Annexure A

Preliminary Feasibility Report (PFR) for Polypropylene Petrochemical Project & Associated Facilities

Mumbai Refinery, Bharat Petroleum Corporation Ltd

MARCH 2018
# Table of Contents

1.0 Executive Summary.......................................................................................................................... 3
2.0 Introduction of the project / Background Information ..................................................................... 3
  2.1 Background ....................................................................................................................................... 3
  2.2 Capacity of the Project....................................................................................................................... 4
  2.3 Need for facility to produce Polypropylene Petrochemicals ............................................................... 4
  2.4 Applications of Polypropylene........................................................................................................... 4
  2.5 Market Scenario & Employment generation ....................................................................................... 4
3.0 Project Description & New Facility Configuration ................................................................................ 5
  3.1 Overview of New Process Units ........................................................................................................ 5
  3.2 Block Flow Diagram .......................................................................................................................... 6
  3.3 Material Balance ............................................................................................................................... 7
  3.4 Technology Highlights ...................................................................................................................... 8
  3.5 Potential Technology Licensors ......................................................................................................... 8
  3.6 Utilities & Offsite Systems ................................................................................................................ 8
4.0 Health, Safety & Environment ............................................................................................................. 11
5.0 Site Analysis, Planning Brief & Proposed Infrastructure .................................................................... 11
  5.1 Site Location ...................................................................................................................................... 11
  5.2 Source of Water ................................................................................................................................. 11
  5.3 Meteorological Conditions ................................................................................................................ 11
  5.4 Rasayani Proposed Plot location, Area available & layout ................................................................. 11
  5.5 Proposed Infrastructure ..................................................................................................................... 14
6.0 Project Implementation & Timeline ..................................................................................................... 18
7.0 Capital Cost ......................................................................................................................................... 18
8.0 Analysis of proposal ............................................................................................................................. 18
1.0 Executive Summary

World over, petrochemicals consumption is benchmarked in terms of Polymer per capita consumption. India’s Per capita Polymer consumption of around 10 kg is far below the world average of 30 kg, giving enough indication of potential growth of Petrochemical industry in India.

As part of the petrochemicals foray of BPCL group, it is envisaged to produce Petrochemicals at our refineries. BPCL is acquiring 360 acres of land at Rasayani, which is located at a distance of approx 45 km from its Mumbai Refinery. BPCL’s Mumbai refinery plans to set up Polypropylene Unit (PP) at Rasayani to valorise polymer grade Propylene produced from its proposed Petro Resid Fluidized Catalytic Cracker (PRFCC). Propylene produced at MR will be transported to Rasayani by pipeline.

The PP unit along with the associated utilities and offsite will be a new facility at Rasayani site. PP unit capacity of 450 TMT per Annum will be set up at Rasayani. Polypropylene is a solid product usually in the form of small pellets.

PP technologies available in the market are mainly Gas Phase Polymerization and Slurry Phase Polymerization. Leading licensors offer wide grade capability, and strength of the technology lies with the quality of catalyst developed by the licensors. Catalyst & Co-Catalyst preparation, polymerization and monomer recovery sections are core technology areas. The finishing section of the PP unit consisting of pneumatic conveying, extruder and packaging are more of mechanical design and engineered by the specialist equipment vendors. Polymerization process has continuous catalyst consumption.

2.0 Introduction of the project / Background Information

2.1 Background

BPCL has already addressed the quality upgrade for gasoline and diesel fuel products to meet BS-VI standards by installing new Diesel Hydro Treater (DHT) and Gasoline Treatment Unit (GTU) units. To remain competitive and improve refinery profitability, BPCL is looking for improving the efficiency of older units thereby reducing fuel & loss. A Preliminary Feasibility study was carried out by M/s Flour evaluating various options for profitability improvement. One of the options was installation of PRFCC to replace the older units of Catalytic Cracking Unit (CCU) & Fluidised Catalytic Cracking Unit (FCCU) by latest state of the art technology, energy efficient & better yield unit. This unit also provides opportunity for setting up downstream petrochemical units like Polypropylene unit.

MR currently has space constraints to accommodate Petro Chemical facilities and hence BPCL is in the process of acquiring 360 acres of land at Rasayani, which is located at a distance of about 45 km from MR. Utilizing this land and leveraging the petrochemical feedstock from PRFCC unit, it is proposed to set up a 450 TMTPA Polypropylene unit with associated facilities at Rasayani.
Detailed Market Survey was carried out through M/S Frost & Sullivan to determine the market demand for Polypropylene. The supply-demand gap is favourable to set up a Polypropylene Plant at Rasayani Complex.

2.2 Capacity of the Project

Capacity of PP Unit will be 450 TMT Per Annum to produce Polypropylene.

2.3 Need for facility to produce Polypropylene Petrochemicals

Petrochemicals market in India is fast growing & profitable with open market pricing providing hedge for refining business. Combined Refinery-Petrochemical complexes can be best option for global competitive advantage, due to availability of low cost feed stock from the refinery.

Polypropylene (PP) is a thermoplastic polymer used in substantial quantities by the plastic processing industry. PP is processed by all types of processing techniques including injection molding, thermoforming, extrusion, etc. The end-uses of PP are ever increasing and continuous R&D in application development adds new applications every year.

The proposed Polypropylene Unit along with the associated utilities and offsite will be a new facility at Rasayani site.

2.4 Applications of Polypropylene

Polypropylene is a colourless semi-rigid, translucent to transparent solid with a glossy surface with no odour. It is used in manufacture of Furniture, House wares, Rigid & flexible packaging, Automotive parts & appliances, Medical & healthcare applications and fiber & filaments.

2.5 Market Scenario & Employment generation

Despite the growing demand for petchem, India is currently among the lowest in petchem penetration among global peers. India’s per capital polymer consumption is 10kg per capita, compared to global average 30kg per capita.

India is heavily dependent for petrochemicals products on imports from Middle East, South Asia and other markets to fulfill growing domestic demand which is expected to increase as demand growth outpaces local capacity addition. Hence, there are several government initiatives to lower the import dependency, by incentivizing local manufacturing, trading and logistics.

Based on favourable growth drivers and given the availability of petrochemicals feedstock from proposed PRFCC, Polypropylene petrochemicals production is a good strategic fit for BPCL.
Polypropylene production unit will generate employment and could further develop ancillary industries in supply & product side.

3.0 Project Description & New Facility Configuration

BPCL proposes to set up a world scale Polypropylene Plant at Rasayani to leverage on available petrochemical feedstock.

3.1 Overview of New Process Units

The unit will comprise of the following sections:

- Feed Purification
- Reaction Section
- Extrusion and Additivation
- Pellet Conveying and Blending
- Bagging and Dispatch
- Auxiliary Facilities
3.2 Block Flow Diagram

Typical Block flow diagram for PP production is given below:
3.3 Material Balance

Following is the typical annual material balance of proposed polypropylene unit based on preliminary estimates.

![Polypropylene Unit Offsites & Utilities Diagram]
3.4 Technology Highlights

Polypropylene is produced by following processes:

a) Vertical Stirred Tank gas phase process
b) Loop Reactor Slurry phase process
c) Fluidized Bed gas phase process

There are multiple licensors for Polypropylene technology and license is freely available. The available technologies are
- Gas-phase - Novolen (by Lummus), Unipol (by Univation / Dow / Grace) and
- Bulk-phase technology - Spheripol (by Lyondell Basel - LB), Spherizone (by LB) and Hypol (by Mitsui).

3.5 Potential Technology Licensors

Potential Technology Licensors for PP unit are:

- CB&I offering NOVOLEN technology
- Lyondell Basell offering SPHERIPOL technology
- W R Grace offering UNIPOL technology

3.6 Utilities & Offsite Systems

The Rasayani site will have its own utilities and offsite facilities to support the Polypropylene unit.

3.6.1. Utility Systems

Raw Water Treatment Plant

Raw Water Treatment Plant will be installed to treat Raw Water for removing suspended solids and storing water for different users. Raw Water is received from Maharashtra Industries Development Corporation (M.I.D.C) and is stored in Reservoir of 30000 m3 (6.6 Million Gallons) capacity. The approximate fresh raw water consumption will be approximately 7000 KL/D. The storage is provided to ensure uninterrupted supply of raw water to the following users:

- Demineralised Water (DM) Water Plant
- Potable Water Plant
- Cooling Tower (as make up water)
- Utility Stations
- Fire Water make up

Cooling water

Cooling Tower will be installed to cool Return Cooling Water from all Cooling Water Users and supply Cooling water to different users in ISBL and OSBL units.
Potable Water

Potable Water unit will be installed to produce Potable water as per World Health Organization (WHO) standard. Produced Potable water is stored in Potable Water Storage Tank.

Demineralised Water Plant:

Demineralised Water Plant will be installed to produce Demineralised water by means of Ion exchange process to remove cations and anions. DM water will be used in steam generation unit, hydrogen generation unit and Polypropylene Unit.

Steam Generation Unit:

Steam Generation unit will be installed to produce both High Pressure (HP) and Low Pressure (LP) Steam. Natural Gas is used as fuel for firing during normal operation and Diesel Oil will be used during start-up.

Condensate Polishing Unit:

Condensate Polishing Unit will be installed to treat recovered condensate from Polypropylene Unit and Air Separation Unit (ASU).

HYDROGEN GENERATION UNIT:

High Purity Hydrogen is required in Polypropylene process in varying quantities for all Polymer grades to control the polypropylene Melt Flow Index (MFI). Two Hydrogen Generation Skids will be installed. These skids will use Electrolytic Cells to produce high purity Hydrogen from DM Water. The Skid will supply high purity hydrogen at 10 kg/cm²g.

COMPRESSED AIR SYSTEM:

Air Compressor (1 Operating and 1 Standby) with a capacity of 5000 Nm³/h will be installed to cater the Instrument Air and Plant Air requirement of Polypropylene and OSBL units. Compressed air from the compressor is sent to Plant Air receiver and supplied to Plant Air header and Instrument Air Dryer Package. Instrument Air from the Instrument Air Dryer Package is supplied to Instrument Air header and supplied to consumers.

AIR SEPARATION UNIT

Air Separation Unit (ASU) will be installed to meet the Nitrogen normal and peak requirement of Polypropylene and OSBL units. This Package will have following facilities:

- ASU skid
- Double Walled Liquid Nitrogen Storage Vessel
WASTE WATER TREATMENT UNIT:
This will be a Zero-Liquid Discharge (ZLD) Waste Water Treatment plant. The treated water will be reused as cooling tower make up & horticulture service. Solid waste from the unit will be disposed as landfill, material.

INCINERATOR:
Treated organic liquid waste is disposed off by burning in incinerator. Natural gas is used for firing in incinerator.

3.6.2. STORAGE:
Following Storage system will be installed:
2. Diesel Oil Storage: Diesel Oil will be used as fuel for Initial start-up of Steam Generation Boilers & Fire water Diesel pumps
3. Propylene Bullets: Propylene will be used as a feed for polypropylene unit. Propylene is imported from Mumbai Refinery and stored in mounded propylene bullets
4. Warehouse for storing Polypropylene Product

3.6.3. FUEL:
Fuel will be used in Boilers for steam generation. For Initial start-up of steam boiler, diesel oil/RLNG will be used. During normal operation, Natural Gas imported from gas grid is used in Boilers for steam generation. Approximate consumption of natural gas will be around 3000 Kg/Hr.
Natural Gas is also used for purging the flare header

3.6.4. POWER:
Total Power Requirement of approx 35 MW will be met by importing power from State Power Grid.

3.6.5. FLARE System
The Flare system serves as safe disposal for hydrocarbon release which occurs during process upsets and disturbances, start-up, shutdown and maintenance. The flare System comprises of High Pressure (HP) and Low Pressure (LP) Flare header from the PP Unit and HP flare header from offsite facilities. The LP and HP flare headers join just upstream of the OSBL Flare Knockout Drum. Any liquid carryover and condensate from flare headers will be knocked off in the Unit Flare Knockout Drum and OSBL knock out drum. Vapor from Flare Knockout drum will be routed to Water Seal Drum, mounted at the bottom of the flare stack and prevents any air ingress in the system. The vapour from the knock out drum is discharged to flare stack. The flare stack comprises of molecular seal to prevent any air ingress in the flare system and flare tip where the flared gas undergoes combustion and MP steam addition is done in the flare tip to have smokeless flaring.
3.6.6. Fire Water Network

A new fire water system designed to fight two major fires simultaneously in accordance with the requirements of OISD-STD-116, is envisaged for the Polypropylene (PP) plant at BPCL Rasayani site. The new fire water system shall comprise of Fire water storage tanks, pumps, Jockey pumps and distribution network.

4.0 Health, Safety & Environment

Health, Safety and Environment will be awarded topmost priority in selection of technology, Equipment and processes. Material selection and design conditions will be validated. The key focus will be to have no impact on Persons, Assets and Environment. For Polypropylene Unit, technologies considered have high safety integrity level and pose no health and environment hazards. Relief system will be designed to safeguard against all credible emergency scenarios and disposed in flare system.

Hazardous liquid wastes will be incinerated. There will be no treated liquid effluent discharge for Rasayani site. The liquid effluent treatment plant will be designed for zero discharge and the treated effluent will be recycled for use as cooling tower make up, fire water make up, horticulture and other services.

5.0 Site Analysis, Planning Brief & Proposed Infrastructure

5.1 Site Location
- Nearest Important Town : Panvel
- Nearest Railway Station : Rasayani
- Nearest Port : Jawaharlal Nehru Port Trust (JNPT)
- Nearest Airport : Mumbai

5.2 Source of Water
Raw water from: Maharashtra Industrial Development Corporation (MIDC)

5.3 Meteorological Conditions
The Rasayani site is surrounded by hillocks on south and south-west and also on north-west and north-east directions. The site is situated in natural valley region of the Sahyadri hills. The elevation above mean sea level is about 20 meters. Rasayani has a moderate climate with average daily temperature of 20-30oC and relative humidity of 60-85%. The area falls under semi-arid zone.

Monthly rainfall is in the range of 2-30 mm except in the month of June – September when under the influence of south-west monsoon the rainfall is in the range of 600-1000 mm. The average annual rainfall is around 3000mm.

5.4 Rasayani Proposed Plot location, Area available & layout
Approximate Plot Area Available

BPCL is acquiring 360 acres of land at Rasayani from Hindustan Organics Ltd at Rasayani. This land will be used to set up PP plant. The details of the plot are given below.

Rasayani Location & HOCL Plot Layout –
Tentative plot layout is provided below. The same will be finalised after Detailed Feasibility Report (DFR).
Tentative proposed Layout at Rasayani Plot -

PLANNED FACILITIES BEING UTILIZED FOR PP PLANT
5.5 Proposed Infrastructure

Polypropylene Plant
The PP plant consists of Feed Purification section, additives sections, Catalyst and co-catalyst preparation & feed, Polymerization, carrier gas compression, recovery section, powder conveying, Extrusion and pellet conveying, blending silos. The unit shall also include dedicated Substation and Satellite Rack Room for the plant.

Polypropylene Warehouse
Warehouse area of 20,000 m² has been identified for PP storage (25 Kg bags on pallets with 3 tiers of stacking)

Utility & Offsite Facilities
Following utilities & offsite facilities are required for PP plant,
- Raw water reservoir
- PP bullets
- Cooling Towers
- Main Receiving Station
- Fire station and first aid centre
- FW tank and pumps
- Laboratory / Product Application Development Centre
- Master control room
- Plant and instrument air system
- Air separation plant (N2 unit)
- Hydrogen generation unit with compressors and storage bullets
- Chemical storage area
- Boiler House
- Flare
- D.M water plant
- Effluent treatment plant
- Raw water treatment
- Condensate polishing unit
- Potable water unit
- Incinerator

Pipeline Transfer
BPCL envisages laying following pipelines to transfer Petroleum Products/Fuel to its proposed infrastructure at Rasayani.
- Propylene Pipeline of capacity 0.6 MMTPA from Mumbai Refinery (MR) to Rasayani
- Multiproduct Pipeline (MS/HSD/SKO/ATF/Naphtha) of capacity 5.5 MMTPA from Mumbai Refinery (MR) to Rasayani.
- Lube Oil/ Unconverted Oil Pipeline of capacity 1.5 MMTPA from Mumbai Refinery (MR) to Rasayani
- Ethylene Pipeline of capacity 0.1 MMTPA from Mumbai Refinery (MR) to Rasayani
The preliminary pipeline route encompasses offshore & on shore portion. The approximate lengths of pipeline between Mumbai Refinery to Rasayani will be 45 Km. Route & size of lines required will be optimised & finalised after detailed feasibility report (DFR).

**Salient features of pipeline section:**

- **Total Pipeline length**: 45 km
- **Off shore pipeline length**: 16 km
- **On shore pipeline length**: 29 km

The proposed route for the above 4 pipeline shall be as under.

**Section 1 : From Mahul Refinery to new LFP-1 : 6 KM**

The Mahul Rasayani Pipeline is going to approx. 6 km length from Mahul Refinery to Refinery Compound Wall to MbPT Area to Sea Portion near LFP-1 of MUPL Pipeline. In this section the pipeline coming out of refinery shall become above ground on pipeline portals up to LFP-1 inside sea. The pipeline may be travelling approx. 2 kms inside sea on above ground portals in order to cross Reliance 4” dia offshore pipeline. The pipeline shall be mandatorily be above ground due to non-availability of space at the converging point of LFP-1.

**Section 2 : From LFP-1 to new LFP-2 : 16 KM**

The line will be laid submarine for approx. 16 Kms . From LFP-1 to LFP-2. The LFP-2 is after crossing Amra Marg in creek below bridge at Morava Phata.

**Section 3 : From new LFP-2 to Rasayani Plot ( North Side ) : 23 KM (in new corridor to be acquired by Section 3 (1) / Section 6 (1) notification )**

From Morava Phata the line will run parallel to NMIA ( Navi Mumbai International Airport ) Boundary , this will run up to NH 4B – “D” point at Pargaon . From here the line will run parallel to NH4 B upto Nandgaon from here it will travel to village Nanadgaon to Turmala to Giravle to Somatne to Dahivli to Devlol to Rasayani.

After this the line will take Branches to Refinery Units of Polypropylene and Ethylene Units and further to POL terminal.

**Co-ordinates:**

Mumbai Refinery : 19°01’39.08” N 72°53’33.67” E
Mangroves / Other Environmental Clearances:

The pipeline encounters Mangrove Plantations on both the banks while crossing Thane Creek and hence it will attract Forest Clearance and Hon. High Court of Bombay Grant of Leave. Project also require CRZ Approval, EC (being passing through Eco Sensitive Zone) and Wildlife Approval apart from other routine approval.

PROJECT SCOPE AND BATTERY LIMIT

- Pipeline from BPCL Mumbai Refinery to Rasayani
- Dispatch facilities at Mumbai Refinery
- Receipt Facilities at Rasayani

PIPELINE FACILITIES

1. Booster Pump: Booster Pump of suitable capacity shall be installed at BPCL Refinery for All four Pipelines
2. Mainline Pump: Mainline Pumps of suitable capacity shall be installed at BPCL Refinery at four pipeline to pump the product upto Rasayani
3. Pigging Facilities: Pig launcher shall be provided at BPCL Refinery and pig receiving facilities shall be provided at Rasayani.
4. Corrosion Monitoring system: Suitable corrosion monitoring system shall be provided
5. Other facilities: All other facilities shall be designed to match the pipeline and pump capacity and shall be suitable for Phase II throughput.
6. General: Adequate Instrumentation and control system will be provided for safe and efficient operation. The pumping station shall be controlled through PLC based as well as panel based
Instrument with Station Emergency Shutdown through single push button / soft command.

7 Type of Control : Electronic

8 Final Control Element : Electro-Hydraulic
   (PCV / FCV)

9 Safety Valve : Thermal relief / safety valves shall be provided wherever required as per design and process requirement.

10 Density Meter : Density meters shall be provided at dispatch station as well as the receipt stations.

11 Flow Meter : Dedicated metering facility shall be provided for each pipeline

12 SCADA & APPS : The supervisory control and data acquisition system shall also be envisaged to ensure effective and reliable control, management and supervision of pipeline from centralized location using Remote Telemetry Units (RTUs) along the pipeline route. Remote work stations (RWSs) shall be provided at both the receipt stations for monitoring purpose. Common SCADA and APPS system shall be provided for all four pipelines

13 Telecom System : Optical Fibre based telecom system shall be provided including SDH equipments at all locations, which shall be a backbone system for carrying voice (EPABX), data (SCADA) and video (CCTV, VCS) information for the pipeline system. Common Telecomm system shall be provided for all four pipelines.
14 Basket Filters: Basket filters shall be provided at all the stations. The basket filters shall have QOC type closer as a top cover as well as with multi-basket design for ease of maintenance. The provision for necessary handling of baskets shall also be provided.

6.0 Project Implementation & Timeline

An EPC/EPCM mode of construction is envisaged for the project & this will be finalized after Detailed Feasibility Study. Total project implementation schedule after getting Environmental clearance, other statutory approvals and final investment approval is expected to be around 36 Months.

7.0 Capital Cost

Estimated Project capital cost for polypropylene unit will be approx Rs 5200 Cr.

8.0 Analysis of proposal

Petrochemical products in the propylene chain are driven by technology and refinery integration. Typically, Refinery integrated players have strong competitive advantage in the market due to lower cash costs. Availability of suitable land in Rasayani and feed from PRFCC unit at Mumbai Refinery provides opportunity for BPCL to leverage on these advantages and set up Polypropylene unit at Rasayani.