column, pumped by the new Stabilizer Reflux Pumps, 77-G201 A/B (new). The water phase is sent to the closed blow down drain.

The naphtha stabilizer is reboiled by the new stabilizer reboiler 77-E112 (new) where heat is exchanged against a part of the stripper bottoms. The flow rate of the stripper bottoms stream to the stabilizer reboiler is controlled by the sensitive tray 16 temperature of the new stabilizer column. Stabilizer bottom is pumped by the new stabilized naphtha pumps 77-G108 A/B (new), cooled into 77- E111 (new) tube side against the stabilizer feed, further cooled in the stabilized naphtha water cooler, 77- E113 (new), and finally routed to battery limit under stabilizer bottom level control as wild naphtha.

A part of stripper bottom product reboils the stabilizer column in Stabilizer Reboiler 77-E112 (new) and rejoins the stripper bottom stream. This stream is routed partially to the tube side of heat exchangers 77-E7 A/B/C/D (retained) to preheat the stripper feed. The part of stripper bottom that is cooled down in 77-E7 A/B/C/D (retained) is further then cooled into new stripper bottom air cooler 77-E161 (new). The other part of the stripper bottom stream will directly join drier feed at the outlet of coalescer for temperature control of drier fed.

The outlet of 77-E161 (new) is then sent to coalescer 77-C17 (retained) in order to remove free water from this stream before being further dried in the Dryer, 77-C18 (retained). In

VGO mode, the coalescer will be bypassed, and the new Stripper Bottom Air Cooler, 77-E161 (new), will be bypassed only in case stripper bottom is routed hot to the FCC unit.

3.6.4 DRYER SECTION

Bypass of 77-E7 (retained)/77-E161 (new)/77-C17 (retained) and the coalescer effluent are then mixed before entering dryer 77-C18 (retained). Temperature control of dryer inlet is achieved by control of the bypass flow rate. Dryer is operated under vacuum. Vapor flow is routed to the new dryer overhead condenser, 77-E114 (new), and new vacuum package (77-H101, 77-H102, 77-E115, 77-E116) (new). Liquid hydrocarbon and aqueous phases obtained at the outlet of the dryer overhead system are recovered into dryer overhead drum 77-C19 (retained). Non-condensable gases are collected to dryer seal pot 77-C25 (retained).

Separation of water and hydrocarbon phases occurs into 77-C19 (retained), where the water phase is pumped by 77-G106 A/B (new) under 77-C19 (retained) water compartment level control and then sent to battery limit, and the hydrocarbon phase is pumped by 77-G7 A/B (retained) under 77-C19 (retained) hydrocarbon compartment level control and then sent to upstream shell side of stripper feed preheater 77- E3 A/B (modified). Dryer bottom product is pumped by 77-G105 A/B (new). The process flow diagram of the dryer section for VGO Case and Diesel Case is given in the following figures:

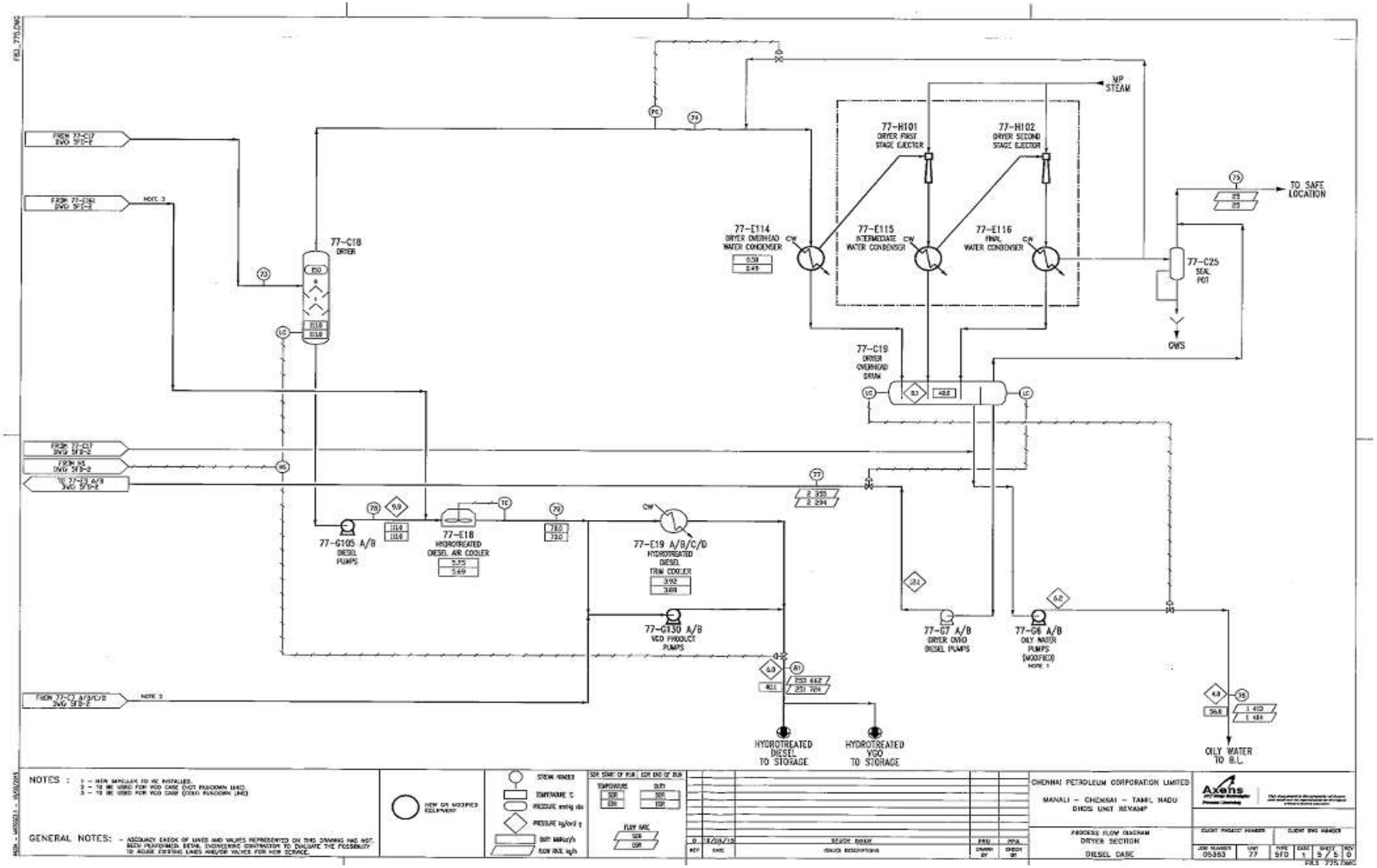

Figure 3.11 Dryer Section Diesel Case

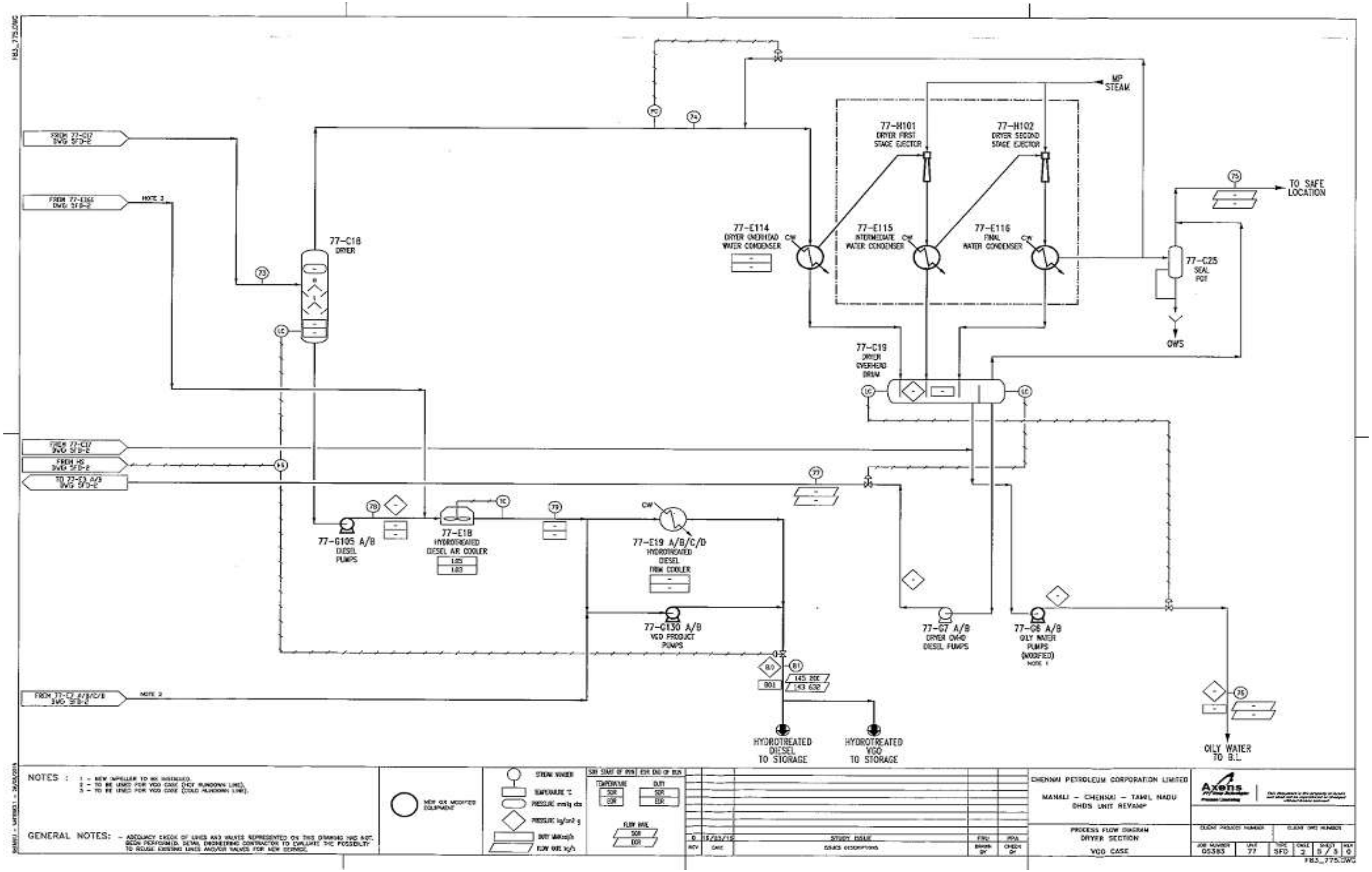

Figure 3.12 Dryer Section for VGO Case

3.6.5 POWER AND FUELS

The existing power requirement is 2500 kWh and with the proposed expansion, additional power required is 741 kWh. This is a combination of HT and LT loads. The power required will be sourced from existing internal Captive Power Plants.

As the existing reactor heater (Furnace) is adequate for the revamp conditions, the fuel oil and fuel gas requirements will not vary when compared to the existing conditions. The details of power and fuel requirements are given in **table 3.7**:

Table 3.7 Power and fuel requirement

Details	Capacity		Source
	Existing	After Proposed Expansion	
Power Requirement	2500 kWh	3241 kWh	Internal Captive Power Plants
Fuel Gas	285 kg/hr	2462 kg/hr (285 kg/hr for furnace and the balance for process requirement)	Refinery Fuel Gas (Internal)
Fuel oil	1178 kg/hr	1272 kg/hr	Refinery Fuel Oil (Internal)

3.6.6 LAND USE

There is no change in land distribution after proposed capacity expansion as all the new equipment will be installed in the spare slots within existing buildings & layouts. The land deed agreement is given in **Annexure 1**.

3.6.7 MANPOWER

The existing DHDS Unit has a total of 20 employees including 2 contract workers. There will be no additional manpower required.

Manpower for DHDS unit		
Designation	Shift	Total Numbers
Manager	General Shift	1
Panel Engineers	Rotating Shift	4
Shift Engineers	Rotating Shift	5
Field Operators	Rotating Shift	8
Contract workers (House Keeping)	General Shift	2
Total Manpower		**20**

3.6.8 WATER REQUIREMENT

The total requirement of raw water for the existing unit is 50234 KLD. The water requirement is met mainly by the treated water from CPCL's sea water desalination plant and effluent recycling units. A small quantity is received from Chennai Metro Water Corporation (CMWSSB). In this regard the correspondence between CPCL and CMWSSB is provided in **Annexure 2** for reference. There is no bore well source inside the Plant premises.

After the proposed Revamp of capacity expansion of DHDS Unit, additional water requirement is not envisaged, as the utilities required for the Revamp condition are met from the available infrastructure only.

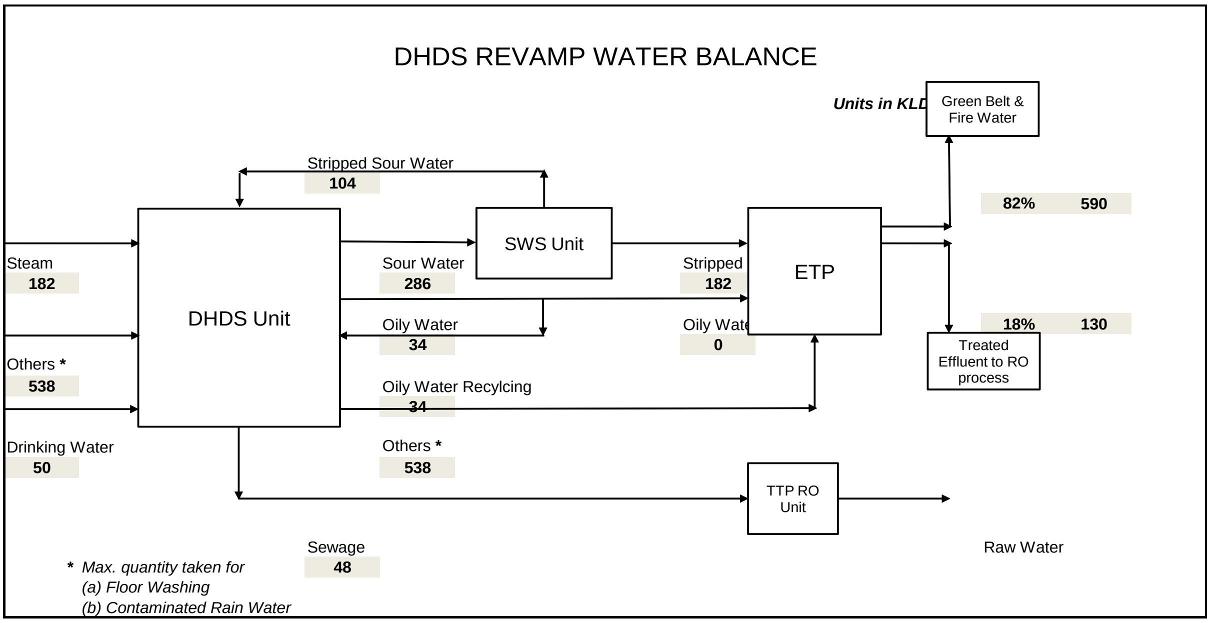

Figure 3.13 Water Balance

3.6.9 UTILITIES

The following table shows the list of utilities in the project:

Table 3.8 List of Utilities

S. No.	Utility	Existing Flow rate	Revised Flow rate
1	VHP Steam	22 MT / hr	23.5 MT / hr
2	MP Steam	12.5 MT / hr	15.7 MT / hr
3	LP Steam	0.8 MT / hr	1.2 MT / hr
4	Nitrogen	49 Nm^3 / hr	49 Nm3 / hr
5	Cooling Water	2295 m^3 / hr	2745 m^3 / hr
6	Service Water	Intermittent Requirement	Intermittent Requirement

7	DM Water	Intermittent Requirement	Intermittent Requirement
8	Boiler Feed Water	Intermittent Requirement	Intermittent Requirement
9	Plant Air	Intermittent Requirement	Intermittent Requirement
10	Electrical Power	2500 kW	3241 kW

3.7 LIQUID WASTE MANAGEMENT

The revamp of DHDS unit designed for a nominal capacity of 2,340,000 MTPA, (130% of the 1,800,000 MTPA original design capacity) with on-stream factor of 8000 hours per year for Diesel Case and Capacity of 500, 000 MTPA with on-stream factor of 3333 hours per year for VGO Case on blocked out mode.

The liquid effluent generated from DHDS unit is treated in the existing Effluent Treatment Plant (ETP-II) and the sewage generated is treated in the existing Tertiary Treatment Plant (TTP). The layouts of Effluent Treatment Plant (ETP-II) and Tertiary Treatment Plant (TTP) are given in **Annexure 10**.

3.7.1 DURING NORMAL OPERATION

1. Sour water is recovered from cold separator. Part of the sour water is re-used as washing water in the process. The balance sour water is sent to Sour Water Stripper (SWS) unit for removal of H_2S and NH_3. After treated in SWS unit, the stripped sour water to the extent of 4338 kg/hr will be re-used as washing water in the process. This facility is introduced in the Revamp project. The details are as given below in **Table 3.9**:

Table 3.9 Liquid Effluent details

Description	Diesel case		VGO case	
	SOR condition	EOR Condition	SOR condition	EOR Condition
Sour water generation (kg/hr)	14150	14149	14039	14043
Re-used as washing water in the process	2255	2254	4644	4648
Sour water to SWS unit	11895	11895	9395	9395
Quality of sour water to SWS unit:				
Water content (wt%)	96.00	96.04	96.01	96.01
H2S content (wt%)	2.67	2.64	2.66	2.66
NH3 content (wt%)	1.33	1.32	1.33	1.33

2. The oily water from Dryer overhead drum can either be routed to washing water drum make-up (or) to ETP. In normal operation, this water is routed to washing water drum.

Quantity: 1413 kg/hr
Quality: Water content (wt%) – 100 / Oil – Traces

3. Waste Water from Cooling of Pump Pedestals, Bearings, etc are as follows:
   Estimated Quantity: 4.2 m^3/hr
   Frequency: Continuous
   Quality: Equivalent to cooling water

3.7.2 DURING START – UP

The details of Waste water generated during DHDS Catalyst Presulphiding is as given in **table 3.10** and the stream will be routed to Sour Water Stripper unit for treatment.

Table 3.10 Waste water details during DHDS Catalyst Presulphiding

Estimated Quantity	69000 kg
Duration	24-26 hours
Frequency	Every 24 months based on estimated catalyst cycle length
Estimated Quality	H_2S up to 0.2 wt.%

3.7.3 DURING SHUT-DOWN

The details of Waste water generated during reactor Heater Decoking are given in **table 3.11**:

Table 3.11 Waste water details of Reactor Heater Decoking

Estimated Quantity	49700 kg/hr
Duration	1-2 days
Frequency	Once every 4 years
Estimated Quality	water containing coke, SO_2, H_2S (0.2-1%) & NH_3

This stream is discharged to Oily water sewer.

3.8 AIR POLLUTION CONTROL MEASURES

During normal operation, the flue gas from reactor heater is emitted. This stream is discharged to the atmosphere. The details are given in **table 3.12**:

Table 3.12 Air pollution emissions

Present Quantity of emission	21750 kg/hr
Frequency	Continuous

Quality	CO_2 : 11.7 vol% O_2 : 3.3 vol% N_2 : 74.5 vol% H_2O : 10.3 vol% SO_2 : 0.2 vol%
After Proposed expansion	21750 kg/hr

Note: As the existing heater is adequate for process conditions, there will not be any change in fuel consumed for revamp conditions.

3.9 HAZARDOUS AND SOLID WASTE MANAGEMENT

The hazardous wastes generated from CPCL are collected, stored and disposed through authorized disposal cum recycle facilities as per the authorization from PCB and the unit has agreements with all waste disposal facilities for the same. There is no internal disposal facility availability within the site. The Authorization Letter from TNPCB is enclosed as **Annexure 4**.

The hazardous waste generated from the DHDS unit, is Spent Catalyst of and this will be sent to MoEF&CC approved TSDF facility which is located in Gummudipondi in TamilNadu for secured landfill.

The Municipal Solid Waste generated from the site is collected and transported to recyclers, municipal yards and landfills depending on the type of waste. The details are given below in **table 3.13**:

Table 3.13 Municipal Solid Waste details

S. No	Nature of Solid Waste	Quantity T / Year	Method of Handling		
			Collection & Storage	Treatment	Disposal
1	Paper / Card Board	125	Manual collection & storage in Bins	Nil	Sales to Recyclers
2	Dust Bin collections	475	Manual collection	Bio Composting	Manali Municipal Yard
3	Dry leaves Grass	95	Manual collection	Nil	Landfill
4	Metal scrap	805	Manual collection scrap yard	Nil	Sales to Recyclers
5	Wooden scrap	175	Manual collection scrap yard	Nil	Sales to Recyclers

3.10 GREEN BELT DEVELOPMENT

The existing Refinery is having a Greenbelt area which already has been developed and the Green belt area coverage is being progressively increased.

3.11 ENVIRONMENT, SAFETY AND HEALTH MONITORING

CPCL periodically carries out Internal Safety Audit, External Safety audit Comprehensive Risk Analysis and HAZOP study periodically. The fire protection systems and equipments are provided as per Oil Industry Safety Directorate (OISD) Standards and other relevant guidelines. Adequate no. of Fire Fighting Vehicles & Emergency Rescue Vehicle equipped with rescue apparatus / gadgets, fire water storage, fire water pumps, fire fighting chemicals meeting the specified norms are available.

Automatic gas detection and alarm systems are installed in refinery units and tank farm for quick detection of hydrocarbon leaks and emergency mitigation. CCTV is installed at critical locations and linked to the Control Rooms for continuous monitoring. For Communication of emergency scenarios, Fire Call telephones, Manual Call Points (MCP), Plant Communication System, UHF handsets and emergency sirens have been provided. CPCL has entered into Mutual Aid Agreement with two of the neighboring industries. Well documented On-site Emergency Preparedness Plan, offsite Emergency preparedness plan & Disaster Management Plan (ERDMP) are in place.

Following pollution control/ mitigation measures are adopted to minimize the impact of Refinery operation on Environment:

- Continuous Operation of 3 numbers of Effluent Treatment plants and reuse of treated effluent.
- Monitoring of treated effluents from Effluent Treatment Plant for compliance against Minimum National Standard (MINAS), surface water & Ground water
- Use of low sulphur fuel & low NO_X burners to maintain emissions from heaters at permissible limits
- Use of Gas turbine in captive power plant with cleaner Naphtha as main fuel.
- Monitoring and inventorisation of Fugitive emissions by using Leak deduction & Repair (LDAR) program in the entire plant area for minimizing emission of Hydrocarbons.
- Continuous improvement in Energy consumption reduction and use of alternate energy like solar & wind power to reduce Carbon-di-Oxide emission.
- Continuous monitoring of Ambient Air Quality & Continuous Emissions Stack Monitoring Green house gas emissions reporting and control measures taken for reducing the GHG.

- Continuous operation of VOC collection & removal system with Activated carbon adsorbent to reduce the VOC emissions.
- Ensuring Hazardous waste management in the refinery as per Hazardous Waste Rules, 2008.
- Safe disposal of Hazardous waste in segregated & dedicated, Hazardous Waste Treatment Storage & Disposal Facility (HAWTSDF)
- Monitoring of ground water quality.

4. SITE ANALYSIS

4.1 CONNECTIVITY

The proposed site on the SH – 56 and it is in the express highway connecting Thiruvottiyur and Ponneri. The nearest railway station is Thiruvottiyur.

4.2 LAND FORM, LAND USE, LAND OWNERSHIP

The Plant is located at survey nos. 266 / 2, 274, 296, 297, 298 and 299, Manali Village, Ambattur Taluk, Tiruvallur District, and Tamil Nadu. The layout plan of DHDS Unit is enclosed in **Annexure-3**. The present land use is special and hazardous zone.

4.3 EXISTING LAND USE PATTERN

The present land use is in industrial zone. The details of sensitive areas from the site boundary are given in **Table 4.1**. The site does not fall within the CRZ area. The CMDA land use map is enclosed in **Annexure 5.**

Table 4.1 Water bodies in the study area

S.No	Name	Distance & Direction (km)
1.	Surplus canal from Korttalaiyar River	0.13 Km (North)
2.	Buckingham canal	0.63 Km (East)
3.	Retteri	7.56 Km(South-west)
4.	Madhavaram Lake	3.57 Km (West)
5.	Kadapakkam Panchayat Lake	4.56 Km (North West)
6.	Periyathoppu Lake	3.1 Km (North West)
7.	Bay of Bengal	3.13 Km (East)

4.4 CLIMATIC CONDITIONS

The study region receives rainfall predominantly during monsoon season with an average annual rainfall of about 1211 mm per year. The South west monsoon season is from July – September and North east monsoon is from October to December. The relative humidity recorded in the district is about 49-79%. Due to its proximity with the Bay of Bengal, the ambient temperature at project site ranged between 25-40°C. The area has a tropical climate with the highest and lowest temperatures recorded is Maximum of 40.3°C and Minimum of 25°C respectively.

Table 4.2 Meteorological Observations

S.No	Parameter	Observation
1	Wind Direction	SW-SE-W-WSW
2	Wind Speed Range	2 to 8.8 m/sec
3	Annual Average Rainfall	1211 mm
4	Average Wind Speed	3 m/sec
5	Temperature Range	Max. Temp: 40°C Min. Temp: 25°C
6	Average Temperature	32°C
7	Humidity Range (24hr)	49 to 79 %
8	Cloud cover	Partly cloudy

5. CONCLUSION

- The proposed project is to produce Diesel fuel to meet the BS V norms which will help in reducing the vehicular emissions to atmosphere.
- As the proposed project is coming up in the existing plant which is located in special and hazardous zone, there will not be any change in land use.
- The existing water requirement will be adequate for the proposed expansion also. The treated water is reused for gardening and process requirements.
- The marginal impact of proposed capacity expansion within the existing facility will be fully mitigated with the existing Environment Management Plans (EMP).