

## Executive summary and recommendations

Oil and Natural Gas Corporation Limited (ONGC) is contributing around 70 *per cent* of domestic production of crude oil in the country. Mumbai High, Neelam and Heera fields of western offshore contribute around 59 *per cent* of this production. These fields have been operating from 1976 and 1984 respectively and therefore these mature fields are susceptible to decline in production. Water injection is a method for reservoir health management and increasing crude oil recovery from the reservoir.

A Compliance Audit was conducted to review performance of water injection operations in western offshore of ONGC for the period 2014-15 to 2018-19 with the following objectives to assess whether:

1. the requirement of water injection planned in the annual water injection build-up plan was commensurate with requirement envisaged in field development schemes/ feasibility reports approved by the management and planned quantity was injected into the reservoir,
2. requisite water injection equipment were made available to inject required quantity of water into reservoir,
3. desired quality of water was injected into the reservoir and
4. water injection facilities were maintained through corrosion monitoring, pigging of water injection lines, workover of injectors, stimulation of injection wells and backwash of injectors.

### Results in Brief

There was inadequate water injection with less than one voidage replacement ratio and cumulative voidage compensation (as of March 2019) was only 54.43 *per cent* in Mumbai High, 78.8 *per cent* in Heera and 42 *per cent* in Neelam fields. Water injection in the field was affected due to ageing of injection infrastructure, frequent pipeline leakages due to poor quality of injection water, non-implementation of feasibility report inputs and to some extent, production from high gas-oil ratio wells. This led to drop in reservoir pressure sharply and impacted crude oil production. Even by the estimate of the company at the request of Audit, this deficient water injection impacted loss of production of crude worth ₹7,802.50 crore for ONGC and revenue loss of ₹3,474.29 crore to the Government of India by way of statutory levies during the audit period. This loss cannot be considered as deferred production but a permanent loss of oil. Further, even for exploitation of a part of this oil deficit, additional investment is required and this needs review from the point of economical oil recovery.

## Audit findings

### Planning and implementation of requirement of water injection

The annual plans for water injection were lower than the requirement as provided in the re-development schemes by 5 to 46 *per cent* during 2014-15 to 2018-19. The annual plan is prepared under resources constraints and instead of overcoming the constraints, they were accepted as reality and planned accordingly. Even the reduced annual targets were not achieved.

(Para 3.2 and 3.3)

Water injection quantity was measured regularly at water injection platform end. With multiple leakages in injection lines noticed during 2014-15 to 2018-19, injection quantity measured and reported at water injection platform end was not the correct measure of quantity injected into the reservoir.

(Para 3.5)

The company commenced water injection six to eight years after commencement of field production in Mumbai High, Neelam and Heera. Cumulative voidage compensation as on 1 April 2019 was only 54.43 *per cent*, 42 *per cent* and 78.8 *per cent* in Mumbai High, Neelam and Heera fields respectively.

(Para 3.6)

**With reference to Audit findings on Planning and implementation of requirement of water injection, Audit recommends that:**

- 1. Annual planning for water injection should emanate from the field development schemes. The company may devise a comprehensive catch-up plan to compensate the excess voidage created.*
- 2. Quantity of water injected has to be measured at unmanned platform end for better and timely monitoring. Integration of SCADA with the online meters may be considered in all platforms.*

### Water injection surface facilities and equipment

Chemical dosing pumps which were required to maintain desired quality to avoid corrosion of water injection equipment, clogging of wellbore and indirectly affecting crude oil production were not considered as essential equipment.

(Para 4.3)

The equipment replacement policy adopted by the company was not adhered to and failure of equipment was attributed to delay in overhauling and replacement/revamping along with deficiency in maintenance.

(Para 4.4)

System availability (availability of equipment for un-interrupted flow of production) of critical equipment was below the adopted target of 100 *per cent*. Instances were noticed where system availability of the equipment were shown as 100 *per cent* when

the equipment failed to meet the field requirement or equipment was shown available when it was sent on repairs. Absence of data in ERP system, lack of proper mapping and maintaining important equipment details outside the ERP indicated that the company did not use the Plant Maintenance module of SAP-ERP effectively to obtain the intended benefits.

**(Para 4.5, 4.6, 4.7 and 4.8)**

There were delays in initiating revamping/ replacement process because of improper planning. Original Equipment Manufacturer (OEM) recommended norms/ maintenance practices were not followed leading to equipment deterioration and rendering it unsafe for full scale operation. In Mumbai High, 52 per cent of the critical/ major water injection rotary equipment were overdue for overhaul.

**(Para 4.9 and 4.10)**

**With reference to Audit findings on Water injection surface facilities and equipment, Audit recommends that:**

3. *The company should ensure maintenance of the equipment availability data through SAP system and ensure generation of reports directly from SAP.*
4. *The company needs to consider efficiency/ performance of the equipment for meeting the operational requirement while working out the 'system availability' of equipment. Management should ensure reliability and availability of equipment for un-interrupted operation.*
5. *Management may extensively use functionalities under Plant Maintenance module in SAP system so as to get its intended benefit of aiding performance analysis, improving operational effectiveness and providing useful insights to Management decisions.*
6. *The company should timely initiate proposals for overhauling and replacement/ revamping to ensure system availability. Also, Original Equipment Manufacturer recommendations for maintenance practices should be adhered to.*
7. *The Replacement policy needs a relook to ensure that the efficiency of the aged pumps is also considered when repair versus replacement decisions are taken.*

### **Quality of water injection**

The company failed to meet desired quality parameters, despite dilution of some of the quality parameters over a period. The quality of water in many water injection platforms was observed as inferior to the quality parameters currently followed by the company.

**(Para 5.2 and 5.3)**

The dosing of chemicals was not ensured to be within recommended levels and in large number of cases, 'nil' and lower dosing of chemicals was observed. This has

consequences of plugging formation, pipeline leakage, etc. Discrepancies and inconsistencies were also noticed in reporting of the water quality. Important quality parameters were not captured due to non-functioning of quality measurement instruments.

**(Para 5.4 and 5.5)**

Quality of water is measured at water injection platform from where it was despatched and reported the quality of water injected into reservoir. However, due to corrosion in water injection lines, quality of water deteriorated en-route to wellheads. Thus, actual quality of water injected into reservoir was inferior to the quality reported at water injection platform.

**(Para 5.6)**

**With reference to Audit findings on quality of water injection, Audit recommends that:**

- 8. Due diligence while recording the data and feeding in SAP system should be ensured so that the desired quality parameters required for injection into the reservoir can be monitored and ensured.*
- 9. Dosing of adequate chemicals as per norms should be maintained so that quality parameters of water are monitored for timely corrective action.*
- 10. The Company needs to properly maintain the data of system and equipment availability of chemical injection system in future for monitoring and timely corrective action.*
- 11. Requisite quality of water injected into reservoir should be monitored throughout the water injection process and ensured till the well-head end for all parameters.*

#### **Maintenance of water injection pipelines and injectors**

Reports of the corrosion monitoring revealed that corrosion rate of water injection pipelines was above safe limit. Pigging helps to remove debris deposited in pipelines, control of microbes and monitoring of pipeline integrity. There was substantial shortfall in pigging operation against requirement and there was inadequate analysis of pigging samples. Internal corrosion was the primary reason for premature failure of water injection lines. Rather than mitigating the corrosion issues, the company reduced the design service life of water injection lines from 25 to 15 years. Time lag was observed between date of leakage and date of repair/ replacement which contributed to substantial loss of water injection.

**(Para 6.1, 6.2 and 6.3)**

To restore or improve the performance of a well, workover or well servicing activities are taken up. In Mumbai High field, workover was carried out only in 49.59 *per cent* wells against the wells planned. In Neelam and Heera fields, injection wells were

serviced after a gap of 15-20 years. This had long term impact on reservoir pressure and ultimate oil recovery.

**(Para 6.4)**

Well stimulation is a well intervention procedure adopted as water injection wells were prone to plugging. Stimulation jobs were carried out in Mumbai High field and Neelam & Heera field in only 18 *per cent* and 39 *per cent* respectively against the approved workload. Situation did not improve even after hiring dedicated stimulation vessel for injection wells.

**(Para 6.5)**

**With reference to Audit findings on maintenance of water injection pipelines and injectors, Audit recommends that:**

12. *Considering large number of pre-mature failure of lines, the company may strengthen corrosion monitoring system urgently. More locations away from the main injection pumps should also be taken up for corrosion monitoring in future.*
13. *The company should adhere to defined frequency of the pigging of lines to ensure health of pipelines and to prevent its faster corrosion. The company should follow pigging operation strictly as per SOP by taking samples on each pig run and analyse them for required quality parameters and microbial growth for corrective actions.*
14. *The company needs to institute a mechanism to workover these water injection wells in a timely manner and prepare action plan accordingly. This will help the company to keep water injection wells in healthy condition and ultimately to attain the goal of maintaining the reservoir pressure for increasing productivity of oil wells.*
15. *The company should review its present practice/ policy of need based approach of stimulating water injection wells to make it in line with the best industry practices. This will help in taking preventive measures before serious damage occurs to the system or wellbore and to improve injectivity of wells.*
16. *The company should regularly backwash the wells as per defined periodicity to improve injectivity of wells and increase water injection. Also resources planned/ mobilized for water injection may be considered separate from the requirements for producer wells.*

#### **Impact of inadequate water injection**

There was continuous decline in reservoir pressure due to inadequate water injection since inception of fields which impacted crude oil productivity and its ultimate recovery. Decline in reservoir pressure is further accentuated by higher gas production from the reservoir. Periodic recommendations of the Ministry on

importance of water injection, its distribution and maintenance of reservoir health were not fully implemented.

**(Para 7.1)**

The Performance Benchmarking Group of the company did not benchmark key performance indicator of 'reservoir health' with world's leading exploration and production companies. Instead, it fixed static targets based on inputs received from its strategic business units. Further, effective 2019-20, the parameter 'reservoir health' is not part of the performance contract indicating lack of monitoring of reservoir health by the management.

**(Para 7.2)**

Shortfall in water injection is one of the significant reasons for less production of crude oil. At the request of Audit, in-house research institute, Institute of Reservoir Studies (IRS) of the company, used the existing simulation model to arrive at the crude that could not be produced due to lesser water injection and worked out oil deficit of 3.695 MMT during audit period. Audit reworked the IRS quoted oil deficit by considering actual operation losses which was 3.79 MMT. The value of oil deficit of 3.79 MMT due to less water injection worked out to ₹11,276.79 crore. Out of this, value of oil deficit was ₹7,802.50 crore for ONGC after considering the statutory levies and the balance ₹3,474.29 crore is revenue loss to the Government of India.

**(Para 7.3)**

**With reference to Audit findings on impact of inadequate water injection, Audit recommends that:**

- 17. Company may devise a time bound action plan to address pressure sinks by ensuring injection volumes to redevelopment scheme levels and avoid uneven areal spread of water injection.***
- 18. Company should fix the target considering benchmark of international/ industry best performance rather than achievable basis so as to evaluate true performance of its operation. Weightage of water injection may be increased in performance monitoring and benchmarking.***

Management/ Ministry accepted (February/ June 2021) the above recommendations and assured that necessary steps are being taken to strengthen the processes. During the exit conference (September 2021), action initiated by the company on overhauling of equipment, improvement of water quality, installation of meters at unmanned platforms and connecting them to SCADA were explained.