Ref: FES/KTPS/PO-4550018425/DPR/TM/Generator/24060 **Date: 4th Oct. 2024**

Final Report

Non-DPR

Turbine Performance Improvement
3x660MW KTPS Koradi

Dist. Nagpur, Maharashtra

Report submitted by

Fluent Energy Solutions

Design and Engineering Consultant

Nagpur (India)

Scheme-2

Performance improvement
and availability of
various Auxiliaries for Generator System
3 x 660 Mw,
KTPS, Koradi

CONTENTS

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1. Introduction to Present System (Installed)-

Koradi Thermal Power Station began operations in 1974 with its first unit of 120 Mw. Later, three more units each of 120 Mw were added between 1975 and 1976, while 210 Mw unit was added in 1978. Two more units of 210 Mw each are added between 1982 and 1983. Out of which 4 x 120 Mw and 2 x 210 Mw units are retired now.

Stage	Unit Number	Installed Capacity (MW)	Working Capacity	Date of Commissioning	Status
Stage 1	1	120	0	1974 June	Decommissioned
Stage 1	2	120	0	1975 March	Decommissioned
Stage 1	3	120	0	1976 March	Decommissioned
Stage 1	4	120	0	1976 July	Decommissioned
Stage 2	5	210	0	1978 July	Decommissioned
Stage 2	6	210	228 (R&M)	1982 March	Running
Stage 2	7	210	0	1983 January	Decommissioned
Stage 3	8	660	660	2015 December	Running
Stage 3	9	660	660	2016 November	Running
Stage 3	10	660	660	2017 April	Running
Total Installed working Capacity			**2208**		

With increasing demand of the power, Mahagenco expanded its capacity by addition of 3 units of 660 Mw thereby taking the total capacity of KTPS to 2190 Mw's. Koradi TPS, 3 x 660 Mw units 8, 9 & 10 are commissioned in 2015, 2016 and 2017 respectively. These three units are with advanced super critical technology.

The Units of 3 x 660 Mw KTPS Koradi, are in continuous service since commissioning of respective units. Maintenance activities are taken at regular intervals to ensure healthiness and to maintain the performance of the units to design standards.

A unit encompasses a large number of sub-systems that comprise of numerous critical auxiliaries which are designed and installed with suitable redundancies to cater any emergency or unforeseen breakdowns.

Also, stand-by auxiliaries are provided in order to avoid generation loss in case of failure of the running auxiliaries. However, such provisions are not available for each and every auxiliary and failure of some critical running auxiliary may result in load restriction or even unit outage and thus huge generation loss.

Such breakdowns, will not only lead to the unit outage but the downtime required for remedial measures for these critical auxiliaries will further add on to the loss including prolonged downtime.

Various auxiliaries for the Generator System at the 3 x 660 Mw KTPS Koradi comprises essential equipment designed specifically to meet the operational requirements of the Melco make generator.

The key auxiliaries supporting the generator system include the seal oil system, stator coil cooling water system, and hydrogen cooling system.

Each of these subsystems plays a critical role in ensuring the smooth and efficient operation of the generator, while maintaining safety and reliability.

These systems are designed uniquely for the high-efficiency supercritical units at KTPS Koradi and are not available in similar configurations at other MSPGCL power stations.

The **seal oil system** is crucial for maintaining proper sealing of the generator shaft, preventing hydrogen leakage and ensuring the efficient cooling of the generator.

The seal oil pumps, integral to the system, are responsible for providing a consistent oil supply to maintain pressure balance and prevent hydrogen leakage. Proper functioning of the seal oil system directly impacts the generator's safety, as hydrogen leaks can pose a significant risk of explosion.

Additionally, the **stator coil cooling water system** is designed to regulate the temperature of the generator's stator winding. This system circulates demineralized water through the stator bars to ensure that heat generated during power production is effectively dissipated.

The stator cooling water pumps are critical for maintaining the necessary flow rate and pressure to avoid overheating of the stator windings, which could lead to insulation damage or even generator failure.

The cooling system, along with associated equipment, requires continuous operation to maintain the generator's performance.

The **hydrogen cooling system** is another vital component installed for the generator's efficiency. Hydrogen is used as a cooling medium because of its superior thermal conductivity and low density, allowing for better heat dissipation compared to air.

The hydrogen system consists of hydrogen gas driers, pressure regulators, and cooling fans. The driers are responsible for maintaining low moisture levels within the generator casing to avoid condensation, which could lead to corrosion or electrical shorts.

The hydrogen pressure control system ensures the hydrogen is maintained at optimal pressure for effective cooling, while the cooling fans help to circulate the hydrogen gas across the generator's heat-exchange surfaces.

Regular monitoring of hydrogen purity and pressure is critical to ensure that the generator operates under ideal conditions.

Over the past 8-10 years, since the commissioning of Units 8, 9, and 10 at KTPS Koradi, these auxiliary systems have been in continuous operation, and the equipment has aged, leading to a gradual decline in their performance and reliability.

The **auxiliary systems** for the generator are subjected to the rigors of high-temperature operations and constant pressure fluctuations, resulting in wear and tear over time.

The assemblies of these critical pumps, including spares, were supplied initially during commissioning but were consumed during previous overhauls, leaving no spare parts currently available at the site.

In addition, the components used in these systems are highly specialized, designed and manufactured by the OEM to meet precise operational requirements. This unique design means that local development of spares is not feasible, as it would compromise the quality, performance, and reliability of the systems.

The original components are made from specific materials and undergo critical manufacturing processes that ensure tight tolerances and long-lasting performance, further emphasizing the importance of adhering to the OEM's specifications.

Any deviations from the original design could result in operational inefficiencies, increased downtime, or potential safety hazards. The current maintenance and inspection of these systems are performed during scheduled overhauls or unit shutdowns.

During these periods, critical components are inspected for damage, wear, and deterioration, and replacements or repairs are carried out as per OEM recommendations. However, due to the unavailability of spare parts and the extended lead time required for ordering and receiving new components, there is a significant risk of extended outages in the event of a breakdown.

Given the aging of the equipment and the critical nature of the generator auxiliaries, it is crucial to ensure the availability of spare parts to maintain the reliability and performance of these systems.

Overall, the present system installed for generator auxiliaries at KTPS Koradi has been effective in supporting the generator's performance, but the lack of readily available spares, combined with the aging of the equipment, necessitates a robust strategy to improve system availability and avoid potential generation losses.

Regular procurement of OEM spares and upgrades to key components are vital to ensuring long-term reliability and minimizing downtime during maintenance activities.

Hence, it is of prime concern to keep assemblies of such equipment readily available in the stock so that they can be replaced immediately and the generation loss can thus be substantially reduced.

The equipment / components shall be kept as capital insurance spares so that during any unforeseen event the equipment can be replaced directly and the removed equipment can be sent for repair and thereafter can be kept as readily available spare for replacement in future.

This will help in reducing the down time of the critical auxiliaries to a substantial level. Also, this eliminates the need to maintain inventory of the high value spares for such critical auxiliaries.

Therefore, considering the above facts "Performance improvement and availability of various Auxiliaries of Generator system" is necessary to process. The DPR is hence prepared as a measure to reduce the prolong downtime required for restoration of system due to unforeseen failures of the critical auxiliaries.

2. Current Process-

The current process for the operation of various auxiliaries supporting the Generator System at 3x660 MW KTPS Koradi is designed to ensure optimal performance, cooling, and safety during the generation of electricity.

These auxiliaries, which include the seal oil system, stator coil cooling water system, and hydrogen cooling system, function continuously to support the generator's complex operations.

Each auxiliary system is integral to maintaining the overall health and reliability of the generator, ensuring that it runs efficiently under high-load conditions. The **seal oil system** works by providing a barrier between the generator’s rotating shaft and its hydrogen-cooled casing.

This system prevents hydrogen leakage, which is essential for maintaining a stable cooling environment. It operates through a network of pumps that supply oil to the seals, maintaining consistent pressure and preventing hydrogen from escaping.

The oil quality and pressure are continuously monitored to ensure there are no leaks, which could pose a risk of explosion or contamination.

In parallel, the **stator coil cooling water system** ensures that the generator's stator windings remain at a safe operating temperature. The system circulates demineralized water through the stator bars to absorb heat generated during power production.

Cooling pumps maintain the necessary flow and pressure to prevent overheating, which could damage the stator insulation and reduce the generator's operational lifespan. The temperature and flow of the cooling water are closely monitored, with alarms triggered in case of deviations from the designed parameters.

The **hydrogen cooling system** is equally critical in managing the heat generated within the generator. Hydrogen, chosen for its superior cooling properties, is circulated through the generator casing, helping to dissipate heat more efficiently than air.

The hydrogen pressure is regulated and maintained using pressure regulators, and the gas is kept dry with hydrogen driers to avoid condensation, which could lead to electrical faults or corrosion.

The purity and pressure of the hydrogen are monitored in real-time to maintain efficiency and prevent performance degradation. These auxiliary systems are interdependent, and their continuous monitoring is essential to prevent breakdowns and ensure seamless generator operation.

Regular inspections and preventive maintenance are conducted to address issues such as wear and tear, leaks, and component degradation. However, due to the aging of the equipment and the limited availability of OEM spares, there are challenges in maintaining these systems at peak performance.

Despite these challenges, the auxiliary systems continue to play a crucial role in safeguarding the generator’s performance and availability, with ongoing efforts to optimize their operation and prevent downtime.

3. Condition of asset under replacement-

The condition of various auxiliary systems supporting the Generator System at 3x660 MW Koradi Thermal Power Station (KTPS) has become a critical concern due to the age and wear of key components.

These auxiliary systems, which include the seal oil system, stator coil cooling water system, and hydrogen cooling system, play a vital role in ensuring the generator’s operational efficiency and preventing potential failures.

As the equipment ages, the performance of these systems has gradually declined, necessitating the replacement of major components to avoid generation loss, ensure safety, and maintain reliability.

Starting with the **seal oil system**, this auxiliary ensures that hydrogen, used to cool the generator, is effectively sealed within the generator housing. Over time, the seals, oil pumps, and related piping have deteriorated due to continuous operation, pressure fluctuations, and exposure to high temperatures.

Common issues include oil leaks, reduced pressure, and contamination in the oil, which compromises the system's ability to form an effective barrier. The pump motors and bearings have experienced increased friction and wear, further reducing system efficiency.

The declining condition of the seal oil system poses a significant risk of hydrogen leakage, which could lead to explosions or severe damage to the generator if left unchecked. Replacement of the seals, pump motors, and filters, along with the rehabilitation of oil tanks, is essential to restore the system's reliability.

The **stator coil cooling water system** is another auxiliary system in need of significant attention.

This system, which circulates demineralized water through the stator windings, has been impacted by erosion, scaling, and the gradual wear of critical components such as cooling pumps, valves, and heat exchangers.

Over time, the pumps responsible for circulating water have experienced reduced output due to mechanical degradation, leading to insufficient cooling of the stator windings. The reduced flow rate has caused overheating of the windings during peak load conditions, increasing the risk of insulation failure.

Additionally, scaling inside the heat exchangers has reduced their efficiency in dissipating heat, leading to higher operating temperatures within the generator.

Regular flushing and cleaning of the system have provided only temporary relief, and replacement of the pumps, valves, and heat exchangers is now required to restore the cooling system to its original operational standard.

The condition of the **hydrogen cooling system** has similarly deteriorated, raising concerns over its ability to effectively manage the heat generated by the generator. Hydrogen cooling, known for its superior thermal conductivity compared to air, is highly effective but also presents unique challenges.

The system components, including hydrogen circulation fans, pressure regulators, and hydrogen driers, have suffered from wear and tear after years of continuous operation. The hydrogen circulation fans have shown signs of imbalance and reduced speed due to the degradation of bearings and motor windings, reducing the system's ability to maintain uniform cooling across the generator.

Pressure regulators, which maintain optimal hydrogen pressure within the generator, have also experienced mechanical wear, leading to fluctuations in hydrogen pressure. These fluctuations compromise the cooling effectiveness and increase the likelihood of hot spots developing within the generator.

The hydrogen driers, which are essential for maintaining the purity and dryness of the gas, have become less efficient due to moisture accumulation in the desiccant beds and mechanical failure of drier units.

The reduced performance of these components has led to suboptimal cooling and increased risks of thermal damage to the generator’s internal parts. Replacing circulation fans, pressure regulators, and hydrogen driers is critical to ensure the system’s continued effectiveness and to prevent damage from overheating.

Overall, the condition of these auxiliary systems has declined significantly due to the natural aging of equipment, harsh operational conditions, and inadequate access to original equipment manufacturer (OEM) spares for maintenance.

The growing issues with pump performance, pressure regulation, and cooling efficiency across the seal oil, stator coil cooling water, and hydrogen cooling systems have increased the risk of failures that could lead to severe consequences, such as generation loss or even catastrophic damage to the generator.

Given the critical nature of these auxiliaries, their replacement has become a high priority to restore system reliability and performance.

The procurement of new components and assemblies, including advanced cooling pumps, modernized hydrogen circulation fans, upgraded pressure regulation systems, and high-efficiency heat exchangers, will enhance the auxiliary systems' performance.

These replacements will not only prevent further degradation but also reduce the frequency of unplanned outages and improve overall plant efficiency.

In addition, the use of modern, more efficient equipment will likely lower operational and maintenance costs over time by minimizing the need for frequent repairs and reducing energy consumption.

Replacing these aging auxiliary systems is an investment in the long-term reliability and efficiency of the generator system. It will safeguard the plant’s operational capacity, prevent costly breakdowns, and improve overall generation availability at KTPS.

Differential Pressure Regulator (DPR) Assembly and Stator Coil Cooling Water (SCCW) System

Differential Pressure Regulator (DPR) Assembly

Stator Coil Cooling Water (SCCW) System

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Mo: 8879021145 / 9823390248

4. Key Issues/Problems Faced-

- Seal leaks compromising the integrity of the system.
- Bearing wear leading to increased friction and operational inefficiency.
- Pump motor failures affecting performance and reliability.
- Contamination of seal oil heightening risk of hydrogen leaks.
- Increased safety hazards due to potential fire risks from oil spills.
- Accumulation of scale in pipes and components reducing efficiency.
- Erosion of vital parts leading to costly repairs and replacements.
- Inconsistent performance of pressure regulators affecting system stability.
- Cavitation causing erosion of impeller surfaces.
- Vibration problems resulting in noise and wear.
- Reduced lifespan and reliability of pumps due to cavitation damage.
- Delays in repair and overhaul processes due to parts unavailability.
- Extended downtime leading to production losses and reduced revenue.
- Increased risk of unscheduled outages affecting power supply reliability.
- Deteriorated auxiliary performance leading to reduced operational efficiency.
- Frequent repairs necessitated by wear and tear of aging components.
- Increased maintenance costs burdening operational budgets.
- Declining efficiency leading to higher energy consumption.
- High risk of hydrogen leakage posing significant safety hazards.
- Potential explosion risks due to failing seals.
- Increased maintenance requirements for seal oil systems.
- Oil leaks creating risks of non-compliance with environmental regulations.
- Necessary repairs can only occur during unit outages, impacting availability.
- Significant financial losses incurred during extended downtimes.
- Unavailability of backup systems exacerbating risks during maintenance.
- Deterioration of auxiliary systems adversely influencing overall parameters.
- No standby systems available, increasing downtime risk during failures.
- Inability to respond promptly to operational challenges.
- Deteriorated auxiliary systems limiting the overall loadability of the generator.
- Lower PLF affecting the efficiency and economics of power generation.
- Potential for hazardous incidents due to compromised system integrity.

5. Alternatives for replacement-

Option 1	Repairing at Manufacturer's Workshop	**Disadvantage** • Shipping equipment to the manufacturer's workshop can result in prolonged downtime, affecting plant operations and productivity. • Scheduling and waiting for repairs at the manufacturer's workshop often led to longer lead times compared to onsite repairs. • Once the equipment is sent off-site, plant personnel have less oversight and control over the repair process, causing communication delays and quality assurance issues. • Repairs at the manufacturer's facility may come with extra charges for testing, handling, and specialized equipment not anticipated during initial assessments. • There is an increased risk of mechanical damage during transit, which can further complicate and delay the repair process. • Small or urgent repairs might not justify the time and costs associated with sending equipment to the manufacturer's workshop. • The need for specific spare parts at the manufacturer's facility may cause additional delays if parts are not readily available.
Option 2	Repairing at Site locally	**Disadvantage** • Onsite repairs lead to a prolonged auxiliary outage, resulting in reduced operational availability during the repair period. • While the cost of onsite repairs may be moderate, it still presents a significant expense due to downtime and repair costs. • Onsite repairs can disrupt the overall plant workflow, as maintenance teams and plant operators must coordinate repairs while trying to maintain operational stability. • The quality of repair work performed onsite may not be at par with the original manufacturer's standards,

		affecting the long-term performance and reliability of the equipment. • MAHAGENCO may lack access to specialized tools, sophisticated test-beds, and machinery required to perform precise repairs or diagnose complex issues accurately. • Onsite repairs may result in a shorter service life for the repaired equipment, as the level of precision and quality control may not match manufacturer-repaired components. • All defects or underlying issues may not be fully addressed during onsite repairs, leading to recurring problems over time. • This can result in more frequent breakdowns or the need for future repairs.
Option-3 (Selected Option)	**Complete Replacement of the equipment for Performance improvement and availability of various Auxiliaries for Generator System 3x660MW, KTPS, Koradi**	**Advantage** • New equipment typically comes with improved designs and technology, which leads to greater reliability and performance compared to older systems that may have been prone to failure. • Replacing outdated equipment ensures that the new components have a longer operational life, reducing the frequency of replacements and maintenance activities. • Modern equipment often operates more efficiently, leading to lower energy consumption and reduced operational costs over time. • Newer equipment is designed to meet current industry standards and specifications, ensuring that it operates at optimal performance levels. • With new equipment, maintenance needs are generally lower during the initial years of operation, which can result in significant cost savings. • New equipment often comes with warranties and manufacturer support, ensuring that any issues can be addressed promptly without additional costs. • Replacing equipment can enhance the overall value of the facility, as newer equipment typically has a higher market value compared to outdated machinery.

		• By replacing older components that are prone to failure, the risk of unplanned outages due to equipment malfunction is minimized, ensuring more consistent operation. • New equipment may be more compact and efficient, allowing for better use of available space in the facility. • Up-to-date equipment often includes safety features that enhance operational safety for personnel, reducing the risk of accidents and injuries.

6. Essentiality of Procurement-

Hydrogen Side Seal Oil Pump (AC):

- This pump is crucial for maintaining the hydrogen seal oil system in generators.
- It supplies oil to seal the hydrogen inside the generator casing, preventing hydrogen leakage.
- Without proper hydrogen containment, the generator's efficiency drops significantly, and there's a risk of hydrogen leakage, which can lead to safety hazards.
- Continuous operation of this pump ensures reliable sealing and operational safety of the generator.
- Failure of this pump would result in significant downtime and potential damage to the generator, making it essential for smooth functioning.

Air Side Seal Oil Pump (AC):

- This pump is responsible for maintaining oil pressure on the air side of the generator's seals, ensuring that air does not leak into the hydrogen-filled areas.
- Air ingress into the hydrogen system can cause inefficiency, increase operational costs, and potentially lead to dangerous conditions.
- This pump is critical to maintaining the integrity of the generator and ensuring no air or hydrogen mix, which could lead to combustion risks.
- Keeping this equipment functional is vital for safe, continuous generator operation.

Differential Pressure Regulator:

- The differential pressure regulator controls and maintains the correct pressure balance between the hydrogen and oil systems, ensuring a stable environment inside the generator.
- A failure in this component can lead to hydrogen leakage or improper pressure balance, potentially leading to reduced generator efficiency and increased operational risks.
- The availability of a working regulator is essential to prevent any pressure-related failures and ensure smooth generator performance.

Hydrogen Dryer Complete Unit:

- The hydrogen dryer removes moisture from hydrogen gas used in the generator.
- Dry hydrogen ensures the generator operates efficiently and reduces the risk of electrical failures due to moisture.
- Moisture in hydrogen can lead to corrosion, inefficiency, and insulation failures in the generator.
- Procuring and maintaining a hydrogen dryer unit is critical to ensuring long-term reliability and preventing equipment damage caused by moisture buildup.

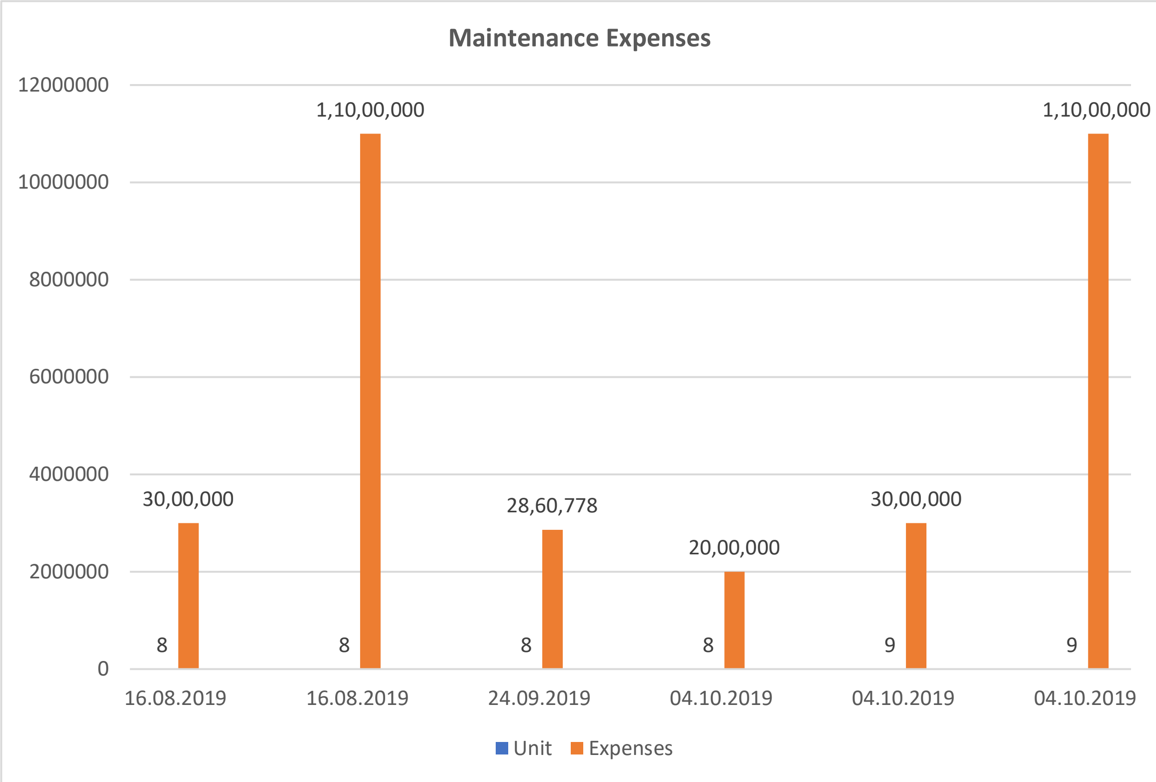
Stator Coil Cooling Water (SCCE) Pump Complete Assembly:

- This pump ensures proper circulation of cooling water to the stator coils, maintaining optimal temperatures within the generator during operation.
- Without proper cooling, the stator coils can overheat, leading to insulation damage, reduced efficiency, and potential failure of the generator.
- Ensuring the availability of a fully functional SCCE pump assembly is critical for the continuous and reliable operation of the generator at its rated load capacity.
- The procurement of these critical components—Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Complete Unit, and SCCE Pump Complete Assembly—is essential for maintaining the safe, efficient, and reliable operation of generators.
- These components ensure key functions such as hydrogen containment, pressure regulation, moisture control, and temperature management, which are all necessary to avoid costly outages, maintenance, and potential safety hazards.

Spares availability and proposed quantity

Sr. No.	Description	Installed Qty	Standby Qty	Spare with TPS	Proposed Qty	Spare as % of installed Qty
1	H2 side AC SOP	3	Nil	Nil	1	33%
2	H2 side SOP	6	3	Nil	1	16.6%
3	DPR	3	Nil	Nil	1	33%
4	H2 Dryer	3	Nil	Nil	1	33%
5	Stator CCW Pump	6	3	Nil	1	16.6%

Past 5-year maintenance expenses.



Past 5-year problems and maintenance expenses.

Sr. No.	Year	Unit	Auxiliary	Reason	Expenses
1	16.08.2019	8	Seal oil pump (H2 Side)	Replaced due to abnormal sound and vibrations	30,00,000
2	16.08.2019	8	Seal oil pump (Air Side)	Replaced due to abnormal sound and vibrations	1,10,00,000
3	24.09.2019	8	DPR Seal oil (Mandatory Spares)	Replaced due to malfunction of DPR during Hydrogen filling in generator (34,000+28,26,778)	28,60,778
4	04.10.2019	8	Stator Coil cooling water pump	Replaced due to abnormal sound and vibrations	20,00,000
5	04.10.2019	9	Seal oil pump (H2 Side)	Replaced due to Not developing pressure	30,00,000
6	04.10.2019	9	Seal oil pump (Air Side)	Replaced due to Not developing pressure	1,10,00,000
Total					3,28,60,778

Seal Oil sample analysis report dated 22.11.2022

MAH ASHTRA STATE POWER GENERATION COMPANY L
KORADI THERMAL POWER STATION 3 x 660MW
CHEMICAL DIVISION GENERAL LABORATORY

Test Report No :-CD/GL/OA/NOV.12
Name & Address of Customer :- TM Koradi TPS 3X660 MW
Ref. Letter No:-7346 on. date 22.11.2022

Date of Report: 23.11.2022
Sample Location: TM (3X660 MW) KTPS
Date of Sample Received: 22.11.2022

OIL SAMPLE ANALYSIS REPORT

	SAMPLE ID	Date of Analysis	SAMPLE	VISCOCITY (cSt) At 40°C	MOISTURE (ppm)	SEDIMENTATION %	ACIDITY mg of KOH/ gm of oil	Ferrous Debris Material (ppm)
1	SAMPLE/OA/NOV.98	23.11.2022	MOT OIL-U#08	30.97	29.5	BDL	0.112	5.0
2	SAMPLE/OA/NOV.99		SEAL-U#08	32.10	23.7	BDL	0.112	5.2
3	SAMPLE/OA/NOV.100		EH OIL-U#08	41.54	1400.0	BDL	1.510	0.0
4	SAMPLE/OA/NOV.101		MOT OIL-U#09	33.45	245.4	BDL	0.111	11.6
5	SAMPLE/OA/NOV.102		SEAL-U#09	33.23	22.0	BDL	0.111	10.0
6	SAMPLE/OA/NOV.103		EH OIL-U#09	40.64	1000.0	Tr	0.447	4.2
7	SAMPLE/OA/NOV.104		MOT OIL-U#10	36.16	36.7	BDL	0.112	9.0
8	SAMPLE/OA/NOV.105		SEAL-U#10	30.06	28.2	BDL	0.112	6.4
9	SAMPLE/OA/NOV.106		EH OIL-U#10	38.40	1100.0	Tr	0.336	3.6
10	SAMPLE/OA/NOV.107		TDBFP Filter Sample	32.10	6900.0	0.3	0.112	10.0

Note - 1) Samples are collected and deposited at OTL by TM section.
2) BDL- Below detectable limit
3) Tr- Traces.

24/11/22.
Executive Chemist
Koradi TPS 3X660 MW

Copy sub.w.r.to :-
1) S.E.(MPD) Koradi TPS, 3X 660 MW
2) S.E.(O), Koradi TPS, 3X 660 MW
Copy to :-
1) E. E (TM) Koradi TPS 3X 660 MW
2) E. E (MPD) Koradi TPS 3X 660 MW
3) E. E (POG) Koradi TPS 3X 660 MW

Seal Oil sample analysis report dated 16.02.2023

MAHARASH RA STATE POWER GENERATION COMPANY L D
KORA I THERMAL POWER STATION 3 x 660MW
CHEMICAL DIVISION GENERAL LABORATORY

Test Report No :-CD/GL/OA/Feb 23
Name & Address of Customer :- TM Koradi TPS 3X660 MW
Ref. Letter No :- 4805 dt 16.02.2023

Date of Report: 21.02.2023
Sample Location: TM (3X660 MW) KTPS
Date of Sample Received: 16.02.2023

OIL SAMPLE ANALYSIS REPORT

Sr. No.	SAMPLE ID	Date of Analysis	SAMPLE	VISCOCITY (cSt) At 40°C	VISCOCITY (cSt) At 100°C	MOISTURE (ppm)	SEDIMENTATION %	ACIDITY mg of KOH/ gm of oil	FERROUS DEBRIS MATERIAL (PPM)
1	SAMPLE/OA/FEB.144	21.02.2023	Unit- #08 EH OIL	40.64	---	1432.5	BDL	1.606	4.4
2	SAMPLE/OA/FEB.145		Unit- #09 EH OIL	43.33	---	1095.7	BDL	0.445	6.8
3	SAMPLE/OA/FEB.146		Unit- #10 EH OIL	41.09	---	1527.7	BDL	0.391	4.6
4	SAMPLE/OA/FEB.147		Unit- #08 MOT OIL	32.10	---	136.4	BDL	0.112	224.2
5	SAMPLE/OA/FEB.148		Unit- #09 MOT OIL	38.85	---	35.4	BDL	0.110	15.8
6	SAMPLE/OA/FEB.149		Unit- #10 MOT OIL	38.63	---	27.5	BDL	0.167	17.4
7	SAMPLE/OA/FEB.150		Unit- #08 SEAL OIL	35.48	---	22.6	BDL	0.111	19.0
8	SAMPLE/OA/FEB.151		Unit- #09 SEAL OIL	33.23	---	29.7	BDL	0.165	15.0
9	SAMPLE/OA/FEB.152		Unit- #10 SEAL OIL	33.91	---	35.6	BDL	0.112	17.6
10	SAMPLE/OA/FEB.153		Unit- #08 HPSU OIL	39.75	---	1057.7	BDL	0.166	7.2
11	SAMPLE/OA/FEB.154		Unit- #09 HPSU OIL	42.88	---	1908.6	BDL	0.223	5.4
12	SAMPLE/OA/FEB.155		Unit#10 HPSU OIL	39.07	---	1562.6	BDL	0.166	14.2

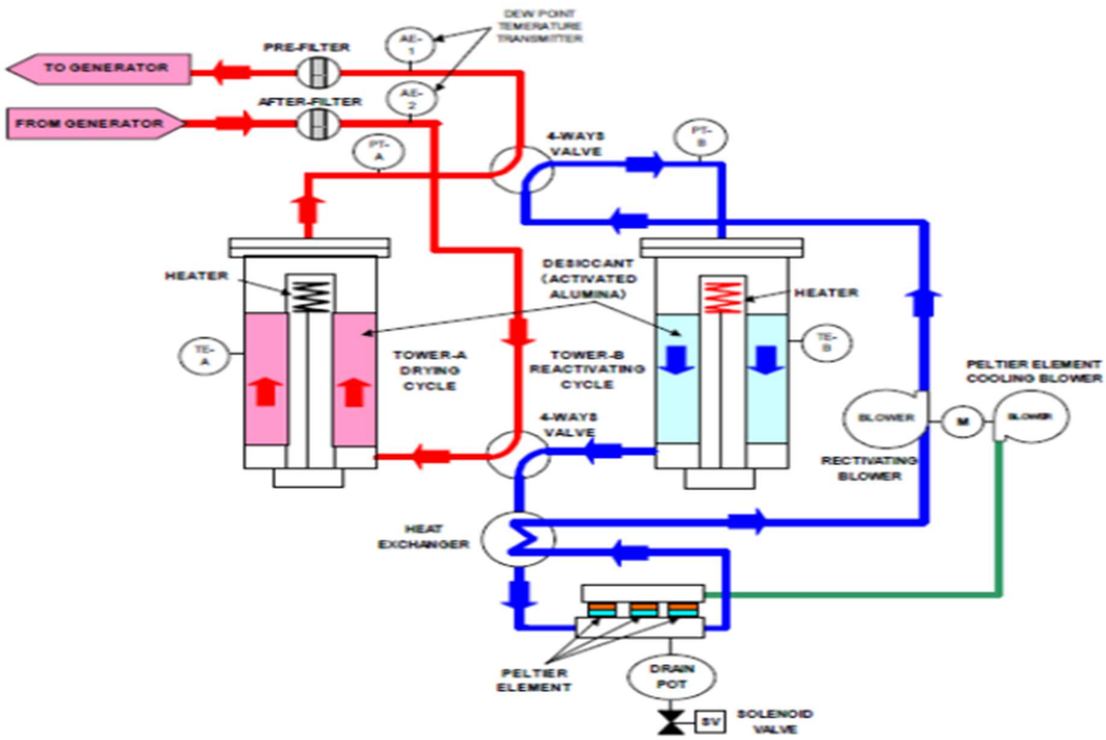
Note - Samples are collected and deposited at OTL by TM section.
Chemical requried for Moisture analysis not available in oil lab.
BDL-Below Detectable Limite

Executive Chemist
Koradi TPS 3X660 MW

Copy sub.w.r.to :-
1) S.E.(MPD) Koradi TPS, 3X 660 MW
2) S.E.(O), Koradi TPS, 3X 660 MW
Copy to :-
1) E. E (TM) Koradi TPS 3X 660 MW
2) E. E (MPD) Koradi TPS 3X 660 MW
3) E. E (POG) Koradi TPS 3X 660 MW

AE(C)

Outline circuit diagram of generator hydrogen dryer



7. Least cost analysis-

Cost benefit analysis.

- The generation loss due to unit outage due to unavailability of these critical equipment will be avoided if the of complete assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Complete Unit and Stator Coil Cooling Water (SCCE) Pump Complete Assembly that proposed in DPR schemes are readily available, this will also reduce the downtime for system restoration.
- The procurement of critical components and equipment is crucial for maintaining operational reliability and performance at Koradi Thermal Power Station (KTPS).
- This analysis emphasizes the importance of having these critical components readily available to prevent significant generation loss and financial implications resulting from unit outages.
- Considering Generation per day @85% = 13.46 MUs.
- Daily Savings Considering Equipment Availability and Considering Generation per day @85% = 13.46 Mus will be as per MYT order by MERC = Rs.1.91 Crores.
- This saving arises from avoiding generation losses due to unit outages, which can be caused by unavailability of essential equipment.
- The proposed components are critical in nature and must be 100% available as backup or standby systems.

- In the event of any unforeseen breakdowns or emergencies, having these components readily available is vital to prevent:
    - Unit outages
    - Catastrophic failures
    - Substantial monetary losses
- Considering the critical nature of these components, it is imperative to maintain a stock that allows for immediate replacement. This strategy minimizes downtime and ensures continuous plant operation.
- **Daily Cost Incurred Due to Unavailability:** Rs.1.91 Crores
- **Estimated Total Cost for Procurement:** Rs.7.31 Crores
- **Payback Period = Estimated Cost/Daily Savings = 7.31/1.91 = 3.83 days (less than 4 days)**

The procurement of critical equipment for KTPS is not merely an operational enhancement but a necessity to safeguard against potential outages and ensure continuous power generation.

The calculated payback period of approximately **3.86 days** underscores the financial viability of this investment, demonstrating that the benefits of having these components readily available far outweigh the costs.

By securing these critical components, KTPS can significantly reduce downtime for maintenance, enhance system reliability, and ultimately improve plant performance, leading to substantial savings and operational efficiency in the long run.

Technical Benefits:

- Improved availability of auxiliary systems will ensure consistent performance and minimize unexpected failures.
- Streamlined auxiliary operations will enhance the overall efficiency of the generator system, leading to better fuel utilization.
- Increased reliability and availability of auxiliaries will significantly decrease the frequency and duration of maintenance outages.
- Enhanced performance of auxiliary systems will enable quicker response to operational changes, optimizing power output.
- Implementation of advanced monitoring systems will allow for real-time adjustments, ensuring that auxiliaries operate within optimal parameters.
- Enhanced auxiliary performance will improve the plant's ability to handle higher loads and operate more flexibly under varying demand conditions.
- Regular maintenance and upgrades to auxiliary systems will help prevent performance degradation over time, ensuring sustained efficiency.
- Enhanced auxiliary reliability will contribute to safer operations and better compliance with environmental regulations.
- Improved auxiliary systems will reduce overall operational costs by decreasing the frequency of repairs and maintenance.

- Effective management of auxiliary systems will maximize resource utilization, contributing to a more sustainable operational model.

Financial Benefits:

- Enhanced performance of auxiliaries will lead to a higher load factor, resulting in more efficient use of generating capacity.
- Improved efficiency and availability of auxiliary systems will lower overall generation costs, contributing to better profitability.
- With increased reliability and reduced downtime, maintenance costs associated with auxiliary systems will be significantly minimized.
- Optimized operation of the generator and auxiliaries will result in better fuel efficiency, leading to substantial savings on coal and other fuel costs.
- Enhanced generation capacity and lower operating costs will positively impact cash flow, allowing for reinvestment in further improvements.
- Reduced outages and compliance with performance standards will help avoid penalties associated with non-compliance or operational failures.
- Investments in auxiliary improvements will yield long-term savings, offsetting initial capital expenditures through enhanced operational efficiency.
- Improved auxiliary performance will lead to more predictable and stable generation outputs, aiding in better financial planning and forecasting.
- Increased reliability and performance of the generator system and auxiliaries will contribute to the overall asset value of the plant.
- Improved operational flexibility may allow the plant to participate in ancillary services markets, generating additional revenue streams.

Quality/Service/Reliability Improvement:

- Improved auxiliaries will result in reduced downtime, ensuring that the generator system operates more consistently and reliably.
- Implementing performance improvements will significantly decrease the frequency and duration of system outages, contributing to uninterrupted power generation.
- Upgraded components and systems will enhance the overall reliability of the generator, leading to smoother operations and less unplanned maintenance.
- The availability of more reliable auxiliary systems will allow for scheduled maintenance to be more effective, reducing the likelihood of unexpected failures.
- Enhanced performance of auxiliaries will lead to more stable voltage and frequency outputs, improving the overall quality of the electricity generated.
- Improved auxiliaries will enable the system to respond more effectively to fluctuations in demand, ensuring optimal performance under varying load conditions.
- By maintaining optimal conditions, the quality of combustion will improve, leading to reduced emissions and better environmental compliance.

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- Enhanced communication and control between auxiliaries and the main generator system will improve overall system integration, leading to more efficient operations.
- Enhanced reliability and performance will boost operator confidence in the system, leading to more effective management and operation practices.
- Higher reliability and service quality will lead to greater satisfaction among customers and stakeholders, strengthening the plant's reputation in the energy market.

Proposed benefits/Key performance indicators

- Improved auxiliary systems will lead to fewer unexpected shutdowns, enhancing system availability and reducing downtime.
- Optimized auxiliary systems will boost the efficiency of power generation, increasing the PLF and overall energy output.
- With better-functioning auxiliary equipment, maintenance needs will decrease, lowering operational costs and extending the lifespan of critical systems.
- Savings generated from reduced outages, lower maintenance costs, and increased efficiency will contribute to a quick payback period for investments made in upgrading auxiliary systems.

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8. Recommendations-

Considering,

- Physical inspection, verification at site and photographs of damaged parts,
- Necessity components and materials that keep operations running smoothly, minimizing downtime and disruptions,
- Timely procurement of quality parts enhances equipment reliability, reducing the likelihood of unexpected failures that can lead to costly downtime,
- Mandatory assembly consumed and no spares available as insurance spares,
- Strategic procurement can lead to cost savings through bulk purchasing, negotiated contracts, and reduced inventory holding costs,
- Ensuring timely delivery of materials and reducing lead times,
- To improve operational efficiency of existing system,
- Improvement in operational performance parameters of the unit,
- To improve the heat rate and expected investment recovery through reduction in heat rate deviations,
- Reduction in maintenance expenses and reduction in inventory of spares,

Procurement of complete assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Complete Unit and Stator Coil Cooling Water (SCCE) Pump Complete Assembly for Performance improvement and availability of various auxiliaries for Generator System 3 x 660 Mw, KTPS, Koradi is the only option for improvement in efficiency, availability and reliability of 3 x 660 Mw Units, KTPS, Koradi.

It is better to Procure complete assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Complete Unit and Stator Coil Cooling Water (SCCE) Pump Complete Assembly and hence it is **recommended** Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Complete Unit and Stator Coil Cooling Water (SCCE) Pump Complete Assembly for Performance improvement and availability of various auxiliaries for Generator System 3 x 660 Mw, KTPS, Koradi.

9. Conclusion-

In view of above details and the DPR sent for scrutiny, need and information, The proposed scheme for Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Complete Unit and Stator Coil Cooling Water (SCCE) Pump Complete Assembly for Performance improvement and availability of various auxiliaries for Generator System 3 x 660 Mw, KTPS, Koradi is **recommended** for implementation.

10. DPR Vetting Report-

Basic Information-

Sr. No.	Particular	Description
1.	Name of the client	Koradi Thermal Power Station, Koradi
2.	Detail Address	Maharashtra State Power Generation Co. Ltd. 3X660, KTPS, Koradi, Dist. - Nagpur-441111 Maharashtra (India)
3.	Contact Details	Ph: 07109 – 262141 to 262146, 262109 E-mail: cegenkoradi@mahagenco.in

DPR Details-

Sr. No.	Particular	Description
1.	Name of DPR Scheme	Turbine Performance Improvement Schemes 3x660MW KTPS Koradi
2.	Sub Scheme Name	Procurement of complete assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Complete Unit and Stator Coil Cooling Water (SCCE) Pump Complete Assembly for Performance improvement and availability of various auxiliaries for Generator System 3x660MW, KTPS, Koradi
3.	Estimated Cost	7.31 Cr.
4.	Mode of Procurement / Implementation	OEM
5.	Implementation Period	24 months

Justification of the Scheme / Project-

S. N.	Particular	Justification	Remark
1.	Need of the scheme as per Regulation clause No. 5.1- (2)-a	Procurement of complete assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Complete Unit and Stator Coil Cooling Water (SCCE) Pump Complete Assembly are	**Procurement is justified** to replace the Existing Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Complete Unit and Stator Coil Cooling Water (SCCE) Pump

		necessary to Prevent Unplanned Outages, Improve System Reliability, Optimize Performance, Avoid Catastrophic Failures, Reduce Maintenance Downtime and Support Long-term Plant Efficiency. Currently, there are no available spare assemblies for these vital components. In case of a failure, the inability to replace or repair these components promptly could lead to extended downtime and huge revenue loss.	Complete Assembly during overhaul to improve operating performance, Unplanned Outages, Improve System Reliability, Optimize Performance, Avoid Catastrophic Failures, Reduce Maintenance Downtime and Support Long-term Plant Efficiency. In case of a failure, the inability to replace or repair these components promptly could lead to extended downtime and huge revenue loss.
2.	Urgency of the Scheme and Impact on performance, if the Capex investment is not done as per Regulation	The assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Unit and Stator Coil Cooling Water (SCCE) Pump are deteriorated and necessary to Prevent Unplanned Outages, Improve System Reliability, Optimize Performance, Avoid Catastrophic Failures, Reduce Maintenance Downtime and Support Long-term Plant Efficiency. Currently, there are no available spare assemblies for	**Justified** as existing assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Unit and Stator Coil Cooling Water (SCCE) Pump are deteriorated and necessary to Prevent Unplanned Outages, Improve System Reliability, Optimize Performance, Avoid Catastrophic Failures, Reduce Maintenance Downtime and Support Long-term Plant Efficiency. Currently, there are no available spare assemblies for

		these vital components. In case of a failure, the inability to replace or repair these components promptly could lead to extended downtime and huge revenue loss.	these vital components. In case of a failure, the inability to replace or repair these components promptly could lead to extended downtime and huge revenue loss.
3.	Expected Benefit as per Regulation clause 5.1- (2)-iv in Term of improvement in o Operational Parameters. o Efficiency o Redundancy o Adopting of latest technology	Improvement in efficiency, plant operational parameters, redundancy and help to reduce generation loss and maintenance expenses.	**Justified** as it will ensure improvement in efficiency, plant operational parameters, redundancy and help to reduce generation loss and maintenance expenses.
4.	Past Trend and Projected operational performance for next 5 Years as per Regulation Clause no – 5.1- (2)-f-v	Past trend of deterioration and utilization of spares necessitates the need of procurement of complete assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Unit and Stator Coil Cooling Water (SCCE) Pump for performance improvement and availability of various Auxiliaries for generator system, 3x660MW, KTPS, Koradi for improvement in efficiency, plant operational parameters,	**Justified** as Past trend of deterioration and utilization of spares necessitates the need of procurement of complete assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Unit and Stator Coil Cooling Water (SCCE) Pump for performance improvement and availability of various Auxiliaries for generator system, 3x660MW, KTPS, Koradi for improvement in efficiency, plant operational parameters,

		redundancy and help to reduce generation loss and maintenance expenses.	redundancy and help to reduce generation loss and maintenance expenses.
5.	Statutory Requirement as per Regulation clause 5.1- (2)-f-ii	Not Applicable	Not Applicable
6.	Mode of procurement / Implementation	OEM	OEM
7.	Quantifiable Tangible Benefit as per Regulation clause 5.1— (1)-m	To ensure efficiency, availability, redundancy, performance of operating parameters and to reduce loss.	Justified as it will ensure efficiency, availability, redundancy and performance of operating parameters and reduction in loss.
8.	Justification of Quantity Proposed as per Regulation clause No – 5.1- (2)-f-vi	Complete replacement of assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Unit and Stator Coil Cooling Water (SCCE) Pump is essential for improvement in efficiency, plant operational parameters, redundancy and help to reduce generation loss and maintenance expenses.	**Justified** as complete replacement of assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Unit and Stator Coil Cooling Water (SCCE) Pump is essential for improvement in efficiency, plant operational parameters, redundancy and help to reduce generation loss and maintenance expenses.
9.	Basis of Test Report, If Capex is for Asset Replacement as per Regulation Clause No – 5.1- (2)-f-vii	Not Applicable	Not Applicable
10.	Phasing of capital investment as per Regulation Clause No – 5.1- (2)-g-i	FY 2024-2025	FY 2024-25

11.	Cost Break-up including IDC as per Regulation Clause No – 5.1- (2)-g-ii	Yes 7.31 Cr	Yes
12.	Impact of Taxes on Project Cost as per Regulation Clause No – 5.1- (2)-g-iv	Yes Included 18%	Yes
13.	Reasonability/comparison of rates as per Regulation Clause No – 5.1- (2)-g-v	The budgetary offer from OEM.	Yes, OEM budgetary offer.
14.	Least Cost Analysis as per Regulation Clause No – 5.1- (2)-g-viii	various options considered and replacement of assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Unit and Stator Coil Cooling Water (SCCE) Pump is essential for improvement in efficiency, plant operational parameters, redundancy and help to reduce generation loss and maintenance expenses.	**Justified** as complete replacement of assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Unit and Stator Coil Cooling Water (SCCE) Pump is essential for improvement in efficiency, plant operational parameters, redundancy and help to reduce generation loss and maintenance expenses.
15.	Projected Revenue addition as per Regulation Clause No – 5.1- (2)-g-x	Not Applicable	Not Applicable
16.	Projected reduction in operating costs as per Regulation Clause No – 5.1- (2)-g-xi	Operating cost will reduce and investment will be pay back through loss reduction.	**Justified** as investment will pay back though loss reduction.
17.	Cost Benefit Analysis as per Regulation Clause No – 5.1- (2)-g-xii	enclosed	Yes
18.	Whether the Quantifiable and Verifiable Benefits as per Regulation Clause No – 8.2- (2)-c	Included	Yes

19.	Bill of Quantity as per Regulation Clause No – 8.2- (2)-h	Included	Yes
20.	Scheme is necessary to discharge the duties and obligations of the Applicant as per the Act or to meet any other statutory or safety requirement as per Regulation Clause No – 8.2- (2)-l	Not Applicable	Not Applicable
21.	All possible alternatives to the proposed Capex have been submitted as per Regulation Clause No – 8.2- (2)-m	Efficient and reasonable alternative is selected for Performance improvement and availability of various auxiliaries for Generator System.	**Justified** as efficient and reasonable alternative is selected for Performance improvement and availability of various auxiliaries for Generator System.
22.	Cost Estimate based on least of the quotations received from vendors as per Regulation Clause No – 8.2- (3)-c	OEM	OEM
23.	Whether the proposed Capex is the Least Cost Option as per Regulation Clause No – 8.2- (3)-f	OEM	OEM
24.	Category of DPR	CAPEX, DPR – **Insurance Spares** for improvement in efficiency, redundancy, to reduce generation loss and maintenance expenses.	Justified as improvement in efficiency, redundancy, to reduce generation loss and maintenance expenses.
25.	Objective of Capital Investment	Quality/Service/Reliability and efficiency Improvement and Performance improvement and availability of various auxiliaries for Generator System.	**Justified** as improvement in efficiency and Performance improvement and availability of various auxiliaries of Generator System.

26.	Any Reference of Study Report / recommendations of Expert	Expert/OES recommendations	**Justified** as recommendations from Expert/OES.
27.	Statutory / Safety Requirement	Not Applicable	Not Applicable
28.	Works intended for adaptation of latest Technology/ Improvement/ Up-gradation of Existing Infrastructure	Working performance of improvement and availability of various auxiliaries for Generator System.	**Justified** as working performance improvement and availability of various auxiliaries of Generator System.
29.	Statutory Clearances and Project Layout	Not Applicable	Not Applicable
30.	Detailed Justification for quantity proposed	Complete assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Unit and Stator Coil Cooling Water (SCCE) Pump is essential for redundancy and help to reduce generation loss and maintenance expenses.	**Quantity is justified** to ensure reliable operation, improvement in efficiency, plant operational parameters, redundancy and help to reduce generation loss and maintenance expenses.

In view of above details, need and information, The proposed scheme for Procurement of complete assembly of Hydrogen Side Seal Oil Pump (AC), Air Side Seal Oil Pump (AC), Differential Pressure Regulator, Hydrogen Dryer Complete Unit and Stator Coil Cooling Water (SCCE) Pump Complete Assembly for Performance improvement and availability of various auxiliaries for Generator System 3 x 660 Mw, KTPS, Koradi under subject is **recommended** for implementation.

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