

Report of Activities
during Major Site Study for RLA
at Unit 3 of Dadri TPS, NTPC, Nov. 30 to Dec. 8, 2015
under the India-Japan Cooperation for Efficiency and Environmental
Improvement of Coal Fired Power Stations

1. Background and justification

The Government of India has been making its strenuous efforts toward sustainable power supply through massive capacity addition. CEA and JCOAL embarked on their bilateral cooperation based on shared recognition that R&M as well as Life Extension (LE) of existing power plants are quite significant in this context, apart from new construction of large scale power plants under Ultra Mega Power Projects (UMPP).

In the light of the foregoing situation, a MOU of Pre-primary Study of Efficiency and Environmental Improvement of Coal-fired Power Stations was signed on April 30, 2010, in the presence of Deputy Chairman, Planning Commission of India, and Minister of Economy, Trade and Industry of Japan, under which and the following MOU diagnostic activities for eight (8) units out of three (3) state owned and four (4) NTPC owned TPS was performed. The proposed improvement has been under discussion at some of the partner utilities, though they have to take time for administrative reasons, etc.

Right now another MOU is at the last stage of government approval process; i.e. the fresh framework of cooperation is substantially in place, under which CEA, JCOAL and NTPC have agreed to conduct two important studies; that is, an RLA study at Dadri TPS and a replacement study at Badarpur TPS, both of which will immensely contribute to the efficiency and environmental improvement of coal power as well as power capacity enhancement in India.

2. Objective and scope of the RLA Study at Dadri TPS

The objective of the RLA Study is to identify the remaining life and the current condition of the target unit; Unit 3, to constitute the base for formulation of the plan of R&M implementation that is tentatively scheduled in 2018. The scope of the Study is BTG (Boiler, Turbine and Generator).

3. Purpose of the Major Site Study at Dadri TPS

- a. To conduct the required testing and inspection following the standard method and procedures in India while incorporating the applicable points of method and procedures in Japan.
- b. To conduct visual inspection according to the standard method and approach employed in Japan.
- c. To collect the required data and information for the RLA Study
- d. To observe O&M practices at the plant for advice and proposal later in the Final Report.

4. Period of implementation of the Major Site Study

From November 30 to December 4, 2015

5. Composition of the Japanese Expert Team

One leader/coordinator

Three boiler experts

Two electrical experts

Two turbine experts

6. Summary of Activities

◇ Day 1

Morning

Kick-off Meeting (all together)

Afternoon

Site tour (all together)

● Boiler

-Meeting for the final confirmation of the schedule and work items and procedures

● Electrical

-Data collection

● Turbine

-Instructed test positions and witnessed Replica & HT of LP rotor

-Replica & Hardness on the rotor shaft and MPI of the Turbine Blade

◇ Day2

● Boiler

- Instruction of test positions and procedures for replica collection of boiler hot parts
- Visual Inspection for Condition Assessment of Boiler Tubes (1st Pss)
- Electrical
 - Interview with Electrical Dep. and data collection
 - Visit main electricity equipment
 - Joint inspection of generator (tan delta and RSO test)
- Turbine
 - Instruction of test positions and witnessed Replica & HT of HP & IP valves
 - Instruction of test positions and witnessed UT of LP rotor
 - Performance data collection
- ◇ Day 3
- Boiler
 - Instruction of test positions and procedures for replica collection of boiler hot parts (All Day)
 - Visual inspection for conditional assessment of boiler auxiliaries
- Electrical
 - Interview with C&I Dep. and visit to C&I Dep. laboratory
 - Joint inspection of generator (PD test) and data collection
- Turbine
 - Collection of ST & Aux. drawings
 - Interviews on O&M of #3 ST (Troubles, S/P, etc.)
 - Observation of MPT of LP rotor blade groove
 - Collection of #3 ST history of Start/Stop
- ◇ Day 4
- Boiler
 - Interview with Boiler Maintenance Dep.
 - Interview with Operation Dep.
- Electrical
 - Data collection
 - Interview with Operation Dep.
- Turbine
 - Hearing of efficiency calculation
 - Review of the obtained survey of ST auxiliaries

✧ Day 5

- Boiler, Electrical, Turbine
 - Compilation of the Activity Report
 - Interim Wrap-up and Tentative Reporting to GGM, Dadri TPS

<< Followings are testing and inspections done by Indian Expert Team >>

- Boiler
 - Replica on CRH, HRH & M.S. Line. VI, DIM, PT & UT test on SHH. UT test on Water Wall Panel.
 - Replica on LTSH, SHH & Eco Inlet. VI, DIM, PT & UT test on LTSH & ECO. Thick. Measurement on Water wall.
- Turbine
 - Eddy Current Test in Condenser (completed only approx. 7% of tubes due to scaling)

✧ Day 6

- Boiler
 - Replica on Feed Water Line. Hardness test on ECO, Boiler drum, LTSH & PLSH. VI, PT & DIM on Feed water piping, Water wall Panel and SHH-4, 5 & 6.t
 - Replica on PRDS Line. VI, PT & DIM of Feed water piping and attemperator link pipe.

✧ Day 7

- Boiler
 - Hardness test on LTSH Coil, Final SH coil. VI, PT & DIM in SCW and PRDS Line
 - Hardness test on Re-heater Inlet outlet, PLSH, LTSH, FSH & RH coils. UT test on Hopper bottom bend, hopper bottom slop, Rear arch nose panel, Water wall tubes and water wall ring header.

✧ Day 8

- Boiler
 - DPT, DIM on PRDS Main Line. DIM in Bottom ring header and Radiand roof tube.

7. Comments by Japanese Experts

a. Residual Life Assessment for boiler tubes

While the basic philosophy of Boiler RLA is common between NTPC and JCOAL Team, we've found some differences in method and procedure of replica collection. This time replica collection was done following the standard method and procedure of Kyushu Electric Power.

b. Conditional assessment for boiler and its auxiliaries

We have observed that Dadri has achieved high standards of maintenance management and keeps a set of best practices based on their own experiences.

c. Conditional assessment for generator and electrical equipments

According to our observation, the plant sustains its value thanks to timely and appropriate updates and maintenance of equipment, all of which are realized through excellent management by NTPC.

d. Turbine replica collection

Some replica inspection points of HP & IP Valves were changed, due to difficulty of polishing.

e. Additionality about turbine inspection

UT inspection on the LP rotor was applied additionally.

f. L-0 blades condition

Erosion by drain attack on L-0 blades surface is not so severe considering that it has been operating more than 20 years

g. Low cycle fatigue analysis on turbine

Repeated number of Start & Stop of #3 ST is about 250 times. Low cycle fatigue analysis will be carried out basing on this number

h. Turbine assessment method and procedure

Microstructure of replica will be observed by microscope in laboratory. Final assessment of the residual life will be made using these microstructural data, operating temperature, stress and period, by employing the latest Japanese technology and approach.

8. Forthcoming schedule of the study

Data Analysis: December 2015 to February 2016

Reporting: Mid to late February 2016

Provision of the final report: March 2016

9. Appendix

Appendix - I Table Outline of the work

Appendix - II Presentation at Kick-off Meeting

Appendix - III Presentation at Interim Wrap-up Meeting

Table Outline of the work: Residual Life Assessment for Unit#3, Dadri Thermal Power Station, NTPC conducted by JCOAL

Day		Boiler		Electrical		Turbine	
		Japanese experts	Indian experts	Japanese experts	Indian experts	Japanese experts	Indian experts
1	AM	Kick-off Meeting					
		Site tour					
	PM	• The meeting for the final confirmation of the examination schedule and contents between the Japanese experts		• Data collection		• Instructed test positions and witnessed Replica & HT of LP rotor	Replica & Hardness on the rotor shaft and MPI of the Turbine Blade
	Note					Replica & Hardness: Three Locations	
2	AM	• Instructed test positions and procedure for Replica of Boiler Hot	Videoprobe in headers in Pent House	• Interview to Electricity Dep. and data collection		• Instructed test positions and witnessed Replica & HT of HP & IP	Replica & Hardness on the rotor shaft & Blade Grooves, MPI of the Turbine
	PM	• Visual Inspection for Condition Assessment of Boiler Tubes (1st Pss)	Videoprobe in headers in Pent House	• Visit main electricity equipment • Joint inspection of Generator (tan delta and RSO test)	Electrical Test in Generator- Stator & Rotor	• Instruction of test positions and witnessed UT of LP rotor • Performance data collection	Replica & Hardness on the HP & IP Valve & UT test on the Rotor Shaft and MPI test of the Turbine Blade
	Note		Completed		Completed	Some positions of Replica & HT of HP & IP valves are limited due to space	Replica and UT Completed
3	AM	• Instruction of test positions & procedure for Replica of Boiler hot parts (All Day) • Visual Inspection for Condition Assessment of Boiler Aux.	Replica On the Superheater Outlet Header & Reheater Outlet Header Left side	• Interview to C&I Dep. and visit C&I Dep. Laboratory	UT test on Generator Retaning Ring	• Obtained ST & Aux. drawings • Hearing of O&M of #3 ST (Troubles, S/P etc.)	MPI test of the Turbine Blade
	PM	• Visual Inspection for Condition Assessment of Boiler Aux.	Replica on the Main steam pipe line	• Joint inspection of Generator (PD test) and data collection		• Observed MPT of LP rotor blade groove	DPT test & Visual Inspection on the turbine auxiliaries
	Note		Completed		Completed		In progress
4	AM	Interview to Boiler Maintenance Dep.	Replica On the Main steam pipe line (Repeat) & HRH Line Visual, DPT and DIM: PLSH, RH / VI of FSH/ VI, DPT, UT of LTSH and	• Data collection		• Hearing of efficiency calculation • Reviewed obtained data & drawings	DPT test & Visual Inspection on the turbine auxiliaries
	PM	• Interview to Operation Dep.	Replica On the Final SH, Re-heater & Platen SH Header. (Inlet & Outlet) VI: Eco to Boiler Drum Link pipe, Boiler Drum and Downcomer Pipe/ VI and DPT of link pipe FSH	• Interview to Operation Dep.		• Survey of ST Aux.	DPT test & Visual Inspection on the turbine auxiliaries
	Note		In progress		Completed	• DCS display around #3 ST at rated load after this O/H is to be printed out and	
5	AM	• Compilation & Data collection • Interview to Maintenance Dep.	Replica on CRH, HRH & M.S. Line. VI, DIM, PT & UT test on SHH. UT test on Water Wall Panel.	Compilation & Data collection		• Compilation	Eddy Current Test in Condenser
	PM		Replica on LTSH, SHH & Eco Inlet. VI, DIM, PT & UT test on LTSH & ECO. Thick. Mesurement on Water wall.	Wrap-up Meeting			Eddy Current Test in Condenser (completed only approx 7% of tubes due to scaling)
6	AM		Replica on Feed Water Line. Hardness test on ECO, Boiler drum, LTSH & PLSH. VI, PT & DIM on Feed water piping, Water wall Panel and SHH-4, 5 & 6.				
	PM		Replica on PRDS Line. VI, PT & DIM of Feed water piping and attemperator				
	Note						
7	AM		Hardness test on LTSH Coil, Final SH coil. VI, PT & DIM in SCW and PRDS Line				
	PM		Hardness test on Re-heater Inlet outlet, PLSH, LTSH, FSH & RH coils. UT test on Hopper bottom bend, hopper bottom slop, Rear arch nose panel, Water wall tubes and water wall ring header.				
	Note						
8	AM		DPT, DIM on PRDS Main Line. DIM in Bottom ring header and Radiand roof				
	PM		Completed				
	Note						



Japan Coal Energy Center (JCOAL) and its engagements under the CEA-JCOAL Cooperation

**Japan Coal Energy Center (JCOAL)
At Kick-off Meeting for RLA Study at Dadri TPS
November 30, 2015**

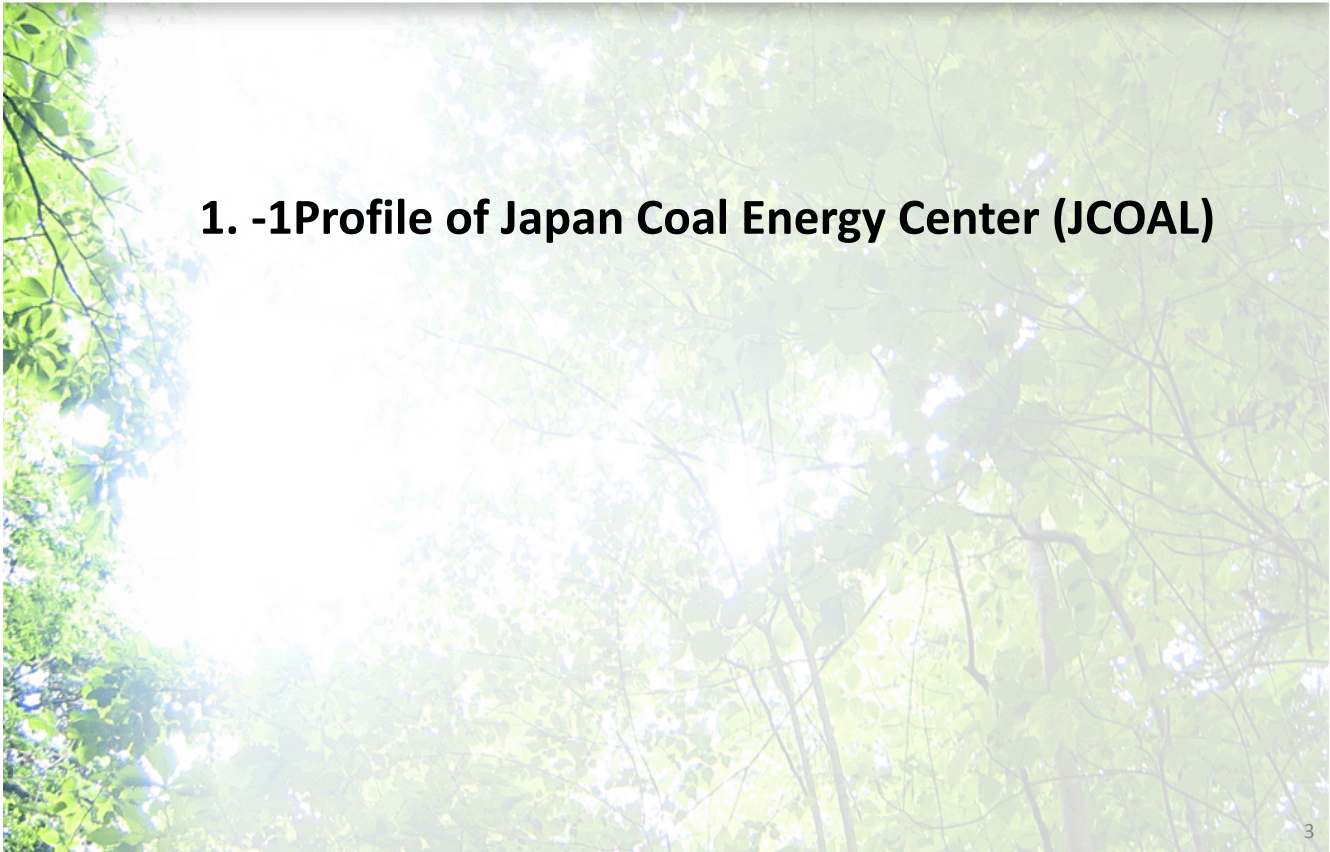
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Overview



- 1. JCOAL and its activities in India Coal Sector**
- 2. Outline of the India-Japan cooperation for improvement of coal fired power stations**
- 3. On-going activities**
- 4. Summary**

2



1. -1 Profile of Japan Coal Energy Center (JCOAL)

Japan Coal Energy Center (JCOAL)



- Established as a foundation in 1990, with its origin back to 1948
- Covers all coal related issues from upstream to downstream of the coal chain
- Members: 119 incl. major public-listed companies and main players in energy and relevant sectors
- Supervision by METI (Ministry of Economy, Trade and Industry of Japan)

Facilitation and promotion of cleaner utilization of coal



Mining & Preparation



Exploration

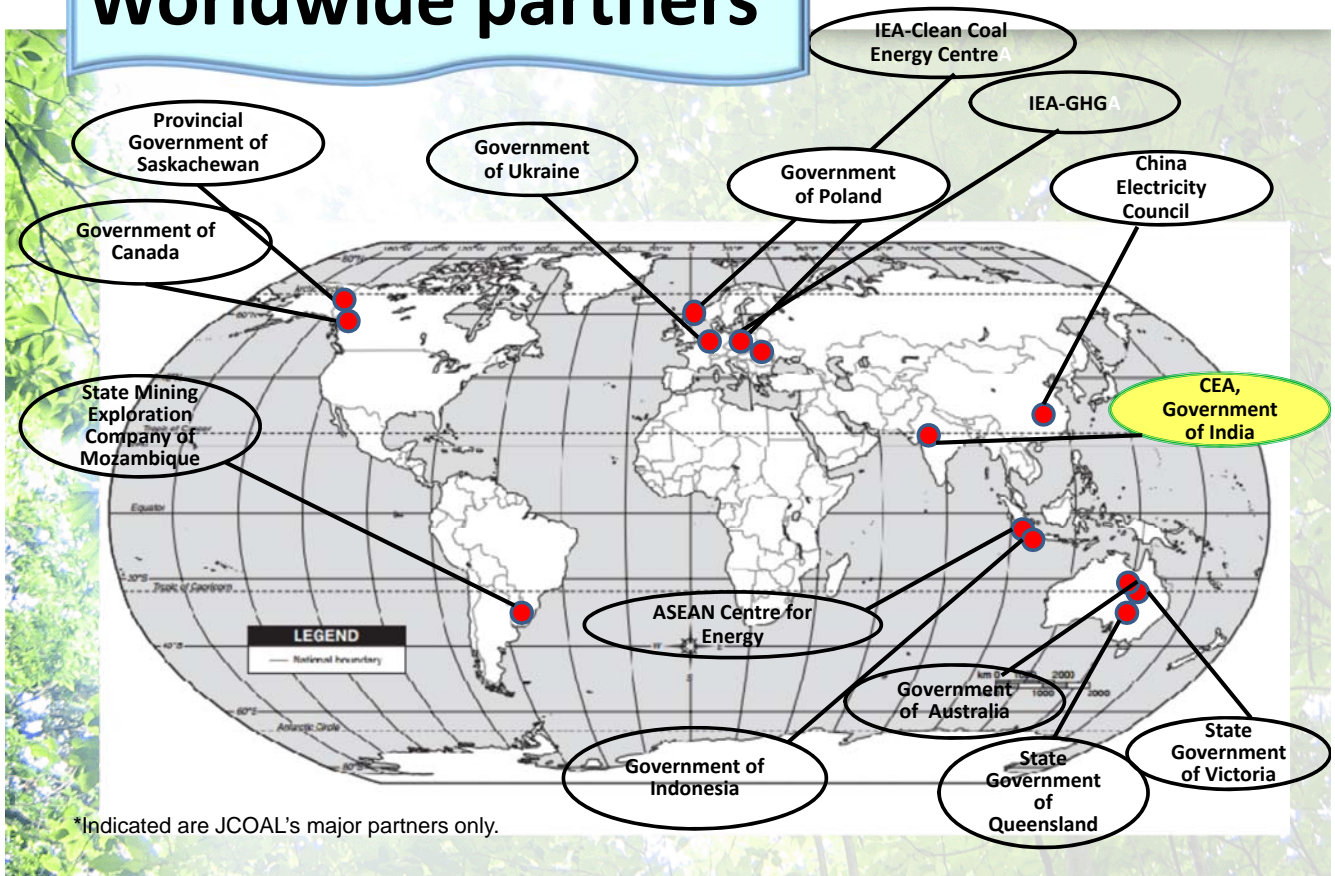


Coal utilization technology development





Worldwide partners



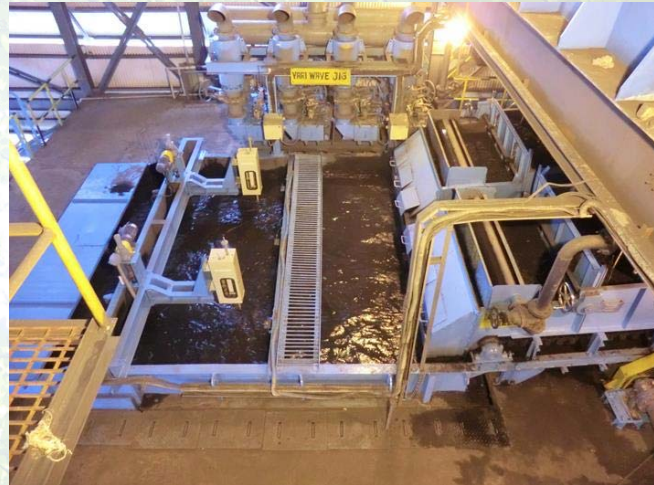
1.-2 JCOAL activities in India Coal Sector

High Efficiency Coal Washery Plant (NEDO)



High efficiency coal preparation plant in Odisha

- ✓ High efficiency coal preparation plant with the latest vari-wave jig technology with a capacity of 350t/h. has been commissioned on July 25th, 2014 in Angul, Odisha.



Source: NEDO (New Energy and Industrial Technology Development Organization)

CCT Transfer/Knowledge and Technology Exchange Program on coal preparation technology



CCT transfer project on coal preparation technology

- ✓ Coal preparation technology is deemed to be a key technology to address the requirement of high ash coal processing and a course on the technology under the scheme of CCT Transfer Program has been arranged and conducted.
- ✓ 150 Indian experts out of the grand total of 1,305 participants visited Japan on the Program as of the end of JFY2011.
- ✓ Exchanges under the Program have been conducted in both ways; through having the relevant sector stakeholders visiting Japan and also by dispatching Japanese experts to India.



Vari-Wave Jig (KCM)



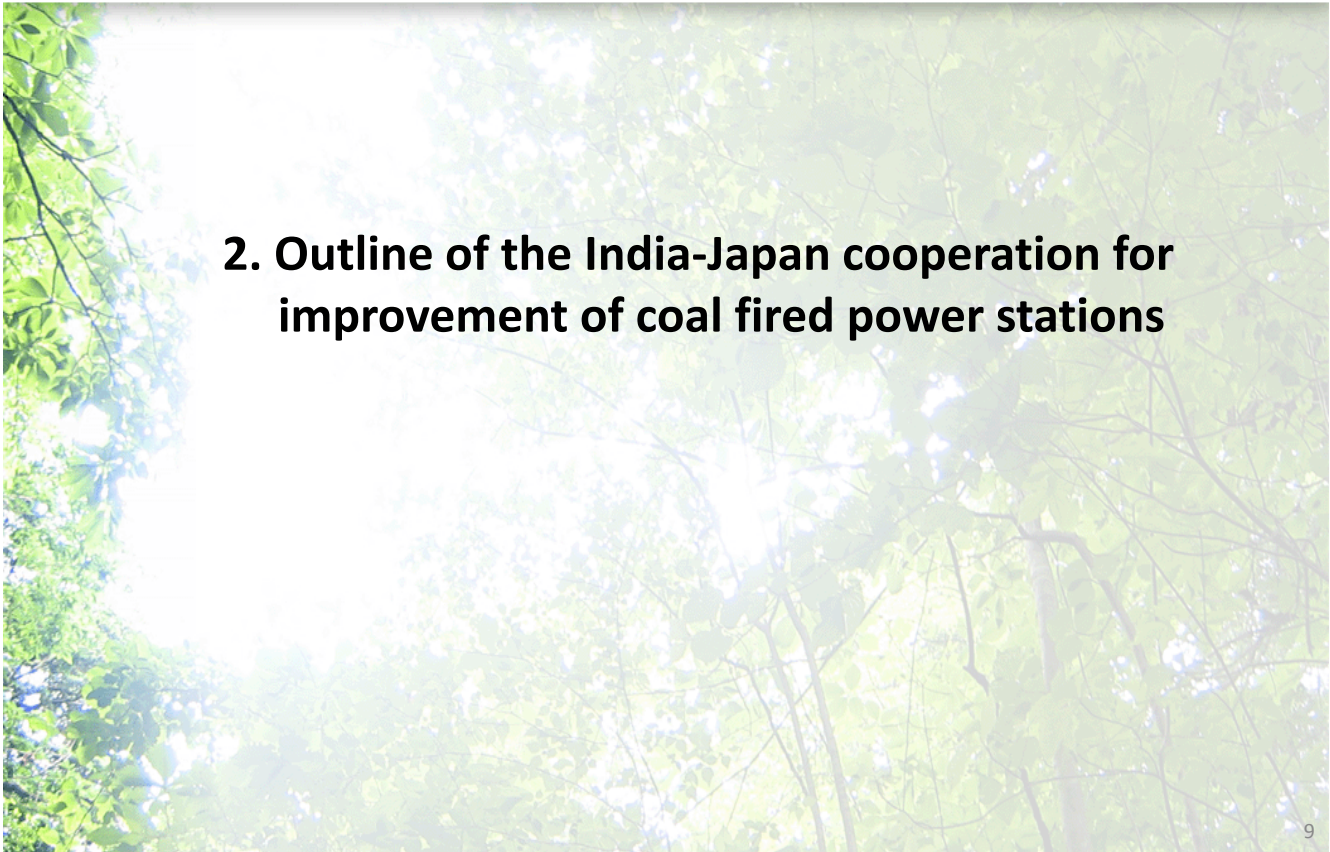
Control panel (KCM)



Port facilities (Kushiro)



Dry separation facility (Nagata Eng.)



2. Outline of the India-Japan cooperation for improvement of coal fired power stations

Short history of CEA-JCOAL Cooperation



<p>FY 2010</p>	<p>A MOU of Pre-primary Study of Efficiency and Environmental Improvement of Coal-fired Power Stations was signed on April 30, 2010, in the presence of Deputy Chairman, Planning Commission of India, and Minister of Economy, Trade and Industry of Japan. Diagnostic activities for two (2) state owned and one (1) NTPC owned TPS Diagnostic activities for two (2) state owned, one (1) NTPC owned TPS R&M Workshop in Delhi</p>	
<p>FY 2011</p>	<p>A MOU for the Project on Efficiency and Environmental Improvement of Coal fired Power Station was signed on June 11, 2012.</p>	
<p>FY 2012</p>	<p>Diagnostic activities for Durgapur of DVC, Unchahar & Badarpur of NTPC were conducted; all of which were referred to in the Joint Statement on the occasion of the 6th Japan-India Energy Dialogue between the Ministry of Economy, Trade and Industry of Japan and the Planning Commission of India on October 10, 2012. CCT workshop in Delhi</p>	
<p>FY 2013</p>	<p>Follow up activities in close cooperation with partner utilities as well as CEA have been ongoing. CCT Transfer program for the relevant stakeholders of India power sector has been carried out. CEA-JCOAL workshop in Delhi</p>	
<p>FY 2015</p>	<p>Next MOU with CEA is expected to be signed very soon. CCT Transfer Program in its 3rd year is to be conducted in Jan-Feb 2016; RLA Study for Dadri and FS for Badarpur is on-going.</p>	



Scope of diagnostic activities

Target power station	Conducted in FY	O&M	Boiler	Turbine	ESP	BOP
Ramagundam, NTPC	2010		○		○	
Kahalgaon, NTPC	2011			○	○	
Unchahar, NTPC	2012	○	○	○		
Badarpur, NTPC	2012		○	○		○
Wanakbori, GSECL	2010 & 2011		○	○	○	
Dr. NTTPS, APGENCO	2010-2012			○	○	
Durgapur, DVC	2012		○	○		

Risk Based Maintenance is recommended

Discussion is on-going in preparation for R&M tender and implementation including LMZ turbine rehabilitation based on diagnosis with measurements and cost-benefit analysis

HPT has been awarded as contractor for ESP rehabilitation at NTPC's Rihand Power Station

Some others are also under consideration

CCT Transfer/Knowledge and Technology Exchange Program for the power sector



First group of Clean Coal Technology (CCT) Transfer Program was implemented in October, 2013 reflecting the newly incorporated item of activities under the CEA-JCOAL Cooperation for the Project on Efficiency and Environmental Improvement of Coal fired Power Stations. They visited relevant equipments or facilities actually working and effective and see the high technology of O&M in subcritical coal-fired thermal power station, the latest USC technology, etc. and exchange views with Japanese experts.

2013 : 9 delegates in 1 Group

2014 : 42 delegates in 3 Groups

2015 : 20 delegates in 2 Groups



CEA-JCOAL Workshop



Project on Efficiency and Environmental Improvement for Sustainable, Stable and Low-carbon Supply of Electricity

CEA –JCOAL annual Workshop is held in Delhi so that all relevant organization can participate to hear latest topics and discuss the pressing issues to be addressed in India power sector.

Focus of each workshop

2010 : Debriefing of Diagnosis at 3 TPS

2011 : R&M technologies Diagnostic plan in 2011

2012 : Technologies in coal utilization, blending and R&M for existing unit

2013 : Technologies of USC and its O&M, Outcomes of Diagnosis

2014 : USC, O&M, Emission control, coal quality evaluation, Finance,

2015 : USC, Environmental measures, Finance,



13



3. On-going activities

14



The forthcoming MOU is further focused

1st and 2nd MOU (2010 - 2015)

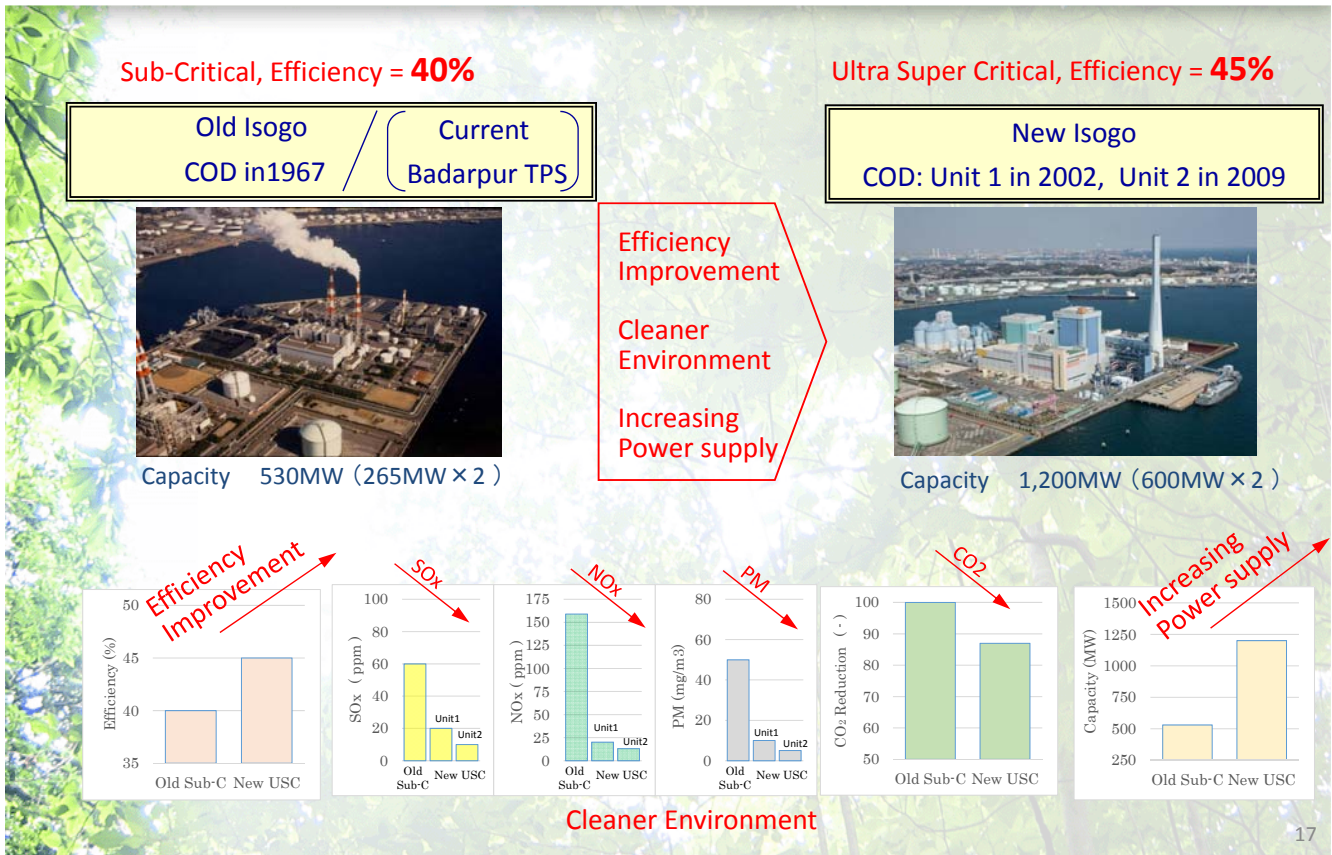
<u>4 mainstays to meet surging power demand</u>	Diagnostic Activities	CCT Transfer programme	Workshop
Capacity addition		✓	✓
R&M	✓	✓	✓
demand side management			
Renewable energy			

The forthcoming MOU is further focused



<u>Thrusts to meet surging power demand</u>		Diagnostic Activities	Replacement FS	CCT Transfer programme	Workshop
Fresh capacity addition	High efficiency SC/USC		✓	✓	✓
	Environmental measures	✓	✓	✓	✓
R&M	R&M or replacement of Existing plant	✓	✓	✓	✓✓
	demand side management	↑ Dadri, NTPC		↑ Gov. institutions and utilities	↑ All designated power sector stakeholders
Renewable energy	↑ Badarpur, NTPC				

Feasibility Study of Replacement of Badarpur TPS HELE: High Efficiency Low Emissions



Outline of Combustion Test of Indian Coal



Background

- Regulatory enhancement on emissions from power station is under discussion by the Government of India. That may be introduced as a new regulation.
- Japan may provide a set of knowledge, experience and technology that has been obtained through coping with the emission issues and achieving low emissions of dust, Sox and Nox.

Objectives

- Acquisition of data about performances of the emission control system
- Feasibility study

Expected Results

- Low emission by the combined system of SCR low-temperature EP and FGD system
- Basic design for the next stage; demonstration

Source: MHPS

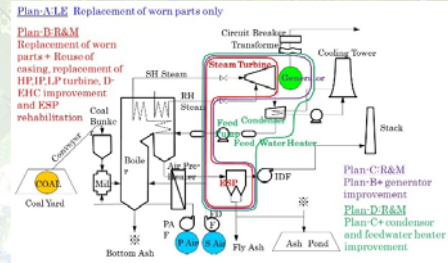
18



R&M (1): Follow-up activities

Follow-up by sharing of the diagnosis experiences with potential partner utilities

Plan	Policy (Effect)	Specification	Upper: Capacity(MW)		Lower: Heat rate(Kcal/kWh)		Analysis
			Design	Actual	After R&M	After R&M	
A (LE only)	Keep the status quo with 20 year LE	Replacement of worn parts only			—	—	Required cost for 20 years LE
B	Keep rated capacity 210MW with heat consumption rate improvement by 5% and 20 year LE	Reuse of casing, replacement of HP,IP,LP turbine, D-EHC improvement and ESP rehabilitation	210	2420	+10 210	-120 2300	High FIRR with environmental improvement
C	Uprate of rated capacity to 225MW heat consumption rate improvement by 5% and 20 year LE	Plan B+ generator improvement	2350	2000	+25 225	-120 2300	Good FIRR with environmental improvement even with LE
D	Uprate of rated capacity to 225MW heat consumption rate improvement by 5% and 20 year LE	Plan C+ condenser and feedwater heater improvement			+25 225	-140 2280	Environmental improvement and low FIRR with current price level of electricity



R&M proposal of Plan B,C and D are found to be effective for efficiency and environmental improvement as well as economically beneficial.

Two from State Utilities will be selected to introduce our main proposal for R&M.

March, 2016

R&M (2): RLA Study at Unit 3 of Dadri TPS: Background



The initial idea came from NTPC in July 2014, when JCOAL discussed with NTPC how to make the relevant knowledge, technology and experience Japan has nurtured may be utilized in R&M in India, in relation to which the planned R&M of Dadri in 2018 and possibility of involvement of Japanese expert team came up. Based on it, CEA, NTPC and JCOAL have been together deliberating and discussing to conduct an RLA study for Dadri under the framework of the CEA-JCOAL Cooperation.



R&M (2): RLA Study at Unit 3 of Dadri TPS: Schedule

- Preliminary data collection : Sept. 10, 2015
- Hot/cold walk-down survey: November 2, 2015
- Visual inspection of the inner part of LP turbine: November 23, 2015
- Major site study: November 30 to December 10, 2015
- Data Analysis : December 2015 to February 2016
- Reporting: Mid to late February 2016
- Provision of the final report: March 2016

21

R&M (2): RLA Study at Unit 3 of Dadri TPS: Basic framework



- JCOAL will be responsible in interacting with NTPC on behalf of the Team, so the Leader/Coordinator from JCOAL will participate in the site study until it is over on December 10.
- Testing and inspection work is undertaken by our sub-team of Indian experts in close consultation with the sub-team of Japanese experts. The report of testing and inspection will be first submitted to our Japanese experts for deliberation and examination, followed by analytical work.
- Japanese experts mainly engage in analysis & judgment of replication and hardness data, making judgment and providing advice during the site study.
- Reporting and provision of the report will be conducted by JCOAL Team.

22



We look forward to working with you

Website:

<http://www.jcoal.or.jp/index-en.html>

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Overview Of Kyushu Electric Power(KEPCO)'s Team

November 2015

Kyushu Electric Power Co., Inc.



Purpose of Diagnosis Work on RLA,O&M Dadri TPS

Taking advantage of the knowledge of Japan, comprehensively carried out the testing and inspection for each unit, and the confirmation of the state of equipment

- (1) Remaining Life Assessment for Boiler Tubes
 - Super Heater Outlet Header / Re-Heater Outlet Header
 - Main Steam Pipe / Hot Re-Heater Pipe etc.
- (2) Condition Assessment for Boiler and its auxiliaries
- (3) Condition Assessment for Generator and Electric Equipments
- (4) O&M improvement
 - Maintenance and /or Improvement of Thermal Efficiency
 - Power Saving and /or Cost Saving based on Our Experience
 - Occupational Health, Safety and Environment

Schedule

Site survey : 2015. 11. 30 – 12. 4 (at Dadri TPS)

JCOAL Work on Dadri TPS in India**Draft Schedule of the Work at Dadri TPS**

Date	Day	Time	Activities	
30 Nov.	Mon.	AM	Kick-off Meeting / Site Tour (Taking Photos)	
		PM	Site Tour (Taking Photos)	
1 Dec.	Tue.	Witness to Generator Electrical Tests	Witness to Boiler NDT Inspection	Replication Sampling (Super Heater Outlet Header)
2 Dec.	Wed.	Witness to Electric Equipments Inspection	Witness to Boiler auxiliaries Inspection	Replication Sampling (Re-Heater Outlet Header)
3 Dec.	Thu.	Interview on I&C and Electrical Equipment	Interview on Mechanical Maintenance & Operation of Balance of Plant	Replication Sampling (Main Steam Pipe/Hot Re-Heater Pipe)
4 Dec.	Fri.	AM	Site Tour (Taking Photos)	
		PM	Wrap-Up Meeting	

These schedule is tentative and will depend on actual site condition and availability of front

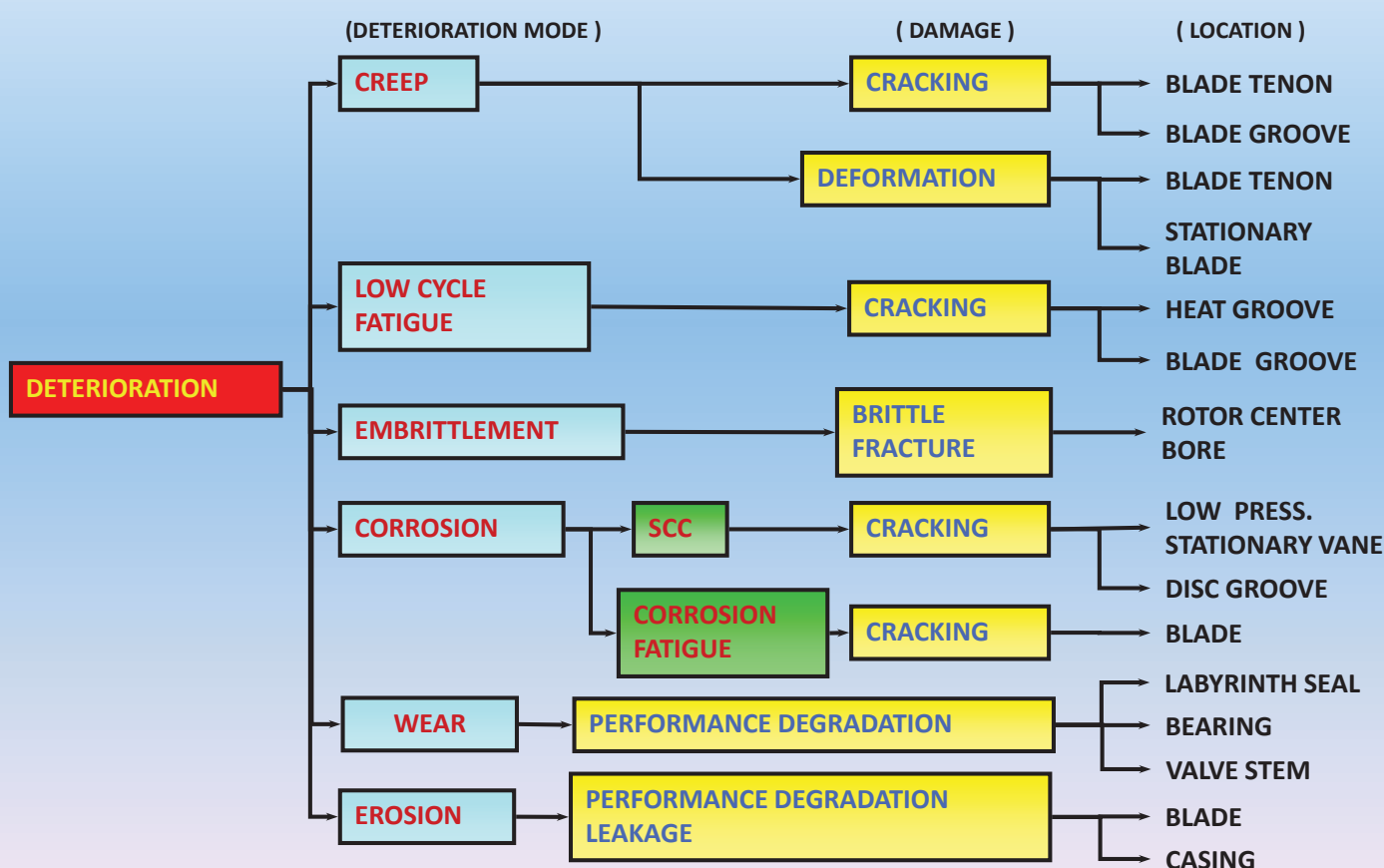
JCOAL Work on Dadri TPS in India**The Team Members****Kazutoshi HIWAKI****(Mechanical)****Masatoshi YAMAMOTO****Satoshi NAKASHIMA****(Metallurgical)****Ryoussuke TANIGUCHI****(I&C, Electrical)****Shinya KONDO**

Integrity Inspection for Life Assessment of ST

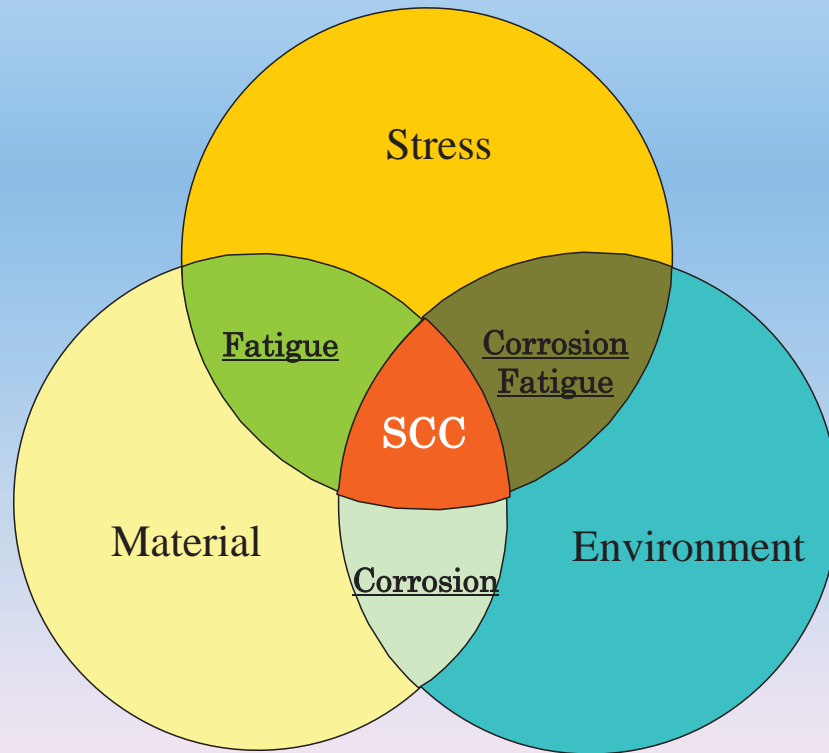
JCOAL / Turbine Team

- November 2015 -

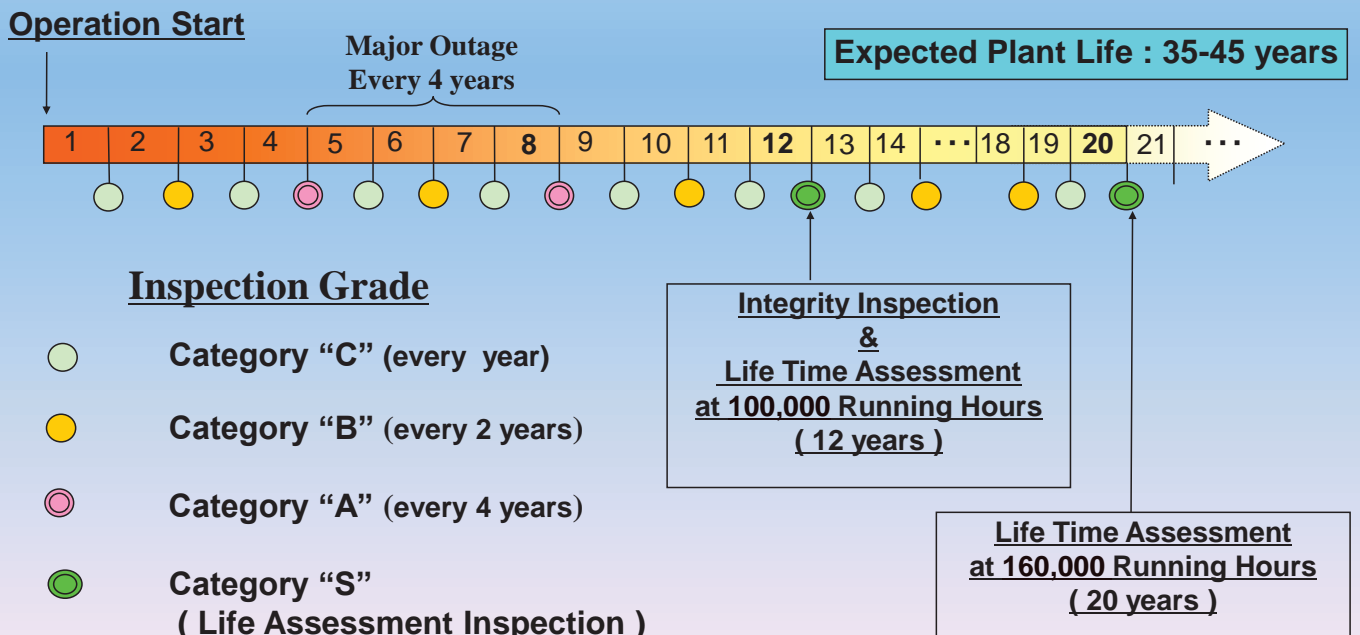
Aged Deterioration Mode and Damage



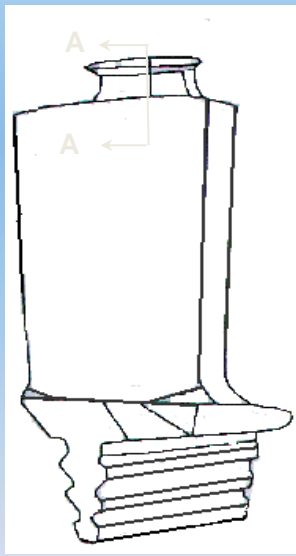
Factors of S C C generation (Stress corrosion Crack)



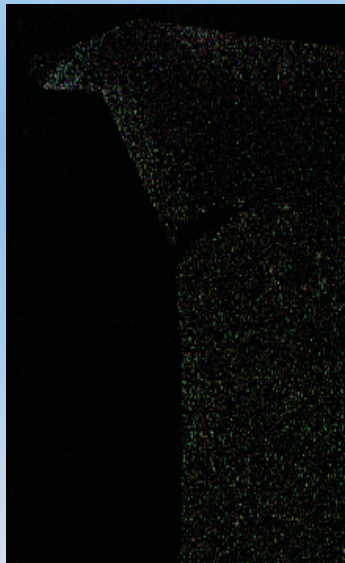
Maintenance Intervals



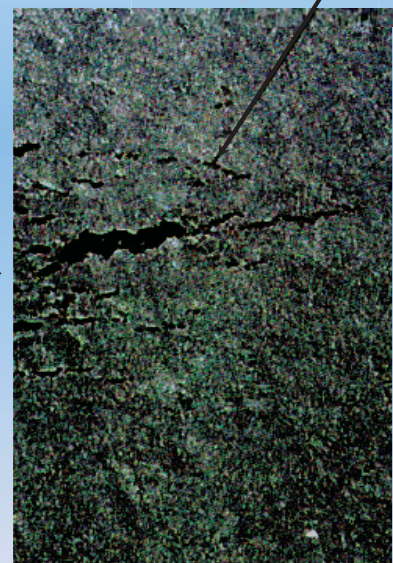
Example of Creep Damage (IP Blade Tenon)



IP blade



Sectional Macro-structure

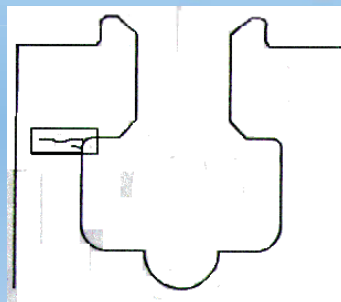


Tip of crack

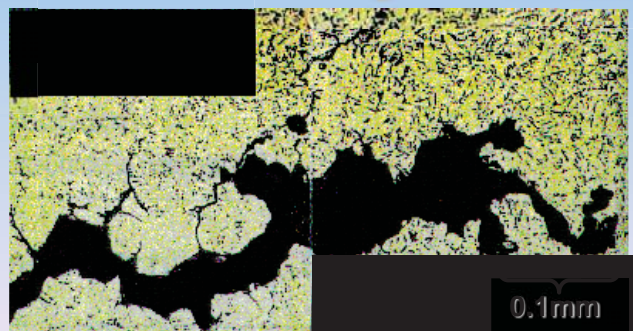
Example of SCC of LP Rotor (T-shaped Groove)



(Blade inserting disc groove)



**Branched cracking
intergranular cracking**

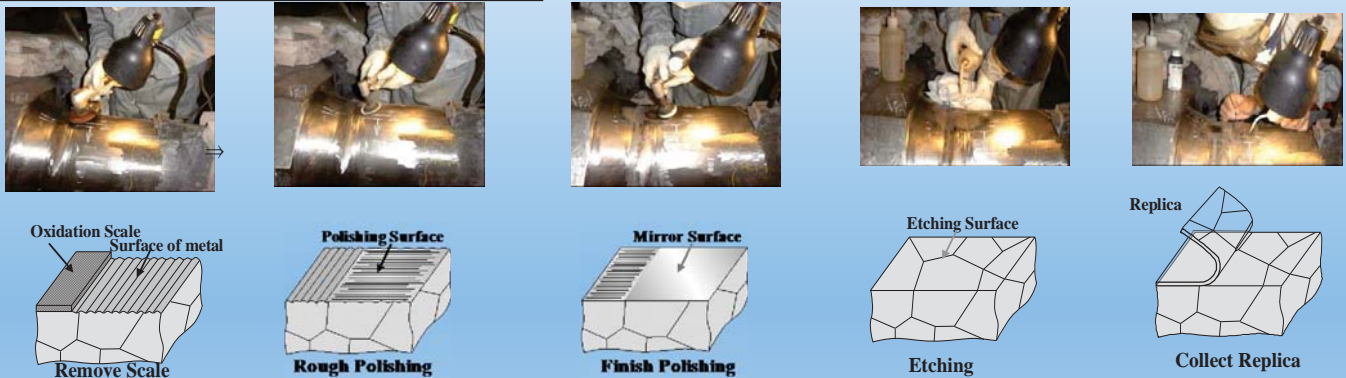


Life Assessment Inspection Menu

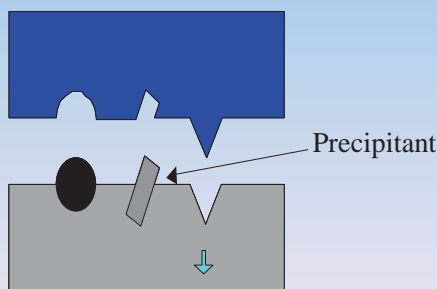
Components	Inspection	Point/Area/Zone	Evaluation
Rotor	VI, PT, MT	All Surface	Crack, Erosion Corrosion
	DI	Shroud Clearance	Creep
	UT	Blade Groove	Crack, SCC
	HT	High Temp. Surface	Softening
	Replica	Blade Groove	SCC, Fatigue
Casing	VI, PT, MT	All Surface	Crack
	HT	High Temp. Surface	Softening
	HT, MT	Casing Bolt of HP Part	Creep, Softening
M.S.V G.V	VI, PT, MT	All Surface	Crack
	HT	High Temp. Surface	Softening
	Replica	High Temp. Surface	Creep
	HT, MT	Casing Bolt of HP Part	Creep, Softening

Procedure of Replica Test for Microstructure

Step1. Polishing & Etching for Replica

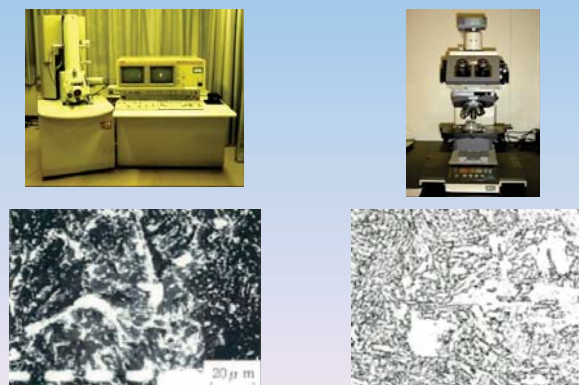


Step2. Replica



Microstructure ⇒ Optical Microscope

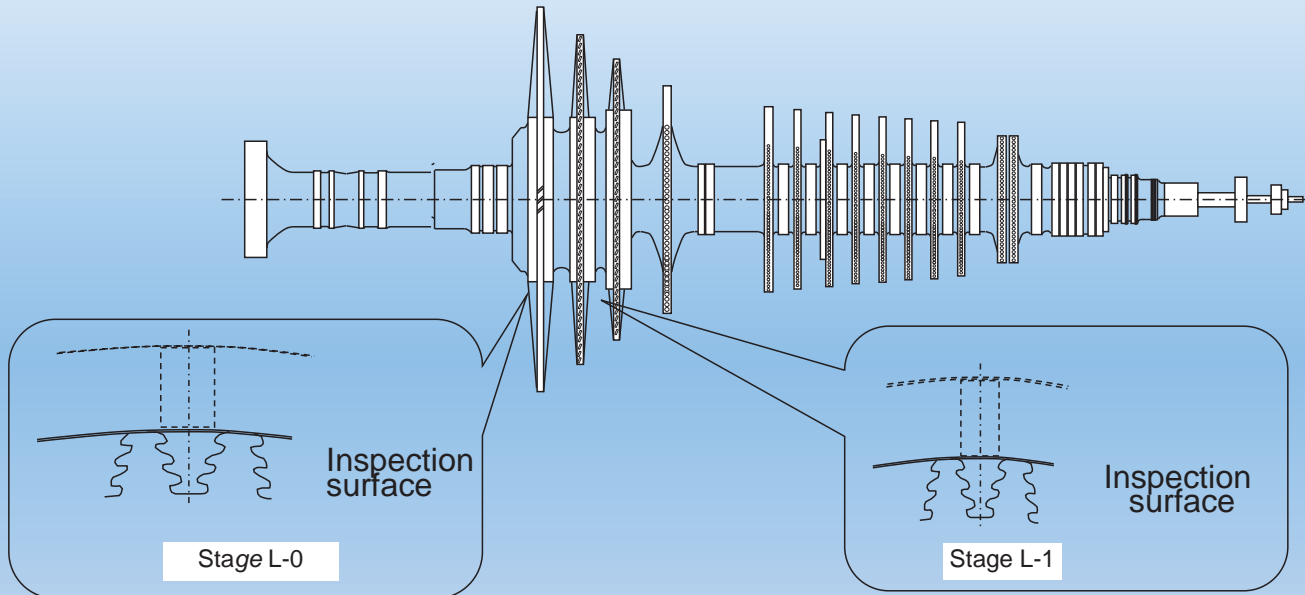
Step3. Evaluation of Deterioration



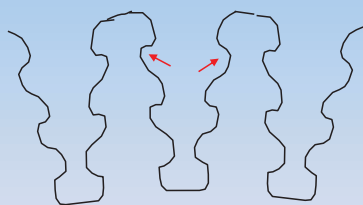
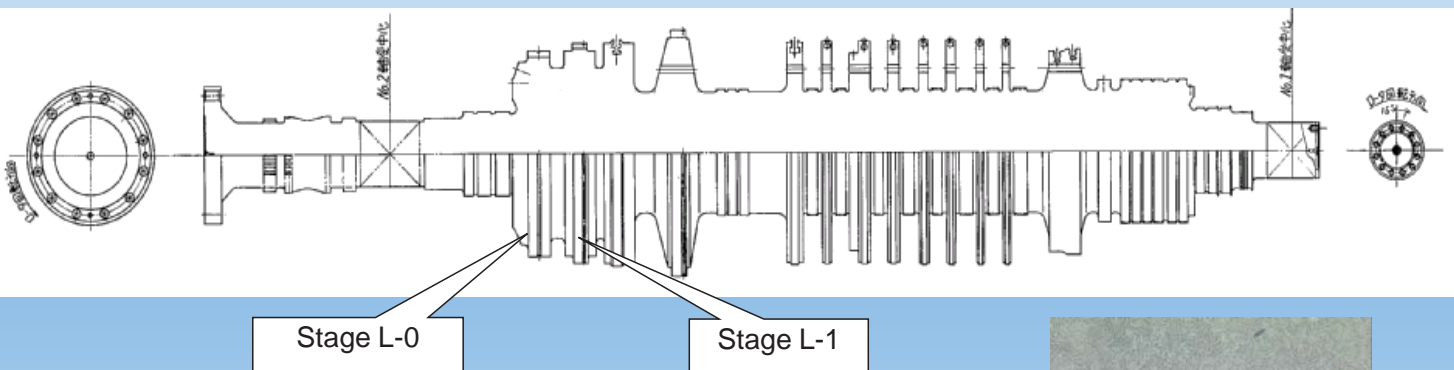
25 Scanning Electron Microscope
for Physical Damage

Optical Microscope
for Microstructure

MT for Side-face of Side-Entry Profile Groove



MT or Replica Test for Inner Surface of Blade Grooves (After Removing Blades)



(Side-Entry profile)

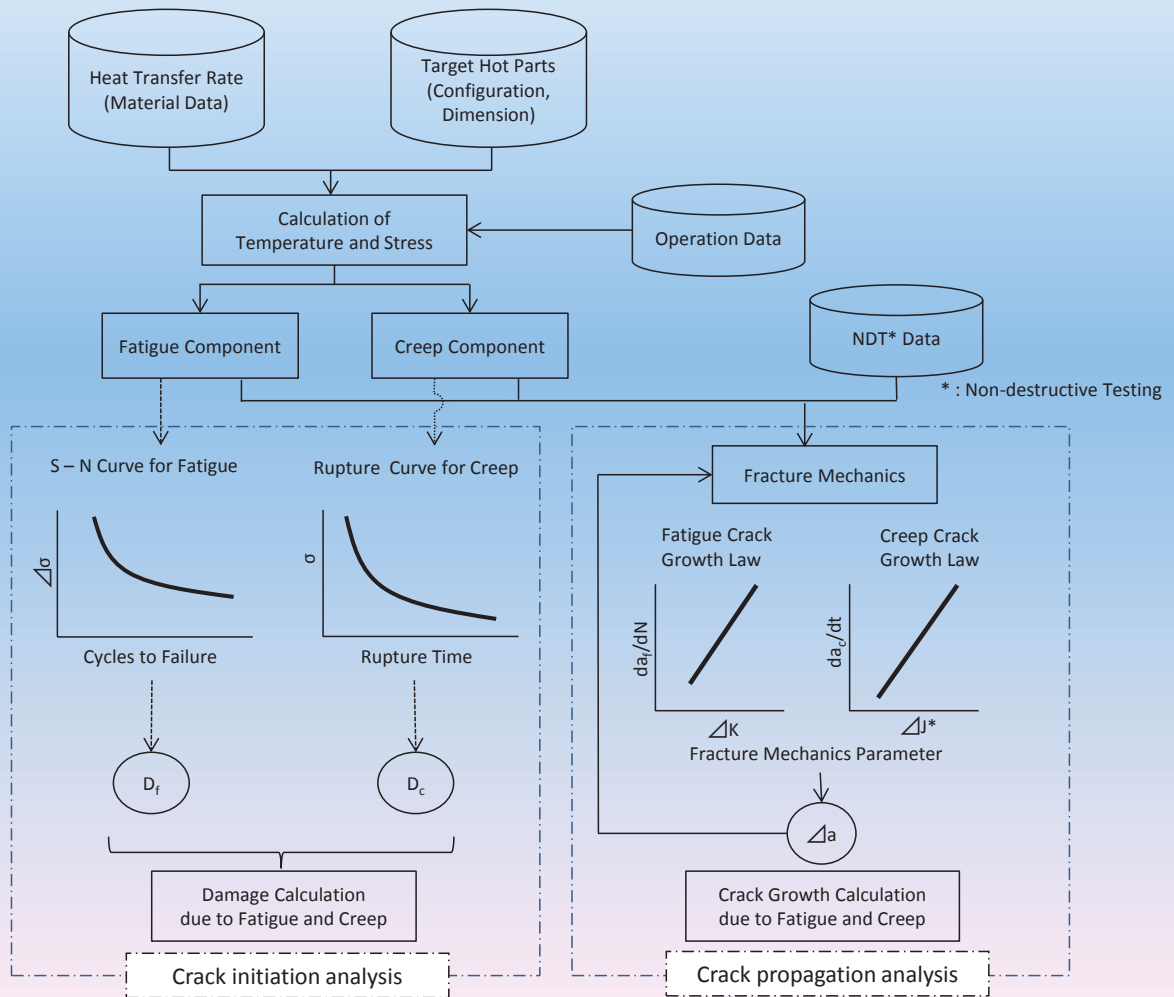


Blade groove after removing blades



Microstructure by Replica Test

Typical Flow on Residual Life Assessment of Hot Components



Neubauer's Creep Damage Classification by Observation of Replicas

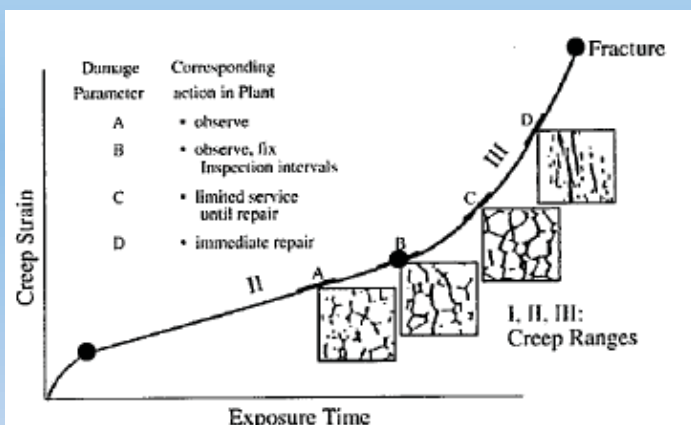
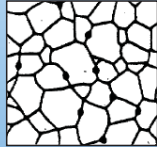
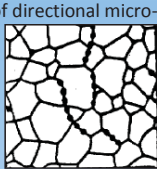
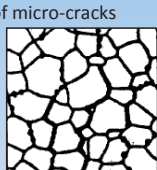
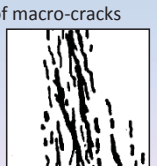
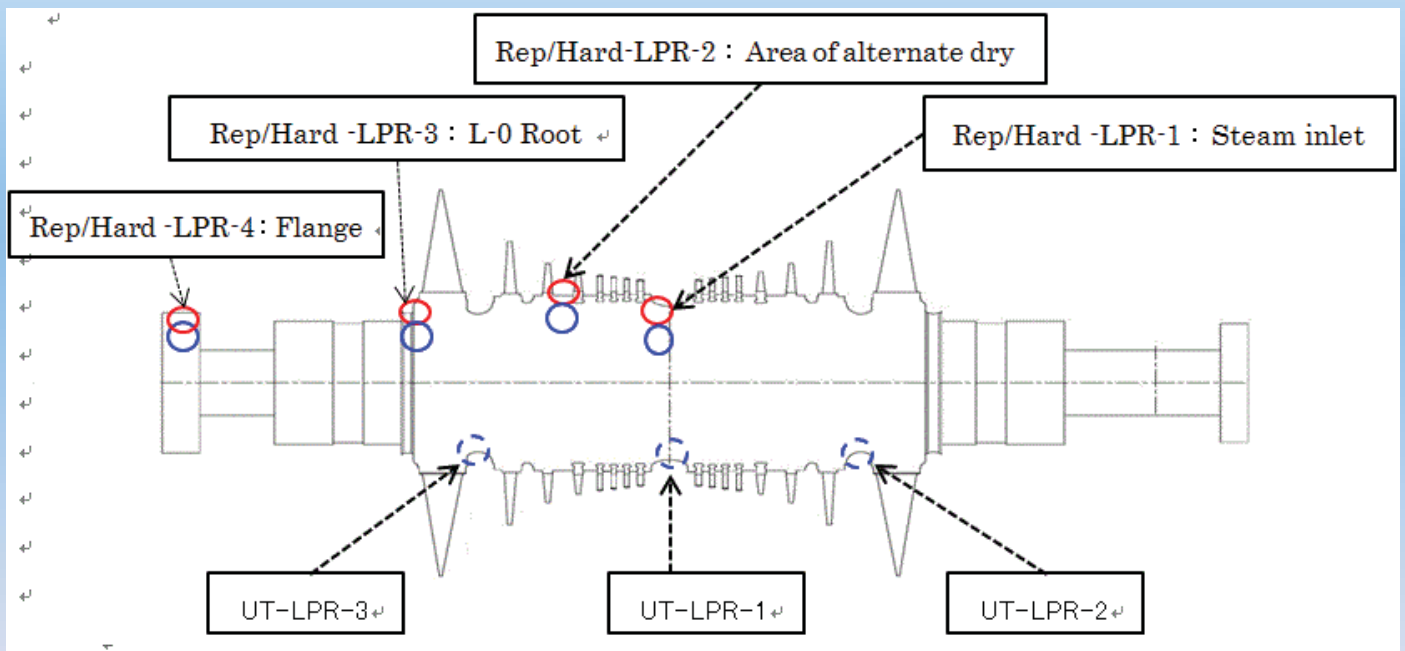


Figure 1. Neubauer's classification of creep damage from observation of replicas and consequent action to be taken.

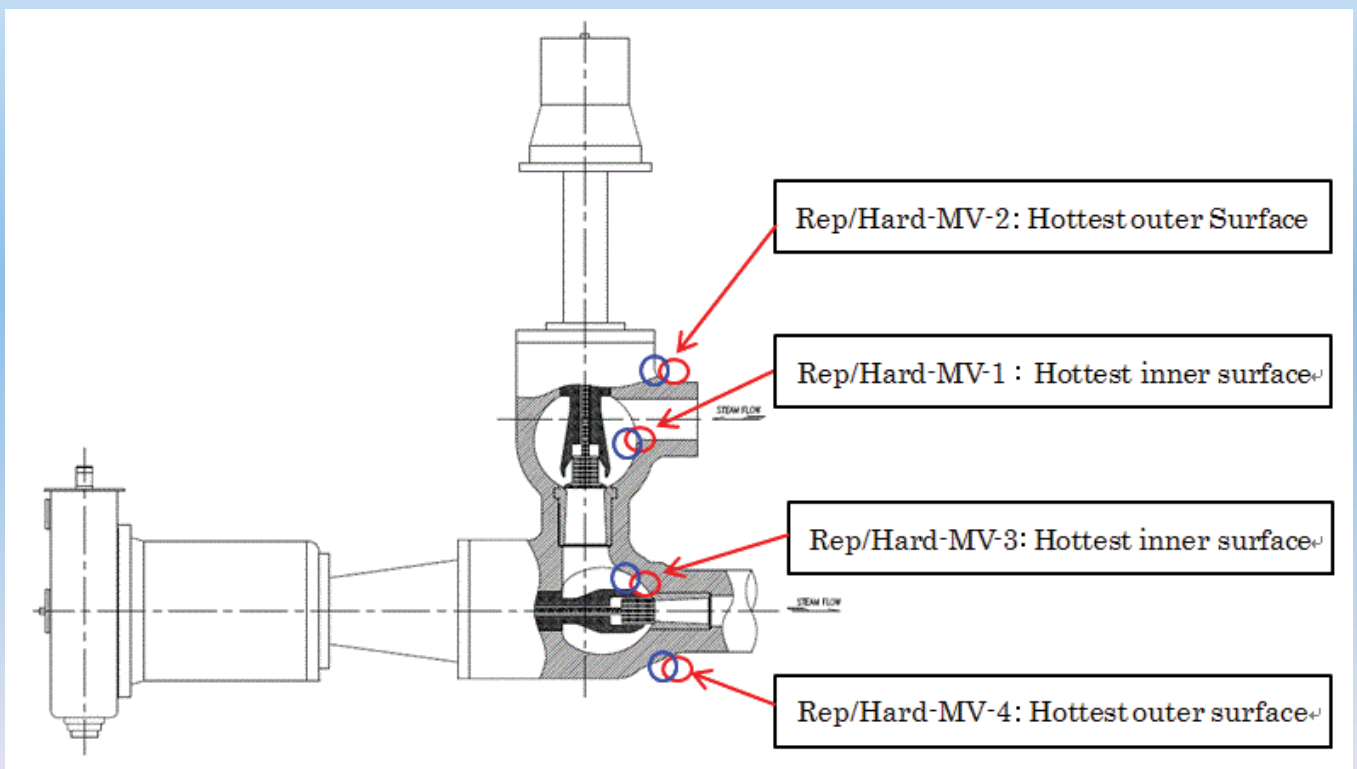
Damage Parameter	Micro-structure	Corresponding Action in Plant
A	Presence of isolated micro-cavities 	Observe
B	Presence of directional micro-cavities 	Observe, Fix Inspection intervals
C	Presence of micro-cracks 	Limited service until repair
D	Presence of macro-cracks 	Immediate repair

Inspection Points for Replication & Hardness



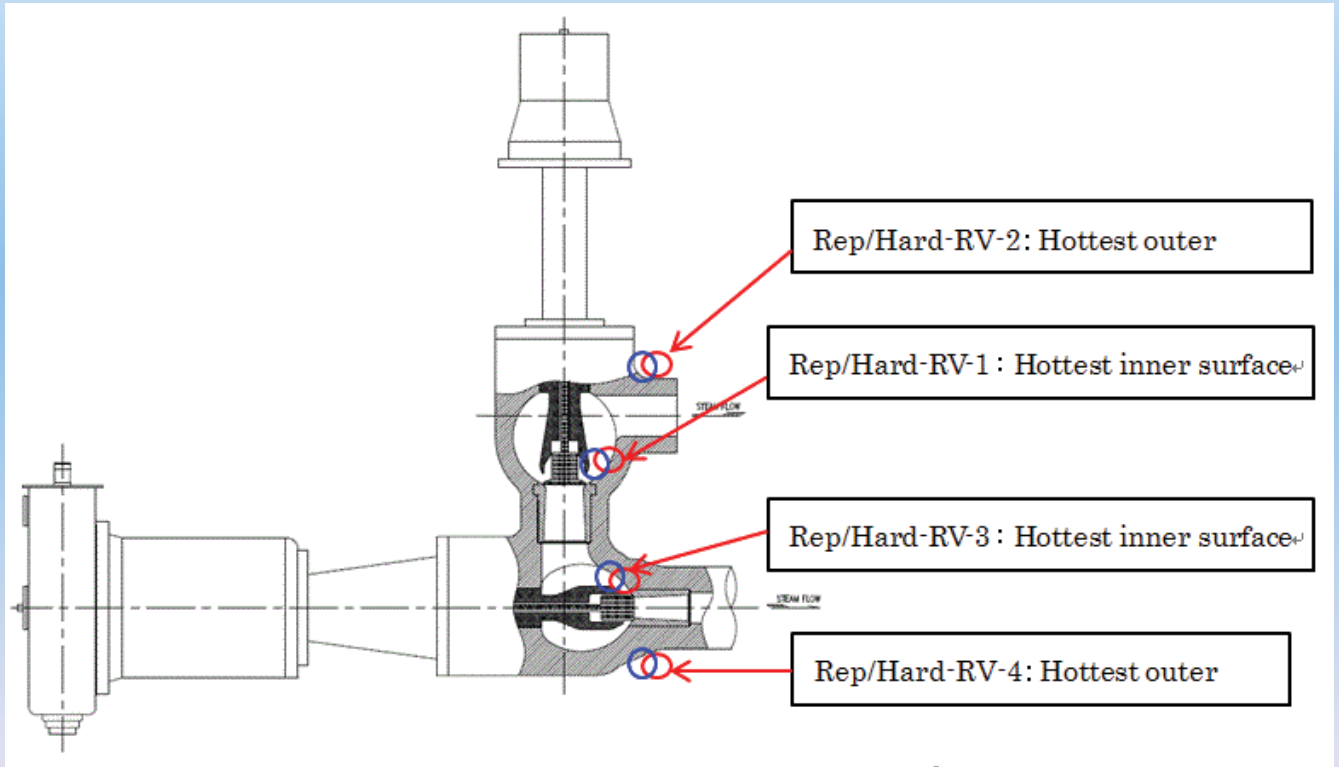
LP Rotor

Inspection Points for Replication & Hardness



HP Stop & Control Valve

Inspection Points for Replication & Hardness



IP Intercept & Control Valve



Major Site Study for RLA at Unit 3 of Dadri TPS, NTPC under the CEA-JCOAL Cooperation

**Japan Coal Energy Center (JCOAL)
At Wrap-up & Interim Activity Report Meeting
for RLA Study at Dadri TPS
December 4, 2015**

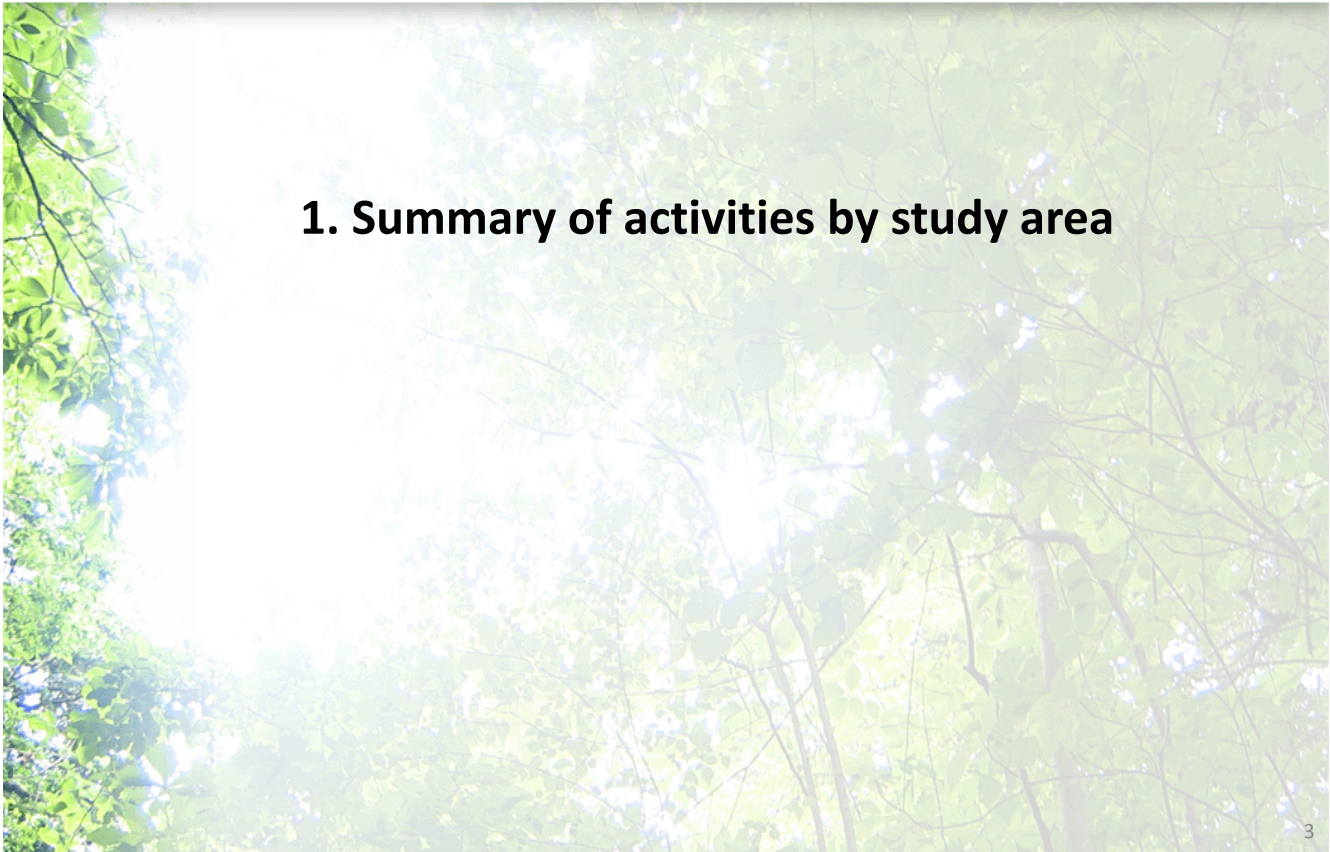
1

Overview



- 1. Summary of activity by study area**
- 2. Comments by Generator/Electrical/Turbine Team**
- 3. Timeline toward Final Report**

2



1. Summary of activities by study area



Activities on Day 1 & Day 2

Day	Boiler		Electrical		Turbine		
	Japanese experts	Indian experts	Japanese experts	Indian experts	Japanese experts	Indian experts	
1	Kick-off Meeting						
	Site tour						
	AM						
PM	• The meeting for the final confirmation of the examination schedule and contents		• Data collection		• Instructed test positions and witnessed Replica & HT of LP rotor	Replica & Hardness on the rotor shaft and MPI of the Turbine Blade	
Note						Replica & Hardness: Three Locations MPI:	
2	AM	• Instructed test positions and procedure for Replica of Boiler Hot parts	Videoprobe in headers in Pent House	• Interview to Electricity Dep. and data collection		• Instructed test positions and witnessed Replica & HT of HP & IP valves	Replica & Hardness on the rotor shaft & Blade Grooves, MPI of the Turbine Blade
	PM	• Visual Inspection for Condition Assessment of Boiler Tubes (1st Pss)	Videoprobe in headers in Pent House	• Visit main electricity equipment • Joint inspection of Generator (tan delta and RSO test)	Electrical Test in Generator- Stator & Rotor	• Instruction of test positions and witnessed UT of LP rotor • Performance data collection	Replica & Hardness on the HP & IP Valve & UT test on the Rotor Shaft and MPI test of the Turbine Blade
	Note		Completed		Completed	Some positions of Replica & HT of HP & IP valves are limited due to space	Replica and UT Completed

Activities on Day 3, Day 4, and Day 5



Day	Boiler		Electrical		Turbine		
	Japanese experts	Indian experts	Japanese experts	Indian experts	Japanese experts	Indian experts	
3	AM	<ul style="list-style-type: none"> • Instruction of test positions & procedure for Replica of Boiler hot parts (All Day) • Visual Inspection for Condition Assessment of Boiler Tubes (2nd Pss) 	Replica On the Superheater Outlet Header & Reheter Outlet Header Left side	<ul style="list-style-type: none"> • Interview to C&I Dep. and visit C&I Dep. Laboratory 	UT test on Generator Retaning Ring	<ul style="list-style-type: none"> • Obtained ST & Aux. drawings • Hearing of O&M of #3 ST (Troubles, S/P etc) 	MPI test of the Turbine Blade
	PM	<ul style="list-style-type: none"> • Visual Inspection for Condition Assessment of Boiler Aux. 	Replica on the Main steam pipe line	<ul style="list-style-type: none"> • Joint inspection of Generator (PD test) and data collection 		<ul style="list-style-type: none"> • Observed MPT of LP rotor blade groove • Obtained #3 ST history of Start/Stop 	DPT test & Visual inspection on the turbine auxiliaries
	Note		Completed		Completed		In progress
4	AM	Interview to Boiler Maintenance Dep.	Replica On the Main steam pipe line (Repeat) & HRH Line Visual, DPT and DIM: PLSH, RH / VI of FSH/ VI,DPT,UT of LTSH and Economiser	<ul style="list-style-type: none"> • Data collection 		<ul style="list-style-type: none"> • Hearing of efficiency calculation • Reviewed obtained data & drawings 	DPT test & Visual Inspection on the turbine auxiliaries
	PM	<ul style="list-style-type: none"> • Interview to Operation Dep. 	Replica On the Final SH, Re-heater & Platen SH Header. (Inlet & Outlet) VI: Eco to Boiler Drum Link pipe, Boiler Drum and Downcomer Pipe/ VI and DPT of link pipe FSH	<ul style="list-style-type: none"> • Interview to Operation Dep. 		<ul style="list-style-type: none"> • Survey of ST Aux. 	DPT test & Visual Inspection on the turbine auxiliaries
	Note		In progress		Completed	ST at rated load after this O/H is to be printed out and sent to JCOAL.	Completed
5	AM	<ul style="list-style-type: none"> • Compilation & Data collection • Interview to Maintenance Dep. 		Compilation & Data collection		<ul style="list-style-type: none"> • Compilation 	
	PM	Interim wrap-up & tentative reporting					



2. Comments by Boiler/Electrical/Turbine Team

Boiler & Electrical

By Kyushu Electric Power Company

7

JCOAL Work on Dadri TPS in India

Diagnosis Work on RLA, CA, O&M Dadri TPS (30th Nov. – 4th Dec. 2015)

Point of View	Our Activities
(1) Remaining Life Assessment for Boiler Tubes	Guidance and advice of work for the collection of the replica sample of boiler hot section tube
(2) Condition Assessment for Boiler and its auxiliaries	Visual Inspection for Boiler Tubes and Coal Burner Part
(3) Condition Assessment for Generator and Electric Equipments	Check the status of the witness facilities to test and inspection
(4) O&M improvement	Interviewing about O & M for improvement of O & M Procedure to reduce the workload and to continue to effectively maintenance

(1) Remaining Life Assessment for Boiler Tubes



While the basic philosophy of Boiler RLA is common between NTPC and JCOAL Team, we've found some differences in method and procedure of replica collection. This time replica collection was done following the standard method and procedure of Kyushu Electric Power.

 Kyushu Electric Power Co., Inc.

(2) Condition Assessment for Boiler and its auxiliaries



We have observed that Dadri has achieved high standards of maintenance management and keeps a set of best practices based on their own experiences.

 Kyushu Electric Power Co., Inc.

(3) Condition Assessment for Generator and Electric Equipments



According to our observation, the plant keeps its value thanks to timely and appropriate updates and maintenance of equipment, all of which are realized through excellent management by NTPC.

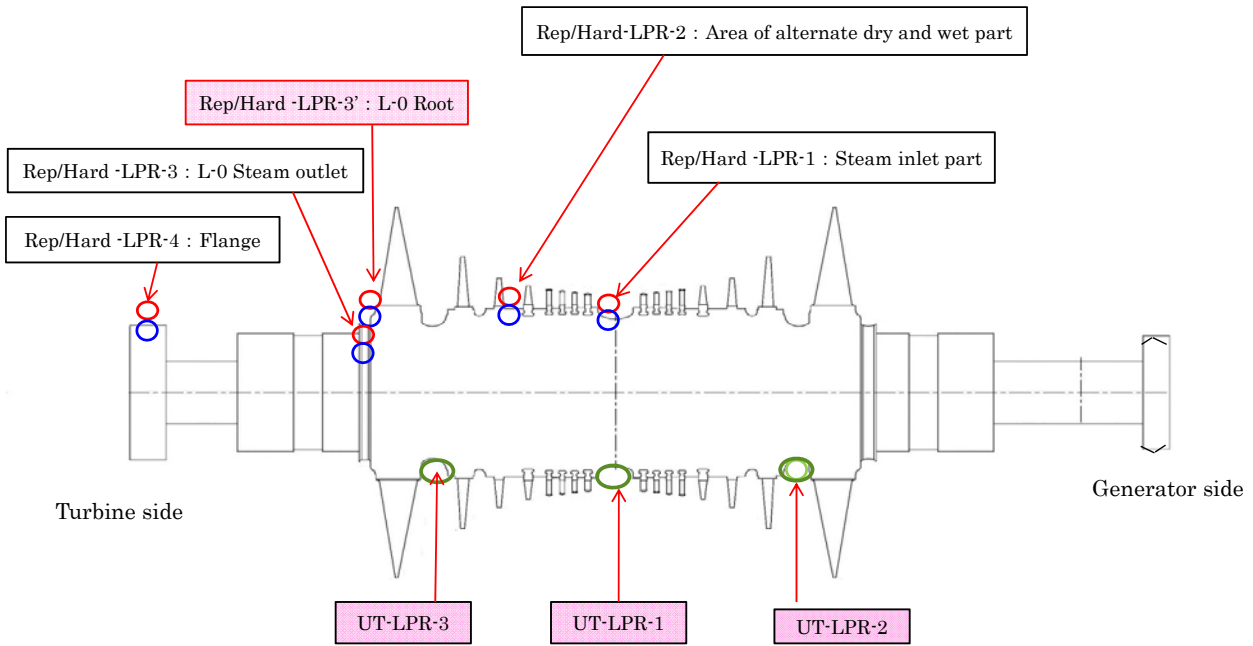
 Kyushu Electric Power Co., Inc.



Turbine

By JCOAL Team of Senior Technical Advisors

Replication & Hardness Test on LP Rotor



□ : additionally inspected

Replication & Hardness Test on LP Rotor



Replica Test



Hardness Test



Ultrasonic Test



Magnetic Particle Test

Replication & Hardness Test on HP & IP Valve



Preliminary comments

- Some replica inspection points of HP & IP Valves were changed, due to difficulty of polishing.
- UT inspection on the LP rotor was applied additionally.
- Erosion by drain attack on L-0 blades surface is not so severe, considering operation period more than 20 years.
- Repeated number of Start & Stop of #3 ST is about 250 times. Low cycle fatigue analysis will be carried out basing on this number.
- Microstructure of replica will be observed by microscope in laboratory. RLA will be done using these microstructural data, operating temperature, stress and period, basing on the latest Japanese technology.

3. Timeline toward Final Report

19

Timeline

- ✓ **Testing and inspection of the Major Site Study: December 5 to December 9, 2015***
*To be completed one day earlier than planned
- ✓ **Data Analysis : December 2015 to February 2016**
- ✓ **Reporting: Mid to late February 2016**
- ✓ **Provision of the final report: March 2016**

20

For the optimal outcome of the RLA Study

- Testing and inspection work will go on until December 9 and will be supervised by JCOAL. One JCOAL person will be based at the VIP Guest House throughout the period.
- While most of the required data and information have been provided thanks to enthusiastic involvement and firm cooperation by Dadri officers and engineers devoted to the RLA Study, some of them are to be provided later due to the circumstances.
In this connection, prompt provision of such data and information will be most appreciated.
- We will do our best in producing the optimal outcome of the RLA Study under the India-Japan Cooperation.

21

Thousands of thanks for your kind cooperation

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<http://www.jcoal.or.jp/index-en.html>

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22