



**Indian Oil Corporation Limited  
Barauni, Refinery**

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**EXPANSION OF BARAUNI REFINERY FROM 6 MMTPA TO 9 MMTPA  
ALONG WITH POLYMER UNITS**

**1.0 BACKGROUND:**

- 1.1 Barauni Refinery (BR) was commissioned with an initial capacity of 2.0 MMTPA in 1964 and through various unit additions and revamps the crude processing capacity has been augmented to 6.0 MMTPA in 2002. At present BR consists of 3 main crude processing units namely AVU-I/II (design capacity: 1.75 MMTPA each designed for processing low sulphur crudes) and AVU-III (design capacity: 2.5 MMTPA designed for processing both low sulphur as well as high sulphur crudes).
- 1.2 To improve productivity & profitability, refinery expansion project at 6.0 MMTPA consisting of RFCCU, DHDT, SRU I/II, ARU, SWSU and HGU along with associated utilities and offsite facilities were commissioned in 2002. MSQ project with Naphtha Hydrotreating unit (NHDT), Isomerization (ISOM), selective Hydrogenation Unit (SHU), Hydro Desulphurization unit (HDS) and one new Hydrogen generation unit was commissioned in 2010 to produce BS- III compliant MS.
- 1.3 Barauni Refinery is currently in the process of implementing BS-IV project with proposed revamp in existing DHDT, Prime G and NSU units. Also new units of CCRU, NSU and Prime G will be installed. These changes will enable refinery to produce 100% BS-IV compliant MS & HSD.

**2.0 NEED FOR CAPACITY EXPANSION**

- 2.1 In the era of changing market scenario, stringent product quality specifications and emission standards, there is a need to exploit opportunities available in existing operating units as well as setting up of new process units for enhancing flexibility in operation and profitability of the refinery.
- 2.2 With rapid growth in demand for refined products and widening price differential between low sulfur and high sulfur/heavy crudes, opportunity exists for improving refining margin. It is planned to augment capacity of Barauni Refinery from current installed capacity of 6.0 MMTPA to 9.0 MMTPA along-with feasibility of production of Petrochemical products

**3.0 CONFIGURATION STUDY**

In house configuration study has been carried out by Process Design Engineering Cell (PDEC) of IOCL for capacity augmentation from 6.0 to 9.0 MMTPA. The

configuration study considered various refinery configuration using new process units and petrochemical options.

Preliminary adequacy checking of Crude Pipeline carried out by Pipelines indicated that Haldia - Barauni Crude section capacity augmentation will be required for pumping additional 3 MMTPA crude. It is envisaged that 2 intermediate pumping stations and modification of existing pumping stations are required. Pipelines have estimated cost of Rs 350 crore (+/- 30% accuracy) for crude pipeline capacity augmentation. A separate proposal for crude pipeline capacity augmentation will be put up by Pipeline Division.

Preliminary adequacy checking of Project pipeline indicates that this line is adequate for transporting products corresponding to refinery capacity of 9 MMTPA.

### 3.1 PRESENT BARAUNI REFINERY CONFIGURATION

3.2.1 Barauni Refinery is the second refinery of Indian Oil Corporation built in 1964. The major processing units at Barauni Refinery along with their capacities at 6 MMTPA are summarised below:

PROCESS UNIT	DESIGN CAPACITY
AVU-I/II	1.75 MMTPA each
AVU-III	2.5 MMTPA
RFCCU	1.4 MMTPA
DHDT	2.2 MMTPA
Coker-A	0.6 MMTPA (HS / LS VR)
Coker-B	0.5 MMTPA (LS VR)
NSU	0.464 MMTPA
NHDT/CRU	0.30 MMTPA
NHDT/ISOM	0.23 / 0.126 MMTPA
SHU/ Prime G+	0.32 (SHU) / 0.22 (HDS) MMTPA
HGU's	HGU-1 (34 TMTPA) HGU-2 (20 TMTPA)
SRU	80 TPD (40 TPD each train x 2)

3.2.2 Presently Barauni refinery is carrying out low cost revamp / implementing new process units for producing 100% BS-IV HSD / MS at the current installed capacity:

#### *Modifications under BS-IV project*

Process Unit	Design Capacity (MMTPA)	Proposed capacity (MMTPA)	Modification
NSU	0.464	0.32	Capacity de-rated with revamp to meet product quality
NSU (New Unit)	New	0.48	-

CRU	0.3	0.21	Capacity de-rated for BS-IV operation.
CCRU (New Unit)	New	0.375	-
PRIME G+	0.320	0.840	Integrated unit after revamp of existing PRIME G+ and addition of New PRIME G+ chain.
PRIEM G+ (New Unit)	New		
DHDT	2.2	3.30	Revamp

The BS-IV quality project under implementation at BR is targeted for completion in two phases, viz., Mar 2017 (unit revamps) and Mar 2018 (New units).

Govt. Of India has announced on 6<sup>th</sup> Jan'16, the decision to implement BS-VI grade fuel in the entire country w.e.f. 1<sup>st</sup> April 2020 i.e. switching over directly from BS-IV grade fuels to BS-VI grade fuel. The above revamp / new facilities are sufficient to achieve BS-VI quality w.r.t. to MS and HSD and no further modification shall be required at BR after implementation of proposed BS-IV projects. Hence Barauni refinery will be capable of producing 100% BS-VI quality fuel products at 6.0 MMTPA.

## 3.2 REFINERY CONFIGURATION STUDY AT 9 MMTPA

### 3.2.1 BASIS CONSIDERATIONS

#### 3.2.2 Refinery base and project case:

*Base case:* 6 MMTPA operation with BS-VI quality of MS & HSD.

*Project case:* 9.0 MMTPA crude refining capacity with BS-VI quality of MS & HSD along with downstream petrochemical unit.

#### 3.2.3 Crude cost and availability

The Crude cost for configuration study considered the average Crude cost for Barauni refinery for the last three years (2013-16) in IP model for economic evaluation. The crude mix & availability is based on IOCL CO (Optimization) forecast considering Long term availability.

#### 3.2.4 Product Demand

The product demand numbers considered for the configuration study for Barauni Refinery fed region for the year 2021-22 is summarised below.

<b>PRODUCT</b>	<b>Demand numbers</b>
Liquefied Petroleum Gas	As Produced
Naphtha (PNCP grade)	To be minimized
Superior Kerosene Oil	735 TMTPA max
Aviation Turbine Fuel	220 TMTPA max
Motor Spirit (BS-VI)	1565 TMTPA (To be maximized)
High Speed Diesel (BS-VI)	6834 TMTPA max
Furnace Oil	50 TMTPA max
Bitumen	100 TMTPA max
Carbon Black Feed Stock	45 TMTPA max
Poly Propylene	To be maximized
Coke	As Produced
Sulphur	As Produced

### 3.2.5 Product Prices

The Product Prices are considered as the average Refinery Transfer Price of last three years (2013-14, 2014-15 and 2015-16) in IP run for economic evaluation.

### 3.3 REFINERY CONFIGURATION OPTIONS

New process units such as Atmospheric and Vacuum Distillation unit, Once through Hydrocracker unit (OHCU), Full Conversion Hydrocracker (HCU), INDMAX, INDALIN, Diesel Hydrotreater (DHDT), Delayed Coking Unit (DCU), Isomerization unit (ISOM), Solvent Deasphalting unit (SDA), Sulphur recovery unit (SRU), Hydrogen Generation unit (HGU), Resid Hydrocracker such as H-OIL, LC fining, Slurry Hydrocracker, Petrochemical unit such as Poly-propylene, Phenol, Propylene oxide, Propylene recovery unit (PRU) and Revamp of existing RFCC are considered under expansion study.

## 4.0 PROJECT DETAILS

### 4.1 PROCESS UNITS

The following process units (revamp / new units) are envisaged in the recommended configuration

<b>Configuration</b>		
<b>PROCESS UNIT</b>	<b>CURRENT</b>	<b>PROPOSED</b>

	<b>CAPACITY</b>	<b>CAPACITY</b>
	<b>TMTPA</b>	<b>TMTPA</b>
AVU I/II	3500	UNIT IDLE
AVU-III <sup>(1)</sup>	2500	3300
<b>NEW AVU</b>	-	<b>5700</b>
<b>REFINERY CAPACITY</b>	<b>6.0 MMTPA</b>	<b>9.0 MMTPA</b>
NSU	800	880
NHDT+CRU	575	575
NHT (ISOM)	183	183
ISOM Unit	126	126
RFCC	1700	1700
Prime G+ SHU	840	681
Prime G+ HDS	630	553
DHDT	3300	3300
COKER-A	600	463
<b>COKER-B<sup>(2)</sup></b>	<b>500</b>	<b>662</b>
BITUROX	100	100
HGU	54	54
SRU	80 TPD	80 TPD
NEW SRU	-	160 TPD
New NHT (ISOM)	-	357
New ISOM Unit	-	304
NEW DHDT	-	1218
NEW HGU	-	41
OHCU	-	1000
PRU	-	562
PP	-	200
TOTAL REQD.POWER, MWH		103
POWER IMPORT, MWH		48

Notes:

- (1) AVU-III low cost revamp will be implemented for capacity augmentation from 2.5 to 3.3 MMTPA
- (2) Coker-B capacity revamp will be done for processing HS VR with low recycle to improve product yield(will call for major revamp including in LRU. Needs to check if new coker can be considered)

4.1.1 Atmospheric and Vacuum Distillation unit: A 5.7 MMTPA new Atmospheric and Vacuum Distillation unit is considered in place of existing low capacity AVU-I/II. With AVU-III capacity revamp to 3.3 MMTPA, the combined total refinery capacity will be 9.0 MMTPA. AVU-I & II units are considered idle because they are smaller capacity

units which are old and inefficient. Accordingly a new AVU of higher capacity is considered for energy conservation thereby taking advantage of the latest available technology.

4.1.2 Once through Hydrocracker unit (OHCU): A 70 % Conversion Hydrocracker unit is considered in the configuration. Once-through Hydrocracker in combination of RFCC would enable higher propylene rich LPG yield, which is the feedstock for downstream Petrochemical unit.

4.1.3 Diesel Hydrotreater (DHDT): An additional Diesel Hydrotreater unit is being considered for making BS-VI Diesel in addition to the existing 3.3 MMTPA DHDT for matching with the additional crude throughput.

4.1.4 High CCR DCU: A high CCR Delayed Coking unit is being considered to process high Sulphur Vacuum residue feed sulphur up to 5.4 wt% sulphur and 24 CCR wt%. This Coker would also have provision of HCGO cut which would be processed in New OHCU which would in turn increase the overall conversion and reduce FO generation. Post revamp, this Coker along with Coker-A which can handle feed sulphur up to 5.4 wt% and CCR up to 17.5 wt% in HS mode operation with a capacity of 0.6 MMTPA after its revamp completion.

Existing Coker B is designed based on RCO feed and can handle feed sulphur up to 0.6 wt% and CCR up to 8-10 wt%. For refinery capacity expansion to 9.0 MMTPA, Coker-B capacity revamp is considered to process High CCR, High Sulphur feedstock with lower recycle rate to improve product yields. Delayed Coker unit in combination with New OHCU will improve refinery profitability due to increased processing of high sulphur crudes.

4.1.5 Isomerization unit (ISOM): Current installed capacity of ISOM unit is 126 TMTA and is designed for Isomerate RON of 87.5. With stringent specifications in Aromatic content in BS- VI MS, more Isomerate is required to be blended in MS pool for diluting the high aromatic content in CRU / CCRU reformat. New NHDT/ISOM unit with Isomerate RON of 87.5 is considered for capacity expansion.

4.1.6 Sulphur Recovery Unit (SRU) block: New SRU block units consisting of Sulphur recovery unit, Amine regeneration unit, Sour water stripper are required to match with the new process unit requirement and increased high HS crude processing.

4.1.7 Hydrogen Generation Unit (HGU): Existing combined installed capacity of HGU-1 and HGU-2 is 54 TMTA. However, maximum achievable capacity is 48 TMTA. Further, additional capacity of Hydrogen generation unit is required to match with the new process unit requirement.

4.1.8 Revamp of RFCC: Considering Polypropylene production in the refinery expansion configuration, major Revamp of existing RFCC may be required to increase the

Polypropylene potential. IOCL R&D has worked out the material balance, product specifications, required modifications and provided ball park cost estimate for major revamp of existing RFCC for improving Propylene rich LPG potential. IOC R&D has proposed to keep RFCC feed CCR in the range of 0.3 – 0.5 wt% for revamp case to achieve high Propylene yield from the unit. The unit is estimated to generate around 200 TMTPA Propylene under the major revamp case.

4.1.9 Propylene Recovery Unit (PRU): For integrating the refinery with Polypropylene unit, a Propylene recovery unit is required. PRU shall recover propylene from propylene rich LPG streams of RFCC. The Propylene ex PRU unit is the feed stock for Polypropylene unit.

4.1.10 Polypropylene Unit (PP): A new Polypropylene Unit of 200 TMTPA capacity is considered for processing propylene feed stock ex Propylene Recovery Unit (PRU)

## **4.2 OFFSITE & UTILITY SYSTEM**

The additional power requirement of the project is expected to be 45-48 MW shall be sourced by Import of Power from National Grid. However the actual additional power requirement will be firmed up during DFR stage. IOCL BR power generation capacity is 90 MW out of which 55 MW is the realizable capacity. Based on stand-by capacity requirement to cater to the statutory and mandatory maintenance as per schedule. Cost provision towards power import facility is kept under the project.

It is estimated that 150-200 TPH of additional steam will be required. Prima facie it is seen that additional steam will be meet from the existing steam generation facility. However, same shall be firmed up during DFR stage.

New storage tanks, mounded bullets for LPG, propylene, control rooms, sub-stations, cooling water, nitrogen plant, DM plant, RO plant, fire water facilities, instrument air dryers, flare headers, ETP facilities, raw water facilities, Coke silo etc will be required for the capacity expansion. The actual details of offsite and utility facilities requirement would be firmed up during DFR stage.

## **5.0 Project Location**

All the new process units and new offsite & utility facilities under BR 9.0 MMTPA expansion project will be located in the area inside refinery premises.

## **6.0 Project Implementation**

It is envisaged to execute the project in 60 months time schedule. However, detailed execution philosophy shall be finalized during DFR stage.

## **7.0 Project Cost**

The total project cost has been estimated to be Rs. 8287 Crore (with + 30% accuracy). The cost estimate has been worked out based on Mar'2016 prices.

Project cost estimation is based on in-house data, budgetary offers from Licensors & guidelines provided in 'Project Cost Estimation & Cost Data Bank', IOCL RHQ Projects.