MINISTRY OF PETROLEUM AND NATURAL GAS

CHAPTER V

Indian Oil Corporation Limited

Operation of Haldia Refinery

Highlights

- Planning for production of Euro III high speed diesel from Diesel Hydro Desulphurisation Unit was inadequate.

(Para 5.7.2)

- Resid Fluidised Catalytic Cracking Unit (RFCCU) could not process planned quantity of short residue (SR). The unprocessed SR was disposed of as Furnace Oil resulting in loss of Rs.127.79 crore.

(Para 5.7.3.1)

- The capacity of RFCCU was not designed in line with the crude processing capacity of the refinery resulting in diversion of available unprocessed feedstock for production of low value product.

(Para 5.7.3.2)

- Despite adequate domestic demand, capacity utilisation of Catalytic Iso-Dewaxing Unit for production of Group II Lube Oil Base Stock (LOBS) ranged between 32 *per cent* and 67 *per cent.*

(Para 5.7.4)

- The consumption of naphtha for production of hydrogen in Hydrogen Generation Unit (HGU) was in excess of norms resulting in loss of Rs.15.80 crore.

(Para 5.7.5)

Summary of recommendations

1. ***MOU target of the refinery may be fixed considering the potential refining capacity.***
2. ***The Company should commensurate the capacity of the secondary processing units of the refinery with its crude processing capacity and properly plan the production of environment friendly petroleum products as per time frame prescribed by the Government of India.***

3. The Company should augment the feed processing capacity of RFCCU so as to process the available feedstock for generating more distillate product and remove the problems in the reactor and regenerator section of RFCCU for processing planned quantity of SR in a time bound manner.

4. The Company should maximise the production of Group II LOBS from CIDWU after assessing existing and future demand for these products.

5. The Company should institute corrective measures to reduce excess consumption of naphtha in HGU.

5.1 Introduction

5.1.1 Haldia Refinery, located at East Midnapur district of West Bengal, was commissioned in 1975 with an installed capacity of 2.5 MMTPA[1]. The primary objective of the refinery is to maximise production of distillates and generate feedstock for Lube Oil Base Stock (LOBS) and to produce finished LOBS as per market requirement. Petroleum products from the refinery are supplied mainly to eastern region[2] through product pipelines, rail wagons, trucks and tankers. It is the only LOBS producing refinery of the Company.

5.1.2 Processing units

The Crude Distillation Unit I (CDU I) of Haldia Refinery was designed to process 2.5 MMTPA of imported High Sulphur (HS) crude oil. Subsequently, the capacity of the unit was de-bottlenecked to 2.75 MMTPA in 1989 and with further modifications, it was augmented to 3.6 MMTPA in June 1996. Another Crude Distillation Unit (CDU II) with 1 MMTPA capacity was added (1997) for processing Low Sulphur (LS) crude increasing the capacity of the refinery to 4.6 MMTPA. After minor modifications, the capacity of CDU II increased to 2.4 MMTPA from 1997. Thus, from 1998 the crude processing capacity of the refinery was six MMTPA.

The lube oil block consisting of Vacuum Distillation Unit (VDU I), Visbreaker Unit (VBU), Bitumen Treating Unit (BTU), Propane Deashphalting Unit (PDA), Furfural Extraction Unit (FEU), Solvent Dewaxing Unit (SDU) and Hydrofinishing Unit (HFU) was commissioned in 1977. The Diesel Hydro Desulphurisation Unit (DHDS) was commissioned in 1999 for production of High Speed Diesel (HSD) with sulphur content equivalent to 0.25 *percent* by weight. VDU II and Resid Fluidised Catalytic Cracking Unit (RFCCU) were commissioned in 2001-02 for upgradation of heavy ends to value added products. In addition, a Catalytic Iso-Dewaxing Unit (CIDWU) was commissioned in 2003 for production of high quality Lube Oil Base Stock (LOBS). Motor Spirit Quality (MSQ) improvement facilities were commissioned during 2005 for production of improved quality Motor Spirit (MS).

5.1.3 Production process

Crude oil is processed in CDU (primary processing unit) from where different value added straight run products like Liquefied Petroleum Gas (LPG), Naphtha, Superior Kerosene Oil (SKO), Aviation Turbine Fuel (ATF), MS and HSD are generated. The bottom product from CDU which is called Reduced Crude Oil (RCO) is further processed

[1] Million Metric Ton Per Annum

[2] The eastern region consists of West Bengal, Orissa, Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura.

in VDU for production of feedstock for RFCCU and lube units. The Short Residue (SR) generated from the bottom of VDU is used for making lube products through subsequent processing in PDA unit and SDU. The SR is also processed in RFCCU for production of distillate products like LPG, MS and HSD. Remaining part of RCO and SR are disposed of as low value product like Furnace Oil (FO). The process flow diagram of the refinery operation is given at ***Annexure XV***.

5.2 Scope of Audit

The Performance Audit on operation of Haldia Refinery of the Company during the five year period from 2002-03 to 2006-07 was conducted through test check of records maintained at Refinery Office at Haldia and Refinery Project Office in New Delhi.

5.3 Audit objectives

The Performance Audit was conducted to assess that:

- the capacity fixed for the processing units and the product improvement/ diversification/ augmentation schemes in the refinery was reasonable;
- the utilisation of the processing capacity was optimised for achieving the desired refinery throughput and distillate yield; and
- the consumption of chemicals, catalyst and other inputs were within norms.

5.4 Audit Criteria

The following criteria were adopted for judging the performance of the Refinery:

- Installed capacity of Refinery and Memorandum of Understanding (MOU) targets.
- Expected market demand of Euro III HSD/ MS and Group II LOBS as assessed by the Company.
- Capacity of DHDS/ MSQ for production of Euro III HSD/ MS.
- Available feed for RFCCU/ VBU/ DHDS.
- Approved proposals/ schemes.
- Fuel consumption as per Technical Audit Norms.

5.5 Audit Methodology

After a preliminary study and collection of background information an entry conference was held with the Management on 6 March 2007 to discuss the audit objectives/ sub-objectives and audit criteria. Test audit was conducted during February to July 2007 covering the Refinery Offices at Haldia and New Delhi. A Discussion Paper containing preliminary findings was issued to Management on 10 July 2007. The audit findings were discussed with the Management in the exit conference on 19 September 2007.

5.6 Acknowledgement

Audit acknowledges the co-operation and assistance extended by different levels of Management at various stages of performance audit.

5.7 Audit findings

5.7.1 Capacity utilisation of the refinery

Crude oil processed by the refinery against its installed capacity of six MMTPA and targets set in MOU during the five years ending 31 March 2007 is detailed in Table 5.1 below:

Table – 5.1

Year	Installed Capacity (MMT)	MOU target (MMT)	Crude oil processed (MMT)	*Percentage* of Utilisation to installed capacity
2002-03	6.0	4.1	4.51	75.2
2003-04	6.0	4.2	4.52	75.3
2004-05	6.0	4.6	5.42	90.3
2005-06	6.0	5.0	5.50	91.7
2006-07	6.0	5.2	5.84	97.3

It was observed that the capacity utilisation of the refinery was low during 2002-03 and 2003-04. Despite some improvement in the last three years *i.e.*, upto 2006-07 this continued to be lower than the installed capacity.

The Management stated (August and November 2007) that the crude throughput target of the refinery set out in the MOU entered into between the Company and Ministry of Petroleum and Natural Gas (Ministry) should be the performance criteria of the refinery since MOU target was utilisation based on estimated demand of basket of petroleum products in the region in which refinery is located, capacity of the refineries in the region and availability of product evacuation logistic support. It was also contended that the performance of the refinery was excellent during the above years since it exceeded the MOU targets.

However, it is evident from Table-5.1 above that the MOU targets of the refinery were low when compared with its potential refining capacity. Hence, the contention of the Management that MOU target should be the benchmark of the performance of Haldia Refinery during the above period can not be acceptable. Besides, the Company had to bring in to the region 8922 Thousand Metric Tons (TMT) of different petroleum products during 2002-03 to 2006-07 which indicates existence of more demand in the region. Thus, it is evident that the MOU target was fixed on a lower side without fully taking into consideration the refinery's capacity and the existence of demand for its products in the region.

Recommendation No. 5.1

MOU target of the refinery may be fixed considering the potential refining capacity.

5.7.2 Capacity limitation in DHDS unit

The Ministry stipulated (March 1995) that use of HSD with sulphur (S) content 0.25 *percent* by weight (wt) would become mandatory from April 1999. Accordingly, the Company decided (August 1996) to set up DHDS unit with a capacity of 1.2 MMTPA (matching with the refinery's potential crude processing capacity of 4.6 MMTPA from 1997). DHDS unit was commissioned (September 1999) at a cost of Rs.315.06 crore. The

unit was subsequently modified (December 2000) to produce HSD with sulphur content 0.05 *per cent* by weight following instruction (January 2000) of Government of India (GOI) for supply of HSD of that specification to the metros. With the implementation of auto fuel policy, MOP&NG directed (February 2002) that supply of HSD would be (i) BS II HSD (0.05 *percent* by wt 'S') for entire country from April 2005 and (ii) Euro III HSD (0.035 *percent* by wt 'S') for four metros and seven other major cities from April 2005 and for entire country from April 2010.

In November 2000, the Company decided to set up facilities for improvement in diesel quality and distillate yield (Hydrocracker Project) at Haldia Refinery at an estimated cost of Rs.1518 crore. The basic objective of this project was to produce Euro – III HSD in line with the existing crude processing capacity (six MMTPA from 1998) of the refinery. Since the entire Euro III HSD would be available from the proposed Hydrocracker unit, the refinery did not consider enhancing the capacity of DHDS for production of Euro III HSD in line with its crude processing capacity. It was subsequently decided (April 2003) to defer the implementation of Hydrocracker project till April 2010 as a major portion of projected output from the unit would be surplus since supply of Euro III HSD would be applicable for the country from April 2010. DHDS unit was modified in November 2005 for production of Euro III HSD but without enhancing its capacity in line with the crude throughput (six MMTPA) of the refinery. In June 2006, the refinery decided on a low cost revamp of DHDS unit to 1.5 MMTPA at a capital cost of Rs.7.80 crore with a completion schedule of November 2007. The work is yet to be completed (January 2008).

As is evident from the sequence of events narrated above, the Company took three years (from 2003 to 2006) to decide on the upgradation of the DHDS unit to meet the Euro III norms and to enhance the capacity of the unit to match the refinery capacity. The refinery, therefore, could not meet the requirement of HSD (BS II and Euro III) of the region and brought about 663 TMT HSD (including 242 TMT Euro III grade) into eastern region during 2005-06 and 2006-07 to meet the deficit. The refinery, however, produced about 100 TMT Euro III HSD from CIDWU (set up for production of Group II LOBS) during 2005-06 and 2006-07 by not fully utilising the CIDWU for production of Group II LOBS despite the existence of domestic demand for such LOBS (refer to para 5.7.4).

While the Management in its reply justified the choice of Hydrocracker technology over the other alternatives, it did not justify the delay in exploring the possibility of a low cost revamp to tide over intervening period. The decision to modify the unit for production of Euro III HSD and the capacity revamp at a low cost could have been taken after the postponement of the Hydrocracker project in April, 2003.

Recommendation No. 5.2

The Company should

(i) commensurate the capacity of the secondary processing units of the refinery with its crude processing capacity; and

(ii) properly plan the production of environment friendly petroleum products as per time frame prescribed by the Government of India.

5.7.3 Resid Fluidised Catalytic Cracking Unit (RFCCU)

Audit noticed constraints in the design and operation of RFCCU as discussed below:

(i) The Company decided (February 1999) to set up RFCCU to upgrade the heavy ends to value added products (LPG, MS and HSD) and thereby increase the distillate yield of the refinery. The feedstock processing capacity (0.7 MMTPA) of the unit was fixed on the basis of refinery crude throughput of 4.6 MMTPA although the crude processing capacity of the refinery had gone up to six MMTPA in 1998. Consequences of this mismatch in capacities have been discussed in para 5.7.3.2.

(ii) One of the basic objectives of RFCCU was to process Short Residue (SR), which would otherwise be disposed off as FO (a low value product), for production of value added products. If SR is disposed off as FO without processing in RFCCU, the refinery has to blend distillate product (HSD) as cutter stock to make SR marketable as FO leading to loss of distillate yield. As per design feedstock composition, RFCCU was required to process SR to the extent of 20 *per cent* of its feed. It was observed that three types of feedstock composition (Feed I, II and III) were considered for finalisation of design of RFCCU. While SR was not included in Feed I and II, Feed III consisted of SR to the extent of 20 *per cent.* Though RFCCU was finally designed to process SR to the extent of 20 *per cent* of its feedstock (*i.e.,* Feed III), the Reactor and Regenerator (RR) section of RFCCU was designed for Feed II *i.e.,* without SR as a feedstock component. The result of the RFCCU's inability to process SR to the extent of 20 *per cent* due to problems in RR section has been discussed in para 5.7.3.1.

5.7.3.1 Inability to process SR as per the design feed

RFCCU was commissioned in September 2001 at a cost of Rs.362.82 crore. Since its commissioning, the unit failed to process SR to the designed level of 20 *per cent* of its feedstock because its RR section was not designed to process feedstock with SR content leading to high regenerator temperature, more coke formation and inferior product pattern. RFCCU was operated by processing lower quantity of SR during the period from 2002-03 to 2006-07. Hence, the SR had to be sold as FO and the refinery had to blend HSD (131 TMT) as cutter stock with the unprocessed SR (396 TMT) to make it marketable as FO (Table-5.2). This resulted in loss of distillate (HSD) yield of the refinery to the extent of Rs.127.79 crore[3].

Table – 5.2

Year	RFCCU Throughput (feedstock processed) (TMT)	SR processed in RFCCU (as a *percentage of feedstock processed*)	SR not processed in RFCCU & diverted to FO* (TMT)	HSD blended as cutter stock with unprocessed SR (TMT)	Distillate loss due to blending of HSD as cutter stock (Rs. in crore)
(1)	(2)	(3)	(4)	(5)	(6)
2002-03	635	11.0	58	19	9.04
2003-04	577	8.9	64	21	12.63
2004-05	730	6.0	102	34	33.04
2005-06	738	7.6	92	30	34.73
2006-07	812	10.1	80	27	38.35
Total			**396**	**131**	**127.79**

**** Difference between 20 per cent of feedstock processed and the SR processed in RFCCU***

[3] ***Rs.127.79 crore is the differential cost.***

The Management stated (August and November 2007) that: -

- The unit was unable to process more SR due to operational problems and maximisation of SR processing would result in lower LPG production and lower liquid distillate yield.
- The present viscosity[4] of SR was more than that considered for designing of RFCCU resulting in lesser SR processing.
- RFCCU processed 730 TMT to 812 TMT of feed during 2004-05 to 2006-07 against its capacity of 700 TMTPA and earned additional margin which was more than the distillate loss suffered by the refinery during such period due to processing of lesser SR.

The Management's contentions are not tenable in view of the following:

- With six *per cent* SR processing the LPG yield was 15.2 *per cent* in 2004-05; whereas the yield increased to 16.3 *per cent* in 2006-07 with 10.1 *per cent* SR processing. With 8.9 *per cent* SR processing the yield of liquid distillate was 79.8 *per cent* in 2003-04 whereas the yield decreased to 79.6 *per cent* in 2005-06 with 7.6 *per cent* SR processing. Thus, there is no linear relation between the processing of SR in RFCCU and yield of LPG and liquid distillate therefrom.
- Viscosity of SR was not considered as a characteristic of the design feed while finalising RFCCU design. Characteristics of the SR should have been analysed at the feasibility stage to avoid such problems in the future.
- The additional margin earned by the refinery during 2004-05 to 2006-07 by increasing the throughput of RFCCU had no relation with the quantum of SR not processed in the RFCCU. The fact remains that RFCCU, which was installed to process 20 *per cent* SR of the feed, could not meet its objective.

The Management further stated that revamp of RFCCU capacity with modifications in the design of its reactor and regenerator section with the assistance of the process licensor would be considered after implementation of Hydrocracker project (2009-10).

5.7.3.2 Capacity limitation

The feedstock processing capacity (0.7 MMTPA) of the unit was fixed on the basis of refinery crude throughput of 4.6 MMTPA although the crude processing capacity of the refinery had gone up to six MMTPA in 1998. The details of refinery and RFCCU throughput, feed availability and diversion of unprocessed feed to FO in the five years ended 2006-07 is given in Table – 5.3.

[4] ***Property of liquid indicating resistance to flow.***

Table – 5.3

Year	Refinery Throughput (TMT)	RFCCU Feed Availability (TMT)	RFCCU Throughput (TMT)	Unprocessed RFCCU feed diverted to FO (TMT)	Opportunity loss due to not producing value added product (Rs. in crore)	Total (Rs. in crore)
(1)	(2)	(3)	(4)	(5) = (3)–(4)	(6)	(7)
2002-03	4513	700	635	65	26.27	100.61
2003-04	4518	700	577	123	74.34	
2004-05	5418	850	730	120	101.53	285.00
2005-06	5502	850	738	112	94.09	
2006-07	5836	900 *	812 #	88	89.38	
Total					**385.61**	**385.61**

**** Proportionate to 0.85 MMTPA RFCCU capacity at refinery capacity of 5.5 MMTPA as assessed by the Management***

 # Throughput was increased by operating the unit for 363 days against 333 design operating days.

The unit could not be operated at its full capacity during 2002-03 and 2003-04 although the required feedstock was available. Low capacity utilisation of RFCCU during these two years was on account of shutdown of the unit due to inherent problems in its reactor and regenerator section. The unprocessed feed of the unit had to be disposed off as FO, which resulted in an opportunity loss of Rs.100.61 crore based on the difference between the value of distillate products that could be generated from such feedstock in RFCCU and FO.

Further, with the increase in refinery throughput beyond 4.6 MMTPA from 2004-05, more feedstock was available for RFCCU. However, due to its capacity limitation (0.7 MMTPA), the unit was unable to process such excess available feedstock for production of value added distillates (LPG, MS, HSD) and the unprocessed feedstock was diverted for production of low value product (FO). Thus during 2004-05 to 2006-07, the refinery lost an opportunity to earn Rs.285 crore[5].

Besides, it was assessed that the availability of feedstock for RFCCU at the refinery throughput level of six MMTPA was about one MMTPA. Hence there was a mismatch in capacity fixation of RFCCU at the installation stage (in 1999) with reference to crude processing capacity of the refinery since 1998.

The Management stated (November 2007) that at the existing crude throughput capacity and with the enhancement of LOBS production capacity after commissioning of CIDWU, the feed availability would be less than the actual capacity of RFCCU. The contention is not tenable since after the commissioning of CIDWU (March 2003) the actual feed availability for RFCCU increased from 850 TMT to 900 TMT during 2004-05 to 2006-07 which was more that its capacity.

[5] ***Rs.285 crore have been calculated based on the difference between the value of distillate products that could be generated from such feedstock in RFCCU and FO.***

Recommendation No. 5.3

The Company should

(i) augment the feed processing capacity of RFCCU so as to process the available feedstock for generating more distillate product; and

(ii) remove the problems in the reactor and regenerator section of RFCCU for processing planned quantity of SR in a time bound manner.

5.7.4 Capacity utilisation of CIDWU for production of Group II LOBS

In order to enhance LOBS production with improved quality oils, the Company decided (July 1999) to install Catalytic Iso-Dewaxing Unit (CIDWU) for production of 140 TMT *per annum* Group II LOBS. The capacity of this unit was fixed based on projected indigenous demand. The CIDWU set up at a cost of Rs.361.84 crore, was commissioned in March 2003. The year wise market demand and production of Group II LOBS by the refinery during the four years ending 2006-07 are given in Table – 5.4.

Table – 5.4

Year	Domestic market demand of Group II LOBS (TMT)	Group II LOBS production capacity of CIDWU (TMT)	Actual Group II LOBS production in CIDWU (TMT)	Percentage of capacity utilisation of CIDWU for production of Group II LOBS
2003-04	149	140	45.72	32
2004-05	172	140	79.60	57
2005-06	194	140	76.82	55
2006-07	235 *	140	93.13	67

**** Projected by the Marketing Division***

The Management stated (November 2007) that the production of Group II LOBS was in accordance with demand placed by the Marketing Division. However, as evident from Table-5.4 above, there was sufficient domestic demand for Group II LOBS, while the actual production was only 30 *per cent* to 46 *per cent* of the domestic demand and 32 *per cent* to 57 *per cent* of the installed capacity during the period from 2003-04 to 2004-05. During 2005-06 and 2006-07, the production of Group II LOBS was only 55 *per cent* to 67 *per cent* of the installed capacity and the spare capacity of the unit was utilised for production of Euro III HSD (71 TMT in 2005-06 and 28 TMT in 2006-07) due to capacity limitation of DHDS unit (refer to Para 5.7.2).

The Management further stated that Euro III HSD was produced from CIDWU by using the available spare capacity after meeting the market demand of Group II LOBS as per requirement furnished by Marketing Division and thereby the gross margin of the refinery was increased during 2005-06 and 2006-07 as this operation boosted the refinery throughput.

The contention of the Management is not tenable since there was adequate domestic demand for Group II LOBS during the above period as assessed by the Marketing Division, but the Company could not cater to it resulting in idling of CIDWU. With the requisite enhancement in DHDS capacity and utilisation of CIDWU for Group II LOBS production, the Management could have achieved higher refinery throughput and gross margin in 2005-06 and 2006-07.

The Management also stated that there was limitation of gradewise production capacity of CIDWU for Group II LOBS. This is contendable by the fact that the actual production of a particular grade of Group II LOBS (500 N/H 500) was more than its production capacity during all the four years from 2003-04 to 2006-07.

Recommendation No. 5.4

The Company should maximise the production of Group II LOBS from CIDWU after assessing existing and future demand for these products.

5.7.5 Excess consumption of naphtha in Hydrogen Generation Unit (HGU) for production of Hydrogen

To meet the requirement of hydrogen for DHDS unit, one HGU with a capacity of 11,000 MTPA was installed in July 1999. The capacity of HGU was subsequently (June 2003) enhanced to 15,000 MTPA. Hydrogen was produced from this unit by processing naphtha (distillate product) as input. The design yield of hydrogen from naphtha was 26.5 *per cent*. It was, however, observed that during the period 2002-03 to 2006-07 (excepting 2003-04) the actual recovery of hydrogen from naphtha was less than the design yield resulting in excess consumption of naphtha (9.8 TMT) valuing Rs.15.80 crore for generation of the required quantity of hydrogen. It was observed that such excess consumption of naphtha was the result of frequent start up and shut down of the unit due to unreliable power supply.

The Management stated (November 2007) that modification jobs in the electrical system were taken up for improvement in reliability in power supply.

Recommendation No. 5.5

The Company should institute corrective measures to reduce excess consumption of naphtha in HGU.

5.8 Conclusion

The capacity utilisation of Haldia Refinery was low during 2002-03 to 2005-06 and the Company had to bring in products from other regions to meet the demands of the regions. Capacities of the secondary processing units like DHDS and RFCCU did not match the primary crude processing capacity of the refinery. This resulted in diversion of unprocessed feedstock for production of low value products, blending of considerable quantity of distillate products as cutter stock as well as lower crude throughput leading to substantial revenue loss. There was also lack of preparedness for meeting the product (Euro III HSD) specification requirements of Auto Fuel Policy (February 2002) of Government of India. Despite availability of domestic demand for Group II LOBS, there was not only under utilisation of CIDWU but the unit was used for generation of Euro III HSD.

The matter was reported to the Ministry in January 2008; reply was awaited.